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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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ABSTRACT

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

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

Setting Data from the International COVID-19 Awareness and Responses Evaluation survey collected between March 2020 and February 2021 from 175 countries.

Participants Convenience sample around the world.

Main outcome measures We examined the role of sex and gender-related factors in relation to non-adherence of protective health behaviours including: (1) hand washing; (2) mask wearing; and (3) physical distancing. Multivariable logistic regression was conducted to determine the factors associated with non-adherence to behaviours.

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

Conclusion While females showed greater adherence to COVID-19 protective health behaviours, gender-related factors, including employment status and high country-wide gender inequality, were independently associated with non-adherence. These findings may inform public health and vaccination policies in current as well as future pandemics.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study had a large sample size with a global perspective, and availability of gender-related factors to examine the impact of gender.
⇒ The online nature of the International COVID-19 Awareness and Responses Evaluation survey might have limited the participation from individuals who did not have access to computers and internet, limiting the generalisation of findings.
⇒ Our global sample was highly educated group of people whose results are likely to be 'best case scenario'.
⇒ The global sample was also mostly females, so males are under-represented in this study.
⇒ Self-reported behaviour of the respondents might not have accurately represented the actual behaviour; hence, the findings should be interpreted with caution.

INTRODUCTION

Public behaviour plays an important role during public health emergencies.[1] Behaviours can be influenced by both the biological sex and sociocultural gender (gender identity, gender roles, gender relations and institutionalised gender) of an individual.[2] According to the Canadian Institutes of Health and Research, sex refers to '*a set of biological attributes and associated physical and physiological features including chromosomes, gene expression, hormone levels and function, and reproductive/sexual anatomy*' and is categorised as female or male,[3] while gender refers to '*the array of socially constructed roles and relationships, personality traits, attitudes, behaviours, values, relative power and influence that society ascribes to women and men on a differential basis*'.[4 5] In the case of the COVID-19 pandemic, both men and women worldwide have shown inconsistent responses to

acute infection as well as differing long-term health, economic and social consequences.[6 7] Understanding these responses in relation to sex and/or gender-related attributes in the general population may be particularly valuable to inform tailored sex and gender strategies moving forward.

It has been identified that public health responses to infectious diseases require fundamental changes in individual behaviour. Hand washing, mask wearing and physical distancing (*previously referred to as social distancing*) are the key transmission reduction public health behaviour-based prevention measures[1] that are associated with a reduction in the global prevalence of COVID-19.[8 9] Effectiveness of such responses depends on the generalised adherence of the public and may be specific to certain high-risk groups. Though recommended and proven to limit transmission rates, hand washing, mask wearing and physical distancing have been inconsistently initiated and maintained. There is a dynamic relationship between the voluntary adoption of public health behaviours and infection transmission during infectious disease epidemics.[10] The COVID-19 pandemic has sparked an unparalleled global discourse around the adoption of protective behaviours and other public health and social measures to slow the person-to-person spread of SARS-CoV-2.[1]

COVID-19 has highlighted the role that sex and gender play in our lives. This includes influencing an individual's exposure to COVID-19 through sex and gender-related occupations, risk-taking behaviours and employment of precautions. Sex and gender also are known to have an impact on health through the gendered nature of the workforce and the predominant risk associated with it, increased caregiving responsibilities at home limiting the work and economic opportunities, or institutional biases and policies.[2 11] Gender affects the division of labour and care duties in families and communities. Hence, it is of utmost importance that we gather, from our recent lived experience, evidence on the potential sex and gender-related differences in perception and behavioural responses experienced during COVID-19 pandemic.

A few studies have shown sex-based differences in COVID-19-related beliefs and behaviours and have reported that compared with males, females are more likely to perceive the pandemic as a serious health problem and comply more with the preventive behaviours.[12 13] In addition, as gender is culturally and geographically based, we hypothesised that there is a difference in preventive behaviours and pandemic-related concerns based on sex and gender-related factors. Also, regardless of sex-based differences, our previous studies highlight the need of focusing on the gender-related factors.[14 15] Hence, the purpose of this study was to examine whether sex and gender-related factors are associated with the engagement in the recommended key protective health behaviours such as hand washing, mask wearing and physical distancing during the COVID-19 pandemic.

