Egyptian Journal of Medical Research

Print ISSN: 2682-4396 / Online ISSN: 2682-440X

Compliance of the General Population to Precautionary Measures During the Early Waves of COVID-19 in Alexandria, Egypt

Engy M. El-Ghitany[1], Eman A. Omran[2], Azza Galal Farghaly[1], Mona H. Hashish[2] *, Mahmoud A Hassaan[3], Ehab Elrewany [1], Nada M. Ibrahim [4]

[1] *Department of Tropical Health, High Institute of Public Health, Alexandria University Alexandria, Egypt*

[2] *Department of Microbiology, High Institute of Public Health, Alexandria University, Alexandria, Egypt*

[3] *Institute of Graduate Studies and Research, Alexandria University, Alexandria, Egypt*

[4] *Department of Nutrition, High Institute of Public Health, Alexandria University, Alexandria, Egypt*

Article Info

Corresponding Author:
Engy M. El-Ghitany
ingy.elghitany@alexu.edu.eg

Keywords
Seroprevalence
SARS-CoV-2
Behaviour
Alexandria districts
Egypt

Abstract

Background: During the COVID-19 pandemic, countries that imposed regulations on activities related to gatherings, transportation and personal precautionary measures have reported reduced surging of COVID-19 cases. The degree of people's adherence to these precautionary measures was variable between countries. **Aim:** To assess the compliance of a sample of Alexandrian residents with the precautionary measures against COVID-19 during the first and second waves of the pandemic. **Methods:** This cross-sectional study comprised 715 participants of the general population from Alexandria who were invited to fill out a pre-designed self-reported questionnaire entailing compliance to precautionary measures. Data on SARS-CoV2 spike antibodies were

obtained.**Results:** Hand hygiene was the most practiced preventive measure (91.3%), followed by wearing masks (59.2% self-reported to "always" wear a facemask outdoors). Regarding the frequency of practicing physical distancing, only 37.6% reported to "always" abide to it. More individuals used public transportation as opposed to taxis (34.9% compared to 9.8% respectively, p <0.01). There were differences among participants from different districts regarding most of the studied preventive measures as well as vaccine acceptance and COVID-19 diagnosis rates. Multivariate regression analysis showed that among all the investigated social practices, the use of public transport was the only significant predictor for SARS-CoV-2 antibody seropositivity [OR(95% CI; LL-UL)=2.763(1.745-4.373, p <0.001). **Conclusions:** The studied sample displayed better compliance to hand washing than to wearing face masks, while fewer participants practiced physical distancing. Using public transportation was the only predictor of seropositivity among all the studied risk factors. Alexandrian districts showed differences between their residents in the studied parameters.

1. Introduction:

Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) was first detected in Wuhan, China in December 2019 (1) and has continued to pose a threat to the global community ever since. According to the World Health Organization (WHO) COVID-19 Dashboard, as of 27 January 2023, the cumulative cases of COVID-19 in Egypt reached 515,609, and the cumulative deaths reported were 23,889 deaths. As of the same date, a total of 101,357,078 vaccine doses have been administered.(2)

Non-pharmaceutical mitigation strategies against COVID-19 have varied greatly from international-scale interventions, such as border closures and flight restrictions, to individual-based measures, including physical distancing and face mask imposition. (3) In Egypt, a lockdown was

enforced on 25 March, 2020, shutting down schools, cafés and restaurants.(4) However, these restrictions eased gradually and were not re-enacted as a response to subsequent COVID-19 epidemic waves.

The WHO's recommendations to impede the transmission of COVID-19 include staying at least 1 metre apart from others, wearing a suitable-sized mask when physical distancing is not possible or when present in poorly-ventilated areas, choosing open spaces over closed ones, and washing hands regularly using soap and water or disinfecting them with alcohol-based sanitizers.(5)

Numerous studies proved the association of observing measures such as hand washing, physical distancing, and mask wearing with a reduction in COVID-19 incidence.(6, 7) The present study thus aimed to assess the degree to which a sample of Alexandrian residents self-reported to comply with precautionary measures against COVID-19 during the second and third waves of the pandemic. Being aware of any defect in behavioural precautionary measure adopted by the community would facilitate and direct prompt action in future similar epidemics.

2. Subjects and Methods:

This descriptive study took place between January and June 2021, which coincided with the second and third waves of the COVID-19 pandemic in Egypt. At that time, vaccines were not readily available except for healthcare workers, particularly those working in COVID-19 isolation/screening hospitals. This present study was part of a larger cross-sectional survey which was originally conducted for the purpose of determining the seroprevalence of COVID-19 in several Egyptian governorates (8).

Sampling technique:

The study was conducted using a multistage stratified cluster sampling technique as described in our original survey (8). Stratification was done based on gender and age to include both genders and all age groups. People were invited to participate in our survey through media announcement and distribution of flyers in the local region by our team, explaining the aim and outcome of our survey. More details on sampling were described elsewhere (8).

Study design and setting:

This cross-sectional study was conducted in Alexandria, a port city and major economic centre in Egypt. Alexandria is the second largest city in Egypt by population, comprising around 5.5 million citizens(9). Out of the eight districts in Alexandria, participants were recruited from seven of them (Al Montazah, Eastern District, Central District, Al Gomrok, Western District, Al Agamy, and Al Amreya).

Target population and sample size

All participants who agreed to participate with us were included in our study. There were no exclusion criteria. The sample size was calculated based on the assumption that 50% of the population complied with precautionary measures against COVID-19, using a margin of error of 5%, and a 95% confidence interval; the minimum sample size required was 384. The sample size was calculated using Epi info 7 software. A total of 715 participants were included in the study to reduce any sampling error. A pilot study was carried out before the beginning of the study to ensure feasibility of recruitment and randomization of participants as well as for validation of the questionnaire. The pilot study involved a group of 50 randomly selected participants.

Data collection methods and tools

Each participant was invited to fill a pre-designed questionnaire. Sociodemographic data were collected, including age, gender and district of residence, and the degree to which respondents complied to COVID-19-related precautionary measures (never, sometimes, and always) was assessed. The self-reported precautionary measures under survey were physical distancing, use of public transportation (trams and buses) as opposed to private cars/taxis, eating outdoors, the consistency of wearing masks, and hand hygiene measures, including hand washing using soap and applying alcohol-based sanitizers. Acceptance of the participants to receive COVID-19 vaccines (whenever available at that time of the pandemic for healthcare workers) was recorded. Data on the positivity of SARS-CoV-2 spike antibodies (anti-S) were extracted from the results of our original serosurvey on a larger sample of the Egyptian population(8). The collected data were mapped using ArcGIS (ver. 10.8) (ESRI 2020) (available from: https://www.esri.com/en-us/arcgis/products/arcgis-desktop/resources) and thematic maps were produced representing the precautionary measures, COVID-19 history of infection and diagnostic tools, antibody distribution as well as vaccine acceptance in different districts in Alexandria. Such mapping illustrates the spatial variations (if any) in the studied districts.

Statistical analysis:

The collected data were coded, revised, cleaned, tabulated, and analysed through IBM SPSS Statistics version 26 using appropriate statistics. The descriptive statistics including percentages (%), arithmetic mean ($\bar{X}$) and standard deviation (SD) were calculated for various qualitative and quantitative data to describe the study population. The analytic statistical tests comprised Chi square, Fisher's Exact, student t-test and repeated measures

analysis of variance (ANOVA). Multivariate logistic regression was built to identify predictors of seropositive SARS-CoV-2 antibodies. Variables with p-value less than 0.2 in the bivariate analysis were entered in the model, where p-values equal to or less than 0.05 were considered statistically significant.

