

# Practice of non-pharmaceutical interventions against COVID-19 and reduction of the risk of influenza-like illness: A retrospective cross-sectional population-based study

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## Article

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# Abstract

## Introduction:

While this widespread implementation of the non-pharmaceutical interventions was intended to contain the COVID-19 pandemic, such measures could be also effective in limiting the spread of other respiratory infections. This study aimed to examine the association between the implementation of personal protective measures and the occurrence of influenza-like illnesses (ILI) in the general population.

## Methods:

An online retrospective cross-sectional observational study was conducted in April 2021 to assess cases of ILI among Lebanese adults aged 18 years and above, from all Lebanese governorates during the 2020–2021 flu season. Data was collected using a convenient sampling method. In addition to their sociodemographic information, participants were asked about their frequency of implementing personal protective measures and if they have experienced symptoms of ILI in the previous six months. The overall score of the personal protective measures was computed. Multivariable logistic regression was performed to examine the association between participants' level of adoption of personal protective measures against COVID-19 and the occurrence of ILI.

## Results:

Among the 1019 Lebanese adults participating in this study, 352 (34.54%) of them reported symptoms of ILI between October 2020 and March 2021. Lebanese adults who wore their facemasks frequently or always were less likely to suffer from symptoms of ILI than others who did not wear the mask (aOR = 0.452, 95% CI = 0.349– 0.693,  $p < 0.001$ ). Similarly, adults who adopt the following protective measures washing hands (aOR = 0.608, 95% CI = 0.524– 0.922,  $p < 0.001$ ), respecting cough etiquette (aOR = 0.763, 95% CI = 0.598– 0.918,  $p < 0.001$ ), disinfecting surface (aOR = 0.892, 95% CI = 0.632–0.911,  $p = 0.012$ ), avoiding crowded places surface (aOR = 0.739, 95% CI = 0.688–0.903,  $p = 0.049$ ), respecting physical distancing surface (aOR = 0.646, 95% CI = 0.482–0.833,  $p = 0.031$ ) on a regular basis (frequently/always) were less likely to report symptoms of influenza-like illnesses when compared with those who did not adhere at all to these measures.

## Conclusion:

Our study highlighted the potential of personal protective measures against COVID-19 in reducing the transmission of respiratory infections such as ILI. Such findings might be invested during influenza season, particularly among groups at high risk of developing severe complications. Exploring trends

detected by the national severe acute respiratory infection surveillance system is recommended to confirm the utility of these measures.

## Background

The severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) is a novel virus that emerged in China in late 2019 and then turned into a worldwide disaster (1). Given the novelty of the causative virus, there was a lack of available pharmaceutical options to fight it such as vaccines and specific antiviral treatment (2). At this point, non-pharmaceutical interventions (NPIs) seem like the merely available option, gaining, therefore, prominence over other methods (3). To curtail the virus transmission and to reduce mortality, several preventive measures to protect the communities and individuals through NPIs were recommended by the World Health Organisation (WHO) (4). Moreover, a variety of health policies and large-scale public health measures have been implemented proactively by governments worldwide (5) to contain the ongoing COVID-19 pandemic and to gain time awaiting the availability of pharmaceutical interventions. At the country level, these protective measures included limiting or banning international travel, stringent lockdown, remote work, and cancellation of public events. At the personal level, several health-related behaviors were recommended. The latter encompassed mandatory public use of facemask, regular hand hygiene, compliance to cough etiquette, keeping physical distancing, staying at home when feeling sick, disinfecting touched surfaces and objects avoiding the 3Cs such as crowded places and social gatherings, close contacts, and closed spaces (4). In this context, the findings of various studies have supported the effectiveness of wearing facemasks, protecting the eyes, physical distancing (6), and hand hygiene (7) in impeding the transmission of SARS-CoV-2. A recent systematic review and meta-analysis disclosed that keeping a physical distance of one meter or more can considerably lower the risk of viral transmission (6). Similarly, mask and eye protection use also ensued a large decrease in the risk of infection (mask use: aOR 0.15; eye protection: aOR 0.22) (6). Moreover, the use of masks by all residents was a key component to successfully combat COVID-19 and may have reduced fear and anxiety (8-10). It is worth mentioning that evidence also supported the potential role of limiting contact measure with COVID-19 case, during his or her incubation period by reducing the frequency and the duration of contact, in reducing the average number of individuals to whom the virus was transmitted (11). Even with these procedures in play, reduced and unequal access to health care worldwide was noted due to the overstressing of health systems the economic burden caused by the pandemic (12).

