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People's preferences for epidemic prevention measures

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People's preferences for epidemic prevention measures

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Abstract

Due to its rapid spread and the delay in the discovery of drugs or vaccines to treat it, the epidemic can cause millions of deaths worldwide. Prevention measures are therefore an explicit objective of public health policy. We develop a questionnaire that allows us to analyze people's preferences for different prevention measures classified by epidemic severity. Failure to comply with the recommended prevention measures is both dangerous to the health of the population and economically costly to society. We see that part of our panel is willing to comply voluntarily with the recommended prevention measures. We show that the revelation of people's preferences allows us to determine the individual intangible (psychological) cost for prevention measures. This cost causes the individual not to voluntarily comply with prevention measures. We then propose government interventions to reduce intangible costs and motivate the individual to implement the recommended prevention measures. However, where these incentives fail, mandatory measures are an alternative.

Keywords: epidemic; intangible cost; prevention measures; public health interventions.

JEL Classification: I12; I18 .

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1 Introduction

Since a few decades, many new epidemics have appeared. Spanish Flu (1918-1920), Asian Flu (1957-1958), Hong Kong Flu (1968-1969), Russian Flu (1977-1978), H_1N_1 Flu Pandemic (2009-2010), avian influenza A (H_7N_9) virus (2013) are examples.[1] The common point of these epidemics is the quickness of appearance, the high number of victims and the rapidity of propagation.

The time from when a person is exposed to flu virus to when symptoms begin is about 1 to 4 days. Most healthy adults may be able to infect others beginning 1 day before symptoms develop and up to 5 to 7 days after becoming sick.[2] The principal symptoms are fever, chills, cough, headaches, diarrhea, sore throat, runny nose, body aches and fatigue. The transmission rate of influenza is influenced by various factors, the most important being the rate of contact between infected and susceptible individuals. Reduction of the contact intensity through quarantine[3] and social distancing has proven to be one of the most effective containment measures, especially in the early stages of the pandemic (Kelso et al, 2009; Halder et al, 2010; Milne et al, 2008; Chao et al, 2010). The 2009 H_1N_1 outbreak highlighted the challenges of using quarantine on a large scale to control emerging diseases. In March 2009, H_1N_1 influenza pandemic emerged in Mexico. As of 1 August 2010, more than 214 countries and other territories or communities had reported confirmed laboratory cases of the 2009 H_1N_1 pandemic, including over 18,449 deaths.[4] No pharmaceutical interventions for pandemic influenza at the community level were recommended by the World Health Organization (WHO) during the pandemic before the vaccine could be massively produced (Pérez Velasco et al, 2012). One such no pharmaceutical intervention was quarantine. Many countries then applied voluntary quarantines. Nevertheless, China adopted a much stricter prevention approach: mandatory quarantine for all people who had close contact with an infectious person in hospitals or hotels. The financial expenditure of this mandatory quarantine was 96.6 million US$ (Liang et al, 2012). Would not the Chinese voluntarily accept this quarantine? This would have reduced the huge financial cost. In fact, policy makers are faced with difficult choices when enforcing epidemic prevention measures. Should they only recommend these measures and trust people to respect them? Should they impose the recommendations to the people? Understanding people's preferences for epidemic prevention measures allows policy makers to answer these questions.

We build a questionnaire in which we assume that an epidemic has been declared

[1] For more details see: *http://www.who.int/influenza/en/* and *http://www.cdc.gov/flu/index.html*.

[2] For more details see: *http://www.who.int/influenza/en/*.

[3] From the World Health Organization (WHO), quarantine means the restriction of activities and/or separation from others of suspect persons who are not ill or of suspect baggage, containers, conveyances or goods in such a manner as to prevent the possible spread of infection or contamination.

[4] For more details see: *http://www.who.int/csr/don/2010_08_06/en/index.html*.

and we propose two hypothetical situations to the respondents: first, the respondent was in contact with one or several detected infected people, and second, the respondent has not been in contact with a detected infected person. The measures differ according to the situations and the pandemic severity. We adopt a guidance suggested by the centers for disease control and prevention (2007). The guidance establishes five categories of pandemic severity (from 1 to 5) and recommends different quarantine and closure policies for each of the categories. The categories are determined based on the value of the case fatality ratio (CFR), the proportion of deaths among clinically ill persons. For Category 1 pandemics (CFR is lower than 0.1%), the policy makers may choose to tailor their response by applying no pharmaceutical interventions: when the individual was in contact with infected persons: asking him to call the hospital once a day to control its health status, or be called by the hospital once a day to control its health status; and when the individual has not been in contact: recommending him to wear a mask outside or making temperature measurement by infrared light in public places to check health status. For Category 2 and Category 3 pandemics (CFR is between 0.1% and 1%), the policy makers may choose that when the individual was in contact, a quarantine at home is implemented with an eventual visit of a medical agent (a nurse or a doctor); and when the individual has not been in contact, only a quarantine at home is recommended. Finally, for Category 4 or Category 5 pandemics (CFR is higher than 1%), the policy makers may choose that when the individual was in contact: a quarantine at home with social distancing, or a quarantine at the hospital are recommended; and when the individual has not been in contact: the closure of public places, or a widespread community quarantine such as a "cordon sanitaire" measure in which an entire district, city or town can be isolated from outside are recommended. So, public health measures to reduce transmission of epidemics may be implemented at individual and community levels. All these measures are preventive to avoid the spread of infection and reduce transmission risk.

However, the duration of the measure application is also important for reducing the risk of victims. A prevention measure is then a combination of a measure and a duration. Uribe-Sánchez et al (2011) observe that longer social distancing period (from 11 to 14 days) significantly reduces the pandemic cost (in number of deaths and in monetary unit) by decreasing both the contact intensity and the size of the post-quarantine infectious population. According to the Centers for disease control and prevention (2007), it is recommended to implement quarantine and closure policies during 11 to 14 days for an epidemic. Therefore, the recommended prevention measure is defined as the measure chosen by the government, which follows the advices of the centers for disease control and prevention (2007) applied during 11 to 14 days.