Ethical considerations

The study complied with the international research guidelines and principles of Helsinki declaration. The study was approved by the Institutional Review Board (IRB) Committee, Faculty of Medicine, Alexandria University; IRB number: 00012098- FWA number: 00018699, serial number: 0305136. Administrative approval was taken from each healthcare setting prior to study onset. Anonymity and confidentiality were confirmed and written informed consent was obtained from each participants.

3. Results:

Sociodemographic characteristics

The present study involved 715 participants from Alexandria with a mean age of 36.93 ± 17.32 years. The majority of the studied population were females (57.2%), married (59.2%), living in urban areas (61.3%) and had completed their university degree of education (43.1%). Regarding their distribution among Alexandrian districts, almost two thirds of the participants were from the Central (37.8%) and Al Amreya (32.9%) districts. Only two participants have already received COVID-19 vaccine. Vaccine acceptance was prevalent in 53.3% (n=381) of our participants while the rest were either hesitant or refused vaccination.

Compliance with COVID-19 precautionary measures

As regards physical distancing measures, over a third of the respondents (37.6%) reported "always" practicing physical distancing, while 56.8% occasionally ("sometimes") abided by it. As for transportation, more individuals mainly used public transportation as opposed to taxis (34.9% compared to 9.8% respectively, with $x^2 = 13.97$ and $p < 0.01$). Most respondents (59.2%) self-reported to "always" wear a facemask outdoors. Hand hygiene was the most practised preventive measure, with 91.3% of participants reporting regularly washing their hands before eating and after returning home. Most respondents consistently used soap to wash their hands (91.6%). Nearly half the respondents washed their hands for duration of over 20 seconds (**table 1**), in accordance with the Centers for Disease Control and Prevention's (CDC) recommendations, and 49.1% reported the consistent use of alcohol-based hand rubs.(10)

Approximately one third of the female participants reported "never" eating out,

while 21.6% of males "never" dined outdoors (x^2 = 16.877, p <0.001). More females used taxis compared to males (p<0.01). Females further complied more with mask-wearing regulations (n=255, 62.3%) than males (n=168, 54.9%). Significantly more females reported regularly washing their hands before eating (p < 0.01) and after returning home (p<0.001), using soap (p< 0.01), and consistently using alcohol-based sanitizers (p<0.01). Females also spent significantly more time washing their hands (>20s) than men (p <0.01) **(table 1).**

The mean age of individuals reporting "always" vs. "never" practicing physical distancing was higher , while the opposite was true for dining outside (ANOVA = 1.893, p < 0.001) and using public buses. Riding taxis was more common among older persons compared to younger ones (p<0.01). Notably, older Alexandrian residents (mean age=41) reported regularly wearing face masks as opposed to younger respondents of (mean age=32) who reported "never" wearing them (ANOVA =1.947, p<0.001). Similarly, hand hygiene, exemplified by the use of hand sanitizers, was "always" observed by individuals whose mean age was 38 years, whereas respondents reporting "never" using hand sanitizers were significantly younger, with a mean age of 34 years (ANOVA = 1.397, p= 0.019) (**table 1**).

Table (1) Relation between age and gender and anti-COVID-19 social practices of 715 Alexandrian residents

		Total		**Gender**		**Test of significance (p-value)**	**Age**	**Test of significance (p-value)**
		N = 715		**Male**	**Female**		**Min – Max (2-81)**	
		N (%)		**306 (42.8)**	**409 (57.2)**		**Mean ± SD**	
		N	**%**	**n (%)**	**n (%)**		**36.93 ± 17.32**	
Physical distancing	Never	**40**	**5.6**	19 (6.2)	21 (5.1)	$x^2 = 0.525$	26.83 ± 19.61	ANOVA = 1.174
	Sometimes	**406**	**56.8**	175 (57.2)	231 (56.5)	P = 0.769	35.57 ± 17.19	P = 0.159
	Always	**269**	**37.6**	112 (36.6)	157 (38.4)		40.48 ± 16.31	
Eating outdoors	Never	**198**	**27.7**	*66 (21.6)	132 (32.3)	$x^2 = 16.877$	*40.63 ± 19.93	ANOVA = 1.893
	Sometimes	**423**	**59.2**	185 (60.5)	238 (58.2)	P < 0.001	35.72 ± 16.6	P < 0.001
	Always	**94**	**13.1**	55 (18.0)	39 (9.5)		34.55 ± 12.98	
Riding public buses/tramways	Never	**164**	**22.9**	69 (22.5)	95 (23.2)	$x^2 = 1.308$	41.95 ± 15.68	ANOVA = 1.155
	Sometimes	**308**	**43.1**	126 (41.2)	182 (44.5)	P = 0.52	33.43 ± 18.68	P = 0.185
	Always	**243**	**34.0**	111 (36.3)	132 (32.3)		37.97 ± 15.59	
Riding taxis	Never	**370**	**51.7**	183 (59.8)	187 (45.7)	$x^2 = 13.97$	34.81 ± 18.48	ANOVA = 1.557
	Sometimes	**275**	**38.5**	*99 (32.4)	176 (43.0)	P < 0.01	36.68 ± 15.98	P < 0.01
	Always	**70**	**9.8**	*24 (7.8)	46 (11.2)		*41.21 ± 14.43	
Wearing masks	Never	**18**	**2.5**	7 (2.3)	11 (2.7)	$x^2 = 4.565$	31.3 ± 21.02	ANOVA = 1.947
	Sometimes	**274**	**38.3**	131 (42.8)	143 (35.0)	P = 0.102	31.86 ± 17.56	P < 0.001
	Always	**423**	**59.2**	168 (54.9)	255 (62.3)		*40.45 ± 16.12	
Washing hands before eating	Never	**7**	**1.0**	4 (1.3)	3 (0.7)	$x^2 = 13.256$	11.0 ± 9.93	ANOVA = 1.726
	Sometimes	**55**	**7.7**	36 (11.8)	19 (4.6)	P < 0.01	27.2 ± 17.13	P < 0.001
	Always	**653**	**91.3**	*266 (86.9)	387 (94.6)		*38.02 ± 16.94	
Washing hands after returning home	Never	**6**	**0.8**	3 (1.0)	3 (0.7)	$x^2 = 18.109$	16.17 ± 13.14	ANOVA = 1.074
	Sometimes	**56**	**7.8**	39 (12.7)	17 (4.2)	P < 0.001	29.79 ± 18.31	P = 0.321
	Always	**653**	**91.3**	*264 (86.3)	389 (95.1)		37.73 ± 17.03	
Duration of hand washing	≥20 seconds	**343**	**48.0**	128 (41.8)	215 (52.6)	$x^2 = 8.085$	38.43 ± 16.62	t test = 2.235
	<20 seconds	**372**	**52.0**	*178 (58.2)	194 (47.4)	P < 0.01	*35.54 ± 17.85	P = 0.026

Using soap for hand washing	Sometimes Always	**60** **655**	**8.4** **91.6**	37 (12.1) *269 (87.9)	23 (5.6) 386 (94.4)	$x^2 = 9.526$ P < 0.01	34.35 ± 20.52 37.16 ± 16.99	t test = -1.204 P = 0.229
Using hand sanitizers	Never Sometimes Always	**52** **312** **351**	**7.3** **43.6** **49.1**	25 (8.2) 150 (49.0) *131 (42.8)	27 (6.6) 162 (39.6) 220 (53.8)	$x^2 = 8.443$ P < 0.01	34.16 ± 21.34 35.67 ± 18.73 *38.45 ± 15.13	ANOVA = 1.397 P = 0.019

***: significant category in table**

Data pertaining to preventive measures were additionally sorted according to their practice in the 7 studied districts (**table 2**). Residents of Gomrok and Central districts seemed to consistently abide by physical distancing (53.8% and 51.5% respectively) in contrast to rates in Al-Amreya (17%). Considering mask wearing, over 80% of individuals living in Western District and Al Agamy districts reported to "always" abide by this measure, in contrast to only 37% of Al Amreya's residents. A larger percentage of participants who reported "never" eating outdoors (as opposed to "sometimes" and "always") were residents of Western (44.4%), Al Amreya (40.0%), and Agamy (35.7%) districts. Public transport was the least used by participants in Gomrok (38.5%) and Eastern (38.3%) districts.

