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Association of Biological Sex and Gender-related Factors with Public Engagement in Protective Health Behaviours during the COVID-19 Pandemic: Lessons Learned Going Forward

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3 1 **Association of Biological Sex and Gender-related Factors with Public Engagement in**
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5 2 **Protective Health Behaviours during the COVID-19 Pandemic: Lessons Learned Going**
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7 3 **Forward**
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34 ABSTRACT

35
36 **Introduction:** While COVID-19 vaccination campaigns are proceeding at high-speed to advance
37 necessary protection, recommendations regarding protective health behaviours still remain a
38 critical part of the global response to slow the spread of the infection. Understanding what drives
39 people to engage in or refrain from health behaviours during a pandemic is vital to planning
40 tailored public health interventions. Given the role of sociocultural gender in shaping human
41 behaviours, we examined whether sex and gender-related factors were associated with the public's
42 adherence to COVID-19 recommended protective health behaviours.

43 **Methods:** Using data from the International COVID-19 Awareness and Responses Evaluation
44 (iCARE) survey collected between March 2020 to February 2021 from 175 countries, we focused
45 on the role of sex and gender-related factors in relation to adherence of protective health behaviors
46 including: (i) hand washing; (ii) mask wearing; and (iii) physical distancing behaviours.
47 Multivariable logistic regression was conducted to determine the factors associated with adherence
48 to behaviors.

49 **Results:** Among 48,668 respondents (mean age: 43 years; 71% female), 98.3% adopted hand
50 washing, 68.5% mask wearing, and 76.9% physical distancing. Compared with males, females
51 were more likely to adopt hand washing (OR=1.97, 95%CI: 1.71-2.28) and maintain physical
52 distancing (OR=1.28, 95%CI: 1.22-1.34). However, in multivariable sex-stratified models,
53 females in countries with higher gender inequality indexes (GII) were less likely to report hand
54 washing (aOR=0.47, 95%CI: 0.21-1.05). Females who reported being employed (aOR=0.22,
55 95%CI: 0.10-0.48) and in countries with low/medium GIIs (aOR=0.18, 95%CI: 0.06-0.51) were
56 less likely to report mask wearing. Females who reported being employed were less likely to report
57 physical distancing (aOR=0.39, 95%CI: 0.32-0.49).

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3 58 **Conclusion:** While females showed greater adherence to COVID-19 protective health behaviours,
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5 59 gender-related factors, including employment status and high-country wide gender inequality were
6
7 60 independently associated with non-adherence. These findings may inform public health and
8
9 61 vaccination policies in current as well as future pandemic.

11
12 62 **Keywords:**

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15 63 COVID-19, SARS-Cov-2, health behaviours, hand washing, mask wearing, physical distancing
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18 65
19 66 **Strengths and limitations of this study:**

- 20
21
22 67 • The study had a large sample size with a global perspective, and availability of gender-
23
24 68 related factors to examine the impact of gender.
- 25
26 69 • The online nature of the iCARE survey might have limited the participation from
27
28 70 individuals who did not had access to computers and internet, limiting the generalization
29
30 71 of findings.
- 31
32
33 72 • Our global sample was highly educated group of people whose results are likely to be ‘best
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35 73 case scenario’.
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38 74 • The global sample was also mostly women, so men are underrepresented in this study.
- 39
40 75 • Self-reported behaviour of the respondents might not have accurately represented actual
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42 76 behaviour, hence, the findings should be interpreted with caution.
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79 INTRODUCTION

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81 Public behaviour plays an important role during public health emergencies (1). Behaviours can be
82 influenced by both the biological sex and sociocultural gender (gender identity, gender roles,
83 gender relations, and institutionalized gender) of an individual (2). In the case of the Coronavirus
84 Disease 2019 (COVID-19) pandemic, both men and women worldwide have shown inconsistent
85 responses to acute infection as well as differing long-term health, economic, and social
86 consequences (3, 4). Understanding these responses in relation to biological sex and/or gender-
87 related attributes in the general population may be particularly valuable to inform tailored sex and
88 gender strategies moving forward.

89
90 It has been identified that public health responses to infectious diseases require fundamental
91 changes in individual behaviour. Hand washing, mask wearing, and physical distancing
92 (*previously referred to as social distancing*) are the key transmission reduction public health
93 behaviour-based prevention measures (1) that are associated with a reduction in the global
94 incidence of COVID-19 (5, 6). Effectiveness of such responses depends not only on the
95 generalized adherence of the public but may be specific to certain high-risk groups. Though
96 recommended and proven to limit transmission rates, hand washing, mask wearing, and physical
97 distancing have been inconsistently initiated and maintained. There is a dynamic relationship
98 between the voluntary adoption of public health behaviours and infection transmission during
99 infectious disease epidemics (7). The COVID-19 pandemic has sparked an unparalleled global
100 discourse around the adoption of protective behaviours and other public health and social measures
101 to slow the person-to-person spread of SARS-CoV-2 (1).

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3 103 COVID-19 has highlighted the role that sex and gender play in our lives. This includes influencing
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5 104 an individual's exposure to COVID-19 through sex and gender-related occupations, risk-taking
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8 105 behaviours, and employment of precautions. Sex and gender also are known to have an impact on
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10 106 health through the gendered nature of the workforce and the predominant risk associated with it,
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12 107 increased caregiving responsibilities at home limiting the work and economic opportunities, or
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14 108 institutional biases and policies (2, 8). Gender affects the division of labor and care duties in
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16 109 families and communities. Hence, it is of utmost importance that we gather, from our recent lived
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18 110 experience, evidence on the potential sex and gender-related differences in perception and
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20 111 behavioural responses experienced during COVID-19 pandemic.
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26 113 A few studies have shown sex-based differences in COVID-19 related beliefs and behaviours and
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28 114 have reported that compared to men, women are more likely to perceive the pandemic as a serious
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30 115 health problem and comply more with the preventive behaviours (9, 10). Therefore, as gender is
31
32 116 culturally and geographically based, we hypothesized that there is a difference in preventive
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34 117 behaviours and pandemic related concerns based on biological sex and gender-related
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36 118 factors. Also, regardless of sex-based differences, our previous studies highlight the need of
37
38 119 focusing on the gender-related factors (11, 12). Hence, the purpose of this study was to examine
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40 120 whether biological sex and sociocultural gender-related factors are associated with the engagement
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42 121 in the recommended key protective health behaviours such as hand washing, mask wearing, and
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44 122 physical distancing during the COVID-19 pandemic.
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51 125 **METHODS**
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54 126 **Study design**
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3 127 Survey datasets from the ongoing iCARE (International Covid-19 Awareness and Responses
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5 128 Evaluation) study led by the Montreal Behavioural Medicine Centre (MBMC: www.mbmc-
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8 129 cmcm.ca) in collaboration with a team of 200 international collaborators from 42 countries was
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10 130 used for the data analyses. The iCARE study design has been previously described (13). Briefly,
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12 131 iCARE is an international multi-wave cross-sectional observational cohort study of public
13
14 132 awareness, attitudes, and responses to public health policies implemented to reduce the spread of
15
16 133 COVID-19 on people around the world (www.iCAREstudy.com). It collects data on study
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18 134 demographics, perceptions of government policy, health behaviours, adherence to health
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20 135 measures, types of concerns, and adherence motivators. The iCARE study was approved by the
21
22 136 research ethics committee of the Comité d'éthique de recherche du CIUSSS-NIM (Centre intégré
23
24 137 universitaire de santé et de services sociaux du Nord-de-l'île-de-Montréal), approval #: 2020-2099
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26 138 / 25-03-2020. The current secondary analysis was approved by the ethics committee at the
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28 139 University of Alberta (Pro107407).
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35 141 Survey data were collected in 4-6 week rounds using convenience snowball sampling (globally,
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37 142 25-30K per wave) and parallel representative sampling (in targeted countries), generating data for
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39 143 multiple cohorts of participants that were added to the first round cohort launched on March 27,
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41 144 2020. We analyzed data from Survey 1 – Survey 7 that was collected between March 27, 2020 to
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43 145 February 9, 2021. A total of 61,552 respondents participated in the survey from over 175 countries.
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45 146 The data was analyzed for 48,668 respondents (female=34,556, male=14,112). The questionnaire
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47 147 used in the survey is publicly available via the Open Science Framework (<https://osf.io/nswcm/>)
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49 148 and the survey is available in 34 languages (14).
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151 **Biological sex and gender-related factors**

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153 For each surveyed individual the following variables were collected: socio-demographic
154 characteristics (sex at birth, age in years, level of education, work status, perceived annual
155 household income, number of adults and children living in the household, country of residence,
156 and likelihood of getting vaccinated *i.e.*, respondents' willingness to get a COVID-19 vaccine),
157 the presence of a physician-diagnosed depressive and/or anxiety disorder, and adoption of
158 protective health behaviours (hand washing, wearing a face mask, and physical distancing).

159
160 To account for institutionalized gender, the Gender Inequality Index (GII), developed by the
161 United Nations Development Programme, was used as a measure of country specific gender
162 inequality (15) and as a measure of institutionalized gender in this study. This index is a continuous
163 measure for the degree of gender inequality per country on a scale between 0 and 1, with lower
164 values representing near-perfect gender equality and higher values representing greater levels of
165 inequality favoring males. The GII is based on several aspects of institutionalized gender: (i)
166 reproductive health, measured by the maternal mortality ratio and adolescent birth rates; (ii)
167 empowerment, measured by the proportion of parliamentary seats occupied by women and the
168 proportion of adult women and men with at least some secondary education; and (iii) economic
169 status, measured by labor force participation rate of men and women (16). GIIs in this study were
170 divided into tertiles and later categorized into high and low/medium GII categories. We used data
171 on GIIs from 2019. Some of the countries in the region were excluded from the analysis due to the
172 unavailability of data.

173 **Outcome measures**

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3 176 The main outcomes of the analysis were self-reported adherence to three recommended protective
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5 177 health behaviours including: (i) hand washing with soap and water; (ii) wearing a face mask; and
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8 178 (iii) a composite measure of physical distancing behaviours (specifically: staying at least 1-2
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10 179 meters away from other people; staying/working at home rather than going to work or school; self-
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12 180 quarantining if returning from a trip; self-quarantining if one have the virus or believe they have
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14 181 the virus; avoid going out to bars/pubs/restaurants; avoiding large social gatherings; avoiding small
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16 182 social gatherings; avoiding indoor social gatherings; and avoiding any non-essential travel) (17).
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19 183 A composite binary variable was constructed in which, the participants who met the above
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21 184 mentioned criteria were coded with a value of 1; otherwise, the participants were coded with a
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23 185 value of 0. A set of measures in the iCARE survey intended to explore the prevention measures
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25 186 used by the public to prevent the spread of COVID-19 by maintaining a physical distance between
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27 187 two people and reducing the number of times people come into close physical contact with one
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29 188 another (18) were used to create a composite variable for physical distancing.
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35 191 **Statistical analysis**

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37 193 A global analysis of public engagement in three recommended protective health behaviours was
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39 194 performed to investigate whether the outcomes differed by sex. Descriptive sex-stratified analyses
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41 195 were run for: age; baseline mental health conditions (any depressive or anxiety disorders); and
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43 196 gender-related factors such as level of education, work status, annual household income, and
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45 197 GII. Continuous variables were presented as mean and standard deviation (SD). Categorical
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47 198 variables were presented as counts and percentages. Sex differences in outcomes (protective health
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49 199 behaviours) were completed and associations between sex, gender-related factors, and outcomes
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51 200 were tested in a multivariable model. Bivariate logistic regressions were run for crude analysis
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3 201 followed by collinearity diagnostics to account for inflation in standard errors of parameter
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5 202 estimates caused by collinear cofactors (19). If variables were collinear, we included the variable
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7 203 with the least amount of missing data in the multivariable models. *A priori* age and gender-related
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9 204 cofactors (i.e., education level, work status, annual household income, and GII) were included in
10
11 205 multivariable models. Two-way interaction between the sex and gender-related factors were tested
12
13 206 by including an interaction term in bivariate models. All statistical analyses were performed using
14
15 207 statistical software STATA version 16 (College Station, TX, USA). Tests were two sided and the
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17 208 significance was defined as $p < 0.05$.
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24 210 **Ethics approval:**

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26 211 The study was approved by the Health Research Ethics Board-Health Panel, University of Alberta
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28 212 (Pro00107407).
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33 214 **Patient and public involvement**

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35 215 It was not appropriate or possible to involve patients or the public in the design, or conduct, or
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37 216 reporting, or dissemination plans of our research. For the dissemination of results, we will submit
38
39 217 the results of the study to relevant national and international journals with the intention of
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41 218 publishing the results widely. Further, we will make national and international presentations in
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43 219 conferences and symposiums to stakeholder groups including those involving general public,
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45 220 researchers, clinicians, and policymakers.
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49 221 50 222 51 223 **RESULTS** 52 224

53 225 **Descriptive characteristics of respondents**

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3 226 Our study population included 34,556 females (71%) and 14,112 males (29%) (**Table 1**). The
4
5 227 mean age of the respondents was 43 years (SD: 16). A majority (n=23,462, 48.8%) was between
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7 228 26 and 50 years of age. Most respondents (79.7%) reported high levels of education, were
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9 229 employed (61.8%), were from Europe and North American countries (66.3%), and from regions
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11 230 with high levels of gender equity as measured by low/medium GIIs (66.9%). Females were more
12
13 231 likely to report having a physician-diagnosed depressive disorder (9.5% vs 6.7%, $p \leq 0.001$) and
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15 232 anxiety disorder (17.7% vs 10.7%, $p \leq 0.001$) compared to males. Irrespective of sex, only 68.5%
16
17 233 of responders disclosed wearing a facemask, while a higher percentage of females reported
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19 234 adherence to physical distancing behaviours compared to males (78.3% vs 73.7%, $p < 0.001$).
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21 235 Participants aged 51 and older were more likely to engage in all three-key protective behaviours
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23 236 as compared with younger participants: hand washing (Odds ratio [OR]= 5.60, 95% Confidence
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25 237 interval [CI]: 4.51-6.94); mask wearing (OR=1.11, 95% CI: 1.04-1.18); and physical distancing
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27 238 (OR=1.50, 95% CI: 1.41-1.61) (**Table 2**).
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33 239 **Gender-related factors associated with adoption of protective health behaviours**

34 240 For the univariate analysis, the proportion of people adopting the protective health-related
35 241 behaviours, varied depending on the gender-related factor examined. Despite employed
36 242 respondents being 84% more likely to engage in hand washing than unemployed respondents, they
37 243 were 65% less likely to engage in mask wearing and 47% less likely to engage in physical
38 244 distancing ($p < 0.001$ for all comparisons). Hand washing and physical distancing was less common
39 245 as the number of adults ≥ 18 years living in the household increased. The proportion of adoption
40 246 was lowest for wearing a facemask, both for females and males (58.5% vs 57%) in low/medium
41 247 GII countries (**Figure 1**). Respondents living in the countries with high GII were 4.38 times (95%
42 248 CI: 4.15-4.63) more likely to use mask than respondents living in the countries with low GIIs;
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251 however, they were less likely to engage in hand washing and less likely to engage in physical
252 distancing (**Table 2**).

253 **Sex and gender-related differences in the adoption of protective health behaviours**

254 Sex-stratified multivariate analyses demonstrated that the factors associated with the adoption of
255 protective health behaviours varied by sex. Among females, the factors associated with not
256 adhering to health behaviours were: (i) for hand washing: higher country gender inequality
257 favoring males GII (aOR=0.47, 95% CI: 0.21-1.05, p=0.07) (ii) for mask-wearing: older age (aOR
258 females=0.35, 95% CI:0.12-1.03, p=0.05), being employed (aOR females=0.22, 95% CI:0.10-
259 0.48, p<0.001), and living in a country with more gender equity as measured by the GII
260 (aOR=0.18, 95% CI: 0.06-0.51, p<0.01); and (iii) for physical distancing: being employed (aOR
261 females=0.39, 95% CI:0.32-0.49, p<0.001) (**Table 3, Appendix-Table 1a, Table 1b**).

262 Factors that were associated with not adhering to protective health behaviours among males were:
263 (i) for hand washing: higher level of education (aOR males=0.37, 95% CI: 0.14-1.01, p=0.05) and
264 with a household size of > 2 (aOR males=0.46, 95% CI: 0.21-1.03, p=0.06); (ii) for mask wearing:
265 being employed (aOR males=0.15, 95% CI:0.04-0.53, p<0.01) and living in a country with more
266 gender equity as measured by the GII (aOR=0.29, 95% CI: 0.09-0.91, p<0.05); and (iii) for
267 physical distancing: being employed (aOR males=0.38, 95% CI:0.27-0.52, p<0.001) and with
268 household size of > 2 (aOR males=0.66, 95% CI: 0.47-0.92, p<0.05) (**Table 3, Appendix-Table**
269 **1a, Table 1b**).

270 There was a significant interaction between sex and educational level of the participants. High
271 level of education decreased the use of mask wearing among females compared to males (p=0.03).