Our approach relies on two building blocks. First, we contribute to the literature that examines the human behavior faces to an epidemic. Many studies have been done on

the impact of an illness using a cost illness study. As example, Achonu et al (2005) use a cost analysis to study the financial impact of controlling a respiratory virus outbreak in a teaching hospital. Gupta et al (2005), and Mubayi et al (2010) focus on an emerging infectious disease, SARS, and make a cost-based comparison of different quarantine strategies. However, as Bosworth et al (2010) say, understanding people's preferences for the different interventions is also required as cost-effectiveness for defining health policy. Indeed, as studied in Zhu et al (2017), the human behavior in social network determines the impact of the epidemics. An individual who does not want to respect the prevention measures would become increasingly dangerous for himself and for the rest of the society. Hence, determining in advance the individual reactions when deciding public health policy is necessary. We then propose to derive individual preferences for epidemics prevention measures. Rheinberger et al (2016) have found that for a disease, the people's demand value of prevention always exceeds that of treatment. We then focus on prevention measures and not on the treatment.

Furthermore, our paper is linked to the literature that examines intangible costs. As suggested by Castro et al (2010), Montgomery et al (1985), and Zhu and Sano (2006), intangible costs have to include the subjective burden that depends on the individual's perception of the impact of the objective burden related to caregiving. Brouwer et al (2004) and Hastrup et al (2011) also consider that the subjective burden is influenced by the amount of time spent on caregiving. Additionally, Brouwer et al (1999) and Kobelt et al (2006) associated to intangible costs the grief, anxiety, fatigue, giving up leisure activities, and fewer social contacts. These costs are the most difficult type of cost to assess and quantify since they are subjective. A scan of the literature shows that studies focus in the main on tangible direct and indirect costs. Fewer studies (Drummond et al (2015) on health care programs, Jeanrenaud and Pellegrini (2007) with alcohol dependence, Mulvaney-Day (2005) with mental health care, Olsson (2014) with the effects of endocrine disrupting substances on male reproductive health, and Xie et al (2008) for patients with knee osteoarthritis in Singapore) attempt to estimate the intangible costs of disease using the willingness to pay (WTP), the Quality Adjusted Life Years (QALY), the human capital approach, and the Disability Adjusted Life Years (DALY) method. An epidemic is stressful for the individual, restricts its usual activities of families and reduces its quality of life. These inconveniences are then intangible costs due to the epidemic. In the questionnaire, we ask to people how long they are willing to respect the measures to the maximum. This revelation allows us to provide a more comprehensive estimation of the individual subjective burden for each prevention measures. We consider that the duration chosen by the individual expresses that the individual does not have any intangible cost for this duration and for all the shorter durations. However, a longer duration is costly for him, it increases its subjective burden.

We find that part of our panel does not reveal an intangible cost to spend 11 to 14 days to respect the different measures. However, the other part of our panel presents a cost that does not voluntarily respect this duration. This is at once dangerous for people's health and is financially costly for the society. For the recommended duration (11 to 14 days), we show the measures which imply a social distancing, or a loss of familiar point of reference, are the less appreciated by the individuals. On the other hand, the individuals prefer the measures with a medical assistance. Moreover, we exhibit that a greater experience of emergency measures leads the individual to be more compliant with the recommended prevention measures. Therefore, based on these results, we propose government interventions to reduce the intangible costs of the individual and motivate the individual to implement the recommended epidemic prevention measures. However, we introduce the possibility for the government to make mandatory the recommendations. Indeed, the level of intangible costs is different for each individual and depends on the situation (individual was or not in contact with infected persons). Despite government incentives, some individuals may be resistant to respect of the recommended prevention measures.

The paper is organized as follows. Section 2 details the study. Section 3 presents on the results by analyzing the respondents' willingness to spend time respecting the different measures, the determinants of the respondents' willingness to spend time, and the impact of the respondents' life experience on their willingness to spend time. Section 4 discusses intangible costs and various government interventions to enforce the recommended prevention measures. Section 5 concludes.

2 The study

To evaluate people's preferences for epidemic prevention measures, we decide to use the willingness to pay approach. For an epidemic, the application time of the measure is an important parameter, as the price in a market. Hence, we consider the maximum time that a person is willing to devote to the measure.

We make a questionnaire in which, we assume that an epidemic has been declared. We propose two hypothetical situations to the respondents: first, the respondent was in contact with one or several detected infected people (Situation 1), and second, the respondent has not been in contact with a detected infected person (Situation 2). For each situation, we offer different measures, and we ask them to choose between time intervals for which they are willing to respect these measures: 0 day, 1 to 3 days, 4 to 7 days, 8 to 10 days, and 11 to 14 days.[5] We use the guidance suggested by the centers

[5]These intervals were determined from Uribe-Sánchez et al (2011) and the World Health Organization program (WHO) on influenza.

for disease control and prevention (2007) which establishes five categories of pandemic severity (from 1 to 5) and recommends different quarantine and closure policies for each of the categories.[6] Table 1 sums up the different measures according to the pandemic severity and the hypothetical situations.

Situation 1	**Situation 2**
CFR higher than 1% (Categories 4 and 5)	
Home Q + Avoid contacts	PP closure
Hospital Q	Cordon sanitaire
CFR between 0.1% and 1% (Categories 2 and 3)	
Home Q	Home Q
Home Q + Home worker visit	
CFR lower than 0.1% (Category 1)	
Call	Mask
Be called	Temp

Table 1: Measures according to pandemic severity.