Table (2) Distribution of the self-reported social practices of 715 Alexandrians according to district

		Total		Alexandrian District							Test of significance (P-value)
				Al Montazah	Eastern District	Central District	Gomrok	Western District	Al Agamy	Al Amreya	
		N (%)		80 (11.2)	94 (13.1)	270 (37.8)	13 (1.8)	9 (1.3)	14 (2.0)	235 (32.9)	
		N	(%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
Practicing physical distancing	Never	**40**	**5.6**	1 (1.3)	2 (2.1)	8 (3.0)	1 (7.7)	0 (0.0)	0 (0.0)	28 (11.9)	Fisher's Exact = 84.803 P < 0.001
	Sometimes	**406**	**56.8**	46 (57.5)	51 (54.3)	123 (45.6)	5 (38.5)	5 (55.6)	9 (64.3)	167 (71.1)	
	Always	**269**	**37.6**	33 (41.3)	41 (43.6)	139 (51.5)	*7 (53.8)	4 (44.4)	5 (35.7)	*40 (17.0)	
Eating outdoors	Never	**198**	**27.7**	15 (18.8)	22 (23.4)	57 (21.1)	1 (7.7)	4 (44.4)	5 (35.7)	94 (40.0)	Fisher's Exact = 43.647 P < 0.001
	Sometimes	**423**	**59.2**	55 (68.8)	53 (56.4)	171 (63.3)	8 (61.5)	5 (55.6)	6 (42.9)	125 (53.2)	
	Always	**94**	**13.1**	10 (12.5)	19 (20.2)	42 (15.6)	4 (30.8)	0 (0.0)	3 (21.4)	16 (6.8)	
Riding public buses/tramways	Never	**164**	**22.9**	13 (16.3)	36 (38.3)	97 (35.9)	5 (38.5)	0 (0.0)	0 (0.0)	13 (5.5)	Fisher's Exact = 156.534 P < 0.001
	Sometimes	**308**	**43.1**	31 (38.8)	22 (23.4)	81 (30.0)	3 (23.1)	1 (11.1)	5 (35.7)	165 (70.2)	
	Always	**243**	**34.0**	36 (45.0)	36 (38.3)	92 (34.1)	5 (38.5)	8 (88.9)	9 (64.3)	*57 (24.3)	
Riding taxis	Never	**370**	**51.7**	28 (35.0)	43 (45.7)	80 (29.6)	8 (61.5)	6 (66.7)	5 (35.7)	*200 (85.1)	Fisher's Exact = 202.296 P < 0.001
	Sometimes	**275**	**38.5**	45 (56.3)	44 (46.8)	136 (50.4)	4 (30.8)	3 (33.3)	9 (64.3)	34 (14.5)	
	Always	**70**	**9.8**	7 (8.8)	7 (7.4)	54 (20.0)	1 (7.7)	0 (0.0)	0 (0.0)	1 (0.4)	
Wearing mask when going outside	Never	**18**	**2.5**	1 (1.3)	1 (1.1)	6 (2.2)	0 (0.0)	1 (11.1)	0 (0.0)	9 (3.8)	Fisher's Exact = 78.069 P < 0.001
	Sometimes	**274**	**38.3**	24 (30.0)	30 (31.9)	75 (27.8)	4 (30.8)	0 (0.0)	2 (14.3)	139 (59.1)	
	Always	**423**	**59.2**	55 (68.8)	63 (67.0)	189 (70.0)	9 (69.2)	*8 (88.9)	12 (85.7)	87 (37.0)	
Washing hands before eating	Never	**7**	**1.0**	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (3.0)	Fisher's Exact = 19.203 P = 0.05
	Sometimes	**55**	**7.7**	8 (10.0)	6 (6.4)	15 (5.6)	0 (0.0)	0 (0.0)	0 (0.0)	26 (11.1)	
	Always	**653**	**91.3**	72 (90.0)	88 (93.6)	255 (94.4)	13 (100.0)	9 (100.0)	14(100.0)	202 (86.0)	
	Never	**6**	**0.8**	0 (0.0)	1 (1.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (2.1)	

Washing hands after returning home	Sometimes	**56**	**7.8**	2 (2.5)	4 (4.3)	17 (6.3)	0 (0.0)	0 (0.0)	1 (7.1)	32 (13.6)	Fisher's Exact = 24.586 P < 0.01
	Always	**653**	**91.3**	78 (97.5)	89 (94.7)	253 (93.7)	13 (100.0)	9 (100.0)	13 (92.9)	*198 34.3)	
Duration of hand wash	≥20 seconds	**343**	**48.0**	47 (58.8)	49 (52.1)	151 (55.9)	6 (46.2)	4 (44.4)	*11 (78.6)	75 (31.9)	x^2 = 40.808 P < 0.001
	<20 seconds	**372**	**52.0**	33 (41.3)	45 (47.9)	119 (44.1)	7 (53.8)	5 (55.6)	3 (21.4)	160 (68.1)	
Use of soap	sometimes	**60**	**8.4**	3 (3.8)	7 (7.4)	14 (5.2)	0 (0.0)	1 (11.1)	0 (0.0)	35 (14.9)	Fisher's Exact = 18.497 P < 0.01
	Always	**655**	**91.6**	77 (96.3)	87 (92.6)	256 (94.8)	13 (100.0)	8 (88.9)	14 (100.0)	*200 (85.1)	
Use of hand disinfectant	Never	**52**	**7.3**	2 (2.5)	2 (2.1)	5 (1.9)	0 (0.0)	2 (22.2)	0 (0.0)	41 (17.4)	Fisher's Exact = 156.121 P < 0.001 Fisher's Exact = 19.571 P= 0.06
	Sometimes	**312**	**43.6**	25 (31.3)	36 (38.3)	95 (35.2)	1 (7.7)	1 (11.1)	6 (42.9)	148 (63.0)	
	Always	**351**	**49.1**	53 (66.3)	56 (59.6)	170 (63.0)	*12 (92.3)	6 (66.7)	8 (57.1)	*46 (19.6)	
Exercise	Never	**113**	**15.8**	10 (12.5)	15 (16.0)	38 (14.1)	2 (15.4)	0 (0.0)	1 (7.1)	47 (20.0)	
	Occasionally	**274**	**38.3**	27 (33.8)	38 (40.4)	92 (34.1)	6 (46.2)	2 (22.2)	6 (42.9)	103 (43.8)	
	Consistently	**328**	**45.9**	43 (53.8)	41 (43.6)	140 (51.9)	5 (38.5)	7 (77.8)	7 (50.0)	85 (36.2)	
Smoking Index (n=121)	<400	**82**	**67.8**	11 (68.8)	17 (58.6)	27 (65.9)	2 (100.0)	2 (66.7)	1 (50.0)	22 (78.6)	Fisher's Exact = 4.103 P= 0.665
	400-800	**39**	**32.2**	5 (31.3)	12 (41.4)	14 (34.1)	0 (0.0)	1 (33.3)	1 (50.0)	6 (21.4)	

As regards the relationship between social practices and the seroprevalence of SARS-CoV-2 antibodies, factors significantly associated with seropositivity were using public buses/tramways, wearing masks outdoors, and using soap for hand washing.