METHODS

Study design

Survey data sets from the ongoing International COVID-19 Awareness and Responses Evaluation (iCARE) study led by the Montreal Behavioural Medicine Centre (www.mbmc-cmcm.ca) in collaboration with a team of 200 international collaborators from 42 countries were used for the data analyses. The iCARE study design has been previously described.[16] Briefly, iCARE is an international multiwave cross-sectional observational cohort study of public awareness, attitudes and responses to public health policies implemented to reduce the spread of COVID-19 on people around the world (www.iCARESTudy.com). It collects data on study demographics, perceptions of government policy, health behaviours, adherence to health measures, types of concerns and adherence motivators.

Survey data were collected in 4–6 weeks of rounds using convenience snowball sampling (globally, 25 000–30 000 per wave) and parallel representative sampling (in targeted countries), generating data for multiple cohorts of participants that were added to the first round cohort launched on 27 March 2020. We analysed data from survey 1 to survey 7 that were collected between 27 March 2020 and 9 February 2021. A total of 61 552 respondents participated in the survey from over 175 countries. The data were analysed for 48 668 respondents (female=34 556, male=14 112). The questionnaire used in the survey is publicly available via the Open Science Framework (https://osf.io/nswcm/) and the survey is available in 34 languages.[17]

Biological sex and gender-related factors

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

To account for institutionalised gender, the Gender Inequality Index (GII), developed by the United Nations Development Programme, was used as a measure of country-specific gender inequality[18] and as a measure of institutionalised gender in this study. This index is a continuous measure for the degree of gender inequality per country on a scale between 0 and 1, with lower values representing near-perfect gender equality and higher values representing greater levels of inequality favouring males. The GII is based on several aspects of institutionalised gender: (1) reproductive health, measured by the maternal mortality ratio and adolescent birth rates; (2) empowerment, measured by the proportion of parliamentary seats occupied by women and the proportion of adult women and men with at least some secondary education; and (3) economic status, measured by labour force participation rate of men and women.[19] GIIs

in this study were divided into tertiles and later categorised into high and low/medium GII categories. We used data on GIIs from 2019. Some of the countries in the region were excluded from the analysis due to the unavailability of data.

Outcome measures

The main outcomes of the analysis were self-reported non-adherence to three recommended protective health behaviours, including: (1) hand washing with soap and water; (2) wearing a face mask; and (3) a composite measure of physical distancing behaviours (specifically: staying at least 1–2 m away from other people; staying/working at home rather than going to work or school; self-quarantining if returning from a trip; self-quarantining if one has the virus or believe they have the virus; avoiding going out to bars/pubs/restaurants; avoiding large social gatherings; avoiding small social gatherings; avoiding indoor social gatherings; and avoiding any non-essential travel).[20] A composite binary variable was constructed, in which the participants who met the above-mentioned criteria were coded with a value of 1; otherwise, the participants were coded with a value of 0. A set of measures in the iCARE survey intended to explore the prevention measures used by the public to prevent the spread of COVID-19 by maintaining a physical distance between two people and reducing the number of times people come into close physical contact with one another[21] were used to create a composite variable for physical distancing.

Methodological steps

To consider gender-related variables in the evaluation of health behaviour outcomes in retrospective cohort studies, a multistep methodology has been developed by the Gender Outcomes International Group: to Further Well-being Development group.[22] The steps applied in this study are (1) identification of gender-related variables, (2) definition of outcomes, and (3) building of feasible final variable list. The final list of gender-related variables was included in the statistical models.

Statistical analysis

A global analysis of public engagement in three recommended protective health behaviours was performed to investigate whether the outcomes differed by sex. Our outcome of interest in the modelling process was the non-adherence to behavioural recommended measures. Descriptive sex-stratified analyses were run for age; baseline mental health conditions (any depressive or anxiety disorders); and previously defined gender-related factors such as level of education, work status, annual household income and GII. Continuous variables were presented as mean and standard deviation [SD]. Categorical variables were presented as counts and percentages. Sex differences in outcomes (protective health behaviours) were completed and associations between sex, gender-related factors and outcomes were tested in a multivariable model. Bivariate logistic regressions were run for crude analysis, followed by collinearity diagnostics to account for inflation in SEs of parameter estimates caused by collinear cofactors.[23] If variables were collinear, we included the variable with the least amount of missing data in the multivariable models. A priori gender-related cofactors (ie, gender role (work status), gender identity (depressive and/or anxiety disorders) and institutionalised gender (education level, annual household income and GII)) were included in multivariable models adjusting for the potential confounders (ie, age and geographical regions). A two-way interaction between the sex and gender-related factors was tested by including an interaction term in bivariate models. All statistical analyses were performed using statistical software STATA V.16 (College Station, Texas, USA). Tests were two sided and the significance was defined as $p<0.05$.