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3 276 There was a trend for living in a country with lower gender equity to be associated with poorer
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5 277 protective behaviors in females compared to males (p=0.056).
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10 279 **DISCUSSION**

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12 280 The present study provides a comprehensive analysis on the impact of sex and gender-related
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14 281 factors and the association with adherence to protective health behaviours during the COVID-19
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16 282 pandemic. Overall, hand washing, mask wearing, and physical distancing behaviours were adopted
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18 283 globally. However, there were a number of gender-related factors associated with a lower
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20 284 adherence based on sex.
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26 286 Lower adherence to the protective health behaviours was mainly associated with younger age,
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28 287 being employed, and living in a country with low/medium GII (higher gender equity) for females.
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30 288 While high level of education, being employed, and household size of >2 were associated with
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32 289 lower adoption in males. Considering these group of individuals with lower adherence to
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34 290 protective health behaviours, this would suggest that in the current as well as future pandemics it
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36 291 may be useful to target interventions based on sex and gendered factors to increase adherence and
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38 292 reduce disease transmission. Measures such as risk-assessment and mitigation considerations for
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40 293 public settings could be implemented to mitigate the risk of transmission and promote the adoption
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42 294 of protective health behaviours.
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49 296 Overall, mask wearing was lower among both sexes compared to other protective behaviours such
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51 297 as hand washing and physical distancing. Many countries waited to issue mask mandates months
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53 298 into the pandemic (20) even though other behaviours were mandated right away. This may be one
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3 299 of the reasons for lower adherence. Further, adoption of mask wearing was less likely in males
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5 300 compared to females, mainly among those who were employed, indicating substantial room for
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7 301 improvement in male's engagement to mask wearing. In our study, employed female respondents
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10 302 reported that they were more likely to wear a mask compared to male respondents. Similarly, a
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12 303 study conducted in the United States also reported that females were 1.5 times more likely to wear
13
14 304 a mask compared to males (21). It has been suggested that females may be more likely to protect
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16 305 themselves and others by wearing a mask specifically because they handle the majority of
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18 306 caregiving within families and are overrepresented in essential work services, which generally
19
20 307 requires mask wearing (22). Previous studies have also reported mask wearing to be significantly
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22 308 associated with the occupation of respondents (23, 24). A study reported that women make up
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24 309 almost 90 percent of nurses and nursing assistants in the United States and over two-thirds of
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26 310 grocery store cashiers (24). Performing the dual function of an essential worker outside and a
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28 311 caregiver at home, women might face a dilemma of how to keep their families healthy and safe
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31 312 while continuing to work in potentially risky circumstances, suggesting that these factors may
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33 313 make them more adherent to the protective behaviours.
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40 315 Older females were the most likely participants to engage in hand washing and physical distancing,
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42 316 but less likely to engage in mask wearing. Older females may have a higher perceived risk of
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44 317 developing COVID-19 complications and mortality, and thus engaged in more protective health
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46 318 behaviours such as hand washing and physical distancing. Previous studies have shown that
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48 319 females and older adults are less likely to engage in the risky behaviours, feel more vulnerable to
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50 320 contracting diseases, and have a stronger sense of responsibility to protect society (25, 26). This is
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52 321 consistent with the findings of an American study that reported being older and female was related
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3 322 to adopting more pandemic mitigating behaviours (27). Furthermore, a study conducted in China
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5 323 also reported that being female and older was associated with adopting protective behaviours (26).
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8 324 However, our study findings are in contrast with the results of a study conducted in Portugal that
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10 325 reported a decline in engagement in protective health behaviours with advancing age, which was
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12 326 reported to be related to the increased social-isolation and lack of help among older population
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14 327 (28). Even though the study did not report the differences by sex of the respondents, self-isolation
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16 328 could be the reason for lower adherence to mask wearing among females. Depending on the diverse
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18 329 context, public health interventions should be tailored not only to sex, but differing age groups,
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20 330 and importantly institutional gender related variables such as those measured by the GII.
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26 332 Emerging evidence shows that gender including the institutionalized gender shapes mask wearing
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28 333 adherence (29). One of the interesting findings of the current study is respondents from
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30 334 low/medium GII countries with less gender inequity reported a significantly lower adherence to
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32 335 mask wearing compared to respondents from countries with high GII (high gender inequity). Even
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34 336 among the low/medium GII countries, adherence is reported to be poorer among males. Lower
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36 337 adherence among males is in line with a finding from a study conducted in the United States, in
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38 338 which males exhibited poorer mask wearing practices compared with their female counterparts
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40 339 (21). This is also supported by a review that looked at research from multiple countries and found
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42 340 women were 50% more likely than men to practice protective behaviour (30).
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49 342 The strengths of this study include a large sample size, having a global perspective, and availability
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51 343 of gender-related factors to examine the impact of gender. This study also has some limitations
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53 344 that should be acknowledged. First, the online nature of the iCARE survey might have limited the
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3 345 participation from individuals who did not had access to computers and internet, limiting the
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5 346 generalization of findings. However, the advantages of online surveys have been shown to
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8 347 outweigh the disadvantages, mainly in terms of its external validity (31); hence, the bias might be
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10 348 relatively low. Second, our global sample was highly educated group of people whose results are
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12 349 likely to be ‘best case scenario’. The global sample was also mostly women, so men are
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15 350 underrepresented in this study. Third, self-reported behaviour doesn’t always accurately represent
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17 351 actual behaviour, hence, the findings should be interpreted with caution. Finally, although the
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19 352 study established the associations between sex and gender-related factors with the adoption of
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21 353 protective health behaviours, no causal relationships should be assumed due to the nature of the
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24 354 cross-sectional design of the survey.
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28 356 **CONCLUSIONS**

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30 358 In this analysis of a multinational study population, while a majority of respondents reported
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33 359 wearing a facemask, this is likely reflective of country wide mask mandates as opposed to adopting
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35 360 it as a protective health behavior. However, our study findings, suggest that wearing a facemask
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38 361 appeared to be more difficult to adhere to for many compared to other key protective behaviours
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40 362 such as hand washing and physical distancing. Moreover, our study noted that this was even more
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42 363 apparent in countries with low GII (more equity between males and females) indicating substantial
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45 364 room for improvement in public engagement regarding protective health behaviours. Since a
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47 365 widespread protective behavioral response are paramount for a successful containment and control
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49 366 of an infectious disease contagion, the present study provides valuable information for identifying
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51 367 sex and gendered factors that may inform effective public health policies. Further, the Covid-19
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54 368 pandemic highlights the urgent need to incorporate sex and gender analysis into all research and
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3 369 innovation processes in order to target specific groups both to help contain the transmission of the
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5 370 virus and to formulate vaccine policies.
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17 18 376 **Contribution to authorship:**

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538 TABLES

539

540 **Table 1.** Descriptive characteristics of survey respondents by biological sex (N=48668)

	N ¹	Overall n (%) or Mean [SD]	Biological sex	
			Male (N=14112) n (%) or Mean [SD]	Female (N=34556) n (%) or Mean [SD]
Socio-demographic characteristics				
Age (in years)	48524	43 [16]	42 [16]	44 [17]
Age distribution in strata	48049			
• Up to 25		8632 (18.0)	2327 (16.8)	6305 (18.5)
• 26-50		23462 (48.8)	6372 (45.8)	17090 (50.0)
• 51 and older		15955 (33.2)	5197 (37.4)	10758 (31.5)
Education level	38217			
• Low level		7758 (20.3)	2208 (20.5)	5550 (20.2)
• High level		30459 (79.7)	8564 (79.5)	21895 (79.8)
Work status	7071			
• Unemployed		2698 (38.2)	775 (40.7)	1923 (37.2)
• Employed		4373 (61.8)	1131 (59.3)	3242 (62.8)
Annual perceived household income	33814			
• Bottom third		4739 (14.0)	1249 (12.8)	3490 (14.5)
• Middle third		19107 (56.5)	4910 (50.2)	14197 (59.1)
• Top third		9968 (29.5)	3622 (37.0)	6346 (26.4)
Number of adults ≥18 years living in the household	32979			
• 1		15657 (47.5)	4419 (46.8)	11238 (47.7)
• 2		8999 (27.3)	2485 (26.3)	6514 (27.7)
• 3		4756 (14.4)	1352 (14.3)	3404 (14.5)
• 4		2231 (6.8)	700 (7.4)	1531 (6.5)
• ≥ 5		1336 (4.0)	478 (5.1)	858 (3.6)
Number of children ≤ 18 years living in the household	12357			
• 1		5951 (48.2)	1575 (45.7)	4376 (49.1)
• 2		4620 (37.4)	1271 (36.9)	3349 (37.6)
• 3		1290 (10.4)	401 (11.6)	889 (10)
• 4		323 (2.6)	117 (3.4)	206 (2.3)
• ≥ 5		171 (1.4)	82 (2.4)	91 (1)
Gender Inequality Index	45615			
• Low/Medium GII		30530 (66.9)	8188 (62.3)	22342 (68.8)
• High GII		15085 (33.1)	4951 (37.7)	10134 (31.2)
Geographic Regions	48632			
• Europe		12106 (24.9)	3558 (25.3)	8548 (24.8)
• North America		18658 (38.4)	4674 (33.2)	13984 (40.5)
• Others		17868 (36.7)	5860 (41.2)	12008 (34.8)
Likelihood of getting vaccinated	38979			
• Unlikely		4664 (11.9)	1220 (10.9)	3444 (12.4)
• Likely		34315 (88.0)	9930 (89.1)	24385 (87.6)
Psychosocial characteristics				
Depressive disorder	37616	3276 (8.7)	705 (6.7)	2571 (9.5)
Anxiety disorder	37481	5889 (15.7)	1133 (10.7)	4756 (17.7)

¹ Number of observations with complete information; GII: Gender Inequality Index

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Table 2. Bivariate association between gender-related variables and adoption of three key protective health behaviours

	Hand washing (n=43318)		Mask wearing (n=42767)		Physical distancing (n=43368)	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Socio-demographic characteristics						
Biological sex						
• Male (ref)	-		-		-	
• Female	1.97 (1.71-2.28)	<0.001	0.98 (0.94-1.03)	0.41	1.28 (1.22-1.34)	<0.001
Age distribution						
• Up to 25 (ref)	-		-		-	
• 26-50	2.71 (2.31-3.17)	<0.001	0.86 (0.82-0.92)	<0.001	1.11 (1.04-1.18)	<0.001
• 51 and older	5.60 (4.51-6.94)	<0.001	1.11 (1.04-1.18)	<0.01	1.50 (1.41-1.61)	<0.001
Education level						
• Low level (ref)	-		-		-	
• High level	1.56 (1.31-1.85)	<0.001	0.99 (0.94-1.04)	0.78	1.20 (1.13-1.27)	<0.001
Work status						
• Unemployed (ref)	-		-		-	
• Employed	1.84 (1.25-2.71)	<0.01	0.35 (0.23-0.54)	<0.001	0.53 (0.47-0.60)	<0.001
Annual household income						
• Bottom third (ref)	-		-		-	
• Middle third	1.47 (1.18-1.84)	<0.01	1.18 (1.11-1.26)	<0.001	0.98 (0.91-1.06)	0.78
• Top third	1.63 (1.27-2.10)	<0.001	1.02 (0.95-1.10)	0.52	1.23 (1.12-1.33)	<0.001
Adults ≥18 years living in the household						
• 1 (ref)	-		-		-	
• 2	0.80 (0.65-0.99)	<0.05	1.27 (1.21-1.35)	<0.001	0.73 (0.69-0.78)	<0.001
• 3	0.59 (0.46-0.75)	<0.001	1.63 (1.52-1.76)	<0.001	0.64 (0.59-0.69)	<0.001
• 4	0.59 (0.43-0.82)	<0.01	2.31 (2.06-2.58)	<0.001	0.50 (0.45-0.55)	<0.001
• ≥ 5	0.35 (0.25-0.48)	<0.001	2.77 (2.39-3.22)	<0.001	0.43 (0.38-0.48)	<0.001
Children ≤18 years living in the household						
• 1 (ref)	-		-		-	
• 2	1.18 (0.88-1.58)	0.26	0.81 (0.74-0.87)	<0.001	1.09 (0.99-1.19)	0.06
• 3	0.91 (0.59-1.39)	0.68	0.81 (0.71-0.92)	<0.01	0.92 (0.80-1.05)	0.25
• 4	0.68 (0.34-1.36)	0.28	1.10 (0.85-1.42)	0.45	0.75 (0.58-0.96)	0.05
• ≥ 5	0.23 (0.13-0.41)	<0.001	0.95 (0.68-1.32)	0.79	0.55 (0.41-0.76)	<0.001
Gender Inequality Index						
• Low/Medium GII (ref)	-		-		-	
• High GII	0.52 (0.45-0.60)	<0.001	4.38 (4.15-4.63)	<0.001	0.91 (0.86-0.96)	<0.001
Geographic Regions						
• Europe	1.63 (1.37-1.95)	<0.001	0.29 (0.27-0.31)	<0.001	1.21 (1.14-1.28)	<0.001
• North America	2.54 (2.13-3.04)	<0.001	0.21 (0.20-0.22)	<0.001	2.30 (2.18-2.42)	<0.001

• Others (ref)	-		-		-	
Likelihood of getting vaccinated						
• Unlikely (ref)	-		-		-	
• Likely	3.04 (2.57-3.61)	<0.001	1.15 (1.08-1.22)	<0.001	2.18 (2.04-2.32)	<0.001
Psychosocial characteristics						
Depressive disorder	0.76 (0.59-0.98)	<0.05	0.91 (0.85-0.98)	<0.05	1.15 (1.05-1.26)	<0.01
Anxiety disorder	0.91 (0.73-1.11)	0.35	0.88 (0.83-0.93)	<0.001	1.22 (1.14-1.31)	<0.001

¹Number of observations with complete information

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Table 3. Association between gender-related variables and adoption of facemask wearing, by sex

	Mask wearing							
	Female				Male			
	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value
Sociodemographic characteristics								
Age distribution								
• Up to 25 (ref)	-		-		-		-	
• 26-50	0.85 (0.79-0.91)	<0.001	0.77 (0.26-2.35)	0.65	0.91 (0.81-1.01)	0.11	0.59 (0.07-5.04)	0.63
• 51 and older	1.11 (1.02-1.18)	<0.01	0.35 (0.12-1.03)	0.05	1.12 (1.00-1.26)	<0.05	0.52 (0.06-4.47)	0.55
Education level								
• Low level (ref)	-		-		-		-	
• High level	0.95 (0.89-1.01)	0.15	0.84 (0.43-1.66)	0.61	1.08 (0.98-1.20)	0.10	0.37 (0.10-1.33)	0.12
Work status								
• Unemployed (ref)	-		-		-		-	
• Employed	0.38 (0.23-0.63)	<0.001	0.22 (0.10-0.48)	<0.001	0.31 (0.14-0.67)	<0.01	0.15 (0.04-0.53)	<0.01
Annual household income								
• Bottom third (ref)	-		-		-		-	
• Middle third	1.19 (1.10-1.29)	<0.001	0.76 (0.32-1.84)	0.54	1.12 (0.98-1.27)	0.08	1.64 (0.57-4.74)	0.36
• Top third	1.01 (0.92-1.10)	0.80	0.89 (0.35-2.28)	0.81	1.01 (0.87-1.15)	0.93	5.93 (0.64-21.48)	<0.01
Adults ≥18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	1.79 (1.68-1.93)	<0.001	0.89 (0.46-1.71)	0.71	1.73 (1.56-1.93)	<0.001	1.79 (0.50-6.40)	0.36
Children ≤18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	1.03 (1.81-2.49)	0.66			0.79 (0.65-0.96)	0.02		
Gender Inequality Index								
• High GII (ref)	-		-		-		-	
• Low/Medium GII	0.23 (0.21-0.24)	<0.001	0.18 (0.06-0.51)	<0.01	0.23 (0.21-0.25)	<0.001	0.29 (0.09-0.91)	<0.05
Geographic Regions								
• Europe	0.31 (0.28-0.33)	<0.001			0.26 (0.23-0.29)	<0.001		
• North America	0.21 (0.20-0.23)	<0.001			0.21 (0.18-0.23)	<0.001		
• Others (ref)	-				-			
Psychosocial characteristics								
Depressive disorder	0.91 (0.83-0.99)	<0.05	0.99 (0.33-3.07)	1.00	0.95 (0.81-1.12)	0.57	1.01 (0.20-5.01)	0.98
Anxiety disorder	0.87 (0.81-0.93)	<0.001	2.29 (0.84-6.24)	0.11	0.94 (0.82-1.07)	0.39	0.85 (0.23-3.18)	0.81

Note: In the multivariable model, geographic regions variable dropped due to collinearity with GII. Number of children in household variables dropped due to collinearity with number of adults in the household variable.

References:

1. Jalloh MF, Nur AA, Nur SA, Winters M, Bedson J, Pedi D, et al. Behaviour adoption approaches during public health emergencies: implications for the COVID-19 pandemic and beyond. *BMJ global health*. 2021;6(1):e004450.
2. Tadiri CP, Gisinger T, Kautzy-Willer A, Kublickiene K, Herrero MT, Raparelli V, et al. The influence of sex and gender domains on COVID-19 cases and mortality. *CMAJ*. 2020;192(36):E1041-E5.
3. Burki T. The indirect impact of COVID-19 on women. *The Lancet Infectious Diseases*. 2020;20(8):904-5.
4. World Health O. Gender and COVID-19: advocacy brief, 14 May 2020. World Health Organization; 2020.
5. Islam N, Sharp SJ, Chowell G, Shabnam S, Kawachi I, Lacey B, et al. Physical distancing interventions and incidence of coronavirus disease 2019: natural experiment in 149 countries. *bmj*. 2020;370.
6. Leung GM, Lam TH, Ho LM, Ho SY, Chan BHY, Wong IOL, et al. The impact of community psychological responses on outbreak control for severe acute respiratory syndrome in Hong Kong. *Journal of Epidemiology & Community Health*. 2003;57(11):857-63.
7. Poletti P, Caprile B, Ajelli M, Pugliese A, Merler S. Spontaneous behavioural changes in response to epidemics. *Journal of theoretical biology*. 2009;260(1):31-40.
8. Wenham C, Smith J, Morgan R. COVID-19: the gendered impacts of the outbreak. *The lancet*. 2020;395(10227):846-8.
9. Galasso V, Pons V, Profeta P, Becher M, Brouard S, Foucault M. Gender differences in COVID-19 attitudes and behavior: Panel evidence from eight countries. *Proceedings of the National Academy of Sciences*. 2020;117(44):27285-91.
10. Warraich HJ, Califf RM. Differences in health outcomes between men and women: biological, behavioral, and societal factors. *Clinical chemistry*. 2019;65(1):19-23.
11. Pilote L, Karp I. GENESIS-PRAXY (GENdEr and Sex determinantS of cardiovascular disease: From bench to beyond-Premature Acute Coronary SYndrome). *American heart journal*. 2012;163(5):741-6.
12. Norris CM, Murray JW, Triplett LS, Hegadoren KM. Gender roles in persistent sex differences in health-related quality-of-life outcomes of patients with coronary artery disease. *Gender medicine*. 2010;7(4):330-9.
13. Bacon SL, Lavoie KL, Boyle J, Stojanovic J, Joyal-Desmarais K. International assessment of the link between COVID-19 related attitudes, concerns and behaviours in relation to public health policies: Optimising policy strategies to improve health, economic and quality of life outcomes (the iCARE Study). *BMJ open*. 2021;11(3):e046127.
14. Lavoie KL, Bacon SL. for the iCARE study team: iCARE Surveys. 2020.
15. Gaye A, Klugman J, Kovacevic M, Twigg S, Zambrano E. Measuring key disparities in human development: The gender inequality index. *Human development research paper*. 2010;46:1-37.
16. Stachura P, Śleszyński J. Gender indicators of the United Nations Development Programme. *Economic and Environmental Studies*. 2016;16(4 (40)):511-30.
17. Durand H, Bacon SL, Byrne M, Kenny E, Lavoie KL, McGuire BE, et al. Identifying and addressing psychosocial determinants of adherence to physical distancing guidance during the COVID-19 pandemic—project protocol. *HRB Open Research*. 2020;3.