While this widespread implementation of the above mentioned preventive measures was intended to mitigate and contain the COVID-19 pandemic, such procedures could be also effective in limiting the spread of other respiratory illnesses such as seasonal influenza, outpatient pneumonia, and severe acute respiratory infection (SARI) and flu-like illnesses (13, 14). This could be anticipated since SARS-CoV-2 and other viruses causing acute respiratory infections shared similar transmission routes and spread mainly by respiratory droplets. Despite the paucity of data related to the effectiveness of these measures in preventing community transmission of influenza-like illnesses (15, 16), Olsen et al., reported a sharp decline in influenza activity and influenza-like illnesses after the implementation of the above-mentioning

measures (15). In addition, several reports have showed a decrease in the numbers of influenza cases during the 2019–2020 influenza season. This was supported by the influenza data reported to the WHO through FluNet platform in 2021, where a decline in influenza-positive results and outpatient visits for influenza-like illnesses (17) was recorded in the majority of countries and regions in the Southern, Northern Hemisphere and in temperate zones. A study conducted in New Zealand reported that the incidence of influenza decreased 79-fold during post-lockdown period in addition to a significant reduction in the incidence of other respiratory viruses in comparison with the same period in the previous year (18). Similar findings were reported in a study conducted in Japan where a decrease in the number of people infected with the influenza virus in 2020 was reported, compared to the past year (19).

In Lebanon, the first case of COVID-19 was confirmed on 21 February 2020 (20). Since the early phase of the pandemic, Lebanon has been pre-emptive in responding to Covid-19 by strengthening and maintaining its national capacities required under the International Health Regulations (IHR 2005) (21). A National Committee for COVID-19 (NCC) was established to lead and to run the COVID-19 national preparedness and response using a holistic approach involving all stakeholders including proactive measures to prevent, to control the spread of COVID-19. Similar to other countries, Lebanon has promoted health-related behaviours such as hand washing and physical distancing to protect communities and individuals from transmission of COVID-19. Of note, acquiring such behavioural insights will be essential to boost and encourage compliance with recommended practices and manage disease's transmission. In March, 14, 2020, with the rise of COVID-19 cases to 99, Lebanon declared a state of health emergency and the government imposed two-week "lockdown" on people's movements as part of the country's efforts to slow the spread of the virus (22). Since the acceptance and adoption of such health behaviours by community members during COVID-19 is associated with communication, the lockdown was accompanied with a high level of COVID-19 risk communications and upgrade of preventive measures. Such behavioural practice required that effective operational strategies are put into place. In addition, it is also associated with perceived risk of COVID-19, the level of knowledge and the perceived level of effectiveness of such health-related behaviours among community members(23). Briefly, although these customary strategies may have benefits based on current evidence during the COVID-19 pandemic, their effectiveness on other respiratory infections apart from SARS-CoV-2 remains largely unclear in the Lebanese context. Similar to other countries,. Therefore, it is of great interest to explore the potential of the protective behavioural practices adopted by Lebanese adults in limiting the spread of influenza-like illnesses among Lebanese adult population.

This study aimed to examine the association between the implementation of personal precautionary measures and the cases of influenza-like illnesses in the general population.

## **Methods**

### **Study tool and design:**

A retrospective cross-sectional observational study was carried out in April 2021 to assess cases of influenza-like illnesses among Lebanese adults during the 2020–2021 flu season (from October 2020 and the end of March 2021). Data was collected through an online survey using a convenient sampling method. As the Lebanese government recommended the public minimize face-to-face interaction, potential respondents were electronically invited to participate.

## Questionnaire development

A review of the literature was conducted to list available resources on recommended NPIs during COVID-19 with a special focus on personal health-related behaviors. A 40-item structured questionnaire was initially developed and designed by the authors to cover important aspects of adopted NPIs among the Lebanese population. Before proceeding to the translation and adaptation of the original English draft of the questionnaire into the Arabic language based on the standard translation guidelines, a panel of experts has reviewed the developed questionnaire and assessed the clarity of the questions, and the accuracy of the domains. Then, the questionnaire was also pretested on a convenience sample of 20 male and 20 female Lebanese adults (n=40) to ensure survey flow, readability, clarity of interpretation, comprehension of instructions, and validity of responses. Minor modifications in terms of readability and clarity were made to the questionnaire based on the feedback of the respondents of the pre-test. Since the questionnaire has not been validated previously in the context of this research, its reliability was checked, and the Cronbach Alpha value was calculated indicating a good reliability ( $\alpha=0.79$ ). The average time for completing the survey was 7 minutes. The questionnaire was self-administered and its final version consisted of open-ended questions and was divided into four main sections:

1. **The baseline characteristics of the study participants section** included information about age, gender, marital status, educational level, urbanicity, working status, health status, underlying health conditions, current smoking status and health coverage of the participants. Surveyed adults were also asked whether they had a previous history of COVID-19 infection and if they have been tested positive for COVID-19 during the current influenza season (October 2020 to March 2021).
2. **Vaccination status:** Participants were asked if they have received the influenza vaccine for the current season and if they are being vaccinated against COVID-19.
3. **Influenza like illness section:** Participants were asked if they experienced symptoms of influenza-like illnesses (ILI) in the previous months. This question was answered on yes or no basis. In this section ILI symptoms were defined as an acute respiratory infection with an onset within 10 days, fever of  $>38^{\circ}\text{C}$ , and persistent cough in the absence of an alternative causative agent (24, 25). Adults who reported symptoms of fever, sore throat, and persistent cough and did not receive any confirmatory tests were regarded as having symptoms of influenza-like illnesses, consistent with the WHO's case definition of influenza-like illnesses.
4. **Personal protective measures:** Participants enrolled were asked about their frequency of adopting the following personal protective measures: wearing facemasks, hand hygiene, surface disinfection,

physical distancing and avoiding crowded places. Participants reported their frequency of implementing the measures using a 5-Likert scale (never=1, rarely=2, sometimes=3, frequently=4, always=5).