Patient and public involvement

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

RESULTS

Descriptive characteristics of respondents

Our study population included 34 556 females (71%) and 14 112 males (29%) (table 1). The mean age of the respondents was 43 years (SD: 16). A majority (n=23 462; 48.8%) was between 26 and 50 years of age. Most respondents (79.7%) reported high levels of education, were employed (61.8%), were from Europe and North American countries (66.3%) and from regions with high levels of gender equity as measured by low/medium GIIs (66.9%). Females were more likely to report having a physician-diagnosed depressive disorder (9.5% vs 6.7%, $p\leq0.001$) and anxiety disorder (17.7% vs 10.7%, $p\leq0.001$) compared with males. Irrespective of sex, only 68.5% of responders disclosed wearing a face mask, while a higher percentage of females reported adherence to physical distancing behaviours compared with males (78.3% vs 73.7%, $p<0.001$). Participants aged 51 and older were more likely to engage in all three key protective behaviours as compared with younger participants: hand washing (OR=5.60, 95% CI: 4.51 to 6.94); mask wearing (OR=1.11, 95% CI: 1.04 to 1.18); and physical distancing (OR=1.50, 95% CI: 1.41 to 1.61) (table 2).

Gender-related factors associated with adoption of protective health behaviours

For the univariate analysis, the proportion of people adopting the protective health-related behaviours varied depending on the gender-related factors examined.

Table 1 Descriptive characteristics of survey respondents by biological sex (N=48 668)

	N*	Overall n (%) or mean [SD]	Biological sex	
			Male (n=14 112) n (%) or mean [SD]	Female (n=34 556) n (%) or mean [SD]
Sociodemographic characteristics				
Age (years)	48 524	43 [16]	42 [16]	44 [17]
Age distribution in strata	48 049			
Up to 25		8632 (18.0)	2327 (16.8)	6305 (18.5)
26–50		23 462 (48.8)	6372 (45.8)	17 090 (50.0)
51 and older		15 955 (33.2)	5197 (37.4)	10 758 (31.5)
Education level	38 217			
Low level		7758 (20.3)	2208 (20.5)	5550 (20.2)
High level		30 459 (79.7)	8564 (79.5)	21 895 (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	33 814			
Bottom third		4739 (14.0)	1249 (12.8)	3490 (14.5)
Middle third		19 107 (56.5)	4910 (50.2)	14 197 (59.1)
Top third		9968 (29.5)	3622 (37.0)	6346 (26.4)
Number of adults ≥18 years living in the household	32 979			
1		15 657 (47.5)	4419 (46.8)	11 238 (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	12 357			
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	45 615			
Low/medium GII		30 530 (66.9)	8188 (62.3)	22 342 (68.8)
High GII		15 085 (33.1)	4951 (37.7)	10 134 (31.2)
Geographical regions	48 632			
Europe		12 106 (24.9)	3558 (25.3)	8548 (24.8)
North America		18 658 (38.4)	4674 (33.2)	13 984 (40.5)
Others		17 868 (36.7)	5860 (41.2)	12 008 (34.8)
Likelihood of getting vaccinated	38 979			
Unlikely		4664 (11.9)	1220 (10.9)	3444 (12.4)
Likely		34 315 (88.0)	9930 (89.1)	24 385 (87.6)
Psychosocial characteristics				
Depressive disorder	37 616	3276 (8.7)	705 (6.7)	2571 (9.5)
Anxiety disorder	37 481	5889 (15.7)	1133 (10.7)	4756 (17.7)

*Number of observations with complete information.
GII, Gender Inequality Index; SD, Standard Deviation.