We divide the questionnaire into three parts. The first part is dedicated to Situation 1 in which, we propose the six measures presented in Table 1: calling the hospital once a day to inform it to its state of health (Call); being called by a healthcare worker from the hospital once a day (Be called); staying at home to avoid illness spread, that is home quarantine (Home Q); staying in hospital, that is hospital quarantine (Hospital Q), staying at home with medical visit once a day (Home Q + Healthcare visit worker), and staying at home with the supplementary constraint of limiting physical contacts with relatives or housemates (Home Q + Avoid contacts). The second part concerns Situation 2, in which we propose the five measures presented in Table 1: wearing a mask outside (Mask), accepting the temperature taken by infrared light in public places (Temp), staying at home (Home Q), closing all public places (PP closure), and isolating from outside the entire district, city or town, that is cordon sanitaire (Cordon sanitaire). The third part is dedicated to personal questions such as the respondent's gender, age, income, household composition, socio-professional category, and its experience on the prevention measures.

After pre-tests, during March 2014, we conducted the study through Marketest in France.[7] As all countries, France is touched by epidemics. The 2009 flu pandemic,

[6]See the introduction for more details on the different categories.

[7]For more details on Marketest see: *http://www.marketest.co.uk/*.

also known as swine flu or grippe A, reached France in early May 2009. By 19 April 2016, 77 outbreaks of influenza H_5N_1, H_5N_2 and H_5N_9 have been detected in southwestern France in nine departments.[8] Marketest had selected French participants by using the quota method, i.e., the same proportions of gender, age and socio-economic status (household composition, occupation, income) criteria in the group of respondents as in the census report of French population by the Institut national de la statistique et des études économiques (INSEE). We had especially prepared the questionnaire to be posted online. The target respondents consists of 200 French people aged between 18 and 72.

Table 2 presents the socio-economic characteristics (gender, age, household composition, income, and occupation) of the respondents. Differences between our panel and INSEE are tested using the Pearson chi-squared test. A P-value (against the null hypothesis of no difference) of less than 5% is considered significant. The results in the last column of Table 2 suggest that the two groups are not significantly different.

Description	Study panel (%)	INSEE (%)	Chi2 test P-value
Gender			
Female	53.0	51.5	0.832
Male	47.0	48.5	
Age			
<20	24.5	25.0	0.996
[20-64]	57.5	57.0	
>64	18.0	18.0	
People living in the household			
1 person	33.5	34.0	0.953
2 persons	24.5	26.0	
3 persons and more	42.0	40.0	
Monthly net income of the household (€)			
<1000	12.9	10.0	0.129
[1000-1500)	12.9	20.0	
[1500-2500)	33.3	20.0	
[2500-4000)	26.9	30.0	
[4000-6000)	10.5	10.0	
6000 ≤	3.5	10.0	
Socio-professional categories			
Farmer	0	1.0	0.682
Craftsman or trading	3.5	3.0	
Executive and professional	20.0	22.6	
Employee	25.0	29.2	
Retired or looking for a job	25.5	26.5	
Without any professional activity	26.0	17.7	

Table 2: Socio-economic characteristics of respondents.

From personal questions, in our panel, we get that only few people practice a medical

[8]For more details see: *http://ec.europa.eu/food/animals/animal-diseases/control-measures/avian-influenza/index_en.html*.

profession (only 6%). 63% of the respondents are in favor with the arrest of people who do not respect the recommended prevention measures if they are compulsory. This result shows that the majority of people take seriously the threat that others do not respect the recommendations. They agree that authority shall sanction this behavior.[9] Finally, 14% of the respondents have already experienced prevention measures as wearing a mask, staying at home... for flu pandemic, whooping cough or meningitis. The hypothetical bias is reduced for these respondents.

3 The results

3.1 Willingness to spend time

Under Situation 1, six measures were proposed: calling the hospital once a day to inform it to its state of health (Call); being called by a healthcare worker from the hospital once a day (Be called); staying at home to avoid illness spread, that is home quarantine (Home Q); staying in hospital, that is hospital quarantine (Hospital Q), staying at home with medical visit once a day (Home Q + Healthcare visit worker), and staying at home with the supplementary constraint of limiting physical contacts with relatives or housemates (Home Q + Avoid contacts). For each measure, we ask respondents to choose between time intervals for which they are willing to respect this measure to the maximum: 0 day, 1 to 3 days, 4 to 7 days, 8 to 10 days and 11 to 14 days. Figure 1 illustrates the results.

[9] Blendon et al (2006) show that in the United States, compulsory quarantine is supported by 42% of their panel, which is a lower proportion than those of our panel.