## **Study participants:**

All Lebanese residents aged  $\geq 18$  years from all the eight Lebanese governorates (Bekaa, Baalbeck-Hermel, Beirut, Mount Lebanon, North, Akkar, Nabatieh, South), who had access to internet, and who gave their consent to participate were eligible for participation in the study. The study excluded adults who didn't speak Arabic, those who don't have internet access literacy and those who have not access to internet. As influenza and SARS-CoV-2 are symptomatically indistinguishable, individuals with positive SARS-CoV-2 test or those who were tested negative for COVID-19 but had contact with COVID-19 cases were excluded from the study.

## **Sample size calculation**

To calculate the sample size of the study, the Raosoft sample size calculator designed specifically for population surveys was used. Assuming that around 3 Million adults reside in Lebanon, a 95% confidence level was used and an absolute error was estimated to be 5%. All previous information was used to calculate the sample size for this study which yielded the least required sample size of 385 participants. To reduce the sampling error and to increase the study power, a rough estimation was made by multiplying the calculated sample size by 2.65 times, leading to a final sample size of 1019 participants.

## **Data collection**

An online questionnaire using a Google form was shared with potential participants recruited through social media platforms, institutional and university groups. This link of the study included a brief introduction to the background, the objective of the survey, and instructions for filling the questionnaire. Participants were screened based on the responses given in the baseline questionnaire to determine whether they met the study's inclusion criteria. No reward was given to respondents for their participation.

## **Ethical considerations**

Given the online nature of the study, an electronic informed consent was obtained for each participant. Respondents were reassured their participation is solicited, yet strictly voluntary. They were free to withdraw at any time without any penalty. All information were gathered anonymously and handled confidentially. As individual participants cannot be identified based on the presented material, this study

caused no plausible harm or stigma to participants and there will be no foreseeable risks for this study and no direct benefit as well. However, the information obtained may help in providing evidence about the effectiveness of personal protective behaviour in decreasing ILI. The study design respected the participant's confidentiality and assured adequate protection of study participants, and neither included clinical data about patients nor configured itself as a clinical trial. This study was exempted from ethical approval by the Ministry of Public Health after review of the study protocol.

## Statistical analysis

All descriptive and comparative analyses were performed using the Statistical Package for the Social Sciences to IBM SPSS 24. Categorical variables with ordinal response scales were grouped according to the frequency of each personal protective measures (wearing facemasks, washing hands, cough etiquette, physical distancing, avoiding crowded places, and disinfecting surfaces) into 3 groups. A value of 0 was assigned for participants who never or rarely applied each specific measure. A value of 1 was assigned for sometimes option and the value of 2 was assigned for “frequently” or “always” options. The overall score of personal protective measure was equal to the sum of each protective measure for each participant and the latter ranged between 0 and 12 where these 2 values represented the lowest and possible score respectively. The frequency of adoption of personal protective measures among Lebanese adults were compared between individuals who had influenza like symptoms is compared between and those who did not. Multivariable logistic regression was carried out on the significant variables in the bivariate analyses (chi-squared test with  $p$ -value $<0.2$ ), to identify the factors associated with the occurrence of influenza like illnesses. The first regression analysis included covariates such as gender, age, educational level, residence, health status and current smoking status, influenza vaccine intake ( $p$ -value less than 0.2 when running bivariate analysis) in addition to the level of implementation of each personal protective measure. As per the result of the first regression, the covariates that were found significantly associated with the occurrence of ILI were controlled and the analysis was rerun with the personal protective measures against COVID-19 (wearing facemasks, hand hygiene, physical distancing, surface disinfection, and avoiding crowded places) set as the covariates (block 2). Significance was set as  $p$ -value $<0.05$ .

## Results

### Baseline characteristics of the participants:

A total of 1019 Lebanese adults who met the inclusion criteria have agreed to participate in this survey. Table 1 displayed the baseline information of the participants. The majority of respondents were females (53.4%), married (81.1%), aged between 30 to 49 years old and having a higher educational than secondary level (66.7%). Most of them were residing in urban areas (66.1%) particularly in Mount-Lebanon province (26.7%). The majority of participants (83.3%) ranked their health status as good or above. On the other hand, around 40% of them were current smoker.