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

	Hand washing (n=43 318)		Mask wearing (n=42 767)		Physical distancing (n=43 368)	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Sociodemographic characteristics						
Biological sex						
Male (ref)	–		–		–	
Female	1.97 (1.71 to 2.28)	<0.001	0.98 (0.94 to 1.03)	0.41	1.28 (1.22 to 1.34)	<0.001
Age distribution						
Up to 25 (ref)	–		–		–	
26–50	2.71 (2.31 to 3.17)	<0.001	0.86 (0.82 to 0.92)	<0.001	1.11 (1.04 to 1.18)	<0.001
51 and older	5.60 (4.51 to 6.94)	<0.001	1.11 (1.04 to 1.18)	<0.01	1.50 (1.41 to 1.61)	<0.001
Education level						
Low level (ref)	–		–		–	
High level	1.56 (1.31 to 1.85)	<0.001	0.99 (0.94 to 1.04)	0.78	1.20 (1.13 to 1.27)	<0.001
Work status						
Unemployed (ref)	–		–		–	
Employed	1.84 (1.25 to 2.71)	<0.01	0.35 (0.23 to 0.54)	<0.001	0.53 (0.47 to 0.60)	<0.001
Annual household income						
Bottom third (ref)	–		–		–	
Middle third	1.47 (1.18 to 1.84)	<0.01	1.18 (1.11 to 1.26)	<0.001	0.98 (0.91 to 1.06)	0.78
Top third	1.63 (1.27 to 2.10)	<0.001	1.02 (0.95 to 1.10)	0.52	1.23 (1.12 to 1.33)	<0.001
Adults ≥18 years living in the household						
1 (ref)	–		–		–	
2	0.80 (0.65 to 0.99)	<0.05	1.27 (1.21 to 1.35)	<0.001	0.73 (0.69 to 0.78)	<0.001
3	0.59 (0.46 to 0.75)	<0.001	1.63 (1.52 to 1.76)	<0.001	0.64 (0.59 to 0.69)	<0.001
4	0.59 (0.43 to 0.82)	<0.01	2.31 (2.06 to 2.58)	<0.001	0.50 (0.45 to 0.55)	<0.001
≥5	0.35 (0.25 to 0.48)	<0.001	2.77 (2.39 to 3.22)	<0.001	0.43 (0.38 to 0.48)	<0.001
Children ≤18 years living in the household						
1 (ref)	–	–	–		–	
2	1.18 (0.88 to 1.58)	0.26	0.81 (0.74 to 0.87)	<0.001	1.09 (0.99 to 1.19)	0.06
3	0.91 (0.59 to 1.39)	0.68	0.81 (0.71 to 0.92)	<0.01	0.92 (0.80 to 1.05)	0.25
4	0.68 (0.34 to 1.36)	0.28	1.10 (0.85 to 1.42)	0.45	0.75 (0.58 to 0.96)	<0.05
≥5	0.23 (0.13 to 0.41)	<0.001	0.95 (0.68 to 1.32)	0.79	0.55 (0.41 to 0.76)	<0.001
Gender Inequality Index						
Low/medium GII (ref)	–		–			
High GII	0.52 (0.45 to 0.60)	<0.001	4.38 (4.15 to 4.63)	<0.001	0.91 (0.86 to 0.96)	<0.01
Geographical regions						
Europe	1.63 (1.37 to 1.95)	<0.001	0.29 (0.27 to 0.31)	<0.001	1.21 (1.14 to 1.28)	<0.001
North America	2.54 (2.13 to 3.04)	<0.001	0.21 (0.20 to 0.22)	<0.001	2.30 (2.18 to 2.42)	<0.001
Others (ref)	–		–		–	
Likelihood of getting vaccinated						
Unlikely (ref)	–		–		–	
Likely	3.04 (2.57 to 3.61)	<0.001	1.15 (1.08 to 1.22)	<0.001	2.18 (2.04 to 2.32)	<0.001
Psychosocial characteristics						
Depressive disorder	0.76 (0.59 to 0.98)	<0.05	0.91 (0.85 to 0.98)	<0.05	1.15 (1.05 to 1.26)	<0.01
Anxiety disorder	0.91 (0.73 to 1.11)	0.35	0.88 (0.83 to 0.93)	<0.001	1.22 (1.14 to 1.31)	<0.001

CI, Confidence Interval; GII, Gender Inequality Index; OR, Odds Ratio.