18. Harris M, Adhanom Ghebreyesus T, Liu T, et al. : COVID-19. World Health Organization. Archived (PDF) from the original on 2020-03-25. . 2020.
19. Vatcheva KP, Lee M, McCormick JB, Rahbar MH. Multicollinearity in regression analyses conducted in epidemiologic studies. *Epidemiology (Sunnyvale, Calif)*. 2016;6(2).
20. Felter C, Bussemaker N. Council on Foreign Relations. Which countries are requiring face masks? Retrieved on 27 October 2021 at <https://www.cfr.org/in-brief/which-countries-are-requiring-face-masks>.
21. Haischer MH, Beilfuss R, Hart MR, Opielinski L, Wrucke D, Zirgaitis G, et al. Who is wearing a mask? Gender-, age-, and location-related differences during the COVID-19 pandemic. *PloS one*. 2020;15(10):e0240785.
22. Lawson V. Geographies of care and responsibility. *Annals of the Association of American Geographers*. 2007;97(1):1-11.
23. Barceló J, Sheen GC-H. Voluntary adoption of social welfare-enhancing behavior: Mask-wearing in Spain during the COVID-19 outbreak. *PloS one*. 2020;15(12):e0242764.
24. Robertson C, Gebeloff R. How millions of women became the most essential workers in America. *The New York Times*. 2020;18.
25. Barber SJ, Kim H. COVID-19 worries and behavior changes in older and younger men and women. *The Journals of Gerontology: Series B*. 2021;76(2):e17-e23.
26. Ning L, Niu J, Bi X, Yang C, Liu Z, Wu Q, et al. The impacts of knowledge, risk perception, emotion and information on citizens' protective behaviors during the outbreak of COVID-19: a cross-sectional study in China. *BMC public health*. 2020;20(1):1-12.
27. Kim JK, Crimmins EM. How does age affect personal and social reactions to COVID-19: Results from the national Understanding America Study. *PloS one*. 2020;15(11):e0241950.
28. Pasion R, Paiva TO, Fernandes C, Barbosa F. The AGE effect on protective behaviors during the COVID-19 outbreak: sociodemographic, perceptions and psychological accounts. *Frontiers in psychology*. 2020;11:2785.
29. Hearne BN, Niño MD. Understanding how race, ethnicity, and gender shape mask-wearing adherence during the COVID-19 pandemic: evidence from the COVID impact survey. *Journal of Racial and Ethnic Health Disparities*. 2021:1-8.
30. Moran KR, Del Valle SY. A meta-analysis of the association between gender and protective behaviors in response to respiratory epidemics and pandemics. *PloS one*. 2016;11(10):e0164541.
31. Szolnoki G, Hoffmann D. Online, face-to-face and telephone surveys—Comparing different sampling methods in wine consumer research. *Wine Economics and Policy*. 2013;2(2):57-66.

FIGURE

Figure 1: Percentage of adherence to protective health behaviours, per group of Gender Inequality Index (GII), stratified by sex

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FIGURE

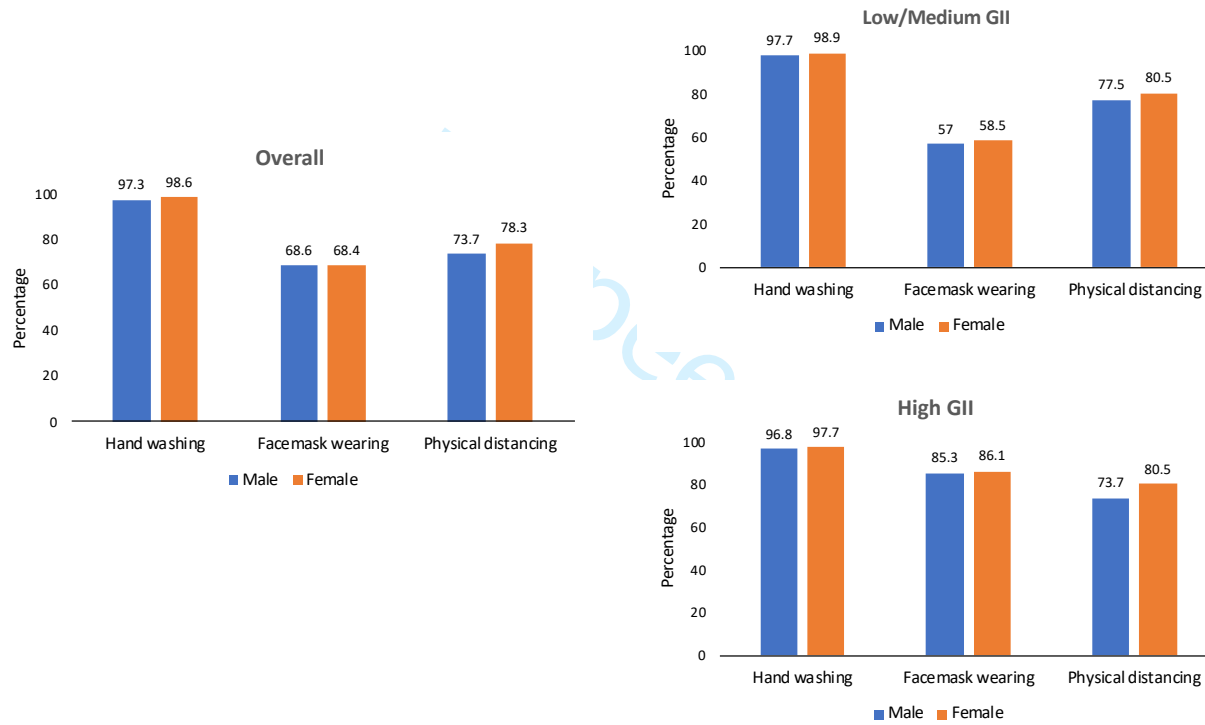


Figure 1: Percentage of adherence to protective health behaviours, per group of Gender Inequality Index (GII), stratified by sex

APPENDIX

Table 1a. Association between gender-related variables and adoption of hand washing, by sex

	Hand washing							
	Female				Male			
	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value
Sociodemographic characteristics								
Age distribution								
• Up to 25 (ref)	-		-		-		-	
• 26-50	2.91 (2.37-3.58)	<0.001	4.44 (1.68-11.76)	<0.01	2.45 (1.91-3.14)	<0.001	1.82 (0.63-5.68)	0.25
• 51 and older	7.71 (5.57-10.66)	<0.001	13.39 (2.87-62.6)	<0.01	4.56 (3.36-6.18)	<0.001	2.23 (0.81-6.27)	0.11
Education level								
• Low level (ref)	-		-		-		-	
• High level	1.63 (1.29-2.07)	<0.001	0.78 (0.32-1.91)	0.58	1.47 (1.12-1.92)	<0.01	0.37 (0.14-1.01)	0.05
Work status								
• Unemployed (ref)	-		-		-		-	
• Employed	2.41 (1.35-4.28)	<0.01	1.19 (0.50-2.83)	0.69	1.38 (0.80-2.40)	0.24	1.91 (0.89-4.13)	0.09
Annual household income								
• Bottom third (ref)	-		-		-		-	
• Middle third	1.50 (1.12-2.01)	<0.01	1.92 (0.83-4.43)	0.12	1.42 (1.00-2.01)	<0.05	1.07 (0.41-2.81)	0.88
• Top third	1.96 (1.36-2.81)	<0.001	3.20 (0.84-12.15)	0.08	1.67 (1.15-2.43)	<0.01	2.52 (0.77-8.41)	0.12
Adults ≥18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	0.52 (0.41-0.66)	<0.001	1.04 (0.44-2.43)	0.93	0.73 (0.56-0.95)	0.02	0.46 (0.21-1.03)	0.06
Children ≤18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	0.69 (0.44-1.08)	0.12			0.84 (0.52-1.37)	0.48		
Gender Inequality Index								
• High GII (ref)	-		-		-		-	
• Low/Medium GII	2.29 (1.88-2.78)	<0.001	2.11 (0.95-4.71)	0.07	1.37 (1.09-1.72)	<0.01	0.57 (0.25-1.32)	0.18
Geographic Regions								
• Europe	1.91 (1.49-2.43)	<0.001			1.28 (0.98-1.67)	0.06		
• North America	2.93 (2.31-3.72)	<0.001			1.87 (1.42-2.46)	<0.001		
• Others (ref)	-				-			
Psychosocial characteristics								
Depressive disorder	0.73 (0.52-1.02)	0.07	0.74 (0.20-2.71)	0.65	0.63 (0.42-0.95)	<0.05	0.72 (0.18-2.98)	0.66
Anxiety disorder	0.90 (0.68-1.18)	0.45	0.98 (0.32-2.96)	0.97	0.71 (0.34-1.44)	0.05	2.51 (0.47-13.38)	0.28

Note: In the multivariable model, geographic regions variable dropped due to collinearity with GII. Number of children in household variables dropped due to collinearity with number of adults in the household variable.

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Table 1b. Association between gender-related variables and adoption of physical distancing, by sex

	Physical distancing							
	Female				Male			
	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value
Sociodemographic characteristics								
Age distribution								
• Up to 25 (ref)	-		-		-		-	
• 26-50	1.10 (1.03-1.18)	<0.01	2.01 (1.54-2.63)	<0.001	1.11 (0.99-1.25)	0.05	2.53 (2.03-4.21)	<0.001
• 51 and older	1.60 (1.47-1.73)	<0.001	3.57 (2.72-4.68)	<0.001	1.41 (1.24-1.58)	<0.001	3.99 (2.47-6.46)	<0.001
Education level								
• Low level (ref)	-		-		-		-	
• High level	1.19 (1.11-1.27)	<0.001	1.39 (1.13-1.74)	<0.01	1.21 (1.09-1.34)	<0.001	0.87 (0.61-1.25)	0.45
Work status								
• Unemployed (ref)	-		-		-		-	
• Employed	0.55 (0.48-0.62)	<0.001	0.39 (0.32-0.49)	<0.001	0.48 (0.38-0.59)	<0.001	0.38 (0.27-0.52)	<0.001
Annual household income								
• Bottom third (ref)	-		-		-		-	
• Middle third	1.26 (0.99-1.60)	0.05	1.26 (0.99-1.59)	0.06	1.24 (0.89-1.73)	0.19	1.54 (1.01-2.32)	<0.05
• Top third	1.90 (1.41-2.56)	<0.001	1.53 (1.17-2.01)	<0.01	1.71 (1.19-2.45)	<0.01	2.13 (1.36-3.35)	<0.01
Adults ≥18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	0.65 (0.60-0.69)	<0.001	0.89 (0.72-1.09)	0.27	0.61 (0.55-0.67)	<0.001	0.66 (0.47-0.92)	<0.05
Children ≤18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	0.79 (0.69-0.92)	<0.01			0.94 (0.78-1.15)	0.56		
Gender Inequality Index								
• High GII (ref)	-		-		-		-	
• Low/Medium GII	0.99 (0.94-1.06)	0.95	0.72 (0.58-0.88)	<0.01	1.23 (1.13-1.34)	<0.001	0.87 (0.64-1.19)	0.39
Geographic Regions								
• Europe	1.16 (1.09-1.24)	<0.001			1.29 (1.17-1.43)	<0.001		
• North America	2.26 (2.12-2.41)	<0.001			2.26 (2.04-2.49)	<0.001		
• Others (ref)	-		-		-		-	
Psychosocial characteristics								
Depressive disorder	1.16 (1.05-1.29)	<0.01	1.07 (0.78-1.48)	0.66	1.00 (0.84-1.19)	0.96	0.86 (0.49-1.50)	0.60
Anxiety disorder	1.21 (1.12-1.31)	<0.001	1.03 (0.79-1.32)	0.84	1.00 (0.95-1.27)	0.19	1.40 (0.85-2.31)	0.18

Note: In the multivariable model, geographic regions variable dropped due to collinearity with GII. Number of children in household variables dropped due to collinearity with number of adults in the household variable.

STROBE Statement—checklist of items that should be included in reports of observational studies

Association of Biological Sex and Gender-related Factors with Public Engagement in Protective Health Behaviours during the COVID-19 Pandemic: Lessons Learned Going Forward

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1,3
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	7
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-9
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	NA
Bias	9	Describe any efforts to address potential sources of bias	NA
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9
		(b) Describe any methods used to examine subgroups and interactions	10
		(c) Explain how missing data were addressed	NA
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	NA

		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	NA

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-12
		(b) Report category boundaries when continuous variables were categorized	9
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg, analyses of subgroups and interactions, and sensitivity analyses	12
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

BMJ Open

Impact of biological sex and gender-related factors on public engagement in protective health behaviours during the COVID-19 pandemic: cross-sectional analyses from a global survey

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3 1 **Impact of biological sex and gender-related factors on public engagement in protective**
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5 2 **health behaviours during the COVID-19 pandemic: cross-sectional analyses from a global**
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7 3 **survey**
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34 ABSTRACT

35
36 **Objective:** Given the role of sociocultural gender in shaping human behaviours, the main
37 objective of this study was to examine whether sex and gender-related factors were associated with
38 the public's adherence to COVID-19 recommended protective health behaviours.

39 **Design:** This was a retrospective analysis of the survey that captured data on people's awareness,
40 attitudes, and behaviours as they relate to the COVID-19 policies.

41 **Setting:** Data from the International COVID-19 Awareness and Responses Evaluation (iCARE)
42 survey collected between March 2020 to February 2021 from 175 countries.

43 **Participants:** Convenience sample around the world.

44 **Main outcome measures:** We examined the role of sex and gender-related factors in relation to
45 non-adherence of protective health behaviors including: (i) hand washing; (ii) mask wearing; and
46 (iii) physical distancing. Multivariable logistic regression was conducted to determine the factors
47 associated with non-adherence to behaviors.

48 **Results:** Among 48,668 respondents (mean age: 43 years; 71% female), 98.3% adopted hand
49 washing, 68.5% mask wearing, and 76.9% physical distancing. Compared with males, females
50 were more likely to adopt hand washing (OR=1.97, 95%CI: 1.71-2.28) and maintain physical
51 distancing (OR=1.28, 95%CI: 1.22-1.34). However, in multivariable sex-stratified models,
52 females in countries with higher gender inequality indexes (GII) were less likely to report hand
53 washing (aOR=0.47, 95%CI: 0.21-1.05). Females who reported being employed (aOR=0.22,
54 95%CI: 0.10-0.48) and in countries with low/medium GIIs (aOR=0.18, 95%CI: 0.06-0.51) were
55 less likely to report mask wearing. Females who reported being employed were less likely to report
56 physical distancing (aOR=0.39, 95%CI: 0.32-0.49).

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3 57 **Conclusion:** While females showed greater adherence to COVID-19 protective health behaviours,
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5 58 gender-related factors, including employment status and high-country wide gender inequality were
6
7 59 independently associated with non-adherence. These findings may inform public health and
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10 60 vaccination policies in current as well as future pandemic.

11
12 61 **Keywords:**

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15 62 COVID-19, SARS-Cov-2, health behaviours, hand washing, mask wearing, physical distancing
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19 65 **Strengths and limitations of this study:**

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21 66
- 22 • The study had a large sample size with a global perspective, and availability of gender-
23 related factors to examine the impact of gender.
24 67
 - 25 68 • The online nature of the iCARE survey might have limited the participation from
26 individuals who did not had access to computers and internet, limiting the generalization
27 of findings.
28 69
 - 29 70 • Our global sample was highly educated group of people whose results are likely to be ‘best
30 case scenario’.
31 71
 - 32 72 • The global sample was also mostly females, so males are underrepresented in this study.
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 - 34 74 • Self-reported behaviour of the respondents might not have accurately represented actual
35 behaviour, hence, the findings should be interpreted with caution.
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78 INTRODUCTION

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80 Public behaviour plays an important role during public health emergencies.¹ Behaviours can be
81 influenced by both the biological sex and sociocultural gender (gender identity, gender roles,
82 gender relations, and institutionalized gender) of an individual. ² According to Canadian Institutes
83 of Health and Research (CIHR), sex refers to “*a set of biological attributes and associated physical*
84 *and physiological features including chromosomes, gene expression, hormone levels and function,*
85 *and reproductive/sexual anatomy*” and are categorized as female or male.³ While gender refers to
86 “*the array of socially constructed roles and relationships, personality traits, attitudes, behaviours,*
87 *values, relative power and influence that society ascribes to women and men on a differential*
88 *basis*”.^{4,5} In the case of the Coronavirus Disease 2019 (COVID-19) pandemic, both men and
89 women worldwide have shown inconsistent responses to acute infection as well as differing long-
90 term health, economic, and social consequences.^{6,7} Understanding these responses in relation to
91 sex and/or gender-related attributes in the general population may be particularly valuable to
92 inform tailored sex and gender strategies moving forward.

93
94 It has been identified that public health responses to infectious diseases require fundamental
95 changes in individual behaviour. Hand washing, mask wearing, and physical distancing
96 (*previously referred to as social distancing*) are the key transmission reduction public health
97 behaviour-based prevention measures ¹ that are associated with a reduction in the global incidence
98 of COVID-19.^{8,9} Effectiveness of such responses depends not only on the generalized adherence
99 of the public but may be specific to certain high-risk groups. Though recommended and proven to
100 limit transmission rates, hand washing, mask wearing, and physical distancing have been
101 inconsistently initiated and maintained. There is a dynamic relationship between the voluntary

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3 102 adoption of public health behaviours and infection transmission during infectious disease
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5 103 epidemics.¹⁰ The COVID-19 pandemic has sparked an unparalleled global discourse around the
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8 104 adoption of protective behaviours and other public health and social measures to slow the person-
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10 105 to-person spread of SARS-CoV-2.¹
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14 107 COVID-19 has highlighted the role that sex and gender play in our lives. This includes influencing
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16 108 an individual's exposure to COVID-19 through sex and gender-related occupations, risk-taking
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18 109 behaviours, and employment of precautions. Sex and gender also are known to have an impact on
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20 110 health through the gendered nature of the workforce and the predominant risk associated with it,
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22 111 increased caregiving responsibilities at home limiting the work and economic opportunities, or
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24 112 institutional biases and policies.^{2,11} Gender affects the division of labor and care duties in families
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26 113 and communities. Hence, it is of utmost importance that we gather, from our recent lived
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28 114 experience, evidence on the potential sex and gender-related differences in perception and
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30 115 behavioural responses experienced during COVID-19 pandemic.
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35 117 A few studies have shown sex-based differences in COVID-19 related beliefs and behaviours and
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37 118 have reported that compared to men, women are more likely to perceive the pandemic as a serious
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39 119 health problem and comply more with the preventive behaviours.^{12,13} Therefore, as gender is
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41 120 culturally and geographically based, we hypothesized that there is a difference in preventive
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43 121 behaviours and pandemic related concerns based on sex and gender-related factors. Also,
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45 122 regardless of sex-based differences, our previous studies highlight the need of focusing on the
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47 123 gender-related factors.^{14,15} Hence, the purpose of this study was to examine whether sex and
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49 124 gender-related factors are associated with the engagement in the recommended key protective
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3 125 health behaviours such as hand washing, mask wearing, and physical distancing during the
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5 126 COVID-19 pandemic.
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10 129 **METHODS**