<b>Table 1: Baseline characteristics of study population</b>		
	<b>N</b>	<b>%</b>
<b>Gender</b>		
Male	475	46.60%
Female	544	53.40%
<b>Age Groups (years)</b>		
18-29	290	28.50%
30-49	555	54.50%
50 and above	174	17.10%
<b>Marital status</b>		
Single	152	14.90%
Married	826	81.10%
Other (Divorced, widowed)	41	4%
<b>Educational level</b>		
Secondary or Below	339	33.30%
More than Secondary (University, Master...)	680	66.70%
<b>Urbanicity</b>		
Rural	345	33.90%
Urban	674	66.10%
<b>Province</b>		
Great Bekaa	176	17.30%
North and Akkar	211	20.70%
South and Nabatyeh	150	14.70%
Mount Lebanon	272	26.70%
Beirut	210	20.60%
<b>Working status</b>		
No	174	17.10%
Yes	845	82.90%
<b>Profile</b>		

Student	149	14.60%
Worker	822	80.70%
Other (Retired, Housewife...)	48	4.70%
<b>Perceived health status</b>		
Fair or below	170	16.70%
Good and above	849	83.30%
<b>Underlying health condition</b>		
No	853	83.70%
Yes	166	16.30%
<b>Current smoking status (shisha or cigarette)</b>		
Non smoker	613	60.20%
Smoker	406	39.80%
<b>Total</b>	<b>1019</b>	<b>100%</b>
N: Frequency, %: percentage		

## Influenza like illness among participants:

As shown in figure 1, a total of 352 (34.54%) participants reported symptoms of influenza-like illness between October 2020 and March 2021. The occurrence of ILI cases increased gradually from October (15.06%) till December (38.64%) where the majority of ILI symptoms occurred. Then the frequency of cases decreased during the next months and it reached its least during March (4.26%) (Figure 2).

## Implementation of personal protective measures by participants

Table 2 displayed the frequency of implementation of each personal protective measure by the Lebanese adults. We found that participants who did not have symptoms of influenza-like illnesses reported higher level of implementation of all the personal protective measures than those who experienced symptoms. However, around 20% of those who showed ILI symptoms didn't adhere or rarely adhere to the majority of protective measures.

<b>Table 2: Frequency of each recommended personal protective measures as applied by participants</b>				
		<b>Never/Rarely</b>	<b>Sometimes</b>	<b>Frequently/Always</b>
	<b>N</b>	<b>n(%)</b>	<b>n(%)</b>	<b>n(%)</b>
<b>Participants without influenza like illness</b>				
Wearing facemask	667	7(1%)	158(23.7%)	502(75.3%)
Hand Hygiene	667	10(1.5%)	20(3%)	637(95.5%)
Cough etiquette	667	2(0.25%)	25(3.75%)	640(96%)
Surface disinfection	667	3(0.5%)	113(16.9%)	551(82.6%)
Physical distancing	667	6(0.9%)	216(32.4%)	445(66.7%)
Avoiding crowding place	667	11(1.6%)	180(27%)	476(71.4%)
<b>Participants with influenza like illness (N=352)</b>				
Wearing facemask	352	100(28.5%)	146(41.5%)	106(30.1%)
Hand Hygiene	352	23(6.5%)	187(53.1%)	142(40.4%)
Cough etiquette	352	70(19.9%)	157(44.6%)	125(35.5%)
Surface disinfection	352	72(20.5%)	150(42.6%)	130(36.9%)
Physical distancing	352	79(22.4%)	178(50.6%)	95(27%)
Avoiding crowding place	352	71(20.2%)	139(39.5%)	142(40.3%)

## **Influenza-like illnesses and overall protective measure score**

Figure 3 showed the variation of occurrence of influenza-like illnesses by protective measure score. The level of personal protection against COVID-19 was higher among adults who did not have influenza-like illnesses (Figure 3), further indicating a link between implementation of the measures against coronavirus and cases of influenza-like illnesses. Of the adults who reported influenza-like illnesses, 67% (n=236) had scores below the median and 33% (n=116) had scores above the median person protective measure (median=11). The bivariate analysis showed a significant difference between individuals between participants who scored below the median and those who scored above the median, ( $\chi^2=33.87$ ,  $p<0.001$ , OR=0.347).

## Factors associated with the occurrence of influenza-like illness:

The first regression analysis that included covariates such as gender, age group, marital status, health status, educational level, current smoking status, and vaccination status in addition to the implementation of personal protective measures found that the baseline covariates did not significantly affect the occurrence of influenza-like illnesses except for influenza intake ( $p=0.019$ ). Therefore, the baseline covariates were removed from the regression model, and the analysis was rerun with the six protective measures after controlling the influenza vaccination status. As seen in table 3, the final regression analysis showed that at a Lebanese adults who wore their facemasks frequently or always were less likely to suffer from symptoms of influenza-like illnesses than other who did wore the mask sometimes, rarely or not wearing the facemask at all (aOR=0.452, 95% CI=0.349– 0.693,  $p<0.001$ ). Similarly, adults who adopt the following protective measures frequently or always: washing hands (aOR=0.608, 95% CI=0.524– 0.922,  $p<0.001$ ), respecting cough etiquette (aOR=0.763, 95% CI=0.598– 0.918,  $p<0.001$ ), disinfecting surface (aOR=0.892, 95% CI=0.632–0.911,  $p=0.012$ ), avoiding crowded places surface (aOR=0.739, 95% CI=0.688–0.903,  $p=0.049$ ), respecting physical distancing surface (aOR=0.646, 95% CI=0.482–0.833,  $p=0.031$ ) were less likely to report symptoms of influenza-like illnesses when compared with those who did not adhere at all to these measures. Of note, no significant difference in terms of the occurrence of influenza like illness between adults who didn't adhere at all to the over mentioned protecting measures and those who only applied these measures occasionally.