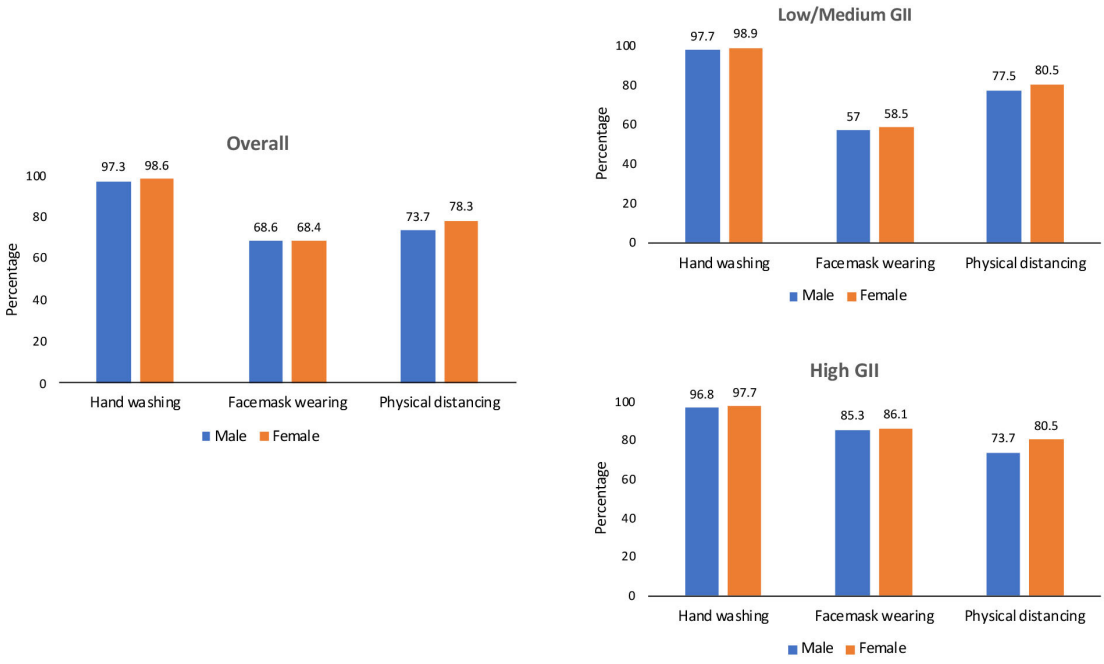

Figure 1 Percentage of adherence to protective health behaviours, per group of Gender Inequality Index (GII), stratified by sex.

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 were less common as the number of adults ≥18 years living in the household increased. The proportion of adoption was lowest for wearing a face mask, both for females and males (58.5% vs 57%) in low/medium-GII countries (figure 1). Respondents living in the countries with high GIIs were 4.38 times (95% CI: 4.15 to 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 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: (1) for hand washing—higher country gender inequality favouring males' GII (adjusted OR (aOR)=0.47, 95% CI: 0.21 to 1.05, p=0.07); (2) for mask wearing—older age (aOR females=0.35, 95% CI: 0.12 to 1.03, p=0.05), being employed (aOR females=0.22, 95% CI: 0.10 to 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 to 0.51, p<0.01); and (3) for physical distancing—being employed (aOR females=0.39, 95% CI: 0.32 to 0.49, p<0.001) (table 3, online supplemental appendix table 1A,B).

Among males, factors that were associated with not adhering to protective health behaviours were: (1) for hand washing—higher level of education (aOR males=0.37, 95% CI: 0.14 to 1.01, p=0.05) and with a household size of >2 (aOR males=0.46, 95% CI: 0.21 to 1.03, p=0.06); (2) for mask wearing—being employed (aOR males=0.15, 95% CI: 0.04 to 0.53, p<0.01) and living in a country with more gender equity as measured by the GII (aOR=0.29, 95% CI: 0.09 to 0.91, p<0.05); and (3) for physical distancing—being employed (aOR males=0.38, 95% CI: 0.27 to 0.52, p<0.001) and with household size of >2 (aOR males=0.66, 95% CI: 0.47 to 0.92, p<0.05) (table 3, online supplemental appendix table 1A,B).