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12 130 **Study design**

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14 131 Survey datasets from the ongoing iCARE (International Covid-19 Awareness and Responses
15 132 Evaluation) study led by the Montreal Behavioural Medicine Centre (MBMC: [www.mbmc-](http://www.mbmc-cmc.ca)
16 133 [cmc.ca](http://www.mbmc-cmc.ca)) in collaboration with a team of 200 international collaborators from 42 countries was
17 134 used for the data analyses. The iCARE study design has been previously described.¹⁶ Briefly,
18 135 iCARE is an international multi-wave cross-sectional observational cohort study of public
19 136 awareness, attitudes, and responses to public health policies implemented to reduce the spread of
20 137 COVID-19 on people around the world (www.iCAREstudy.com). It collects data on study
21 138 demographics, perceptions of government policy, health behaviours, adherence to health
22 139 measures, types of concerns, and adherence motivators.
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38 141 Survey data were collected in 4-6 week rounds using convenience snowball sampling (globally,
39 142 25-30K per wave) and parallel representative sampling (in targeted countries), generating data for
40 143 multiple cohorts of participants that were added to the first round cohort launched on March 27,
41 144 2020. We analyzed data from Survey 1 – Survey 7 that was collected between March 27, 2020 to
42 145 February 9, 2021. A total of 61,552 respondents participated in the survey from over 175 countries.
43 146 The data was analyzed for 48,668 respondents (female=34,556, male=14,112). The questionnaire
44 147 used in the survey is publicly available via the Open Science Framework (<https://osf.io/nswcm/>)
45 148 and the survey is available in 34 languages.¹⁷
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4 150 **Biological sex and gender-related factors**
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6 152 For each surveyed individual the following variables were collected: socio-demographic
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9 153 characteristics (sex at birth, age in years, level of education, work status, perceived annual
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11 154 household income, number of adults and children living in the household, country of residence,
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13 155 and likelihood of getting vaccinated *i.e.*, respondents' willingness to get a COVID-19 vaccine),
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15 156 the presence of a physician-diagnosed depressive and/or anxiety disorder, and adoption of
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17 157 protective health behaviours (hand washing, wearing a face mask, and physical distancing).
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22 159 To account for institutionalized gender, the Gender Inequality Index (GII), developed by the
23
24 160 United Nations Development Programme, was used as a measure of country specific gender
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26 161 inequality¹⁸ and as a measure of institutionalized gender in this study. This index is a continuous
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28 162 measure for the degree of gender inequality per country on a scale between 0 and 1, with lower
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30 163 values representing near-perfect gender equality and higher values representing greater levels of
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32 164 inequality favoring males. The GII is based on several aspects of institutionalized gender: (i)
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34 165 reproductive health, measured by the maternal mortality ratio and adolescent birth rates; (ii)
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36 166 empowerment, measured by the proportion of parliamentary seats occupied by women and the
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38 167 proportion of adult women and men with at least some secondary education; and (iii) economic
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40 168 status, measured by labor force participation rate of men and women.¹⁹ GIIs in this study were
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42 169 divided into tertiles and later categorized into high and low/medium GII categories. We used data
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44 170 on GIIs from 2019. Some of the countries in the region were excluded from the analysis due to the
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46 171 unavailability of data.
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53 173 **Outcome measures**
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3 175 The main outcomes of the analysis were self-reported non-adherence to three recommended
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5 176 protective health behaviours including: (i) hand washing with soap and water; (ii) wearing a face
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7 177 mask; and (iii) a composite measure of physical distancing behaviours (specifically: staying at
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9 178 least 1-2 meters away from other people; staying/working at home rather than going to work or
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11 179 school; self-quarantining if returning from a trip; self-quarantining if one have the virus or believe
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13 180 they have the virus; avoid going out to bars/pubs/restaurants; avoiding large social gatherings;
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15 181 avoiding small social gatherings; avoiding indoor social gatherings; and avoiding any non-
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17 182 essential travel).²⁰ A composite binary variable was constructed in which, the participants who met
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19 183 the above-mentioned criteria were coded with a value of 1; otherwise, the participants were coded
20
21 184 with a value of 0. A set of measures in the iCARE survey intended to explore the prevention
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23 185 measures used by the public to prevent the spread of COVID-19 by maintaining a physical distance
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25 186 between two people and reducing the number of times people come into close physical contact
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27 187 with one another²¹ were used to create a composite variable for physical distancing.
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190 **Statistical analysis**

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192 A global analysis of public engagement in three recommended protective health behaviours was
193 performed to investigate whether the outcomes differed by sex. Our outcome of interest in the
194 modeling process was the non-adherence to behavioural recommended measures. Descriptive sex-
195 stratified analyses were run for: age; baseline mental health conditions (any depressive or anxiety
196 disorders); and gender-related factors such as level of education, work status, annual household
197 income, and GII. Continuous variables were presented as mean and standard deviation (SD).
198 Categorical variables were presented as counts and percentages. Sex differences in outcomes
199 (protective health behaviours) were completed and associations between sex, gender-related

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3 200 factors, and outcomes were tested in a multivariable model. Bivariate logistic regressions were run
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5 201 for crude analysis followed by collinearity diagnostics to account for inflation in standard errors
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8 202 of parameter estimates caused by collinear cofactors.²² If variables were collinear, we included the
9
10 203 variable with the least amount of missing data in the multivariable models. *A priori* gender-related
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12 204 cofactors (i.e., gender role [work status], gender identity [depressive and/or anxiety disorders], and
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14 205 institutionalized gender [education level, annual household income, and GII]) were included in
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16 206 multivariable models adjusting for the potential confounders (i.e., age and geographical regions).
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19 207 Two-way interaction between the sex and gender-related factors were tested by including an
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21 208 interaction term in bivariate models. All statistical analyses were performed using statistical
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23
24 209 software STATA version 16 (College Station, TX, USA). Tests were two sided and the
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26 210 significance was defined as $p < 0.05$.

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212 **Patient and public involvement**

213 It was not possible to involve patients or the public in the design, or conduct, or reporting, or
214 dissemination plans of our research. For the dissemination of results, we will submit the results of
215 the study to relevant national and international journals with the intention of publishing the results
216 widely. Further, we will make national and international presentations in conferences and
217 symposiums to stakeholder groups including those involving general public, researchers,
218 clinicians, and policymakers.

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221 **RESULTS**

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223 **Descriptive characteristics of respondents**

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3 224 Our study population included 34,556 females (71%) and 14,112 males (29%) (**Table 1**). The
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5 225 mean age of the respondents was 43 years (SD: 16). A majority (n=23,462, 48.8%) was between
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7 226 26 and 50 years of age. Most respondents (79.7%) reported high levels of education, were
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9 227 employed (61.8%), were from Europe and North American countries (66.3%), and from regions
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11 228 with high levels of gender equity as measured by low/medium GIIs (66.9%). Females were more
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13 229 likely to report having a physician-diagnosed depressive disorder (9.5% vs 6.7%, $p \leq 0.001$) and
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15 230 anxiety disorder (17.7% vs 10.7%, $p \leq 0.001$) compared to males. Irrespective of sex, only 68.5%
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17 231 of responders disclosed wearing a facemask, while a higher percentage of females reported
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19 232 adherence to physical distancing behaviours compared to males (78.3% vs 73.7%, $p < 0.001$).
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21 233 Participants aged 51 and older were more likely to engage in all three-key protective behaviours
22
23 234 as compared with younger participants: hand washing (Odds ratio [OR]= 5.60, 95% Confidence
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25 235 interval [CI]: 4.51-6.94); mask wearing (OR=1.11, 95% CI: 1.04-1.18); and physical distancing
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27 236 (OR=1.50, 95% CI: 1.41-1.61) (**Table 2**).
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237 **Gender-related factors associated with adoption of protective health behaviours**

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34 238 For the univariate analysis, the proportion of people adopting the protective health-related
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36 239 behaviours, varied depending on the gender-related factor examined. Despite employed
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38 240 respondents being 84% more likely to engage in hand washing than unemployed respondents, they
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40 241 were 65% less likely to engage in mask wearing and 47% less likely to engage in physical
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42 242 distancing ($p < 0.001$ for all comparisons). Hand washing and physical distancing was less common
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44 243 as the number of adults ≥ 18 years living in the household increased. The proportion of adoption
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46 244 was lowest for wearing a facemask, both for females and males (58.5% vs 57%) in low/medium
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48 245 GII countries (**Figure 1**). Respondents living in the countries with high GII were 4.38 times (95%
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50 246 CI: 4.15-4.63) more likely to use mask than respondents living in the countries with low GIIs;
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249 however, they were less likely to engage in hand washing and less likely to engage in physical
250 distancing (**Table 2**).

251 **Sex and gender-related differences in the adoption of protective health behaviours**

252 Sex-stratified multivariate analyses demonstrated that the factors associated with the adoption of
253 protective health behaviours varied by sex. Among females, the factors associated with not
254 adhering to health behaviours were: (i) for hand washing: higher country gender inequality
255 favoring males GII (aOR=0.47, 95% CI: 0.21-1.05, p=0.07) (ii) for mask-wearing: older age (aOR
256 females=0.35, 95% CI:0.12-1.03, p=0.05), being employed (aOR females=0.22, 95% CI:0.10-
257 0.48, p<0.001), and living in a country with more gender equity as measured by the GII
258 (aOR=0.18, 95% CI: 0.06-0.51, p<0.01); and (iii) for physical distancing: being employed (aOR
259 females=0.39, 95% CI:0.32-0.49, p<0.001) (**Table 3, Appendix-Table 1a, Table 1b**).

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263 Among males, factors that were associated with not adhering to protective health behaviours were:
264 (i) for hand washing: higher level of education (aOR males=0.37, 95% CI: 0.14-1.01, p=0.05) and
265 with a household size of > 2 (aOR males=0.46, 95% CI: 0.21-1.03, p=0.06); (ii) for mask wearing:
266 being employed (aOR males=0.15, 95% CI:0.04-0.53, p<0.01) and living in a country with more
267 gender equity as measured by the GII (aOR=0.29, 95% CI: 0.09-0.91, p<0.05); and (iii) for
268 physical distancing: being employed (aOR males=0.38, 95% CI:0.27-0.52, p<0.001) and with
269 household size of > 2 (aOR males=0.66, 95% CI: 0.47-0.92, p<0.05) (**Table 3, Appendix-Table**
270 **1a, Table 1b**).

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272 There was a significant interaction between sex and educational level of the participants. High
273 level of education decreased the use of mask wearing among females compared to males (p=0.03).

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3 274 There was a trend for living in a country with lower gender equity to be associated with poorer
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5 275 protective behaviors in females compared to males (p=0.056).
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10 277 **DISCUSSION**
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12 278 The present study provides a comprehensive analysis on the impact of sex and gender-related
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14 279 factors and the association with adherence to protective health behaviours during the COVID-19
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16 280 pandemic. Overall, hand washing, mask wearing, and physical distancing behaviours were adopted
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18 281 globally. However, there were a number of gender-related factors associated with a lower
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20 282 adherence based on sex.
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26 284 Lower adherence to the protective health behaviours was mainly associated with younger age,
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28 285 being employed, and living in a country with low/medium GII (higher gender equity) for females.
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30 286 While high level of education, being employed, and household size of >2 were associated with
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32 287 lower adoption in males. Considering these group of individuals with lower adherence to
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34 288 protective health behaviours, this would suggest that in the current as well as future pandemics it
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36 289 may be useful to target interventions based on sex and gendered factors to increase adherence and
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38 290 reduce disease transmission. Measures such as risk-assessment and mitigation considerations for
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40 291 public settings could be implemented to mitigate the risk of transmission and promote the adoption
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42 292 of protective health behaviours.
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49 294 Overall, mask wearing was lower among both sexes compared to other protective behaviours such
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51 295 as hand washing and physical distancing. Many countries waited to issue mask mandates months
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53 296 into the pandemic²³ even though other behaviours were mandated right away. This may be one of
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3 297 the reasons for lower adherence. Further, adoption of mask wearing was less likely in males
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5 298 compared to females, mainly among those who were employed, indicating substantial room for
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8 299 improvement in male's engagement to mask wearing. In our study, employed female respondents
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10 300 reported that they were more likely to wear a mask compared to male respondents. Similarly, a
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12 301 study conducted in the United States also reported that females were 1.5 times more likely to wear
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14 302 a mask compared to males.²⁴ It has been suggested that females may be more likely to protect
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16 303 themselves and others by wearing a mask specifically because they handle the majority of
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18 304 caregiving within families and are overrepresented in essential work services, which generally
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20 305 requires mask wearing.²⁵ Previous studies have also reported mask wearing to be significantly
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22 306 associated with the occupation of respondents.^{26,27} A study reported that women make up almost
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24 307 90 percent of nurses and nursing assistants in the United States and over two-thirds of grocery
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26 308 store cashiers.²⁷ Performing the dual function of an essential worker outside and a caregiver at
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28 309 home, women might face a dilemma of how to keep their families healthy and safe while
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30 310 continuing to work in potentially risky circumstances, suggesting that these factors may make them
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32 311 more adherent to the protective behaviours.

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39 313 Older females were the most likely participants to engage in hand washing and physical distancing,
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41 314 but less likely to engage in mask wearing. Older females may have a higher perceived risk of
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43 315 developing COVID-19 complications and mortality, and thus engaged in more protective health
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45 316 behaviours such as hand washing and physical distancing. Previous studies have shown that
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47 317 females and older adults are less likely to engage in the risky behaviours, feel more vulnerable to
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49 318 contracting diseases, and have a stronger sense of responsibility to protect society.^{28,29} This is
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51 319 consistent with the findings of an American study that reported being older and female was related
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3 320 to adopting more pandemic mitigating behaviours.³⁰ Furthermore, a study conducted in China also
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5 321 reported that being female and older was associated with adopting protective behaviours.²⁹
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7 322 However, our study findings are in contrast with the results of a study conducted in Portugal that
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9 323 reported a decline in engagement in protective health behaviours with advancing age, which was
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11 324 reported to be related to the increased social-isolation and lack of help among older population.³¹
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13 325 Even though the study did not report the differences by sex of the respondents, self-isolation could
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15 326 be the reason for lower adherence to mask wearing among females. Depending on the diverse
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17 327 context, public health interventions should be tailored not only to sex, but differing age groups,
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19 328 and importantly institutional gender related variables such as those measured by the GII.
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26 330 Emerging evidence shows that gender including the institutionalized gender shapes mask wearing
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28 331 adherence.³² One of the interesting findings of the current study is respondents from low/medium
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30 332 GII countries with less gender inequity reported a significantly lower adherence to mask wearing
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32 333 compared to respondents from countries with high GII (high gender inequity). Even among the
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34 334 low/medium GII countries, adherence is reported to be poorer among males. Lower adherence
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36 335 among males is in line with a finding from a study conducted in the United States, in which males
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38 336 exhibited poorer mask wearing practices compared with their female counterparts.²⁴ This is also
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40 337 supported by a review that looked at research from multiple countries and found women were 50%
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42 338 more likely than men to practice protective behaviour.³³ The correlation between a Gini coefficient
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44 339 (a measure of income inequality) and GII (a measure of gender inequality) could explain the lower
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46 340 adherence to protective health behaviours in countries with low/medium GII where income
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48 341 inequality arises mainly through gender gaps in economic participation.³⁴
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3 343 The strengths of this study include a large sample size, having a global perspective, and availability
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5 344 of gender-related factors to examine the impact of gender. This study also has some limitations
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7 345 that should be acknowledged. First, the online nature of the iCARE survey might have limited the
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10 346 participation from individuals who did not had access to computers and internet, limiting the
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12 347 generalization of findings. However, the advantages of online surveys have been shown to
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14 348 outweigh the disadvantages, mainly in terms of its external validity;³⁵ hence, the bias might be
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16 349 relatively low. Second, our global sample was highly educated group of people whose results are
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18 350 likely to be 'best case scenario'. The global sample was also mostly women, so men are
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21 351 underrepresented in this study. Third, self-reported behaviour doesn't always accurately represent
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23 352 actual behaviour, hence, the findings should be interpreted with caution. Finally, although the
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25 353 study established the associations between sex and gender-related factors with the adoption of
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27 354 protective health behaviours, no causal relationships should be assumed due to the nature of the
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30 355 cross-sectional design of the survey.
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35 357 **CONCLUSIONS**

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37 359 In this analysis of a multinational study population, while a majority of respondents reported
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39 360 wearing a facemask, this is likely reflective of country wide mask mandates as opposed to adopting
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41 361 it as a protective health behavior. However, our study findings, suggest that wearing a facemask
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43 362 appeared to be more difficult to adhere to for many compared to other key protective behaviours
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45 363 such as hand washing and physical distancing. Moreover, our study noted that this was even more
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47 364 apparent in countries with low GII (more equity between males and females) indicating substantial
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49 365 room for improvement in public engagement regarding protective health behaviours. Since a
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51 366 widespread protective behavioral response are paramount for a successful containment and control
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3 367 of an infectious disease contagion, the present study provides valuable information for identifying
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5 368 sex and gendered factors that may inform effective public health policies. Further, the Covid-19
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7 369 pandemic highlights the urgent need to incorporate sex and gender analysis into all research and
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9 370 innovation processes in order to target specific groups both to help contain the transmission of the
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11 371 virus and to formulate vaccine policies.
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394 Dataset are available from the iCARE team upon reasonable request.