<b>Table 3: Multivariable logistic regression of the factors associated with ILI among Lebanese adults</b>				
	<b>P-Value</b>	<b>aOR</b>	<b>Confidence interval 95%</b>	
			<b>Lower</b>	<b>Upper</b>
<b>Wearing facemask</b>				
Never/Rarely	Ref			
Sometimes	0.142	0.843	0.751	1.829
Frequently/Always	<b>&lt;0.001</b>	0.452	0.349	0.693
<b>Hand Hygiene</b>				
Never/Rarely	Ref			
Sometimes	0.072	0.903	0.767	2.012
Frequently/Always	<b>&lt;0.001</b>	0.608	0.524	0.922
<b>Cough etiquette</b>				
Never/Rarely	Ref			
Sometimes	0.231	0.978	0.832	3.012
Frequently/Always	<b>&lt;0.001</b>	0.763	0.598	0.918
<b>Surface disinfection</b>				
Never/Rarely	Ref			
Sometimes	0.389	0.832	0.724	1.571
Frequently/Always	<b>0.012</b>	0.892	0.632	0.911
<b>Physical distancing</b>				
Never/Rarely	Ref			
Sometimes	0.128	0.805	0.601	2.129
Frequently/Always	<b>0.031</b>	0.646	0.482	0.833
<b>Avoiding crowding place</b>				
Never/Rarely	Ref			
Sometimes	0.521	0.656	0.502	2.032
Frequently/Always	<b>0.049</b>	0.739	0.688	0.903

## Discussion

The recent COVID-19 outbreak has stimulated a public-driven movement for prevention and governments worldwide have made many attempts to control the situation resulting from emergence of COVID-19. This included the implementation of NPIs at personal and at country levels. Since other viral respiratory infections shared same transmission dynamics with COVID-19 where these viruses spread through close contact, aerosols and/or droplets, therefore, implemented measures could not only curtail the spread of SARS-CoV-2, but might also impact the occurrence of ILI and reduce the transmission of other viral respiratory infections.

## Study main findings

The current study argue that participants who exhibited high level of adherence to COVID-19 personal protective measures were more likely of being free of influenza-like illnesses during the flu season compared to those who did not adhere to the measures. This strongly suggested that the protective measures taken against the spread of SARS-CoV-2 have also interrupted the spread of ILI. Our results were in line with the findings of previous studies that emphasized the potential of community-level strategies used to halt the spread of SARS-CoV-2 in lowering influenza transmission was revealed in several studies (16, 26, 27). Furthermore, a longitudinal study conducted among international students found a two-fold increased risk of ILI among students who did not implement all the personal protective measures compared with those who adhered to the measures (28). Of note, a similar impact of implemented protective measures was detected in European countries such as Austria, Belgium, Italy, Germany, Spain and the Netherlands (29).

Our finding revealed the potential of wearing facemasks on a regular basis (frequently or always) in decreasing the occurrence of ILI among participants (aOR=0.452) in comparison with other individuals who didn't adhere to this protective measure. Based on the literature, several studies aimed to evaluate the effectiveness of facemask use in preventing pandemic influenza infection (30-38). Some of the overmentioned studies reported similar results as our study such as the findings of cross-sectional survey conducted by Kim et al. (34) which revealed a significant protective effect of continuous mask use in children, relative to non-users (OR = 0.51; 95% CI 0.30-0.88), but a non-significant risk increase in irregular users relative to non-users (OR = 1.02; 95% CI 0.83-1.25). A cohort study conducted by Kuster et al. showed also that for each 10% increase in adherence to facial protection, there is a decrease (OR = 0.92) of that the risk of being infected by influenza viruses among healthcare workers (37). Similarly, Suess et al. found in his cluster randomized control trial a significantly protective effect of facemask use (OR = 0.28) (35). However, some studies (30, 33, 38) found a non-significant protective effect of facemask in preventing influenza infection.