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

DISCUSSION

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

Lower adherence to the protective health behaviours was mainly associated with younger age, being employed and living in a country with low/medium GIIs (higher gender equity) for females, while high level of education, being employed and household size of >2 were associated with lower adoption in males. Considering this group of individuals with lower adherence to protective health behaviours, this would suggest that in the current as well as future pandemics it may be useful to

Table 3 Association between gender-related variables and adoption of face mask 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 to 0.91)	<0.001	0.77 (0.26 to 2.35)	0.65	0.91 (0.81 to 1.01)	0.11	0.59 (0.07 to 5.04)	0.63
51 and older	1.11 (1.02 to 1.18)	<0.01	0.35 (0.12 to 1.03)	0.05	1.12 (1.00 to 1.26)	<0.05	0.52 (0.06 to 4.47)	0.55
Education level								
Low level (ref)	–		–		–		–	
High level	0.95 (0.89 to 1.01)	0.15	0.84 (0.43 to 1.66)	0.61	1.08 (0.98 to 1.20)	0.10	0.37 (0.10 to 1.33)	0.12
Work status								
Unemployed (ref)	–		–		–		–	
Employed	0.38 (0.23 to 0.63)	<0.001	0.22 (0.10 to 0.48)	<0.001	0.31 (0.14 to 0.67)	<0.01	0.15 (0.04 to 0.53)	<0.01
Annual household income								
Bottom third (ref)	–		–		–		–	
Middle third	1.19 (1.10 to 1.29)	<0.001	0.76 (0.32 to 1.84)	0.54	1.12 (0.98 to 1.27)	0.08	1.64 (0.57 to 4.74)	0.36
Top third	1.01 (0.92 to 1.10)	0.80	0.89 (0.35 to 2.28)	0.81	1.01 (0.87 to 1.15)	0.93	5.93 (1.64 to 21.48)	<0.01
Adults ≥18 years living in the household								
≤2 (ref)	–		–		–		–	
>2	1.79 (1.68 to 1.93)	<0.001	0.89 (0.46 to 1.71)	0.71	1.73 (1.56 to 1.93)	<0.001	1.79 (0.50 to 6.40)	0.36
Children ≤18 years living in the household								
≤2 (ref)	–				–			
>2	1.03 (1.81 to 2.49)	0.66			0.79 (0.65 to 0.96)	0.02		
Gender Inequality Index								
High GII (ref)	–		–		–		–	
Low/medium GII	0.23 (0.21 to 0.24)	<0.001	0.18 (0.06 to 0.51)	<0.01	0.23 (0.21 to 0.25)	<0.001	0.29 (0.09 to 0.91)	<0.05
Geographical regions								
Europe	0.31 (0.28 to 0.33)	<0.001			0.26 (0.23 to 0.29)	<0.001		
North America	0.21 (0.20 to 0.23)	<0.001			0.21 (0.18 to 0.23)	<0.001		
Others (ref)	–				–			
Psychosocial characteristics								
Depressive disorder	0.91 (0.83 to 0.99)	<0.05	0.99 (0.33 to 3.07)	1.00	0.95 (0.81 to 1.12)	0.57	1.01 (0.20 to 5.01)	0.98
Anxiety disorder	0.87 (0.81 to 0.93)	<0.001	2.29 (0.84 to 6.24)	0.11	0.94 (0.82 to 1.07)	0.39	0.85 (0.23 to 3.18)	0.81

In the multivariable model, geographical 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.
aOR, adjusted OR; GII, Gender Inequality Index.

target interventions based on sex and gendered factors to increase adherence and reduce disease transmission. Measures such as risk assessment and mitigation considerations for public settings could be implemented to mitigate the risk of transmission and promote the adoption of protective health behaviours.