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549 TABLES

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551 **Table 1.** Descriptive characteristics of survey respondents by biological sex (N=48668)

	N ¹	Overall n (%) or Mean [SD]	Biological sex	
			Male (N=14112) n (%) or Mean [SD]	Female (N=34556) n (%) or Mean [SD]
Socio-demographic characteristics				
Age (in years)	48524	43 [16]	42 [16]	44 [17]
Age distribution in strata	48049			
• Up to 25		8632 (18.0)	2327 (16.8)	6305 (18.5)
• 26-50		23462 (48.8)	6372 (45.8)	17090 (50.0)
• 51 and older		15955 (33.2)	5197 (37.4)	10758 (31.5)
Education level	38217			
• Low level		7758 (20.3)	2208 (20.5)	5550 (20.2)
• High level		30459 (79.7)	8564 (79.5)	21895 (79.8)
Work status	7071			
• Unemployed		2698 (38.2)	775 (40.7)	1923 (37.2)
• Employed		4373 (61.8)	1131 (59.3)	3242 (62.8)
Annual perceived household income	33814			
• Bottom third		4739 (14.0)	1249 (12.8)	3490 (14.5)
• Middle third		19107 (56.5)	4910 (50.2)	14197 (59.1)
• Top third		9968 (29.5)	3622 (37.0)	6346 (26.4)
Number of adults ≥18 years living in the household	32979			
• 1		15657 (47.5)	4419 (46.8)	11238 (47.7)
• 2		8999 (27.3)	2485 (26.3)	6514 (27.7)
• 3		4756 (14.4)	1352 (14.3)	3404 (14.5)
• 4		2231 (6.8)	700 (7.4)	1531 (6.5)
• ≥ 5		1336 (4.0)	478 (5.1)	858 (3.6)
Number of children ≤ 18 years living in the household	12357			
• 1		5951 (48.2)	1575 (45.7)	4376 (49.1)
• 2		4620 (37.4)	1271 (36.9)	3349 (37.6)
• 3		1290 (10.4)	401 (11.6)	889 (10)
• 4		323 (2.6)	117 (3.4)	206 (2.3)
• ≥ 5		171 (1.4)	82 (2.4)	91 (1)
Gender Inequality Index	45615			
• Low/Medium GII		30530 (66.9)	8188 (62.3)	22342 (68.8)
• High GII		15085 (33.1)	4951 (37.7)	10134 (31.2)
Geographic Regions	48632			
• Europe		12106 (24.9)	3558 (25.3)	8548 (24.8)
• North America		18658 (38.4)	4674 (33.2)	13984 (40.5)
• Others		17868 (36.7)	5860 (41.2)	12008 (34.8)
Likelihood of getting vaccinated	38979			
• Unlikely		4664 (11.9)	1220 (10.9)	3444 (12.4)
• Likely		34315 (88.0)	9930 (89.1)	24385 (87.6)
Psychosocial characteristics				
Depressive disorder	37616	3276 (8.7)	705 (6.7)	2571 (9.5)
Anxiety disorder	37481	5889 (15.7)	1133 (10.7)	4756 (17.7)

¹ Number of observations with complete information; GII: Gender Inequality Index

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Table 2. Bivariate association between gender-related variables and adoption of three key protective health behaviours

	Hand washing (n=43318)		Mask wearing (n=42767)		Physical distancing (n=43368)	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Socio-demographic characteristics						
Biological sex						
• Male (ref)	-		-		-	
• Female	1.97 (1.71-2.28)	<0.001	0.98 (0.94-1.03)	0.41	1.28 (1.22-1.34)	<0.001
Age distribution						
• Up to 25 (ref)	-		-		-	
• 26-50	2.71 (2.31-3.17)	<0.001	0.86 (0.82-0.92)	<0.001	1.11 (1.04-1.18)	<0.001
• 51 and older	5.60 (4.51-6.94)	<0.001	1.11 (1.04-1.18)	<0.01	1.50 (1.41-1.61)	<0.001
Education level						
• Low level (ref)	-		-		-	
• High level	1.56 (1.31-1.85)	<0.001	0.99 (0.94-1.04)	0.78	1.20 (1.13-1.27)	<0.001
Work status						
• Unemployed (ref)	-		-		-	
• Employed	1.84 (1.25-2.71)	<0.01	0.35 (0.23-0.54)	<0.001	0.53 (0.47-0.60)	<0.001
Annual household income						
• Bottom third (ref)	-		-		-	
• Middle third	1.47 (1.18-1.84)	<0.01	1.18 (1.11-1.26)	<0.001	0.98 (0.91-1.06)	0.78
• Top third	1.63 (1.27-2.10)	<0.001	1.02 (0.95-1.10)	0.52	1.23 (1.12-1.33)	<0.001
Adults ≥18 years living in the household						
• 1 (ref)	-		-		-	
• 2	0.80 (0.65-0.99)	<0.05	1.27 (1.21-1.35)	<0.001	0.73 (0.69-0.78)	<0.001
• 3	0.59 (0.46-0.75)	<0.001	1.63 (1.52-1.76)	<0.001	0.64 (0.59-0.69)	<0.001
• 4	0.59 (0.43-0.82)	<0.01	2.31 (2.06-2.58)	<0.001	0.50 (0.45-0.55)	<0.001
• ≥ 5	0.35 (0.25-0.48)	<0.001	2.77 (2.39-3.22)	<0.001	0.43 (0.38-0.48)	<0.001
Children ≤18 years living in the household						
• 1 (ref)	-		-		-	
• 2	1.18 (0.88-1.58)	0.26	0.81 (0.74-0.87)	<0.001	1.09 (0.99-1.19)	0.06
• 3	0.91 (0.59-1.39)	0.68	0.81 (0.71-0.92)	<0.01	0.92 (0.80-1.05)	0.25
• 4	0.68 (0.34-1.36)	0.28	1.10 (0.85-1.42)	0.45	0.75 (0.58-0.96)	0.05
• ≥ 5	0.23 (0.13-0.41)	<0.001	0.95 (0.68-1.32)	0.79	0.55 (0.41-0.76)	<0.001
Gender Inequality Index						
• Low/Medium GII (ref)	-		-		-	
• High GII	0.52 (0.45-0.60)	<0.001	4.38 (4.15-4.63)	<0.001	0.91 (0.86-0.96)	<0.001
Geographic Regions						
• Europe	1.63 (1.37-1.95)	<0.001	0.29 (0.27-0.31)	<0.001	1.21 (1.14-1.28)	<0.001
• North America	2.54 (2.13-3.04)	<0.001	0.21 (0.20-0.22)	<0.001	2.30 (2.18-2.42)	<0.001

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• Others (ref)	-		-		-	
Likelihood of getting vaccinated						
• Unlikely (ref)	-		-		-	
• Likely	3.04 (2.57-3.61)	<0.001	1.15 (1.08-1.22)	<0.001	2.18 (2.04-2.32)	<0.001
Psychosocial characteristics						
Depressive disorder	0.76 (0.59-0.98)	<0.05	0.91 (0.85-0.98)	<0.05	1.15 (1.05-1.26)	<0.01
Anxiety disorder	0.91 (0.73-1.11)	0.35	0.88 (0.83-0.93)	<0.001	1.22 (1.14-1.31)	<0.001

¹Number of observations with complete information

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Table 3. Association between gender-related variables and adoption of facemask wearing, by sex

	Mask wearing							
	Female				Male			
	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value
Sociodemographic characteristics								
Age distribution								
• Up to 25 (ref)	-		-		-		-	
• 26-50	0.85 (0.79-0.91)	<0.001	0.77 (0.26-2.35)	0.65	0.91 (0.81-1.01)	0.11	0.59 (0.07-5.04)	0.63
• 51 and older	1.11 (1.02-1.18)	<0.01	0.35 (0.12-1.03)	0.05	1.12 (1.00-1.26)	<0.05	0.52 (0.06-4.47)	0.55
Education level								
• Low level (ref)	-		-		-		-	
• High level	0.95 (0.89-1.01)	0.15	0.84 (0.43-1.66)	0.61	1.08 (0.98-1.20)	0.10	0.37 (0.10-1.33)	0.12
Work status								
• Unemployed (ref)	-		-		-		-	
• Employed	0.38 (0.23-0.63)	<0.001	0.22 (0.10-0.48)	<0.001	0.31 (0.14-0.67)	<0.01	0.15 (0.04-0.53)	<0.01
Annual household income								
• Bottom third (ref)	-		-		-		-	
• Middle third	1.19 (1.10-1.29)	<0.001	0.76 (0.32-1.84)	0.54	1.12 (0.98-1.27)	0.08	1.64 (0.57-4.74)	0.36
• Top third	1.01 (0.92-1.10)	0.80	0.89 (0.35-2.28)	0.81	1.01 (0.87-1.15)	0.93	5.93 (0.64-21.48)	<0.01
Adults ≥18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	1.79 (1.68-1.93)	<0.001	0.89 (0.46-1.71)	0.71	1.73 (1.56-1.93)	<0.001	1.79 (0.50-6.40)	0.36
Children ≤18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	1.03 (1.81-2.49)	0.66			0.79 (0.65-0.96)	0.02		
Gender Inequality Index								
• High GII (ref)	-		-		-		-	
• Low/Medium GII	0.23 (0.21-0.24)	<0.001	0.18 (0.06-0.51)	<0.01	0.23 (0.21-0.25)	<0.001	0.29 (0.09-0.91)	<0.05
Geographic Regions								
• Europe	0.31 (0.28-0.33)	<0.001			0.26 (0.23-0.29)	<0.001		
• North America	0.21 (0.20-0.23)	<0.001			0.21 (0.18-0.23)	<0.001		
• Others (ref)	-				-			
Psychosocial characteristics								
Depressive disorder	0.91 (0.83-0.99)	<0.05	0.99 (0.33-3.07)	1.00	0.95 (0.81-1.12)	0.57	1.01 (0.20-5.01)	0.98
Anxiety disorder	0.87 (0.81-0.93)	<0.001	2.29 (0.84-6.24)	0.11	0.94 (0.82-1.07)	0.39	0.85 (0.23-3.18)	0.81

Note: In the multivariable model, geographic regions variable dropped due to collinearity with GII. Number of children in household variables dropped due to collinearity with number of adults in the household variable.

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References:

1. Jalloh MF, Nur AA, Nur SA, et al. Behaviour adoption approaches during public health emergencies: implications for the COVID-19 pandemic and beyond. *BMJ Global Health*. 2021;6(1):e004450.
2. Tadiri CP, Gisinger T, Kautzy-Willer A, et al. The influence of sex and gender domains on COVID-19 cases and mortality. *CMAJ*. 2020;192(36):E1041-E1045.
3. Canadian Institutes of Health Research. What is gender? What is sex? Accessed on 28 March 2022 at <https://cihr-irsc.gc.ca/e/48642.html>.
4. O'Neil A, Scovelle AJ, Milner AJ, Kavanagh A. Gender/sex as a social determinant of cardiovascular risk. *Circulation*. 2018;137(8):854-864.
5. Vlassoff C. Gender differences in determinants and consequences of health and illness. *Journal of Health, Population, and Nutrition*. 2007;25(1):47.
6. Burki T. The indirect impact of COVID-19 on women. *The Lancet Infectious Diseases*. 2020;20(8):904-905.
7. World Health O. *Gender and COVID-19: advocacy brief, 14 May 2020*. 2020.
8. Islam N, Sharp SJ, Chowell G, et al. Physical distancing interventions and incidence of coronavirus disease 2019: natural experiment in 149 countries. *BMJ*. 2020;370
9. Leung GM, Lam TH, Ho LM, et al. The impact of community psychological responses on outbreak control for severe acute respiratory syndrome in Hong Kong. *Journal of Epidemiology & Community Health*. 2003;57(11):857-863.
10. Poletti P, Caprile B, Ajelli M, Pugliese A, Merler S. Spontaneous behavioural changes in response to epidemics. *Journal of Theoretical Biology*. 2009;260(1):31-40.
11. Wenham C, Smith J, Morgan R. COVID-19: the gendered impacts of the outbreak. *The Lancet*. 2020;395(10227):846-848.
12. Galasso V, Pons V, Profeta P, Becher M, Brouard S, Foucault M. Gender differences in COVID-19 attitudes and behavior: Panel evidence from eight countries. *Proceedings of the National Academy of Sciences*. 2020;117(44):27285-27291.
13. Warraich HJ, Califf RM. Differences in health outcomes between men and women: biological, behavioral, and societal factors. *Clinical Chemistry*. 2019;65(1):19-23.
14. Pilote L, Karp I. GENESIS-PRAXY (GENdEr and Sex determinantS of cardiovascular disease: From bench to beyond-Premature Acute Coronary SYndrome). *American Heart Journal*. 2012;163(5):741-746.
15. Norris CM, Murray JW, Triplett LS, Hegadoren KM. Gender roles in persistent sex differences in health-related quality-of-life outcomes of patients with coronary artery disease. *Gender Medicine*. 2010;7(4):330-339.
16. Bacon SL, Lavoie KL, Boyle J, Stojanovic J, Joyal-Desmarais K. International assessment of the link between COVID-19 related attitudes, concerns and behaviours in relation to public health policies: Optimising policy strategies to improve health, economic and quality of life outcomes (the iCARE Study). *BMJ Open*. 2021;11(3):e046127.
17. Lavoie KL, Bacon SL. for the iCARE study team: iCARE Surveys. 2020;
18. Gaye A, Klugman J, Kovacevic M, Twigg S, Zambrano E. Measuring key disparities in human development: The gender inequality index. *Human Development Research Paper*. 2010;46:1-37.
19. Stachura P, Śleszyński J. Gender indicators of the United Nations Development Programme. *Economic and Environmental Studies*. 2016;16(4 (40)):511-530.

20. Durand H, Bacon SL, Byrne M, et al. Identifying and addressing psychosocial determinants of adherence to physical distancing guidance during the COVID-19 pandemic—project protocol. *HRB Open Research*. 2020;3
21. Harris M, Adhanom Ghebreyesus T, Liu T, et al. : COVID-19. World Health Organization. Archived (PDF) from the original on 2020-03-25. . 2020.
22. Vatcheva KP, Lee M, McCormick JB, Rahbar MH. Multicollinearity in regression analyses conducted in epidemiologic studies. *Epidemiology (Sunnyvale, Calif)*. 2016;6(2)
23. Felter C, Bussemaker N. Council on Foreign Relations. Which countries are requiring face masks? Retrieved on 27 October 2021 at <https://www.cfr.org/in-brief/which-countries-are-requiring-face-masks>.
24. Haischer MH, Beilfuss R, Hart MR, et al. Who is wearing a mask? Gender-, age-, and location-related differences during the COVID-19 pandemic. *PloS one*. 2020;15(10):e0240785.
25. Lawson V. Geographies of care and responsibility. *Annals of the Association of American Geographers*. 2007;97(1):1-11.
26. Barceló J, Sheen GC-H. Voluntary adoption of social welfare-enhancing behavior: Mask-wearing in Spain during the COVID-19 outbreak. *PloS One*. 2020;15(12):e0242764.
27. Robertson C, Gebeloff R. How millions of women became the most essential workers in America. *The New York Times*. 2020;18
28. Barber SJ, Kim H. COVID-19 worries and behavior changes in older and younger men and women. *The Journals of Gerontology: Series B*. 2021;76(2):e17-e23.
29. Ning L, Niu J, Bi X, et al. The impacts of knowledge, risk perception, emotion and information on citizens' protective behaviors during the outbreak of COVID-19: a cross-sectional study in China. *BMC Public Health*. 2020;20(1):1-12.
30. Kim JK, Crimmins EM. How does age affect personal and social reactions to COVID-19: Results from the national Understanding America Study. *PloS One*. 2020;15(11):e0241950.
31. Pasion R, Paiva TO, Fernandes C, Barbosa F. The AGE effect on protective behaviors during the COVID-19 outbreak: sociodemographic, perceptions and psychological accounts. *Frontiers in Psychology*. 2020;11:2785.
32. Hearne BN, Niño MD. Understanding how race, ethnicity, and gender shape mask-wearing adherence during the COVID-19 pandemic: evidence from the COVID impact survey. *Journal of Racial and Ethnic Health Disparities*. 2021:1-8.
33. Moran KR, Del Valle SY. A meta-analysis of the association between gender and protective behaviors in response to respiratory epidemics and pandemics. *PloS One*. 2016;11(10):e0164541.
34. Gonzales MC, Jain-Chandra MS, Kochhar MK, Newiak MM, Zeinullayev MT. *Catalyst for change: Empowering women and tackling income inequality*. International Monetary Fund; 2015.
35. Szolnoki G, Hoffmann D. Online, face-to-face and telephone surveys—Comparing different sampling methods in wine consumer research. *Wine Economics and Policy*. 2013;2(2):57-66.

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FIGURE

Figure 1: Percentage of adherence to protective health behaviours, per group of Gender Inequality Index (GII), stratified by sex

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FIGURE

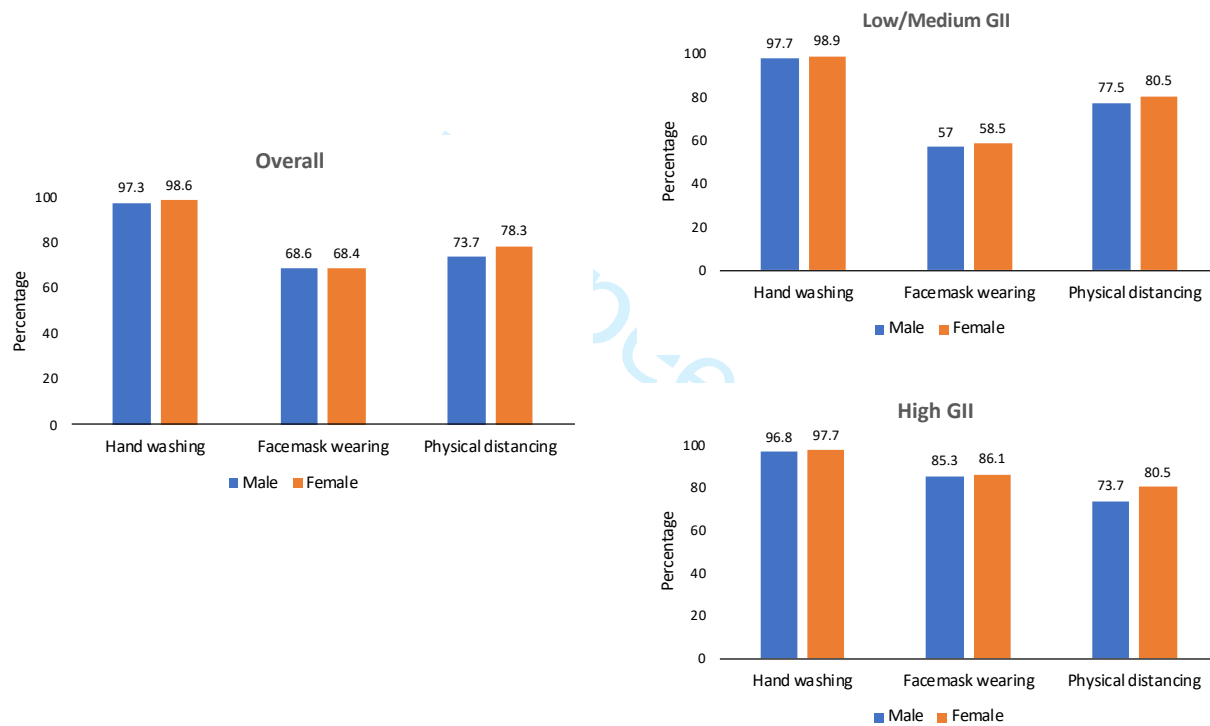


Figure 1: Percentage of adherence to protective health behaviours, per group of Gender Inequality Index (GII), stratified by sex

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APPENDIX

Table 1a. Association between gender-related variables and adoption of hand washing, by sex

	Hand washing							
	Female				Male			
	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value
Sociodemographic characteristics								
Age distribution								
• Up to 25 (ref)	-		-		-		-	
• 26-50	2.91 (2.37-3.58)	<0.001	4.44 (1.68-11.76)	<0.01	2.45 (1.91-3.14)	<0.001	1.85 (0.63-5.68)	0.25
• 51 and older	7.71 (5.57-10.66)	<0.001	13.39 (2.87-62.6)	<0.01	4.56 (3.36-6.18)	<0.001	2.25 (0.81-6.27)	0.11
Education level								
• Low level (ref)	-		-		-		-	
• High level	1.63 (1.29-2.07)	<0.001	0.78 (0.32-1.91)	0.58	1.47 (1.12-1.92)	<0.01	0.37 (0.14-1.01)	0.05
Work status								
• Unemployed (ref)	-		-		-		-	
• Employed	2.41 (1.35-4.28)	<0.01	1.19 (0.50-2.83)	0.69	1.38 (0.80-2.40)	0.24	1.91 (0.89-4.13)	0.09
Annual household income								
• Bottom third (ref)	-		-		-		-	
• Middle third	1.50 (1.12-2.01)	<0.01	1.92 (0.83-4.43)	0.12	1.42 (1.00-2.01)	<0.05	1.07 (0.41-2.81)	0.88
• Top third	1.96 (1.36-2.81)	<0.001	3.20 (0.84-12.15)	0.08	1.67 (1.15-2.43)	<0.01	2.52 (0.77-8.41)	0.12
Adults ≥18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	0.52 (0.41-0.66)	<0.001	1.04 (0.44-2.43)	0.93	0.73 (0.56-0.95)	0.02	0.46 (0.21-1.03)	0.06
Children ≤18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	0.69 (0.44-1.08)	0.12			0.84 (0.52-1.37)	0.48		
Gender Inequality Index								
• High GII (ref)	-		-		-		-	
• Low/Medium GII	2.29 (1.88-2.78)	<0.001	2.11 (0.95-4.71)	0.07	1.37 (1.09-1.72)	<0.01	0.57 (0.25-1.32)	0.18
Geographic Regions								
• Europe	1.91 (1.49-2.43)	<0.001			1.28 (0.98-1.67)	0.06		
• North America	2.93 (2.31-3.72)	<0.001			1.87 (1.42-2.46)	<0.001		
• Others (ref)	-		-		-		-	
Psychosocial characteristics								
Depressive disorder	0.73 (0.52-1.02)	0.07	0.74 (0.20-2.71)	0.65	0.63 (0.42-0.95)	<0.05	0.72 (0.18-2.98)	0.66
Anxiety disorder	0.90 (0.68-1.18)	0.45	0.98 (0.32-2.96)	0.97	0.71 (0.34-1.44)	0.05	2.51 (0.47-13.38)	0.28

Note: In the multivariable model, geographic regions variable dropped due to collinearity with GII. Number of children in household variables dropped due to collinearity with number of adults in the household variable.