In terms of hand hygiene, washing hands regularly and continually was found associated with lower risk of suffering from ILI symptoms. Given the high compliance rate among study participants (95.5%) reporting always or frequently their hands, the results of this study provide a reliable estimate of the impact of hand hygiene in preventing influenza-like illnesses in the context of a pandemic. Our findings

were consistent with the results of several studies evaluating the effectiveness of hand hygiene in preventing influenza infection (31, 32, 35-37, 39). A study conducted by Aiello et al. reported that hand hygiene decreases respiratory infections by 16%–21% (40). Azor-Martinez et al. reported that the school absenteeism associated with pandemic influenza declined in schools that implemented hand sanitizer intervention (39). Swess et al found that the combination of hand hygiene with facemask use (OR = 0.26) were able to decrease the risk of secondary influenza infection (35). However, inconsistent findings in terms of protective effect of hand hygiene were reported by Kim et al who found a non-significant protective effect of subjectively reported “frequent” hand-washing, with OR = 0.99 (95% CI 0.96–1.02). Of note, the protective effect of this intervention was more pronounced in studies where frequency was defined objectively based on a minimum number of times individuals washed their hands daily.

Our study disclosed the potential of the adherence to physical distancing and avoidance of crowded places in decreasing the likelihood of experiencing symptoms of influenza-like illnesses when compared with those who did not adhere at all to these measures. Prem et al. reported the benefits of limiting social mixing (41). However, a previous study conducted among international students did not find any significant association between cases of influenza-like illnesses and avoiding crowded places (28). Of note, the evidence regarding the benefit of avoiding crowded places in preventing respiratory virus infection in individuals remains scarce.

Additionally, our study found a significant association between surface disinfection and reported cases of influenza-like illnesses among Lebanese adults. Our results were in accordance with a previous study that revealed the potential of surface disinfection effectively decreases secondary COVID-19 transmission in households (42).

In terms of cough etiquette which was found associated with lower likelihood of suffering from ILI, no studies were found that evaluated the effectiveness of respiratory etiquette on ILI transmission. However, a study appraising the efficiency of cough etiquette in blocking aerosol particles, found that cough etiquette did not block the release or dispersion of aerosol droplets, particularly those smaller than one micron in size (43). Of note, influenza particles are extremely small (0.08–0.12  $\mu\text{m}$  in diameter) (44), and could easily be transmitted in small droplets expelled during sneezing or coughing.

It is noteworthy that influenza vaccine intake that was found decreasing the likelihood of occurrence of ILI among participants, it is important to mention that the recommendations for vaccination against influenza during this influenza season did not change compared with previous seasons. In Lebanon, the influenza vaccines are normally administered from 1 October each year. However, in the 2020/2021 season, the influenza vaccination was delayed a little bit due to the delay in purchasing the influenza vaccines. However, it is unlikely that the vaccination could have resulted in the sudden sharp decline seen in the occurrence of ILI, since the latest could result from other respiratory viruses. Of note, the low circulation of influenza viruses for one or two seasons shown in several countries could minimize the exposure of young children to these viruses and enlarge the group of children who will be susceptible in the following influenza season.

In summary, the adherence to each of the six personal protective measures recommended by the WHO reduced cases of ILI among Lebanese adults participating in this study. In addition, a synergic implementation of all of the overmentioned personal protective measures offered higher protection to individuals compared with single measures.

## **Strengths of the study:**

To the best of our knowledge, the present study is the first in Lebanon to successfully explore the association between practice of personal protection measures and the risk of influenza-like illnesses in the community during the 2020–2021 flu season. Given the current economic crisis, the fear of COVID-19, the overstrain of healthcare system and the recommendation issued by the government to minimize face to face interaction, Lebanese adults with ILI could hesitate to visit healthcare services and often delay accessing healthcare. Thus, our findings provide a snapshot of the reported cases of ILI among the community where healthcare avoidance may be an important confounder affecting the findings of healthcare-based acute respiratory infection surveillance system. Therefore, our participants could represent a category that may not be captured in hospital visits.

## **Limitations:**

Several limitations should be acknowledged in this study. First, the cross-sectional design of our study preclude the ability to make a causal inference and its retrospective nature presents a risk of reporting biases, which could over-estimate the true effectiveness of the personal protective measures in preventing ILI infection, as ILI cases and free ILI cases may misjudge their adoption of these measures in order to justify their infection status. For example, participants gave a self-reported history of ILI which could be subject to recall bias. In addition, respondents gave their self-evaluation using subjective terms to define frequency of their implementation of personal protective measures against COVID-19 such as “rarely”, “occasionally” or “sometimes”, which may be affected by social desirability and could led to a possible overestimation of their implementation. To resolve any potential social desirability bias, an anonymous online survey was used and participants were assured of the confidentiality of their responses in the introductory part of the survey. The study evaluated only the preventive effects of 6 personal protective measures; other measures may have contributed to suppressing transmission of respiratory infections such as lockdown, mass gathering cancellation and school closure. Furthermore, the convenience sampling technique used in our study, limit the generalizability of our findings. However, a large sample was used to reduce the sampling error and to increase the study power. Lastly, a knowledge gap related to the appropriate “threshold” for adequate personal protective measure scale, exist. It is likely that this will vary depending on individual factors such as exposure, susceptibility and risk of adverse outcomes.