Those "sometimes/always" using public transportation reported higher rates of seropositivity (57.5%, 52.3%, respectively) compared to those "never" using public transportation means (70.7%, $P < 0.01$) more frequently. Strikingly, the group who reported to wear masks "always" had higher seropositivity rates (44.9%) compared to those never using face masks (27.8%, $p=0.04$). Also, contrary to what might be expected, seropositivity was higher among those who reported to "always" *versus* "sometimes" use soap for hand washing (42.6% *versus* 26.7%, $P = 0.016$). History of COVID-19 diagnosis was significantly associated with seropositivity ($p<0.01$) (**table 3**).

Table (3) Relation between social practices of 715 Alexandrians and their SARS-CoV-2 antibody positivity

		Total N = 715		SARS-CoV-2 antibodies		Test of significance (P-value)
				Negative	Positive	
		N (%)		420 (58.7)	295 (41.3)	
		N	%	n (%)	n (%)	
Physical distancing	Never	**40**	**5.6**	22 (55.0)	18 (45.0)	$x^2 = 1.286$
	Sometimes	**406**	**56.8**	233 (57.4)	173 (42.6)	P = 0.526
	Always	**269**	**37.6**	165 (61.3)	104 (38.7)	
Eating outdoors	Never	**198**	**27.7**	117 (59.1)	81 (40.9)	$x^2 = 2.004$
	Sometimes	**423**	**59.2**	254 (60.0)	169 (40.0)	P = 0.367
	Always	**94**	**13.1**	49 (52.1)	45 (47.9)	
Riding public transport	*Never	**164**	**22.9**	116 (70.7)	48 (29.3)	$x^2 = 14.142$
	Sometimes	**308**	**43.1**	117 (57.5)	131 (42.5)	P < 0.01
	Always	**243**	**34.0**	127 (52.3)	116 (47.7)	
Riding taxis	Never	**370**	**51.7**	229 (61.9)	141 (38.1)	$x^2 = 4.474$
	Sometimes	**275**	**38.5**	148 (53.8)	127 (46.2)	P = 0.107
	Always	**70**	**9.8**	43 (61.4)	27 (38.6)	
Wearing masks when going outside	*Never	**18**	**2.5**	13 (72.2)	5 (27.8)	$x^2 = 6.250$
	Sometimes	**274**	**38.3**	174 (63.5)	100 (36.5)	P = 0.044
	Always	**423**	**59.2**	233 (55.1)	190 (44.9)	
Washing hands before eating	Never	**7**	**1.0**	4 (57.1)	3 (42.9)	$x^2 = 0.238$
	Sometimes	**55**	**7.7**	34 (61.8)	21 (38.2)	P = 0.888
	Always	**653**	**91.3**	382 (58.5)	271 (41.5)	
Washing hands after returning home	Never	**6**	**0.8**	3 (50.0)	3 (50.0)	$x^2 = 1.512$
	Sometimes	**56**	**7.8**	37 (66.1)	19 (33.9)	P = 0.470
	Always	**653**	**91.3**	380 (58.2)	273 (41.8)	
Duration of hand washing	≥20 seconds	**343**	**48.0**	204 (59.5)	139 (40.5)	$x^2 = 0.147$
	<20 seconds	**372**	**52.0**	216 (58.1)	156 (41.9)	P = 0.702
Use of soap for hand washing	*Sometimes	**60**	**8.4**	44 (73.3)	16 (26.7)	$x^2 = 5.751$
	Always	**655**	**91.6**	376 (57.4)	279 (42.6)	P = 0.016
Use of hand disinfectants	Never	**52**	**7.3**	35 (67.3)	17 (32.7)	$x^2 = 1.897$
	Sometimes	**312**	**43.6**	184 (59.0)	128 (41.0)	P = 0.387
	Always	**351**	**49.1**	201 (57.3)	150 (42.7)	
Exercise	Never	**113**	**15.8**	72 (63.7)	41 (36.3)	$x^2 = 2.24$
	Occasionally	**274**	**38.3**	164 (59.9)	110 (40.1)	P = 0.326
	Consistently	**328**	**45.9**	184 (56.1)	144 (43.9)	
Smoking Index	<400	**82**	**67.8**	55 (67.1)	27 (32.9)	$x^2 = 0.661$

(n=121)	400-800	**39**	**32.2**	29 (74.4)	10 (25.6)	P = 0.416
COVID-19 diagnosis	No	**640**	**89.5**	404 (63.1)	236 (36.9)	x^2 = 48.379
	*Yes	**75**	**10.5**	16 (21.3)	59 (78.7)	P < 0.001

Multivariate regression analysis (**table 4**) showed that among all the investigated social practices, the use of public transport was the predictor for SARS-CoV-2 antibody seropositivity [adjusted OR (95% CI; LL-UL)=2.763(1.745-4.373, p <0.001).

Table (4): Relation between selected social practices and the seroprevalence of anti-COVID-19 S antibody by multivariate regression analysis

		adjusted OR	95% CI; LL-UL)	P value
Riding public transport	Sometimes	2.489	1.584-3.91	<0.001
	Always	2.763	1.745-4.373	<0.001
Riding taxis	Sometimes	1.186	0.84-1.675	0.332
	Always	0.92	0.522-1.621	0.772
Wearing masks when going outside	Sometimes	1.542	0.515-4.617	0.439
	Always	1.993	0.672-5.908	0.214
Use of soap for hand washing	Always	1.869	0.985-3548	0.056

Table 5 shows that the acceptance to receive the COVID-19 vaccine differed significantly according to which district the respondent resided in.

As regards COVID-19 diagnosis, 89.5% of the respondents reported that they had not contracted COVID-19 by the time of the study. For diagnosis, the respondents mainly relied on more than one laboratory test (6.9%) or clinical signs and symptoms (2.5%).

Table (5) Prevalence of anti-S antibodies, vaccine acceptance, COVID-19 diagnosis and diagnostic means in seven Alexandrian districts