Table 1b. Association between gender-related variables and adoption of physical distancing, by sex

	Physical distancing							
	Female				Male			
	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value
Sociodemographic characteristics								
Age distribution								
• Up to 25 (ref)	-		-		-		-	
• 26-50	1.10 (1.03-1.18)	<0.01	2.01 (1.54-2.63)	<0.001	1.11 (0.99-1.25)	0.05	2.53 (2.03-4.21)	<0.001
• 51 and older	1.60 (1.47-1.73)	<0.001	3.57 (2.72-4.68)	<0.001	1.41 (1.24-1.58)	<0.001	3.99 (2.47-6.46)	<0.001
Education level								
• Low level (ref)	-		-		-		-	
• High level	1.19 (1.11-1.27)	<0.001	1.39 (1.13-1.74)	<0.01	1.21 (1.09-1.34)	<0.001	0.87 (0.61-1.25)	0.45
Work status								
• Unemployed (ref)	-		-		-		-	
• Employed	0.55 (0.48-0.62)	<0.001	0.39 (0.32-0.49)	<0.001	0.48 (0.38-0.59)	<0.001	0.38 (0.27-0.52)	<0.001
Annual household income								
• Bottom third (ref)	-		-		-		-	
• Middle third	1.26 (0.99-1.60)	0.05	1.26 (0.99-1.59)	0.06	1.24 (0.89-1.73)	0.19	1.54 (1.01-2.32)	<0.05
• Top third	1.90 (1.41-2.56)	<0.001	1.53 (1.17-2.01)	<0.01	1.71 (1.19-2.45)	<0.01	2.13 (1.36-3.35)	<0.01
Adults ≥18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	0.65 (0.60-0.69)	<0.001	0.89 (0.72-1.09)	0.27	0.61 (0.55-0.67)	<0.001	0.66 (0.47-0.92)	<0.05
Children ≤18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	0.79 (0.69-0.92)	<0.01			0.94 (0.78-1.15)	0.56		
Gender Inequality Index								
• High GII (ref)	-		-		-		-	
• Low/Medium GII	0.99 (0.94-1.06)	0.95	0.72 (0.58-0.88)	<0.01	1.23 (1.13-1.34)	<0.001	0.87 (0.64-1.19)	0.39
Geographic Regions								
• Europe	1.16 (1.09-1.24)	<0.001			1.29 (1.17-1.43)	<0.001		
• North America	2.26 (2.12-2.41)	<0.001			2.26 (2.04-2.49)	<0.001		
• Others (ref)	-				-			
Psychosocial characteristics								
Depressive disorder	1.16 (1.05-1.29)	<0.01	1.07 (0.78-1.48)	0.66	1.00 (0.84-1.19)	0.96	0.86 (0.49-1.50)	0.60
Anxiety disorder	1.21 (1.12-1.31)	<0.001	1.03 (0.79-1.32)	0.84	1.00 (0.95-1.27)	0.19	1.40 (0.85-2.31)	0.18

Note: In the multivariable model, geographic regions variable dropped due to collinearity with GII. Number of children in household variables dropped due to collinearity with number of adults in the household variable.

STROBE Statement—checklist of items that should be included in reports of observational studies

Association of Biological Sex and Gender-related Factors with Public Engagement in Protective Health Behaviours during the COVID-19 Pandemic: Lessons Learned Going Forward

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1,3
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	7
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-9
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	NA
Bias	9	Describe any efforts to address potential sources of bias	NA
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9
		(b) Describe any methods used to examine subgroups and interactions	10
		(c) Explain how missing data were addressed	NA
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	NA

		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	NA

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	NA
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-12
		(b) Report category boundaries when continuous variables were categorized	9
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg, analyses of subgroups and interactions, and sensitivity analyses	12
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

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Impact of biological sex and gender-related factors on public engagement in protective health behaviours during the COVID-19 pandemic: cross-sectional analyses from a global survey

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3 1 **Impact of biological sex and gender-related factors on public engagement in protective**
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5 2 **health behaviours during the COVID-19 pandemic: cross-sectional analyses from a global**
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7 3 **survey**
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For peer review only

34 ABSTRACT

35
36 **Objective:** Given the role of sociocultural gender in shaping human behaviours, the main
37 objective of this study was to examine whether sex and gender-related factors were associated with
38 the public's adherence to COVID-19 recommended protective health behaviours.

39 **Design:** This was a retrospective analysis of the survey that captured data on people's awareness,
40 attitudes, and behaviours as they relate to the COVID-19 policies.

41 **Setting:** Data from the International COVID-19 Awareness and Responses Evaluation (iCARE)
42 survey collected between March 2020 to February 2021 from 175 countries.

43 **Participants:** Convenience sample around the world.

44 **Main outcome measures:** We examined the role of sex and gender-related factors in relation to
45 non-adherence of protective health behaviors including: (i) hand washing; (ii) mask wearing; and
46 (iii) physical distancing. Multivariable logistic regression was conducted to determine the factors
47 associated with non-adherence to behaviors.

48 **Results:** Among 48,668 respondents (mean age: 43 years; 71% female), 98.3% adopted hand
49 washing, 68.5% mask wearing, and 76.9% physical distancing. Compared with males, females
50 were more likely to adopt hand washing (OR=1.97, 95%CI: 1.71-2.28) and maintain physical
51 distancing (OR=1.28, 95%CI: 1.22-1.34). However, in multivariable sex-stratified models,
52 females in countries with higher gender inequality indexes (GII) were less likely to report hand
53 washing (aOR=0.47, 95%CI: 0.21-1.05). Females who reported being employed (aOR=0.22,
54 95%CI: 0.10-0.48) and in countries with low/medium GIIs (aOR=0.18, 95%CI: 0.06-0.51) were
55 less likely to report mask wearing. Females who reported being employed were less likely to report
56 physical distancing (aOR=0.39, 95%CI: 0.32-0.49).

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3 57 **Conclusion:** While females showed greater adherence to COVID-19 protective health behaviours,
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5 58 gender-related factors, including employment status and high-country wide gender inequality were
6
7 59 independently associated with non-adherence. These findings may inform public health and
8
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10 60 vaccination policies in current as well as future pandemic.

11
12 61 **Keywords:**

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15 62 COVID-19, SARS-Cov-2, health behaviours, hand washing, mask wearing, physical distancing
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18 64
19 65 **Strengths and limitations of this study:**

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21 66
- 22 • The study had a large sample size with a global perspective, and availability of gender-
23 related factors to examine the impact of gender.
24 67
 - 25 68 • The online nature of the iCARE survey might have limited the participation from
26 individuals who did not had access to computers and internet, limiting the generalization
27 of findings.
28 69
 - 29 70 • Our global sample was highly educated group of people whose results are likely to be ‘best
30 case scenario’.
31 71
 - 32 72 • The global sample was also mostly females, so males are underrepresented in this study.
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 - 34 74 • Self-reported behaviour of the respondents might not have accurately represented actual
35 behaviour, hence, the findings should be interpreted with caution.
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78 INTRODUCTION

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80 Public behaviour plays an important role during public health emergencies.¹ Behaviours can be
81 influenced by both the biological sex and sociocultural gender (gender identity, gender roles,
82 gender relations, and institutionalized gender) of an individual. ² According to the Canadian
83 Institutes of Health and Research (CIHR), sex refers to “*a set of biological attributes and*
84 *associated physical and physiological features including chromosomes, gene expression, hormone*
85 *levels and function, and reproductive/sexual anatomy*” and are categorized as female or male.³
86 While gender refers to “*the array of socially constructed roles and relationships, personality traits,*
87 *attitudes, behaviours, values, relative power and influence that society ascribes to women and men*
88 *on a differential basis*”.^{4,5} In the case of the Coronavirus Disease 2019 (COVID-19) pandemic,
89 both men and women worldwide have shown inconsistent responses to acute infection as well as
90 differing long-term health, economic, and social consequences.^{6,7} Understanding these responses
91 in relation to sex and/or gender-related attributes in the general population may be particularly
92 valuable to inform tailored sex and gender strategies moving forward.

93
94 It has been identified that public health responses to infectious diseases require fundamental
95 changes in individual behaviour. Hand washing, mask wearing, and physical distancing
96 (*previously referred to as social distancing*) are the key transmission reduction public health
97 behaviour-based prevention measures ¹ that are associated with a reduction in the global
98 prevalence of COVID-19.^{8,9} Effectiveness of such responses depends not only on the generalized
99 adherence of the public but may be specific to certain high-risk groups. Though recommended and
100 proven to limit transmission rates, hand washing, mask wearing, and physical distancing have been
101 inconsistently initiated and maintained. There is a dynamic relationship between the voluntary

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3 102 adoption of public health behaviours and infection transmission during infectious disease
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5 103 epidemics.¹⁰ The COVID-19 pandemic has sparked an unparalleled global discourse around the
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8 104 adoption of protective behaviours and other public health and social measures to slow the person-
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10 105 to-person spread of SARS-CoV-2.¹

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14 107 COVID-19 has highlighted the role that sex and gender play in our lives. This includes influencing
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16 108 an individual's exposure to COVID-19 through sex and gender-related occupations, risk-taking
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18 109 behaviours, and employment of precautions. Sex and gender also are known to have an impact on
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20 110 health through the gendered nature of the workforce and the predominant risk associated with it,
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22 111 increased caregiving responsibilities at home limiting the work and economic opportunities, or
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24 112 institutional biases and policies.^{2,11} Gender affects the division of labor and care duties in families
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26 113 and communities. Hence, it is of utmost importance that we gather, from our recent lived
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28 114 experience, evidence on the potential sex and gender-related differences in perception and
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30 115 behavioural responses experienced during COVID-19 pandemic.

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37 117 A few studies have shown sex-based differences in COVID-19 related beliefs and behaviours and
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39 118 have reported that compared to males, females are more likely to perceive the pandemic as a
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41 119 serious health problem and comply more with the preventive behaviours.^{12,13} In addition, as gender
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43 120 is culturally and geographically based, we hypothesized that there is a difference in preventive
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45 121 behaviours and pandemic related concerns based on sex and gender-related factors. Also,
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47 122 regardless of sex-based differences, our previous studies highlight the need of focusing on the
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49 123 gender-related factors.^{14,15} Hence, the purpose of this study was to examine whether sex and
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51 124 gender-related factors are associated with the engagement in the recommended key protective
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3 125 health behaviours such as hand washing, mask wearing, and physical distancing during the
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5 126 COVID-19 pandemic.
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10 129 **METHODS**

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12 130 **Study design**

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14 131 Survey datasets from the ongoing iCARE (International Covid-19 Awareness and Responses
15 132 Evaluation) study led by the Montreal Behavioural Medicine Centre (MBMC: [www.mbmc-](http://www.mbmc-cmc.ca)
16 133 [cmc.ca](http://www.mbmc-cmc.ca)) in collaboration with a team of 200 international collaborators from 42 countries was
17 134 used for the data analyses. The iCARE study design has been previously described.¹⁶ Briefly,
18 135 iCARE is an international multi-wave cross-sectional observational cohort study of public
19 136 awareness, attitudes, and responses to public health policies implemented to reduce the spread of
20 137 COVID-19 on people around the world (www.iCAREstudy.com). It collects data on study
21 138 demographics, perceptions of government policy, health behaviours, adherence to health
22 139 measures, types of concerns, and adherence motivators.
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38 141 Survey data were collected in 4-6 week rounds using convenience snowball sampling (globally,
39 142 25-30K per wave) and parallel representative sampling (in targeted countries), generating data for
40 143 multiple cohorts of participants that were added to the first round cohort launched on March 27,
41 144 2020. We analyzed data from Survey 1 – Survey 7 that was collected between March 27, 2020 to
42 145 February 9, 2021. A total of 61,552 respondents participated in the survey from over 175 countries.
43 146 The data was analyzed for 48,668 respondents (female=34,556, male=14,112). The questionnaire
44 147 used in the survey is publicly available via the Open Science Framework (<https://osf.io/nswcm/>)
45 148 and the survey is available in 34 languages.¹⁷
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4 150 **Biological sex and gender-related factors**

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6 152 For each surveyed individual the following variables were collected: socio-demographic
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9 153 characteristics (sex at birth, age in years, level of education, work status, perceived annual
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11 154 household income, number of adults and children living in the household, country of residence,
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13 155 and likelihood of getting vaccinated *i.e.*, respondents' willingness to get a COVID-19 vaccine),
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15 156 the presence of a physician-diagnosed depressive and/or anxiety disorder, and adoption of
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17 157 protective health behaviours (hand washing, wearing a face mask, and physical distancing).
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22 159 To account for institutionalized gender, the Gender Inequality Index (GII), developed by the
23
24 160 United Nations Development Programme, was used as a measure of country specific gender
25
26 161 inequality¹⁸ and as a measure of institutionalized gender in this study. This index is a continuous
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28 162 measure for the degree of gender inequality per country on a scale between 0 and 1, with lower
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30 163 values representing near-perfect gender equality and higher values representing greater levels of
31
32 164 inequality favoring males. The GII is based on several aspects of institutionalized gender: (i)
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34 165 reproductive health, measured by the maternal mortality ratio and adolescent birth rates; (ii)
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36 166 empowerment, measured by the proportion of parliamentary seats occupied by women and the
37
38 167 proportion of adult women and men with at least some secondary education; and (iii) economic
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40 168 status, measured by labor force participation rate of men and women.¹⁹ GIIs in this study were
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42 169 divided into tertiles and later categorized into high and low/medium GII categories. We used data
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44 170 on GIIs from 2019. Some of the countries in the region were excluded from the analysis due to the
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46 171 unavailability of data.
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53 173 **Outcome measures**

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3 175 The main outcomes of the analysis were self-reported non-adherence to three recommended
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5 176 protective health behaviours including: (i) hand washing with soap and water; (ii) wearing a face
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7 177 mask; and (iii) a composite measure of physical distancing behaviours (specifically: staying at
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9 178 least 1-2 meters away from other people; staying/working at home rather than going to work or
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11 179 school; self-quarantining if returning from a trip; self-quarantining if one have the virus or believe
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13 180 they have the virus; avoid going out to bars/pubs/restaurants; avoiding large social gatherings;
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15 181 avoiding small social gatherings; avoiding indoor social gatherings; and avoiding any non-
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17 182 essential travel).²⁰ A composite binary variable was constructed in which, the participants who met
18
19 183 the above-mentioned criteria were coded with a value of 1; otherwise, the participants were coded
20
21 184 with a value of 0. A set of measures in the iCARE survey intended to explore the prevention
22
23 185 measures used by the public to prevent the spread of COVID-19 by maintaining a physical distance
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25 186 between two people and reducing the number of times people come into close physical contact
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27 187 with one another²¹ were used to create a composite variable for physical distancing.
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190 **Methodological steps**

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37 191 To consider gender-related variables in the evaluation of health behavior outcomes in retrospective
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39 192 cohort studies, a multistep methodology has been developed by The Gender Outcomes
40
41 193 International Group: to Further Well-being Development (GOING-FWD) group.²² The steps
42
43 194 applied in this study are (i) identification of gender-related variables (ii) definition of outcomes
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45 195 (iii) and building of feasible final variable list. The final list of gender-related variables was
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47 196 included in the statistical models.
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198 **Statistical analysis**

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3 200 A global analysis of public engagement in three recommended protective health behaviours was
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5 201 performed to investigate whether the outcomes differed by sex. Our outcome of interest in the
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7 202 modeling process was the non-adherence to behavioural recommended measures. Descriptive sex-
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10 203 stratified analyses were run for: age; baseline mental health conditions (any depressive or anxiety
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12 204 disorders); and previously defined gender-related factors such as level of education, work status,
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14 205 annual household income, and GII. Continuous variables were presented as mean and standard
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16 206 deviation (SD). Categorical variables were presented as counts and percentages. Sex differences
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18 207 in outcomes (protective health behaviours) were completed and associations between sex, gender-
19
20 208 related factors, and outcomes were tested in a multivariable model. Bivariate logistic regressions
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22 209 were run for crude analysis followed by collinearity diagnostics to account for inflation in standard
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24 210 errors of parameter estimates caused by collinear cofactors.²³ If variables were collinear, we
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26 211 included the variable with the least amount of missing data in the multivariable models. *A priori*
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28 212 gender-related cofactors (i.e., gender role [work status], gender identity [depressive and/or anxiety
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30 213 disorders], and institutionalized gender [education level, annual household income, and GII]) were
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32 214 included in multivariable models adjusting for the potential confounders (i.e., age and geographical
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34 215 regions). Two-way interaction between the sex and gender-related factors were tested by including
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36 216 an interaction term in bivariate models. All statistical analyses were performed using statistical
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38 217 software STATA version 16 (College Station, TX, USA). Tests were two sided and the
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40 218 significance was defined as $p < 0.05$.

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49 220 **Patient and public involvement**

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51 221 It was not possible to involve patients or the public in the design, or conduct, or reporting, or
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53 222 dissemination plans of our research. However, they were involved in the survey development. For
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223 the dissemination of results, we will submit the results of the study to relevant national and
224 international journals with the intention of publishing the results widely. Further, we will make
225 national and international presentations in conferences and symposiums to stakeholder groups
226 including those involving general public, researchers, clinicians, and policymakers.