## **Implications of the study and future directions**

Our findings suggest that the adherence to these measures can ameliorate the impact from other respiratory pathogens, reducing the strain on healthcare infrastructure. Such findings may be particularly helpful for developing prevention strategies in settings where respiratory infections are very harmful, such as congregate settings and for the elderly and immunosuppressed. Even once the pandemic resolves, practices implemented to reduce COVID-19 transmission may be advisable for vulnerable individuals (elderly, immunocompromised...) particularly in high-risk settings (nursing homes, facilities, entertainment venues), or during travel, especially during the winter months at the annual peak of most respiratory viral infections. As society reels from the financial, societal, and health costs of severe COVID-19 response measures globally, interdisciplinary researchers and policy-makers globally were invited to investigate and facilitate the precise level of prevention for future epidemics. An important implication of this study was the need to perform such maneuvers frequently to curtail the transmission of COVID-19 and reduce the overall burden of communicable diseases, therefore the general public is urged to actively apply these preventative measures. Risk communication strategies to enhance public' knowledge in this area are crucial to clarify locations and situations where viral contact is likely, and to emphasize the value of engaging in such protective behaviours.

## Conclusion

This study constitutes a contribution to the non-pharmaceutical interventions research in the context of a pandemic. Our findings highlighted the potential of personal protective measures against COVID-19 in reducing the transmission of ILI. Optimal intervention strategy may combine broad recommendations for frequent hand hygiene, combined with targeted facemask use and other protective measures among high-risk populations (healthcare workers, schools-aged children, the elderly). Such findings may be particularly helpful for developing prevention strategies in settings where respiratory infections are very harmful. It also might be invested during influenza season, particularly among groups at high risk of developing severe complications. Last of all, exploring trends detected by the national severe acute respiratory infection surveillance system is recommended to confirm the utility of these measures.

## Abbreviations

ILI  
Influenza-like illnesses  
COVID-19  
Coronavirus disease 2019  
aOR  
Adjusted Odds Ratio  
SPSS  
Statistical Package for Social Sciences  
NPI  
Non Pharmaceutical intervention

CI

Confidence interval

SARS-CoV-2

Severe acute respiratory syndrome-Coronavirus2

## **Declarations**

### **Ethics approval and consent to participate:**

Informed consent for participating in the study was obtained digitally from all subjects through Google Forms. All methods were carried out in accordance with the relevant guidelines and national regulations for the Non-clinical studies. Specifically, at the beginning of the questionnaire, participants were asked whether they agree to participate in the research in order to be included in the study. Participants were also informed that their participation was voluntary and that they had the right to leave at any time without providing any explanation.

### **Consent for publication**

Not applicable.

### **Availability of data and materials:**

The datasets generated during the current study are not publicly available but are available from the corresponding author on reasonable request.

### **Competing interests**

The authors declare that they have no competing interests and they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### **Author Contributions:**

Conception and design: D.Y and J.Y

Data collection: D.Y., O.I., and M.K.,

Analysis and interpretation of the data: D.Y.

Critical revision of the article for important intellectual content: D.Y, E.D, L.A.A and J.Y

All authors read and approved the final version of the article.