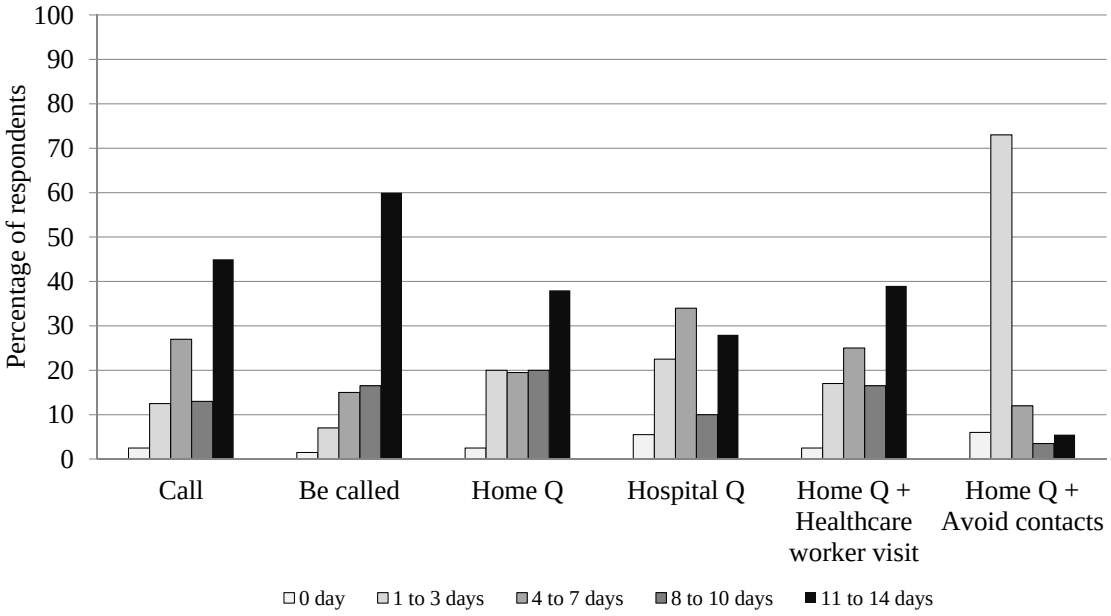

Figure 1: Distribution of respondents according to time intervals choices (in percentage) under situation 1.

We note that the largest part of respondents chooses to respect between 11 and 14 days the 'Call' (45%), 'Be called' (60%), 'Home Q' (38%) and 'Home Q + Healthcare worker visit' (39%) measures. Therefore, the respondents are willing to spend a longer time respecting the measures which allow them to be assisted, such that 'Be called' measure. While, they decrease the time spending for all measures which imply a new environment, as living in a hospital (between 4 to 7 days for 'Hospital Q' (34%)), or a distance with their relatives (between 1 to 3 days for 'Home Q + Avoid contacts' (73%)).

From 'Home Q' measure, we ask to people whether they would change their answer if we include medical visit that is if we set up 'Home Q + Healthcare visit worker' measure. Only 19.5% of the respondents would change their answer. 78% of them would accept to spend more time at home because they would feel reassured by this medical visit while more than 10% of them would decrease the time spent at home because they think that a professional visit is a loss of time, and this visit is infringing their individual freedom.

When we restrict physical contact, percentage of people willing to spend between 11 to 14 days at home is divided by 1.5 whereas percentage of respondents spending maximum 3 days quarantined is almost doubled. Moreover, under this supplementary constraint, more people are not willing to be quarantined at home (3% with no particular constraint

compared with 9% with limiting physical contacts). Therefore, from 'Home Q' measure, we ask to people whether they would change their answer if we do not authorize physical contact that is if we set up 'Home Q + Avoid contacts' measure. 43.5% of the respondents would change their mind. This underlines the impact of isolated a person from its relatives on the individual preferences. All of them would reduce their time spend to quarantine. 44% of them because they consider that their accommodation is not adapted to the isolation, and the others allude that they could not be pulled apart their relatives for affective reasons.

Now, we study Situation 2. In this situation, five measures were proposed: wearing a mask outside (Mask), accepting the temperature taken by infrared light in public places (Temp), staying at home (Home Q), closing all public places (PP closure), and isolating from outside the entire district, city or town, that is cordon sanitaire (Cordon sanitaire). As previously, for each measure, We ask respondents to choose between time intervals for which they are willing to respect this measure to the maximum: 0 day, 1 to 3 days, 4 to 7 days, 8 to 10 days and 11 to 14 days. Figure 2 illustrates the results.

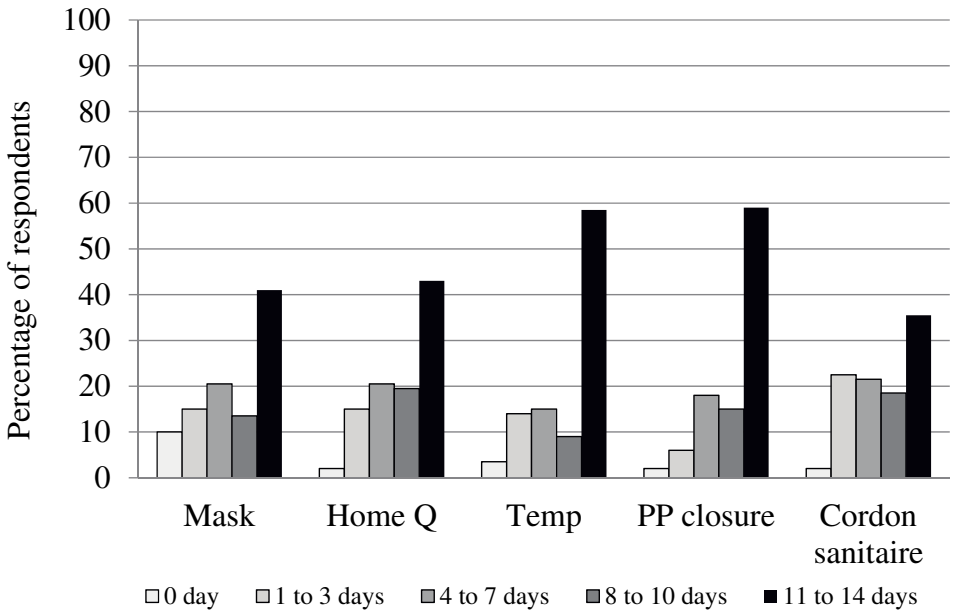

Figure 2: Distribution of respondents according to time intervals choices (in percentage) under situation 2.

We first note that 10% of respondents are not willing to wear a mask at all. The largest part of the respondents chooses to respect all the kind of measures during 11 to 14 days. However, less than the majority of the respondents are willing to accept the

'Mask', the 'Home Q' and the 'Cordon sanitaire' measures more than 10 days. Actually, the measures reducing the individual comfort ('Mask'), or a complete isolation ('Cordon sanitaire') are less chosen for a longer time than those in which the individual is more assisted ('Temp' and 'PP closure').