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228

229 RESULTS

230

231 Descriptive characteristics of respondents

232 Our study population included 34,556 females (71%) and 14,112 males (29%) (**Table 1**). The
233 mean age of the respondents was 43 years (SD: 16). A majority (n=23,462, 48.8%) was between
234 26 and 50 years of age. Most respondents (79.7%) reported high levels of education, were
235 employed (61.8%), were from Europe and North American countries (66.3%), and from regions
236 with high levels of gender equity as measured by low/medium GIIs (66.9%). Females were more
237 likely to report having a physician-diagnosed depressive disorder (9.5% vs 6.7%, $p \leq 0.001$) and
238 anxiety disorder (17.7% vs 10.7%, $p \leq 0.001$) compared to males. Irrespective of sex, only 68.5%
239 of responders disclosed wearing a facemask, while a higher percentage of females reported
240 adherence to physical distancing behaviours compared to males (78.3% vs 73.7%, $p < 0.001$).
241 Participants aged 51 and older were more likely to engage in all three-key protective behaviours
242 as compared with younger participants: hand washing (Odds ratio [OR]= 5.60, 95% Confidence
243 interval [CI]: 4.51-6.94); mask wearing (OR=1.11, 95% CI: 1.04-1.18); and physical distancing
244 (OR=1.50, 95% CI: 1.41-1.61) (**Table 2**).

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246 Gender-related factors associated with adoption of protective health behaviours

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248 For the univariate analysis, the proportion of people adopting the protective health-related
249 behaviours, varied depending on the gender-related factor examined. Despite employed

respondents being 84% more likely to engage in hand washing than unemployed respondents, they were 65% less likely to engage in mask wearing and 47% less likely to engage in physical distancing ($p < 0.001$ for all comparisons). Hand washing and physical distancing was less common as the number of adults ≥ 18 years living in the household increased. The proportion of adoption was lowest for wearing a facemask, both for females and males (58.5% vs 57%) in low/medium GII countries (**Figure 1**). Respondents living in the countries with high GII were 4.38 times (95% CI: 4.15-4.63) more likely to use mask than respondents living in the countries with low GIIs; however, they were less likely to engage in hand washing and less likely to engage in physical distancing (**Table 2**).

Sex and gender-related differences in the adoption of protective health behaviours

Sex-stratified multivariate analyses demonstrated that the factors associated with the adoption of protective health behaviours varied by sex. *Among females*, the factors associated with not adhering to health behaviours were: (i) for hand washing- higher country gender inequality favoring males GII (aOR=0.47, 95% CI: 0.21-1.05, $p=0.07$) (ii) for mask-wearing- older age (aOR females=0.35, 95% CI:0.12-1.03, $p=0.05$), being employed (aOR females=0.22, 95% CI:0.10-0.48, $p < 0.001$), and living in a country with more gender equity as measured by the GII (aOR=0.18, 95% CI: 0.06-0.51, $p < 0.01$); and (iii) for physical distancing- being employed (aOR females=0.39, 95% CI:0.32-0.49, $p < 0.001$) (**Table 3, Appendix-Table 1a, Table 1b**).

Among males, factors that were associated with not adhering to protective health behaviours were: (i) for hand washing- higher level of education (aOR males=0.37, 95% CI: 0.14-1.01, $p=0.05$) and with a household size of > 2 (aOR males=0.46, 95% CI: 0.21-1.03, $p=0.06$); (ii) for mask wearing- being employed (aOR males=0.15, 95% CI:0.04-0.53, $p < 0.01$) and living in a country with more

275 gender equity as measured by the GII (aOR=0.29, 95% CI: 0.09-0.91, $p<0.05$); and (iii) for
276 physical distancing- being employed (aOR males=0.38, 95% CI:0.27-0.52, $p<0.001$) and with
277 household size of > 2 (aOR males=0.66, 95% CI: 0.47-0.92, $p<0.05$) (**Table 3, Appendix-Table**
278 **1a, Table 1b**).

279
280 There was a significant interaction between sex and educational level of the participants. High
281 level of education decreased the use of mask wearing among females compared to males ($p=0.03$).
282 There was a trend for living in a country with lower gender equity to be associated with poorer
283 protective behaviors in females compared to males ($p=0.056$).

285 DISCUSSION

286 The present study provides a comprehensive analysis on the impact of sex and gender-related
287 factors and the association with adherence to protective health behaviours during the COVID-19
288 pandemic. Overall, hand washing, mask wearing, and physical distancing behaviours were adopted
289 globally. However, there were a number of gender-related factors associated with a lower
290 adherence based on sex.

291
292 Lower adherence to the protective health behaviours was mainly associated with younger age,
293 being employed, and living in a country with low/medium GII (higher gender equity) for females.
294 While high level of education, being employed, and household size of >2 were associated with
295 lower adoption in males. Considering these group of individuals with lower adherence to
296 protective health behaviours, this would suggest that in the current as well as future pandemics it
297 may be useful to target interventions based on sex and gendered factors to increase adherence and

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3 298 reduce disease transmission. Measures such as risk-assessment and mitigation considerations for
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5 299 public settings could be implemented to mitigate the risk of transmission and promote the adoption
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8 300 of protective health behaviours.
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12 302 Overall, mask wearing was lower among both sexes compared to other protective behaviours such
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14 303 as hand washing and physical distancing. Many countries waited to issue mask mandates months
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16 304 into the pandemic²⁴ even though other behaviours were mandated right away. This may be one of
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18 305 the reasons for lower adherence. Further, adoption of mask wearing was less likely in males
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20 306 compared to females, mainly among those who were employed, indicating substantial room for
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22 307 improvement in male's engagement to mask wearing. In our study, employed female respondents
23
24 308 reported that they were more likely to wear a mask compared to male respondents. Similarly, a
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26 309 study conducted in the United States also reported that females were 1.5 times more likely to wear
27
28 310 a mask compared to males.²⁵ It has been suggested that females may be more likely to protect
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30 311 themselves and others by wearing a mask specifically because they handle the majority of
31
32 312 caregiving within families and are overrepresented in essential work services, which generally
33
34 313 requires mask wearing.²⁶ Previous studies have also reported mask wearing to be significantly
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36 314 associated with the occupation of respondents.^{27,28} A study reported that women make up almost
37
38 315 90 percent of nurses and nursing assistants in the United States and over two-thirds of grocery
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40 316 store cashiers.²⁸ Performing the dual function of an essential worker outside and a caregiver at
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42 317 home, women might face a dilemma of how to keep their families healthy and safe while
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44 318 continuing to work in potentially risky circumstances, suggesting that these factors may make them
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46 319 more adherent to the protective behaviours.
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3 321 Older females were the most likely participants to engage in hand washing and physical distancing,
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5 322 but less likely to engage in mask wearing. Older females may have a higher perceived risk of
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7 323 developing COVID-19 complications and mortality, and thus engaged in more protective health
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9 324 behaviours such as hand washing and physical distancing. Previous studies have shown that
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11 325 females and older adults are less likely to engage in the risky behaviours, feel more vulnerable to
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13 326 contracting diseases, and have a stronger sense of responsibility to protect society.^{29,30} This is
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15 327 consistent with the findings of an American study that reported being older and female was related
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17 328 to adopting more pandemic mitigating behaviours.³¹ Furthermore, a study conducted in China also
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19 329 reported that being female and older was associated with adopting protective behaviours.³⁰
20
21 330 However, our study findings are in contrast with the results of a study conducted in Portugal that
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23 331 reported a decline in engagement in protective health behaviours with advancing age, which was
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25 332 reported to be related to the increased social-isolation and lack of help among older population.³²
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27 333 Even though the study did not report the differences by sex of the respondents, self-isolation could
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29 334 be the reason for lower adherence to mask wearing among females. Depending on the diverse
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31 335 context, public health interventions should be tailored not only to sex, but differing age groups,
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33 336 and importantly institutional gender related variables such as those measured by the GII.
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42 338 Emerging evidence shows that gender including the institutionalized gender shapes mask wearing
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44 339 adherence.³³ One of the interesting findings of the current study is respondents from low/medium
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46 340 GII countries with less gender inequity reported a significantly lower adherence to mask wearing
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48 341 compared to respondents from countries with high GII (high gender inequity). Even among the
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50 342 low/medium GII countries, adherence is reported to be poorer among males. Lower adherence
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52 343 among males is in line with a finding from a study conducted in the United States, in which males
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3 344 exhibited poorer mask wearing practices compared with their female counterparts.²⁵ This is also
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5 345 supported by a review that looked at research from multiple countries and found women were 50%
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7 346 more likely than men to practice protective behaviour.³⁴ The correlation between a Gini coefficient
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9 347 (a measure of income inequality) and GII (a measure of gender inequality) could explain the lower
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11 348 adherence to protective health behaviours in countries with low/medium GII where income
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13 349 inequality arises mainly through gender gaps in economic participation.³⁵
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19 351 The strengths of this study include a large sample size, having a global perspective, and availability
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21 352 of gender-related factors to examine the impact of gender. This study also has some limitations
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23 353 that should be acknowledged. First, the online nature of the iCARE survey might have limited the
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25 354 participation from individuals who did not had access to computers and internet, limiting the
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27 355 generalization of findings. However, the advantages of online surveys have been shown to
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29 356 outweigh the disadvantages, mainly in terms of its external validity;³⁶ hence, the bias might be
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31 357 relatively low. Second, our global sample was highly educated group of people whose results are
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33 358 likely to be 'best case scenario'. The global sample was also mostly women, so men are
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35 359 underrepresented in this study. Third, self-reported behaviour doesn't always accurately represent
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37 360 actual behaviour, hence, the findings should be interpreted with caution. Finally, although the
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39 361 study established the associations between sex and gender-related factors with the adoption of
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41 362 protective health behaviours, no causal relationships should be assumed due to the nature of the
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43 363 cross-sectional design of the survey.
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50 51 365 **CONCLUSIONS**

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3 367 In this analysis of a multinational study population, while a majority of respondents reported
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5 368 wearing a facemask, this is likely reflective of country wide mask mandates as opposed to adopting
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7 369 it as a protective health behavior. However, our study findings, suggest that wearing a facemask
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10 370 appeared to be more difficult to adhere to for many compared to other key protective behaviours
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12 371 such as hand washing and physical distancing. Moreover, our study noted that this was even more
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14 372 apparent in countries with low GII (more equity between males and females) indicating substantial
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16 373 room for improvement in public engagement regarding protective health behaviours. Since
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18 374 widespread protective behavioural responses are paramount for a successful containment and
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20 375 control of an infectious disease contagion, the present study provides valuable information for
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22 376 identifying sex and gendered factors that may inform effective public health policies. Further, the
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24 377 Covid-19 pandemic highlights the urgent need to incorporate sex and gender analysis into all
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26 378 research and innovation processes in order to target specific groups both to help contain the
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28 379 transmission of the virus and to formulate vaccine policies.
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558 TABLES

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560 Table 1. Descriptive characteristics of survey respondents by biological sex (N=48668)

	N ¹	Overall n (%) or Mean [SD]	Biological sex	
			Male (N=14112) n (%) or Mean [SD]	Female (N=34556) n (%) or Mean [SD]
Socio-demographic characteristics				
Age (in years)	48524	43 [16]	42 [16]	44 [17]
Age distribution in strata	48049			
• Up to 25		8632 (18.0)	2327 (16.8)	6305 (18.5)
• 26-50		23462 (48.8)	6372 (45.8)	17090 (50.0)
• 51 and older		15955 (33.2)	5197 (37.4)	10758 (31.5)
Education level	38217			
• Low level		7758 (20.3)	2208 (20.5)	5550 (20.2)
• High level		30459 (79.7)	8564 (79.5)	21895 (79.8)
Work status	7071			
• Unemployed		2698 (38.2)	775 (40.7)	1923 (37.2)
• Employed		4373 (61.8)	1131 (59.3)	3242 (62.8)
Annual perceived household income	33814			
• Bottom third		4739 (14.0)	1249 (12.8)	3490 (14.5)
• Middle third		19107 (56.5)	4910 (50.2)	14197 (59.1)
• Top third		9968 (29.5)	3622 (37.0)	6346 (26.4)
Number of adults ≥18 years living in the household	32979			
• 1		15657 (47.5)	4419 (46.8)	11238 (47.7)
• 2		8999 (27.3)	2485 (26.3)	6514 (27.7)
• 3		4756 (14.4)	1352 (14.3)	3404 (14.5)
• 4		2231 (6.8)	700 (7.4)	1531 (6.5)
• ≥ 5		1336 (4.0)	478 (5.1)	858 (3.6)
Number of children ≤ 18 years living in the household	12357			
• 1		5951 (48.2)	1575 (45.7)	4376 (49.1)
• 2		4620 (37.4)	1271 (36.9)	3349 (37.6)
• 3		1290 (10.4)	401 (11.6)	889 (10)
• 4		323 (2.6)	117 (3.4)	206 (2.3)
• ≥ 5		171 (1.4)	82 (2.4)	91 (1)
Gender Inequality Index	45615			
• Low/Medium GII		30530 (66.9)	8188 (62.3)	22342 (68.8)
• High GII		15085 (33.1)	4951 (37.7)	10134 (31.2)
Geographic Regions	48632			
• Europe		12106 (24.9)	3558 (25.3)	8548 (24.8)
• North America		18658 (38.4)	4674 (33.2)	13984 (40.5)
• Others		17868 (36.7)	5860 (41.2)	12008 (34.8)
Likelihood of getting vaccinated	38979			
• Unlikely		4664 (11.9)	1220 (10.9)	3444 (12.4)
• Likely		34315 (88.0)	9930 (89.1)	24385 (87.6)
Psychosocial characteristics				
Depressive disorder	37616	3276 (8.7)	705 (6.7)	2571 (9.5)
Anxiety disorder	37481	5889 (15.7)	1133 (10.7)	4756 (17.7)

¹ Number of observations with complete information; GII: Gender Inequality Index

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Table 2. Bivariate association between gender-related variables and adoption of three key protective health behaviours

	Hand washing (n=43318)		Mask wearing (n=42767)		Physical distancing (n=43368)	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Socio-demographic characteristics						
Biological sex						
• Male (ref)	-		-		-	
• Female	1.97 (1.71-2.28)	<0.001	0.98 (0.94-1.03)	0.41	1.28 (1.22-1.34)	<0.001
Age distribution						
• Up to 25 (ref)	-		-		-	
• 26-50	2.71 (2.31-3.17)	<0.001	0.86 (0.82-0.92)	<0.001	1.11 (1.04-1.18)	<0.001
• 51 and older	5.60 (4.51-6.94)	<0.001	1.11 (1.04-1.18)	<0.01	1.50 (1.41-1.61)	<0.001
Education level						
• Low level (ref)	-		-		-	
• High level	1.56 (1.31-1.85)	<0.001	0.99 (0.94-1.04)	0.78	1.20 (1.13-1.27)	<0.001
Work status						
• Unemployed (ref)	-		-		-	
• Employed	1.84 (1.25-2.71)	<0.01	0.35 (0.23-0.54)	<0.001	0.53 (0.47-0.60)	<0.001
Annual household income						
• Bottom third (ref)	-		-		-	
• Middle third	1.47 (1.18-1.84)	<0.01	1.18 (1.11-1.26)	<0.001	0.98 (0.91-1.06)	0.78
• Top third	1.63 (1.27-2.10)	<0.001	1.02 (0.95-1.10)	0.52	1.23 (1.12-1.33)	<0.001
Adults ≥18 years living in the household						
• 1 (ref)	-		-		-	
• 2	0.80 (0.65-0.99)	<0.05	1.27 (1.21-1.35)	<0.001	0.73 (0.69-0.78)	<0.001
• 3	0.59 (0.46-0.75)	<0.001	1.63 (1.52-1.76)	<0.001	0.64 (0.59-0.69)	<0.001
• 4	0.59 (0.43-0.82)	<0.01	2.31 (2.06-2.58)	<0.001	0.50 (0.45-0.55)	<0.001
• ≥ 5	0.35 (0.25-0.48)	<0.001	2.77 (2.39-3.22)	<0.001	0.43 (0.38-0.48)	<0.001
Children ≤18 years living in the household						
• 1 (ref)	-		-		-	
• 2	1.18 (0.88-1.58)	0.26	0.81 (0.74-0.87)	<0.001	1.09 (0.99-1.19)	0.06
• 3	0.91 (0.59-1.39)	0.68	0.81 (0.71-0.92)	<0.01	0.92 (0.80-1.05)	0.25
• 4	0.68 (0.34-1.36)	0.28	1.10 (0.85-1.42)	0.45	0.75 (0.58-0.96)	0.05
• ≥ 5	0.23 (0.13-0.41)	<0.001	0.95 (0.68-1.32)	0.79	0.55 (0.41-0.76)	<0.001
Gender Inequality Index						
• Low/Medium GII (ref)	-		-		-	
• High GII	0.52 (0.45-0.60)	<0.001	4.38 (4.15-4.63)	<0.001	0.91 (0.86-0.96)	<0.001
Geographic Regions						
• Europe	1.63 (1.37-1.95)	<0.001	0.29 (0.27-0.31)	<0.001	1.21 (1.14-1.28)	<0.001
• North America	2.54 (2.13-3.04)	<0.001	0.21 (0.20-0.22)	<0.001	2.30 (2.18-2.42)	<0.001

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• Others (ref)	-		-		-	
Likelihood of getting vaccinated						
• Unlikely (ref)	-		-		-	
• Likely	3.04 (2.57-3.61)	<0.001	1.15 (1.08-1.22)	<0.001	2.18 (2.04-2.32)	<0.001
Psychosocial characteristics						
Depressive disorder	0.76 (0.59-0.98)	<0.05	0.91 (0.85-0.98)	<0.05	1.15 (1.05-1.26)	<0.01
Anxiety disorder	0.91 (0.73-1.11)	0.35	0.88 (0.83-0.93)	<0.001	1.22 (1.14-1.31)	<0.001

¹Number of observations with complete information

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Table 3. Association between gender-related variables and adoption of facemask wearing, by sex

	Mask wearing							
	Female				Male			
	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value
Sociodemographic characteristics								
Age distribution								
• Up to 25 (ref)	-		-		-		-	
• 26-50	0.85 (0.79-0.91)	<0.001	0.77 (0.26-2.35)	0.65	0.91 (0.81-1.01)	0.11	0.59 (0.07-5.04)	0.63
• 51 and older	1.11 (1.02-1.18)	<0.01	0.35 (0.12-1.03)	0.05	1.12 (1.00-1.26)	<0.05	0.52 (0.06-4.47)	0.55
Education level								
• Low level (ref)	-		-		-		-	
• High level	0.95 (0.89-1.01)	0.15	0.84 (0.43-1.66)	0.61	1.08 (0.98-1.20)	0.10	0.37 (0.10-1.33)	0.12
Work status								
• Unemployed (ref)	-		-		-		-	
• Employed	0.38 (0.23-0.63)	<0.001	0.22 (0.10-0.48)	<0.001	0.31 (0.14-0.67)	<0.01	0.15 (0.04-0.53)	<0.01
Annual household income								
• Bottom third (ref)	-		-		-		-	
• Middle third	1.19 (1.10-1.29)	<0.001	0.76 (0.32-1.84)	0.54	1.12 (0.98-1.27)	0.08	1.64 (0.57-4.74)	0.36
• Top third	1.01 (0.92-1.10)	0.80	0.89 (0.35-2.28)	0.81	1.01 (0.87-1.15)	0.93	5.93 (0.64-21.48)	<0.01
Adults ≥18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	1.79 (1.68-1.93)	<0.001	0.89 (0.46-1.71)	0.71	1.73 (1.56-1.93)	<0.001	1.79 (0.50-6.40)	0.36
Children ≤18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	1.03 (1.81-2.49)	0.66			0.79 (0.65-0.96)	0.02		
Gender Inequality Index								
• High GII (ref)	-		-		-		-	
• Low/Medium GII	0.23 (0.21-0.24)	<0.001	0.18 (0.06-0.51)	<0.01	0.23 (0.21-0.25)	<0.001	0.29 (0.09-0.91)	<0.05
Geographic Regions								
• Europe	0.31 (0.28-0.33)	<0.001			0.26 (0.23-0.29)	<0.001		
• North America	0.21 (0.20-0.23)	<0.001			0.21 (0.18-0.23)	<0.001		
• Others (ref)	-				-			
Psychosocial characteristics								
Depressive disorder	0.91 (0.83-0.99)	<0.05	0.99 (0.33-3.07)	1.00	0.95 (0.81-1.12)	0.57	1.01 (0.20-5.01)	0.98
Anxiety disorder	0.87 (0.81-0.93)	<0.001	2.29 (0.84-6.24)	0.11	0.94 (0.82-1.07)	0.39	0.85 (0.23-3.18)	0.81

Note: In the multivariable model, geographic regions variable dropped due to collinearity with GII. Number of children in household variables dropped due to collinearity with number of adults in the household variable.