		Total		District (n = 715)							P value
				Al Montazah District	Eastern District	Central District	Al Gomrok District	Western District	Al Agamy District	Al Amreya District	
		n	(%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
				80 (11.2)	**94 (13.1)**	**270 (37.8)**	**13 (1.8)**	**9 (1.3)**	**14 (2.0)**	**235 (32.9)**	
Anti-S result	Negative	**420**	**58.74**	42 (52.5)	52 (55.3)	165 (61.1)	9 (69.2)	6 (66.7)	9 (64.3)	137 (58.3)	$x^2 = 3.386$ P = 0.759
	Positive	**295**	**41.26**	38 (47.5)	42 (44.7)	105 (38.9)	4 (30.8)	3 (33.3)	5 (35.7)	98 (41.7)	
Acceptance to receive COVID-19 vaccination	Yes	**381**	**53.3**	39 (48.8)	42 (44.7)	129 (47.8)	4 (30.8)	*7 (77.8)	7 (50.0)	153 (65.1)	$x^2 =$ 55.258 P < 0.001
	No	**222**	**31.0**	32 (40.0)	41 (43.6)	103 (38.1)	7 (53.8)	2 (22.2)	4 (28.6)	33 (14.0)	
	Hesitant	**112**	**15.7**	9 (11.3)	11 (11.7)	38 (14.1)	2 (15.4)	0 (0.0)	3 (21.4)	49 (20.9)	
COVID-19 diagnosis	No	**640**	**89.5**	67 (83.8)	*74 (78.7)	239 (88.5)	13 (100.0)	9 (100.0)	12 (85.7)	226 (96.2)	Fisher's Exact = 28.179 P < 0.001
	Yes	**75**	**10.5**	13 (16.3)	20 (21.3)	31 (11.5)	0 (0.0)	0 (0.0)	2 (14.3)	9 (3.8)	
Means of COVID-19 diagnosis	Never	**640**	**89.5**	67 (83.8)	*74 (78.7)	239 (88.5)	13 (100.0)	9 (100.0)	12 (85.7)	226 (96.2)	Fisher's Exact = 50.393 P = 0.01
	PCR only	**2**	**0.3**	0 (0.0)	0 (0.0)	2 (0.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
	Lab tests only	**2**	**0.3**	0 (0.0)	0 (0.0)	2 (0.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
	CT only	**4**	**0.6**	1 (1.3)	1 (1.1)	2 (0.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
	Clinical symptoms only	**18**	**2.5**	5 (6.3)	6 (6.4)	6 (2.2)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.4)	
	>one test	**49**	**6.9**	7 (8.8)	13 (13.8)	19 (7.0)	0 (0.0)	0 (0.0)	*2 (14.3)	8 (3.4)	

Figures 1a-d show the distribution of precautionary measures and social habits as practised among Alexandria's districts. Physical distancing was more evident in the central districts, as Gomrok and the Central district, with over 50% of individuals abiding by this practice. Montazah and Eastern districts practised physical distancing to a lesser extent (40-50%). Al-Agamy and Western districts displayed the highest prevalence of mask-wearing (>75%). The two mentioned precautionary measures were least adhered to in Al Amreya.

As for the practice of certain health-related habits, the Western and Central districts as well as Al Montazah exhibited the highest percentage of respondents who regularly exercised (>60%), while the smoking index was highest in the Eastern and Western districts (>9%). The least percentage of participants partaking in exercise was in Al Amreya (<41%).

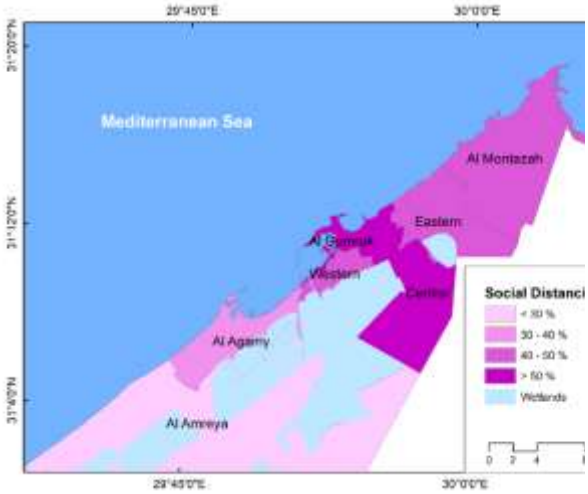

Figure 1 (a): Practicing physical distancing

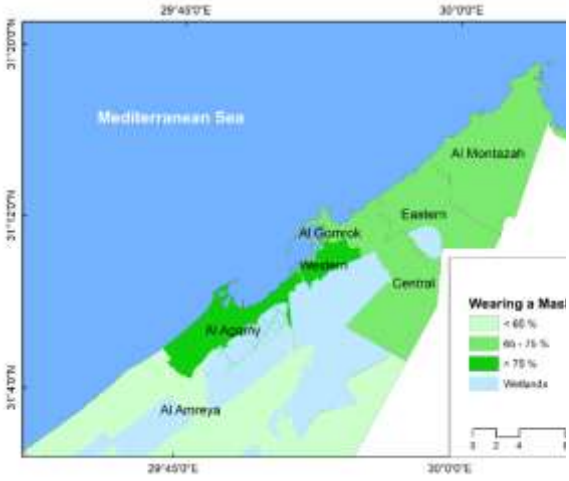

Figure 1 (b): Wearing masks

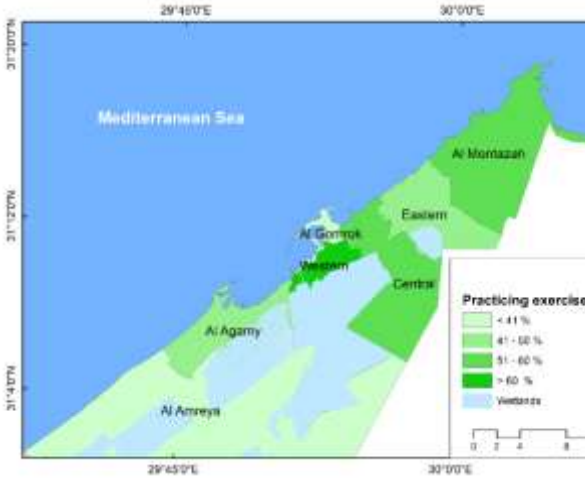

Figure 1 (c): Consistently practicing exercise

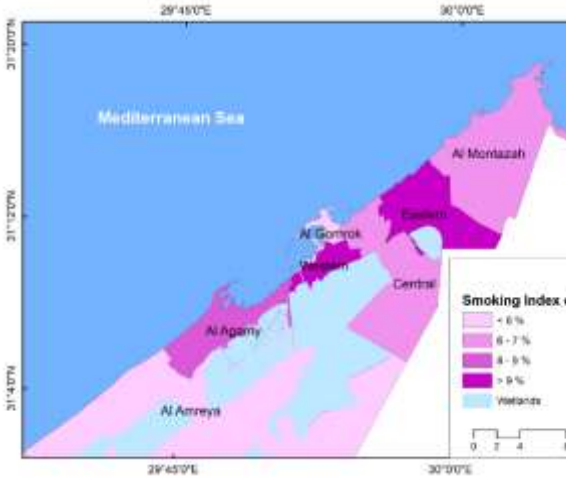

Figure 1 (d): Smoking index (400-800)

Figure 1 (a-d): Participant health behaviors among Alexandria districts

Figure 2 (a and b) displays the diagnosed cases and diagnostic tools used to assess COVID-19 in the Alexandrian districts. Although in all regions diagnostic tools were not used at all in most cases, in districts further to the East, such as Montazah, Eastern, and Central districts, clinical symptoms as well as an additional diagnostic tool were sometimes used. In comparison to the districts situated in the Western part of the city, such as Gomrok, Western, and Amreya districts, the former regions exhibit a higher tendency to resort to clinical and lab testing. This goes in line with the diagnosis rate which is apparently higher (>15%) in the districts situated to the East (Montazah and Eastern) and decreases as we move to the western part of the city, with an island in the centre consisting of Western and Gomrok districts in which no cases were diagnosed.