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## Figures

## Influenza-like illness symptoms among participants

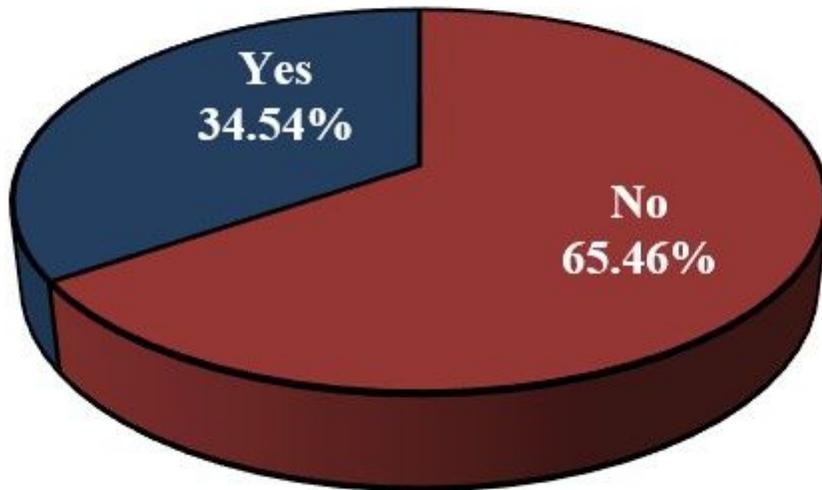


Figure 1

Occurrence of influenza-like illness among participants

## Percentage of participants who reported symptoms of influenza-like illnesses by month (from October 2020- March 2021)

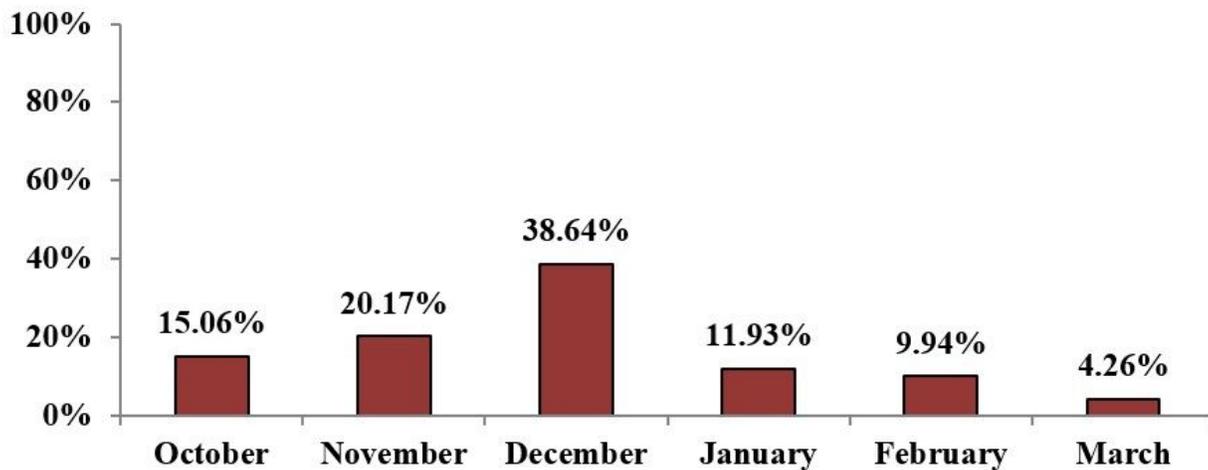
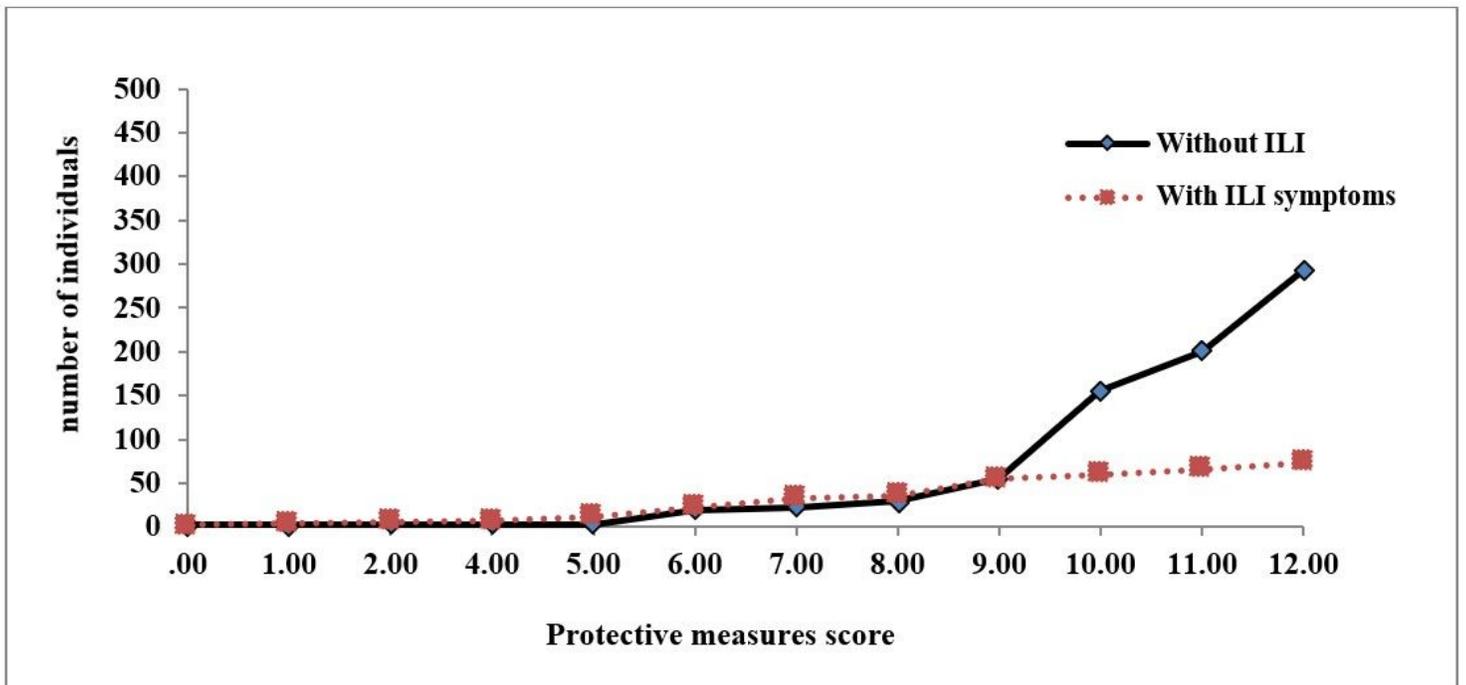


Figure 2

## Influenza-like Illness cases by month of occurrence



**Figure 3**

Personal protective measure score among Lebanese adults with and without symptoms of influenza-like illnesses