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References:

1. Jalloh MF, Nur AA, Nur SA, et al. Behaviour adoption approaches during public health emergencies: implications for the COVID-19 pandemic and beyond. *BMJ Global Health*. 2021;6(1):e004450.
2. Tadiri CP, Gisinger T, Kautzy-Willer A, et al. The influence of sex and gender domains on COVID-19 cases and mortality. *CMAJ*. 2020;192(36):E1041-E1045.
3. Canadian Institutes of Health Research. What is gender? What is sex? Accessed on 28 March 2022 at <https://cihr-irsc.gc.ca/e/48642.html>.
4. O'Neil A, Scovelle AJ, Milner AJ, Kavanagh A. Gender/sex as a social determinant of cardiovascular risk. *Circulation*. 2018;137(8):854-864.
5. Vlassoff C. Gender differences in determinants and consequences of health and illness. *Journal of Health, Population, and Nutrition*. 2007;25(1):47.
6. Burki T. The indirect impact of COVID-19 on women. *The Lancet Infectious Diseases*. 2020;20(8):904-905.
7. World Health Organization. *Gender and COVID-19: advocacy brief, 14 May 2020*. 2020.
8. Islam N, Sharp SJ, Chowell G, et al. Physical distancing interventions and incidence of coronavirus disease 2019: natural experiment in 149 countries. *BMJ*. 2020;370
9. Leung GM, Lam TH, Ho LM, et al. The impact of community psychological responses on outbreak control for severe acute respiratory syndrome in Hong Kong. *Journal of Epidemiology & Community Health*. 2003;57(11):857-863.
10. Poletti P, Caprile B, Ajelli M, Pugliese A, Merler S. Spontaneous behavioural changes in response to epidemics. *Journal of Theoretical Biology*. 2009;260(1):31-40.
11. Wenham C, Smith J, Morgan R. COVID-19: the gendered impacts of the outbreak. *The Lancet*. 2020;395(10227):846-848.
12. Galasso V, Pons V, Profeta P, Becher M, Brouard S, Foucault M. Gender differences in COVID-19 attitudes and behavior: Panel evidence from eight countries. *Proceedings of the National Academy of Sciences*. 2020;117(44):27285-27291.
13. Warraich HJ, Califf RM. Differences in health outcomes between men and women: biological, behavioral, and societal factors. *Clinical Chemistry*. 2019;65(1):19-23.
14. Pilote L, Karp I. GENESIS-PRAXY (GENdEr and Sex determinantS of cardiovascular disease: From bench to beyond-Premature Acute Coronary SYndrome). *American Heart Journal*. 2012;163(5):741-746.
15. Norris CM, Murray JW, Triplett LS, Hegadoren KM. Gender roles in persistent sex differences in health-related quality-of-life outcomes of patients with coronary artery disease. *Gender Medicine*. 2010;7(4):330-339.
16. Bacon SL, Lavoie KL, Boyle J, Stojanovic J, Joyal-Desmarais K. International assessment of the link between COVID-19 related attitudes, concerns and behaviours in relation to public health policies: Optimising policy strategies to improve health, economic and quality of life outcomes (the iCARE Study). *BMJ Open*. 2021;11(3):e046127.
17. Lavoie KL, Bacon SL. for the iCARE study team: iCARE Surveys. 2020;
18. Gaye A, Klugman J, Kovacevic M, Twigg S, Zambrano E. Measuring key disparities in human development: The gender inequality index. *Human Development Research Paper*. 2010;46:1-37.
19. Stachura P, Śleszyński J. Gender indicators of the United Nations Development Programme. *Economic and Environmental Studies*. 2016;16(4 (40)):511-530.

- 1
2
3 20. Durand H, Bacon SL, Byrne M, et al. Identifying and addressing psychosocial determinants
4 of adherence to physical distancing guidance during the COVID-19 pandemic—project protocol.
5 *HRB Open Research*. 2020;3
6
7 21. Harris M, Adhanom Ghebreyesus T, Liu T, et al. : COVID-19. World Health
8 Organization. Archived (PDF) from the original on 2020-03-25. . 2020.
9
10 22. Raparelli V, Norris CM, Bender U, et al. Identification and inclusion of gender factors in
11 retrospective cohort studies: the GOING-FWD framework. *BMJ Global Health*.
12 2021;6(4):e005413.
13
14 23. Vatcheva KP, Lee M, McCormick JB, Rahbar MH. Multicollinearity in regression analyses
15 conducted in epidemiologic studies. *Epidemiology (Sunnyvale, Calif)*. 2016;6(2)
16
17 24. Felter C, Bussemaker N. Council on Foreign Relations. Which countries are requiring
18 face masks? Retrieved on 27 October 2021 at <https://www.cfr.org/in-brief/which-countries-are-requiring-face-masks>.
19
20 25. Haischer MH, Beilfuss R, Hart MR, et al. Who is wearing a mask? Gender-, age-, and
21 location-related differences during the COVID-19 pandemic. *PloS one*. 2020;15(10):e0240785.
22
23 26. Lawson V. Geographies of care and responsibility. *Annals of the Association of American*
24 *Geographers*. 2007;97(1):1-11.
25
26 27. Barceló J, Sheen GC-H. Voluntary adoption of social welfare-enhancing behavior: Mask-
27 wearing in Spain during the COVID-19 outbreak. *PloS One*. 2020;15(12):e0242764.
28
29 28. Robertson C, Gebeloff R. How millions of women became the most essential workers in
30 America. *The New York Times*. 2020;18
31
32 29. Barber SJ, Kim H. COVID-19 worries and behavior changes in older and younger men and
33 women. *The Journals of Gerontology: Series B*. 2021;76(2):e17-e23.
34
35 30. Ning L, Niu J, Bi X, et al. The impacts of knowledge, risk perception, emotion and
36 information on citizens' protective behaviors during the outbreak of COVID-19: a cross-sectional
37 study in China. *BMC Public Health*. 2020;20(1):1-12.
38
39 31. Kim JK, Crimmins EM. How does age affect personal and social reactions to COVID-19:
40 Results from the national Understanding America Study. *PloS One*. 2020;15(11):e0241950.
41
42 32. Pasion R, Paiva TO, Fernandes C, Barbosa F. The AGE effect on protective behaviors
43 during the COVID-19 outbreak: sociodemographic, perceptions and psychological accounts.
44 *Frontiers in Psychology*. 2020;11:2785.
45
46 33. Hearne BN, Niño MD. Understanding how race, ethnicity, and gender shape mask-wearing
47 adherence during the COVID-19 pandemic: evidence from the COVID impact survey. *Journal of*
48 *Racial and Ethnic Health Disparities*. 2021:1-8.
49
50 34. Moran KR, Del Valle SY. A meta-analysis of the association between gender and
51 protective behaviors in response to respiratory epidemics and pandemics. *PloS One*.
52 2016;11(10):e0164541.
53
54 35. Gonzales MC, Jain-Chandra MS, Kochhar MK, Newiak MM, Zeinullayev MT. *Catalyst*
55 *for change: Empowering women and tackling income inequality*. International Monetary Fund;
56 2015.
57
58 36. Szolnoki G, Hoffmann D. Online, face-to-face and telephone surveys—Comparing
59 different sampling methods in wine consumer research. *Wine Economics and Policy*.
60 2013;2(2):57-66.

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FIGURE

Figure 1: Percentage of adherence to protective health behaviours, per group of Gender Inequality Index (GII), stratified by sex

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FIGURE

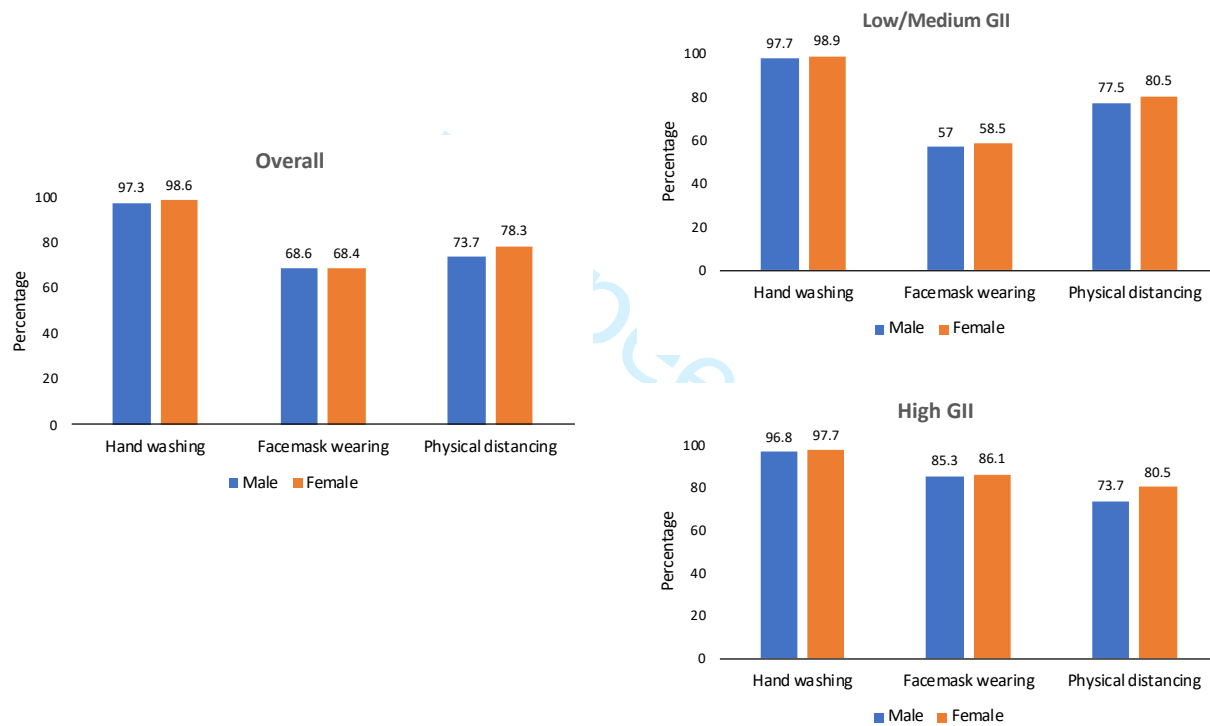


Figure 1: Percentage of adherence to protective health behaviours, per group of Gender Inequality Index (GII), stratified by sex

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APPENDIX

Table 1a. Association between gender-related variables and adoption of hand washing, by sex

	Hand washing							
	Female				Male			
	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value
Sociodemographic characteristics								
Age distribution								
• Up to 25 (ref)	-		-		-		-	
• 26-50	2.91 (2.37-3.58)	<0.001	4.44 (1.68-11.76)	<0.01	2.45 (1.91-3.14)	<0.001	1.82 (0.63-5.68)	0.25
• 51 and older	7.71 (5.57-10.66)	<0.001	13.39 (2.87-62.6)	<0.01	4.56 (3.36-6.18)	<0.001	2.22 (0.81-6.27)	0.11
Education level								
• Low level (ref)	-		-		-		-	
• High level	1.63 (1.29-2.07)	<0.001	0.78 (0.32-1.91)	0.58	1.47 (1.12-1.92)	<0.01	0.37 (0.14-1.01)	0.05
Work status								
• Unemployed (ref)	-		-		-		-	
• Employed	2.41 (1.35-4.28)	<0.01	1.19 (0.50-2.83)	0.69	1.38 (0.80-2.40)	0.24	1.97 (0.89-4.13)	0.09
Annual household income								
• Bottom third (ref)	-		-		-		-	
• Middle third	1.50 (1.12-2.01)	<0.01	1.92 (0.83-4.43)	0.12	1.42 (1.00-2.01)	<0.05	1.07 (0.41-2.81)	0.88
• Top third	1.96 (1.36-2.81)	<0.001	3.20 (0.84-12.15)	0.08	1.67 (1.15-2.43)	<0.01	2.52 (0.77-8.41)	0.12
Adults ≥18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	0.52 (0.41-0.66)	<0.001	1.04 (0.44-2.43)	0.93	0.73 (0.56-0.95)	0.02	0.46 (0.21-1.03)	0.06
Children ≤18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	0.69 (0.44-1.08)	0.12			0.84 (0.52-1.37)	0.48		
Gender Inequality Index								
• High GII (ref)	-		-		-		-	
• Low/Medium GII	2.29 (1.88-2.78)	<0.001	2.11 (0.95-4.71)	0.07	1.37 (1.09-1.72)	<0.01	0.57 (0.25-1.32)	0.18
Geographic Regions								
• Europe	1.91 (1.49-2.43)	<0.001			1.28 (0.98-1.67)	0.06		
• North America	2.93 (2.31-3.72)	<0.001			1.87 (1.42-2.46)	<0.001		
• Others (ref)	-		-		-		-	
Psychosocial characteristics								
Depressive disorder	0.73 (0.52-1.02)	0.07	0.74 (0.20-2.71)	0.65	0.63 (0.42-0.95)	<0.05	0.72 (0.18-2.98)	0.66
Anxiety disorder	0.90 (0.68-1.18)	0.45	0.98 (0.32-2.96)	0.97	0.71 (0.34-1.44)	0.05	2.51 (0.47-13.38)	0.28

Note: In the multivariable model, geographic regions variable dropped due to collinearity with GII. Number of children in household variables dropped due to collinearity with number of adults in the household variable.

Table 1b. Association between gender-related variables and adoption of physical distancing, by sex

	Physical distancing							
	Female				Male			
	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value	Bivariate OR (95% CI)	p-value	Multivariate aOR (95% CI)	p-value
Sociodemographic characteristics								
Age distribution								
• Up to 25 (ref)	-		-		-		-	
• 26-50	1.10 (1.03-1.18)	<0.01	2.01 (1.54-2.63)	<0.001	1.11 (0.99-1.25)	0.05	2.53 (2.03-4.21)	<0.001
• 51 and older	1.60 (1.47-1.73)	<0.001	3.57 (2.72-4.68)	<0.001	1.41 (1.24-1.58)	<0.001	3.99 (2.47-6.46)	<0.001
Education level								
• Low level (ref)	-		-		-		-	
• High level	1.19 (1.11-1.27)	<0.001	1.39 (1.13-1.74)	<0.01	1.21 (1.09-1.34)	<0.001	0.87 (0.61-1.25)	0.45
Work status								
• Unemployed (ref)	-		-		-		-	
• Employed	0.55 (0.48-0.62)	<0.001	0.39 (0.32-0.49)	<0.001	0.48 (0.38-0.59)	<0.001	0.38 (0.27-0.52)	<0.001
Annual household income								
• Bottom third (ref)	-		-		-		-	
• Middle third	1.26 (0.99-1.60)	0.05	1.26 (0.99-1.59)	0.06	1.24 (0.89-1.73)	0.19	1.54 (1.01-2.32)	<0.05
• Top third	1.90 (1.41-2.56)	<0.001	1.53 (1.17-2.01)	<0.01	1.71 (1.19-2.45)	<0.01	2.13 (1.36-3.35)	<0.01
Adults ≥18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	0.65 (0.60-0.69)	<0.001	0.89 (0.72-1.09)	0.27	0.61 (0.55-0.67)	<0.001	0.66 (0.47-0.92)	<0.05
Children ≤18 years living in the household								
• ≤ 2 (ref)	-		-		-		-	
• > 2	0.79 (0.69-0.92)	<0.01			0.94 (0.78-1.15)	0.56		
Gender Inequality Index								
• High GII (ref)	-		-		-		-	
• Low/Medium GII	0.99 (0.94-1.06)	0.95	0.72 (0.58-0.88)	<0.01	1.23 (1.13-1.34)	<0.001	0.87 (0.64-1.19)	0.39
Geographic Regions								
• Europe	1.16 (1.09-1.24)	<0.001			1.29 (1.17-1.43)	<0.001		
• North America	2.26 (2.12-2.41)	<0.001			2.26 (2.04-2.49)	<0.001		
• Others (ref)	-				-			
Psychosocial characteristics								
Depressive disorder	1.16 (1.05-1.29)	<0.01	1.07 (0.78-1.48)	0.66	1.00 (0.84-1.19)	0.96	0.86 (0.49-1.50)	0.60
Anxiety disorder	1.21 (1.12-1.31)	<0.001	1.03 (0.79-1.32)	0.84	1.00 (0.95-1.27)	0.19	1.40 (0.85-2.31)	0.18

Note: In the multivariable model, geographic regions variable dropped due to collinearity with GII. Number of children in household variables dropped due to collinearity with number of adults in the household variable.

STROBE Statement—checklist of items that should be included in reports of observational studies

Association of Biological Sex and Gender-related Factors with Public Engagement in Protective Health Behaviours during the COVID-19 Pandemic: Lessons Learned Going Forward

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1,3
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	7
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-9
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	NA
Bias	9	Describe any efforts to address potential sources of bias	NA
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9
		(b) Describe any methods used to examine subgroups and interactions	10
		(c) Explain how missing data were addressed	NA
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	NA

		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	NA

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	NA
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-12
		(b) Report category boundaries when continuous variables were categorized	9
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg, analyses of subgroups and interactions, and sensitivity analyses	12
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17