Finally, we make some remarks on the respondents' decisions concerning the 'Home Q' measure that is present in the two situations. We analyze the respondents' choices under the two situations. On Figure 3, we represent the willingness to spend time respecting 'Home Q' measure under the two situations.

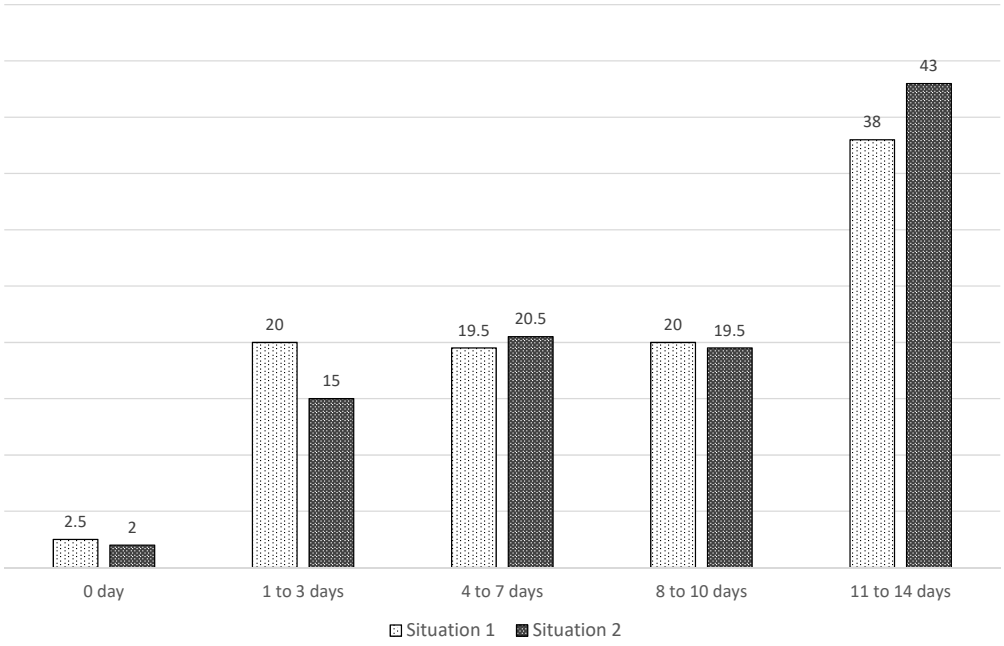

Figure 3: Distribution of respondents according to time intervals choices (in percentage) for 'Home Q' measure under the two situations.

We observe that the two distributions strongly differ for the time intervals, 1 to 3 days and 11 to 14 days. More respondents choose to respect 1 to 3 days the measure under situation 1 than under situation 2 while less respondents choose to respect 11 to 14 days under situation 1 than under situation 2. However, under the two situations, the number of respondents willing to spend time respecting 'Home Q' measure during 11 to 14 days is the highest.

We then study the change of individual behavior between Situation 1 and Situation 2. We get Table 3.

			Percentage of respondents	
	Situation 1	Situation 2		
Change their choice and choose	0 day	1 to 3 days	1	31.5
	0 day	11 to 14 days	1	
	1 to 3 days	4 to 7 days	6	
	1 to 3 days	8 to 10 days	2.5	
	1 to 3 days	11 to 14 days	4	
	4 to 7 days	8 to 10 days	6	
	4 to 7 days	11 to 14 days	3.5	
	8 to 10 days	11 to 14 days	7.5	
	4 to 7 days	0 day	0.5	20
	4 to 7 days	1 to 3 days	3.5	
	8 to 10 days	1 to 3 days	0.5	
	8 to 10 days	4 to 7 days	4.5	
	11 to 14 days	0 day	1	
	11 to 14 days	1 to 3 days	2.5	
	11 to 14 days	4 to 7 days	4	
	11 to 14 days	8 to 10 days	3.5	
Do not change their choice			48.5	48.5

Table 3: Respondents' choice for 'Home Q' measure under the two situations (in percentage).

We note that 51.5% of the respondents change their willingness to spend time respecting 'Home Q' measure between the two situations. So being in contact with an infected person or not has an influence on the respondents' decisions. 31.5% of the respondents increase their period from Situation 1 to Situation 2. This result is due to the consideration of the time from when a person is exposed to flu virus to when symptoms begin, that is about 1 to 4 days. If a person has been in contact with an infected person, he is more concerned by the apparition of the first symptoms of the epidemic. He chooses a shorter period staying at home for waiting the first symptoms than a person who has not been in contact with infected persons who is more concerned by avoiding the epidemic. However, 20% of the respondents decrease their willingness to spend time respecting 'Home Q' measure. These respondents under evaluate the probability of meeting infected persons. As they were not in contact with one of them, they do not see why they were now. They underestimate the risk of being infected. This might lead to a spread acceleration of the epidemic implying more deaths and society's financial costs. This behavior is dangerous for the society.

3.2 Determinants of the willingness to spend time

In this part, we propose to analyze the impacts of the respondents' characteristics (sex, age, people living in the household, monthly net income, socio-professional categories,

and experience (whether the respondent has already experienced prevention measures against epidemics)) on the willingness to spend time respecting the measures. We use an ordered logistic regression which allows us to explain an ordinal dependent variable, that is willingness to spend time respecting a measure expressed in five levels (0 day=1, 1 to 3 days=2, 4 to 7 days=3, 8 to 10 days=4, 11 to 14 days=5) with respect to a quantitative variable (Age) and qualitative variables, which are Sex (Man=1, Woman=2), People living in the household (1 person=1, 2 persons=2, 3 persons and more=3), Monthly net income of the household in euro (<1000=1, [1000-1500)=2, [1500-2500)=3, [2500-4000)=4, [4000-6000)=5, 6000≤=6), Socio-professional category (Craftsman or trading=1, Executive and professional=2, Employee=3, Retired or looking for a job=4, Without any professional activity=5), and Experience (Yes=1, No=2).