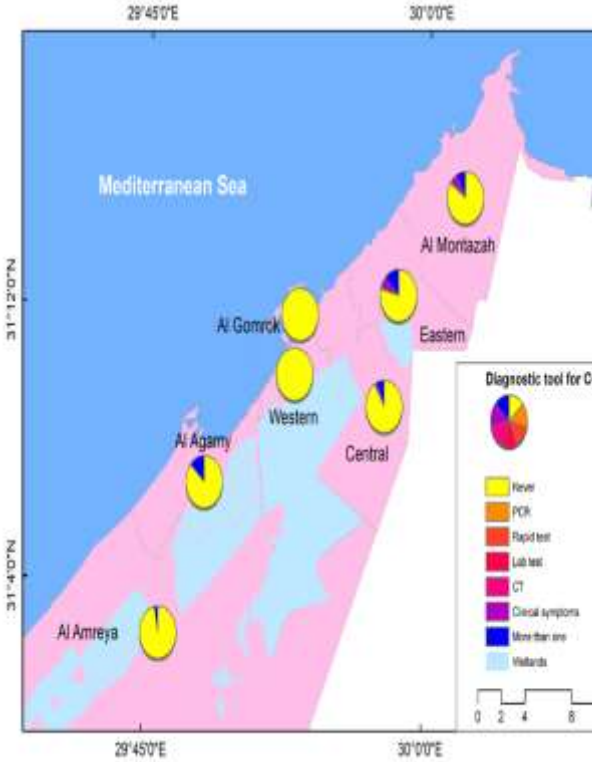

Figure 2 (a): Diagnostic tool for COVID-19

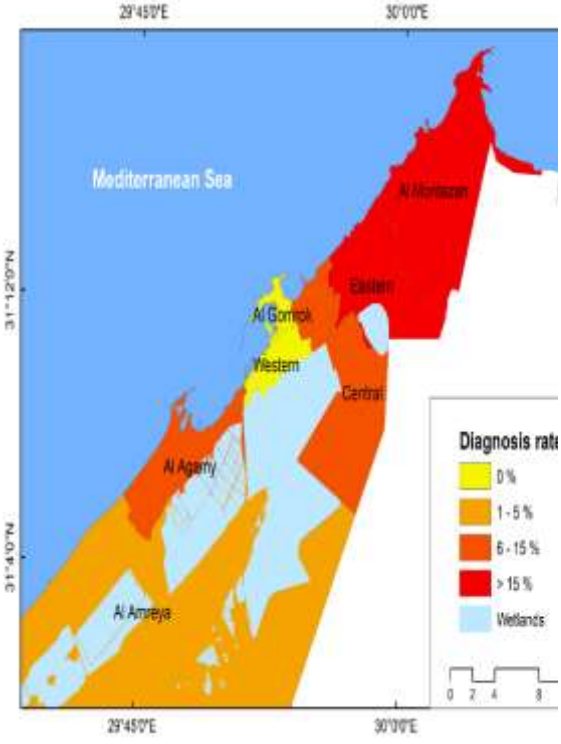

Figure 2 (b): Diagnosed COVID-19 cases

Figure 2 (a&b): Participant history of COVID-19 diagnosis and the diagnostic tool used among Alexandria districts

Figure 3 shows that Montazah was the highest region demonstrating anti-S seropositivity (>45%), with seropositivity declining as we move further west, with Al Amreya exhibiting seropositivity of 41-45%. An island, consisting of the central districts, El Gomrok and Central, displays the least seropositivity (<36%).

In most regions, female participants displayed seropositivity more than males, except for Western and Agamy districts (3c). Also, the age group most commonly exhibiting the highest seropositivity in the different districts was that between 40-59 years (3b).

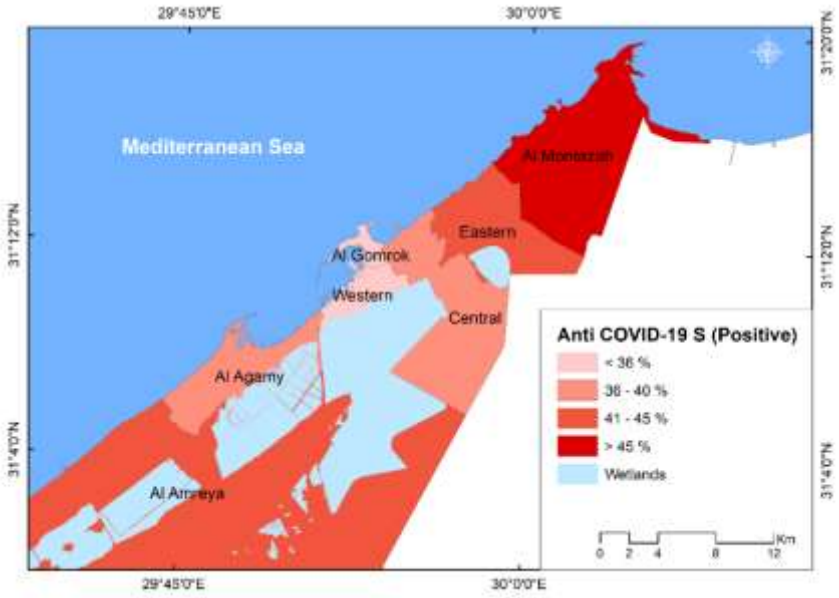

Figure 3 (a): Positive anti S

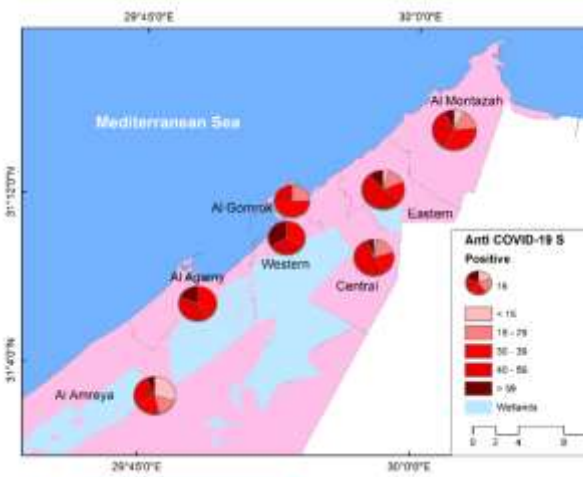

Figure 3 (b): Age group

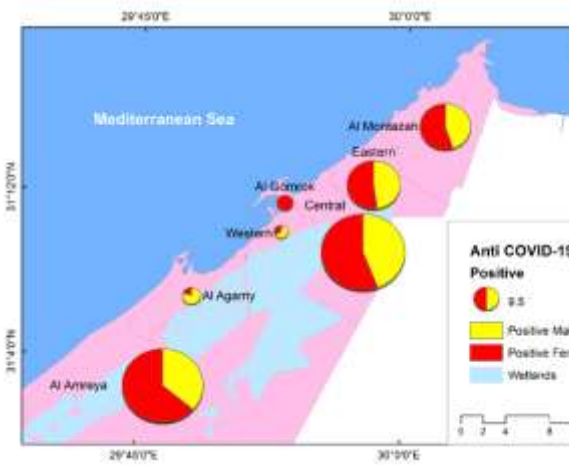

Figure 3 (c): Gender

Figure 3 (a-c): Distribution of positive SARS-CoV-2 antibodies cases among Alexandria districts