Overall, mask wearing was lower among both sexes compared with other protective behaviours such as hand washing and physical distancing. Many countries waited to issue mask mandate months into the pandemic[24] even though other behaviours were mandated right away. This may be one of the reasons for lower adherence. Further, adoption of mask wearing was less likely in males compared with females, mainly among those who were employed, indicating substantial room for improvement in male's engagement to mask wearing. In our study, employed female respondents reported that they were more likely to wear a mask compared with male respondents. Similarly, a study conducted in the USA also reported that females were 1.5 times more likely to wear a mask compared with males.[25] It has been suggested that females may be more likely to protect themselves and others by wearing a mask specifically because they handle the majority of caregiving

within families and are over-represented in essential work services, which generally require mask wearing.[26] Previous studies have also reported mask wearing to be significantly associated with the occupation of respondents.[27 28] A study reported that women make up almost 90% of nurses and nursing assistants in the USA and over two-thirds of grocery store cashiers.[28] Performing the dual function of an essential worker outside and a caregiver at home, women might face a dilemma of how to keep their families healthy and safe while continuing to work in potentially risky circumstances, suggesting that these factors may make them more adherent to the protective behaviours.

Older females were the most likely participants to engage in hand washing and physical distancing, but less likely to engage in mask wearing. Older females may have a higher perceived risk of developing COVID-19 complications and mortality, and thus engaged in more protective health behaviours such as hand washing and physical distancing. Previous studies have shown that females and older adults are less likely to engage in the risky behaviours, feel more vulnerable to contracting diseases and have a stronger sense of responsibility to protect the society.[29 30] This is consistent with the findings of an American study that reported being older and female was related to adopting more pandemic-mitigating behaviours.[31] Furthermore, a study conducted in China also reported that being female and older was associated with adopting protective behaviours.[30] However, our study findings are in contrast with the results of a study conducted in Portugal that reported a decline in engagement in protective health behaviours with advancing age, which was reported to be related to the increased social isolation and lack of help among older population.[32] Even though the study did not report the differences by sex of the respondents, self-isolation could be the reason for lower adherence to mask wearing among females. Depending on the diverse context, public health interventions should be tailored to sex and differing age groups, and importantly institutional gender-related variables such as those measured by the GII.

Emerging evidence shows that gender, including the institutionalised gender, shapes mask-wearing adherence.[33] One of the interesting findings of the current study is respondents from low/medium-GII countries with less gender inequity reported a significantly lower adherence to mask wearing compared with respondents from countries with high GII (high gender inequity). Even among the low/medium-GII countries, adherence is reported to be poorer among males. Lower adherence among males is in line with a finding from a study conducted in the USA, in which males exhibited poorer mask wearing practices compared with their female counterparts.[25] This is also supported by a review that looked at research from multiple countries and found women were 50% more likely than men to practise protective behaviour.[34] The correlation between a Gini coefficient (a measure of income inequality) and GII (a measure of gender inequality) could explain the lower adherence to protective health behaviours in countries with low/medium GIIs where income inequality arises mainly through gender gaps in economic participation.[35]

The strengths of this study include a large sample size, having a global perspective and availability of gender-related factors to examine the impact of gender. This study also has some limitations that should be acknowledged. First, the online nature of the iCARE survey might have limited the participation from individuals who did not have access to computers and internet, limiting the generalisation of findings. However, the advantages of online surveys have been shown to outweigh the disadvantages, mainly in terms of its external validity[36]; hence, the bias might be relatively low. Second, our global sample was a highly educated group of people whose results are likely to be 'best case scenario'. The global sample was also mostly women, so men are under-represented in this study. Third, self-reported behaviour does not always accurately represent actual behaviour; hence, the findings should be interpreted with caution. Finally, although the study established the associations between sex and gender-related factors with the adoption of protective health behaviours, no causal relationships should be assumed due to the nature of the cross-sectional design of the survey.

CONCLUSIONS

In this analysis of a multinational study population, while a majority of respondents reported wearing a face mask, this is likely reflective of country-wide mask mandates as opposed to adopting it as a protective health behaviour. However, our study findings suggest that wearing a face mask appeared to be more difficult to adhere to for many compared with other key protective behaviours such as hand washing and physical distancing. Moreover, our study noted that this was even more apparent in countries with low GII (more equity between males and females), indicating substantial room for improvement in public engagement regarding protective health behaviours. Since widespread protective behavioural responses are paramount for a successful containment and control of an infectious disease contagion, the present study provides valuable information for identifying sex and gendered factors that may inform effective public health policies. Further, the COVID-19 pandemic highlights the urgent need to incorporate sex and gender analysis into all research and innovation processes in order to target specific groups both to help contain the transmission of the virus and to formulate vaccine policies.

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