First, we analyze the determinants of the willingness to spend time respecting the measures in Situation 1. Table 3 sums up the results.

Model: O*rdered logistic regression*

Endogenous variable	*Call*	*Be called*	*Home Q*	*Hospital Q*	*Home Q + Healthcare worker visit*	*Home Q + Avoid contact*
Willingness to spend time	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
Const 1	−2.856**	−4.564***	−4.327***	−6.105***	−3.359***	-3,678***
	(1.211)	(1.376)	(1.226)	(1.199)	(1.208)	(1.166)
Const 2	−0.902	−2.748**	−1.837	−4.152***	−1.074	-1,386
	(1.142)	(1.271)	(1.148)	(1.155)	(1.136)	(1.131)
Const 3	0.576	−1.528	−0.865	−2.625**	0.165	-0,299
	(1.144)	(1.256)	(1.142)	(1.131)	(1.131)	(1.126)
Const 4	1.123	−0.732	−0.008	−2.137*	0.854	0,257
	(1.147)	(1.254)	(1.142)	(1.127)	(1.133)	(1.126)
Sex	0.031	0.029	−0.111	−0.739***	0.039	-0,112
	(0.267)	(0.284)	(0.262)	(0.265)	(0.262)	(0.262)
Age	0.023***	0.012	0.020***	0.007	0.017**	0,035***
	(0.008)	(0.008)	(0.008)	(0.007)	(0.008)	(0.008)
People living in the household	0.151	0.045	0.198*	0.010	0.196*	0,233**
	(0.103)	(0.110)	(0.104)	(0.104)	(0.103)	(0.103)
Monthly net income of the household	−0.044	0.078	−0.122	−0.158**	−0.130*	-0,155**
	(0.078)	(0.084)	(0.079)	(0.078)	(0.077)	(0.078)
Socio-professional category	0.001	−0.066	0.061	−0.001	0.062	-0,22*
	(0.114)	(0.122)	(0.113)	(0.112)	(0.113)	(0.113)
Experience	−0.138	−0.546	−0.770*	−0.930**	−0.303	-0,748*
	(0.402)	(0.448)	(0.394)	(0.390)	(0.383)	(0.388)
Observations	200	200	200	200	200	200
Log-likelihood	−261.148	−224.662	−277.297	−281.349	−276.357	-280.275

*p<0.1; **p<0.05; ***p<0.01. Standard errors are in parenthesis.

Table 4: Determinants of the willingness to spend time respecting the measures under situation 1.

From Table 4, we first note that for all the measures, respondent is significantly more likely to choose 1 to 3 days than 0 day (first line of the Table 3). Hence, do not accepting to respect a measure at all is a low possibility for the respondents. This shows that

respondents accept to respect the measures at least few days. We even observe that for the 'Be called' measure, respondent is significantly more likely to choose 4 to 7 days than 1 to 3 days, and for 'Hospital Q' measure, respondent is more likely to choose the longest time, that is 11 to 14 days. Hence, respondents are more willing to spend time longer for the measures for which they are taken in charge by medical team.

In addition, when the measure is 'Hospital Q', the possibility to choose a longer duration is higher when the participant is a man ($e^{-0.739} = 0.478 < 1$). When the measures are 'Call', 'Home Q', 'Home Q + Healthcare worker visit', and 'Home Q + Avoid contact', if the age increases of one year, the possibility to choose a longer duration increases. The maturity of the respondent plays a role in its decision. A more mature person is willing to abide by the measures longer. Moreover, for all the measures including a quarantine, the possibility to choose a longer duration is higher for a participant with a higher number of people living in its household. Therefore, this emphasizes the importance for respondents to get many social contacts when they face to a quarantine for epidemic case.

When the measures are 'Hospital Q', 'Home Q + Healthcare worker visit', and 'Home Q and Avoid contact', the possibility to choose a longer duration is higher for a participant with a lower income ($e^{-0.158} = 0.854 < 1$, $e^{-0.13} = 0.878 < 1$, and $e^{-0.155} = 0.856 < 1$, respectively). This shows that an individual with a lower income is ready to allocate more time to measures. This agrees with labor economics theories, in which the individual preference for working (in hour spent per day) increases with the wage rate.

Finally, when the measures are 'Home Q', 'Hospital Q', and 'Home Q + avoid contact', the possibility to choose a longer duration is higher for a participant who has already got an experience of emergency measures ($e^{-0.77} = 0.463 < 1$, $e^{-0.93} = 0.395 < 1$, and $e^{-0.748} = 0.473 < 1$, respectively). This implies when an epidemic measure needs to be applied during a long period, it looks necessary to educate and/or to train people to epidemic risk.

Now, we analyze the determinants of the willingness to spend time respecting a measure in Situation 2. Table 5 sums up the results.

Model: O*rdered logistic regression*

Endogenous variable:	*Mask*	*Home Q*	*Temp*	*PP closure*	*Cordon sanitaire*
Willingness to spend time	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
Const 1	−2.702**	−4.350***	−4.566***	−3.229**	−3.601***
	(1.129)	(1.259)	(1.324)	(1.309)	(1.248)
Const 2	−1.578	−1.974*	−2.764**	−1.768	−0.753
	(1.116)	(1.164)	(1.280)	(1.236)	(1.156)
Const 3	−0.635	−0.803	−1.912	−0.354	0.297
	(1.110)	(1.155)	(1.274)	(1.222)	(1.155)
Const 4	−0.074	0.082	−1.508	0.349	1.149
	(1.107)	(1.154)	(1.271)	(1.222)	(1.158)
Sex	−0.380	0.001	−0.441	0.095	0.055
	(0.263)	(0.269)	(0.286)	(0.285)	(0.263)
Age	0.013*	0.032***	0.013	0.021**	0.038***
	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)
People living in the household	0.067	0.214**	0.062	−0.059	0.096
	(0.101)	(0.105)	(0.111)	(0.108)	(0.104)
Monthly net income of the household	−0.134*	−0.170**	−0.045	0.039	−0.048
	(0.076)	(0.077)	(0.083)	(0.082)	(0.077)
Socio-professional category	0.110	0.015	0.231*	0.013	0.128
	(0.113)	(0.115)	(0.122)	(0.123)	(0.114)
Experience	−0.236	−0.772*	−0.961**	−0.160	−0.854**
	(0.389)	(0.412)	(0.470)	(0.414)	(0.409)
Observations	200	200	200	200	200
Log-likelihood	−290.784	−260.510	−235.686	−226.136	−271.084