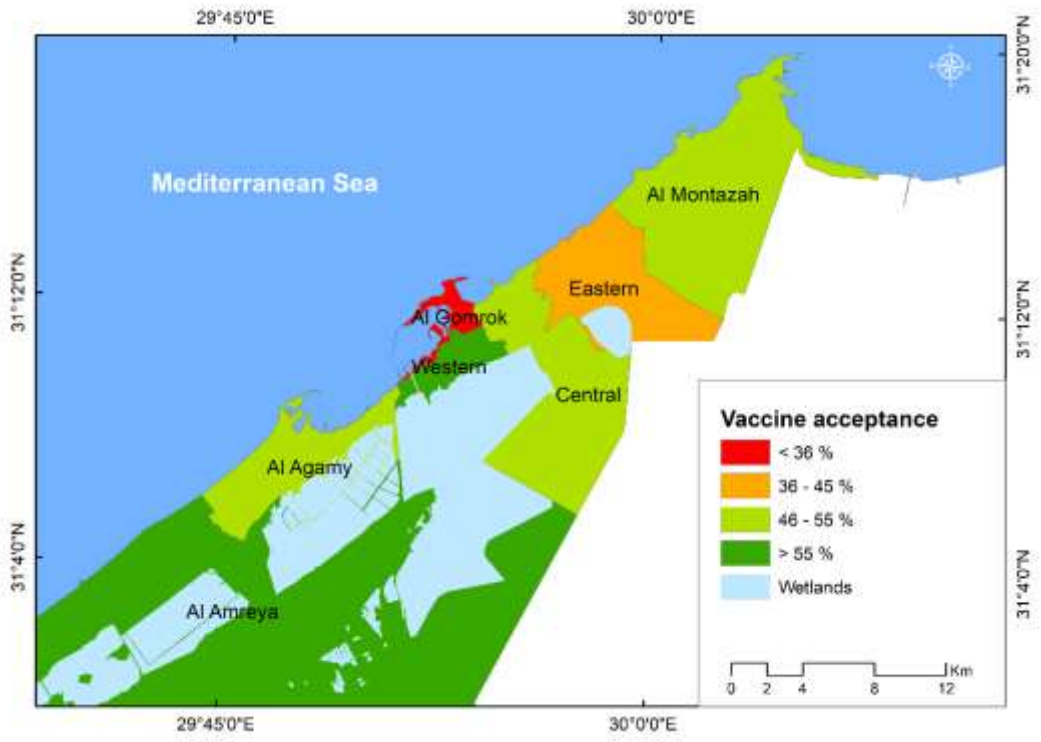

Figure 4: Participants' COVID-19 vaccine acceptance among Alexandrian districts

Figure 4 shows the acceptance of COVID-19 vaccination by respondents mapped according to the Alexandrian districts. The figure shows that regions further west, such as Al Amreya displayed the highest acceptance of receiving the vaccine (>55%), while those located to the east were more hesitant to receive the shots, with Montazah and Central districts showing a vaccine acceptance of 46-55%. Gomrok participants displayed the least vaccine acceptance (<36%).

4. Discussion:

Understanding the extent to which the Alexandrian community adhered to COVID-19 protective strategies proposed by the WHO and accordingly endorsed by the Egyptian government is essential for planning directed health campaigns in case of re-surging of cases in the future or appearance of other pandemics.

Our results show that a relatively low percentage of study participants (37.6%) strictly abided by physical distancing measures. This may be attributed to the time elapsed between the initial outbreak of COVID-19 and the time of the study, which coincided with the second and third waves of the pandemic. Data collated from different world regions over a ten-month period from March 2021 to January 2022 show a general drop in avoidance of public places in relation to time. Examples from the MENA region include Saudi Arabia and the UAE whose figures declined from 75% to 61% and from 77% to 60% respectively over the mentioned period.(11) In Egypt, an earlier study conducted in Sohag during the second wave of the pandemic (August 2020) stated that 50.6% of the study participants avoided going out, while 41.6% reported physical distancing. (12) Combining these figures with our current one suggests that data from Egypt follows this global trend, exhibiting a general decline in conforming to physical distancing measures with progression in time. The reasons for this worldwide trend could be attributed to pandemic fatigue (burnout) as well as increased vaccine availability and vaccination rates, which confer a sense of security over inoculated communities.

In our study, physical distancing was reported by only 37.6% of our study participants, with highest rates in the central districts as Gomrok and the Central district, and lowest rates in Al-Amreya districts. The relatively low reported rates of practicing physical distancing might be due to the high population density in the city and the overcrowding intensified by the return of schools and universities to normal operations as of September 2021. Despite the significant differences between districts, physical distancing was not associated with SARS-CoV-2 seropositivity.

Mask wearing was better observed, with 59.2% reporting firm adherence to this precautionary measure. This figure, however, is lower than those reported in Iran (64%)(13) and Saudi Arabia (88.3%)(14) but higher than that reported in Spain, where only 23.1% of respondents wore face masks “very frequently”.(15) This variation might be due to the disparity

in the strictness of enforcing mask-wearing regulations by different governments. Face-mask wearing is recommended by the WHO whose guidelines clearly state that masks should be worn by the public "in settings where there is community or cluster transmission of SARS-CoV-2, irrespective of vaccination status or history of prior infection."(16) Mask-wearing has proved to be effective in curbing the spread of COVID-19 (7, 15), which underscores the importance of abiding by and encouraging this safety measure while vaccination is on-going. In our study, mask wearing was strikingly associated with higher seropositivity, and on multivariate analysis, was not a predictor of seropositivity. These findings might be due to imprecise reporting by the respondents or improper utilization of face masks (e.g: use when damaged or moist). Our findings also underestimate the role of mask wearing in our study compared to the more significant risk factor " use of public transport ".

Hand hygiene measures were the most frequently observed among the studied precautionary practices (above 90%). Mieth et al., however, argued that direct questioning about a rather delicate issue as hand hygiene is likely to produce an overestimation of positive results.(17)

Although our results show variations in the degree of compliance with preventive practices, females generally tended to be more likely to comply with precautionary practices than males. This can suggest that females are more cautious of contracting the infection than males, which is a finding supported by numerous studies (18-21) despite that mortality is reported to be much higher among males due to COVID-19.(22) As regards age, the current study demonstrated that older individuals were more likely to engage in protective behaviours. This observation is in concordance with studies conducted in Germany(23) and Saudi Arabia,(24); however, the results of a study conducted in Portugal contrast with our findings and report an overall decline in the practice of protective behaviours with advancing age.(25)

As regards the relationship between social practices and the seroprevalence of anti-S antibody, although our results show multiple factors to be significantly associated with seropositivity, including using public transport, wearing masks outdoors, and using soap for hand washing, multivariate analysis ruled them all out as risk factors, except for the use of public transport. Using public transport, thus, was consolidated as a predictor for anti-S seropositivity. In Chile, a nationwide survey among healthcare workers in Chile likewise demonstrated a significant association between the use of public transport and seropositivity(26). However,

in Tunisia, a study amongst the general population found no such association.(27).

Remarkably, the practice of COVID-19 preventive measures was associated with a lower degree of vaccine acceptance. A larger proportion of participants who reported adhering to physical distancing, who used taxis as opposed to public transport, who consistently wore masks outdoors, and who washed their hands for ≥ 20 seconds was hesitant to receive the vaccine. Hesitancy to get vaccinated may have stemmed from mistrust in research, the fear of side effects, and conspiracy theories triggered by social media(28). Our results contrast with results of a systematic review in which low compliance to preventive measures was associated with a higher degree of vaccine hesitancy(29). This discrepancy may be explained by the fact that anxiety and fear from the consequences of the disease encouraged participants to perform these preventive practices, but at the same time triggered their mistrust in the vaccine, preventing them from receiving the shots.

In our study, different districts showed significant variation in the adoption of preventive measures against COVID-19 such as mask wearing and utilization of public transportation. Such differences, however, did not impact the distribution of anti-S seropositivity. Differences in such district-related practices might be attributed to differences in their crowding, educational levels and social standards of their residents.

Strengths and Limitations

To our knowledge, the study is the only of its kind that provides a comprehensive review of the public health situation in Alexandria during the second and third waves of the COVID-19 pandemic. It is the only study that correlates adherence to preventive measures with anti-S seroprevalence, vaccine hesitancy, and demonstrates the prevalence of different practises according to the district. Because data was collected from all seven districts of Alexandria, the results are, to a great extent, representative of the population and provide insight on the health practices and habits of people in different areas of the city.

However, the respondents from some districts such as Western District and Gomrok were few in number, and thus may not be representative of the population in these particular districts. Another possible limitation is that some items on the questionnaire are prone to subjective interpretation (such as the practice of “physical distancing”) and some items could have been difficult for the respondents to accurately recall (such as washing hands for more or less than 20 seconds).

5. Conclusions:

Alexandrian residents showed low compliance to the precautionary social measures such as practicing physical distancing and wearing masks. However, hand hygiene practice was the best observed among them. Females and old age participants showed higher compliance to these measures than males and young age. The investigated measures revealed associations with the seropositivity of anti-COVID-19 S antibody as well as the acceptance of COVID-19 vaccine.

Conflicts of Interest

The authors declare no conflict of interest.

Funding

This research was funded by Science and Technology Development Fund. Grant number: 43834.

6. References:

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with pneumonia in China, 2019. New England journal of medicine. 2020.

2. Organization WH. 2023. Available from: https://covid19.who.int/region/emro/country/eg.

3. Flaxman S, Mishra S, Gandy A, Unwin HJT, Mellan TA, Coupland H, et al. Estimating the effects of non-pharmaceutical interventions on COVID-19 in Europe. Nature. 2020;584(7820):257-61. doi: 10.1038/s41586-020-2405-7.

4. Ghazy RM, Taha SHN, Elhadi YAM. Letter from Egypt. Respirology. 2022.

5. world Health Organization. Coronavirus disease (COVID-19), Prevention 2022. Available from: https://www.who.int/health-topics/coronavirus#tab=tab_2.

6. Talic S, Shah S, Wild H, Gasevic D, Maharaj A, Ademi Z, et al. Effectiveness of public health measures in reducing the incidence of covid-19, SARS-CoV-2 transmission, and covid-19 mortality: systematic review and meta-analysis. BMJ. 2021;375:e068302. doi: 10.1136/bmj-2021-068302.

7. Wang Y, Tian H, Zhang L, Zhang M, Guo D, Wu W, et al. Reduction of secondary transmission of SARS-CoV-2 in households by face mask use, disinfection and social distancing: a cohort study in Beijing, China. BMJ Global Health. 2020;5(5):e002794. doi: 10.1136/bmjgh-2020-002794.

8. El-Ghitany EM, Farag S, Farghaly AG, Hashish MH, Hassaan MA, Omran EA. A pre-vaccine exploratory survey of SARS-CoV-2 humoral immunity among Egyptian general population. Tropical medicine and health. 2022;50(1):1-10.

9. Martinez-Fierro ML, Ríos-Jasso J, Garza-Veloz I, Reyes-Veyna L, Cerda-

Luna RM, Duque-Jara I, et al. The role of close contacts of COVID-19 patients in the SARS-CoV-2 transmission: an emphasis on the percentage of nonevaluated positivity in Mexico. American journal of infection control. 2021;49(1):15-20.

10. CDC. When and How to Wash Your Hands. 2022. Available from: https://www.cdc.gov/handwashing/when-how-handwashing.html.

11. YouGov P. Personal measures taken to avoid COVID-19 2022 [cited 1]. 2022].

12. Ali RAE, Ghaleb AA, Abokresha SA. COVID-19 related knowledge and practice and barriers that hinder adherence to preventive measures among the Egyptian community. An epidemiological study in Upper Egypt. Journal of Public Health Research. 2021;10(1).

13. Kakemam E, Ghoddoosi-Nejad D, Chegini Z, Momeni K, Salehiniya H, Hassanipour S, et al. Knowledge, attitudes, and practices among the general population during COVID-19 outbreak in Iran: a national cross-sectional online survey. Frontiers in Public Health. 2020:868.

14. Almutiri TM, Alzhrani WH, Alraddadi R. Adherence to COVID-19 preventive measures and its predictors among the population of Jeddah City 2020. Age (Years). 2020;20(16):3.4.

15. 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.

16. WHO. Coronavirus disease (COVID-19): Masks 2022 [cited 2022 26/02/2022]. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/question-and-answers-hub/q-a-detail/coronavirus-disease-covid-19-masks.

17. Mieth L, Mayer MM, Hoffmann A, Buchner A, Bell R. Do they really wash their hands? Prevalence estimates for personal hygiene behaviour during the COVID-19 pandemic based on indirect questions. BMC Public Health. 2021;21(1):12. doi: 10.1186/s12889-020-10109-5.

18. Rana IA, Bhatti SS, Aslam AB, Jamshed A, Ahmad J, Shah AA. COVID-19 risk perception and coping mechanisms: Does gender make a difference? International Journal of Disaster Risk Reduction. 2021;55:102096. doi: https://doi.org/10.1016/j.ijdrr.2021.102096 .

19. Gerhold L. COVID-19: risk perception and coping strategies. 2020.

20. Broche-Pérez Y, Fernández-Fleites Z, Jiménez-Puig E, Fernández-Castillo E, Rodríguez-Martin BC. Gender and fear of COVID-19 in a Cuban population sample. International journal of mental health and addiction. 2020:1-9.

21. Reznik A, Gritsenko V, Konstantinov V, Khamenka N, Isralowitz R. COVID-19 fear in Eastern Europe: validation of the fear of COVID-19 scale. International journal of mental health and addiction. 2021;19(5):1903-8.

22. Peckham H, de Gruijter NM, Raine C, Radziszewska A, Ciurtin C, Wedderburn LR, et al. Male sex identified by global COVID-19 meta-analysis as a risk factor for death and ITU admission. Nature communications. 2020;11(1):1-10.

23. Lüdecke D, Von Dem Knesebeck O. Protective behavior in course of the COVID-19 outbreak—survey results from Germany. Frontiers in public health. 2020:567.

24. Almutairi AF, BaniMustafa Aa, Alessa YM, Almutairi SB, Almaleh Y. Public trust and compliance with the precautionary measures against COVID-19 employed by authorities in Saudi Arabia. Risk Management and Healthcare Policy. 2020;13:753.

25. 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. doi: 10.3389/fpsyg.2020.561785.

26. Zuñiga M, Lagomarcino AJ, Muñoz S, Alonso AP, Rodriguez MA, O'Ryan ML. A cross sectional study found differential risks for COVID-19 seropositivity amongst health care professionals in Chile. Journal of Clinical Epidemiology. 2022;144:72-83. doi: https://doi.org/10.1016/j.jclinepi.2021.12.026.

27. Cherif I, Kharroubi G, Chaabane S, Yazidi R, Dellagi M, Snoussi MA, et al. COVID-19 in Tunisia (North Africa): Seroprevalence of SARS-CoV-2 in the General Population of the Capital City Tunis. Diagnostics. 2022;12(4):971. PubMed PMID: doi:10.3390/diagnostics12040971.

28. Palamenghi L, Barello S, Boccia S, Graffigna G. Mistrust in biomedical research and vaccine hesitancy: the forefront challenge in the battle against COVID-19 in Italy. European journal of epidemiology. 2020;35(8):785-8.

29. Yehualashet DE, Seboka BT, Tesfa GA, Mamo TT, Yawo MN, Hailegebreal S. Prevalence and Determinants of COVID-19 Vaccine Hesitancy Among the Ethiopian Population: A Systematic Review. Risk Management and Healthcare Policy. 2022;15:1433.