*p<0.1; **p<0.05; ***p<0.01. Standard errors are in parenthesis.

Table 5: Determinants of the willingness to spend time respecting the measures under situation 2.

We first note that for all the measures, respondent is significantly more likely to choose 1 to 3 days than 0 day. Hence, as previously, the respondents are ready to respect measures at least few days. We also find that for 'Home Q' and 'Temp' measures, respondents are significantly more likely to choose 4 to 7 days than 1 to 3 days.

Except for 'Temp' measure, in which the age does not have any influence on the willingness to spend time, for the other measures, the individual maturity leads him to choose a longer duration. When the measure is 'Home Q', the possibility to choose a longer duration is higher for a participant with a higher number of people living in its household ($e^{0.214} = 1.239 > 1$). The quarantine is more accepted during a long time by people getting a large family around them.

Moreover, for 'Mask' and 'Home Q' measures, the possibility to choose a longer duration is higher for a participant with a lower income ($e^{-0.134} = 0.875 < 1$, and $e^{-0.17} = 0.844 < 1$, respectively). This result on the quarantine verifies the labor economics theory on the link between the wage rate and the labor supply in term of hours.

Finally, when the measures are 'Home Q', 'Temp' and 'Cordon sanitaire', the possibility to choose a longer duration is higher for a participant who already gets an experience

of emergency measures ($e^{-0.772} = 0.462 < 1$, $e^{-0.961} = 0.383 < 1$, and $e^{-0.854} = 0.426 < 1$, respectively). Hence, we note the importance of the knowledge about epidemic plan on the individual acceptation to allocate more time to the measures.

3.3 Impact of the life experience

From Tables 4 and 5, we get that for 'Hospital Q', 'Home Q + Avoid contacts', 'Home Q' in the second situation, 'Temp' and 'Cordon sanitaire' measures, individuals who have already been confronted to these measures are willing to spend longer time respecting these measures. Therefore, it is interesting to compare in details the answers of respondents who have an experience of epidemic prevention measures to those who do not. In our panel, we have only 28 over 200 respondents who have already experienced prevention measures. Figure 4 shows the comparison.

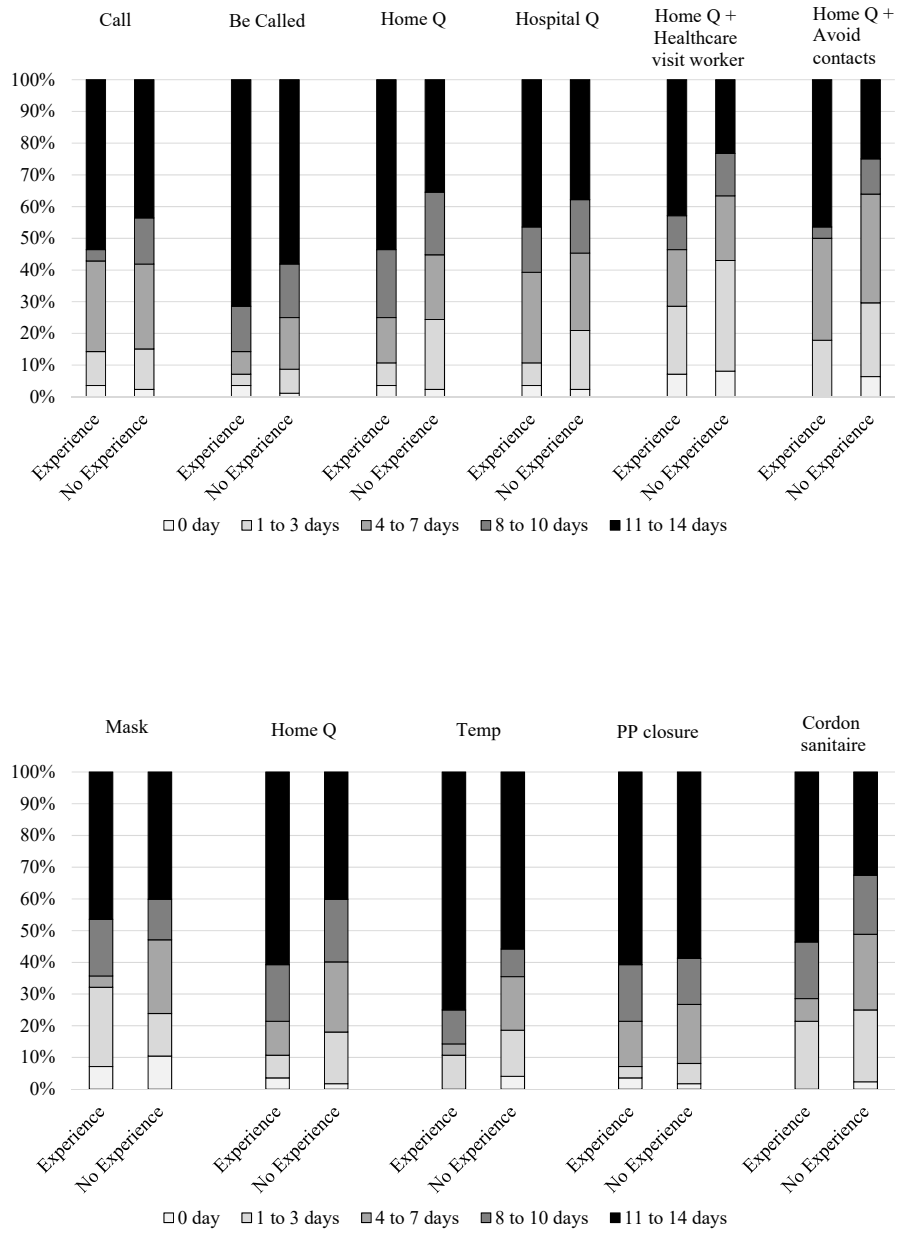

Figure 4: Distribution of respondents according to time intervals choices and their experience (in percentage) under Situation 1 (top figure) and under Situation 2 (bottom figure).

We first observe that for some measures, as 'Home Q + avoid contacts', 'Temp' and 'Cordon sanitaire', none of the participants having an experience has chosen not to accept these measures. In other words, nobody takes the choice 0 day. If we focus on the recommended prevention measures, it is clear that whatever the situation, the proportion of people with experience who are willing to comply with the recommended prevention measures is higher than those with no experience (Black part).

Therefore, in France, simulating an epidemic would be an excellent exercise to raise awareness and to give an experience of epidemic prevention measures to people. According to our result, a higher proportion of people would then agree to comply with the recommended prevention measures.

4 Intangible costs

Research on the cost analysis of prevention measures for infectious diseases has considered different types of cost measures including costs to society, costs to individuals (Coudeville, 2009), quality-of-life measures (Newall et al, 2007), etc. In general, costs can be divided into tangible costs (direct and indirect), and intangible costs. Direct costs are all expenditures for continuing care, health care providers, certain household expenditures (meal and delivery, home energy), cost of appropriate facilities, hospitalization, personal wage employed for the prevention measures. Indirect cost is the productivity loss cost dues to the absence of the individual to its work and the productivity loss cost dues to the closure or the lack of frequentation of public place. Some works as Mubayi et al (2010) have made an estimation of these costs: quarantine costs in Hong Kong 2003, which were US$160 per individual per day, and to quarantine costs in Toronto 2003, which were $CA230 per individual per day.

However, we do not know any work that tries to estimate intangible costs linked to the prevention measures in case of epidemic. The intangible costs capture the psychological dimensions of the prevention measures' application, including anxiety, stress, emotional impairment, health worry and other effects on the individual's quality of life. Influenza infection is stressful for the individual. This can restrict the usual activities of families and reduce the quality of life of individual. Intangible costs are difficult to measure and are usually not included in studies (Tarricone, 2006). Since intangible costs correspond to the subjective burden which depends on the individual's perception of the impact of the objective burden related to the prevention measures, we propose to quantify this subjective burden by using the individual's willingness to spend time respecting measures. More a person is willing to spend time respecting a measure less this measure is awkward for him. Awkward in the sense that there is stress and anxiety for the individual, or/and a reduction of its quality of life (less freedom, more constraints). Quantifying intangible costs helps health public decision makers to both know whether they have to intervene, and which intervention they have to do. We consider that the duration chosen by the individual expresses that the individual does not have intangible cost for this duration and for all the shorter durations. However, a longer duration is costly for him, it increases its subjective burden.

A pandemic outbreak case affects life of thousands persons. We then focus on the

recommended prevention measures that is 11 to 14 days. In table 6, we present the percentage of respondents who are willing to spend 11 to 14 days respecting the measures without any government's interventions.

Situation 1		**Situation 2**	
CFR higher than 1% (Categories 4 and 5)			
Home Q + Avoid contacts	5.5	PP closure	59
Hospital Q	28	Cordon sanitaire	35.5
CFR between 0.1% and 1% (Categories 2 and 3)			
Home Q	38	Home Q	43
Home Q + Home worker visit	39		
CFR lower than 0.1% (Category 1)			
Call	45	Mask	41
Be called	60	Temp	58.5

Table 6: Percentage of respondents who are willing to spend 11 to 14 days respecting the measures under situations 1 and 2.

From table 6, we first note some respondents are willing to spend 11 to 14 days respecting the measures without any information nor governmental interventions. Hence, no supplementary cost would occur for this part of the population, which accepts voluntarily the recommended prevention measures. However, not all the respondents are willing to spend 11 to 14 days respecting these measures. As this is not their choices, accepting to respect the recommended prevention measure would cause to them intangible costs, which are more or less significant according the willingness to spend time that they had chosen. Figures 1 and 2 illustrate the percentage of respondents according to time interval choices. In other words, these figures show the percentage of respondents according to their intangible costs. When the recommendation is to spend 11 to 14 days respecting a measure, an individual who has chosen to spend 0 day will have a higher intangible cost than an individual who has chosen to spend 1 to 3 days (and the same reasoning for the other willingness to spend time chosen).

However, whatever the level of intangible costs, all the population has to respect the recommended prevention measures in order to avoid both the propagation of the epidemic and a large number of deaths. Therefore, the government has to convince and/or to impose to the population to accept these recommended prevention measures. Incentive interventions could be a solution. They could take the form of information campaigns or simulation exercises (such as fires, attacks, etc.) which teach people about the prevention

measures, which exist, the way to apply them and their consequences. This kind of action should not have to be only done when an epidemic is already occurring. Informing people before an epidemic would avoid panic reactions and make them aware about the dramatic consequences (deaths) not to respecting the recommended prevention measure. From the previous section, we have seen that the experience of an epidemic case would be an excellent exercise to raise awareness and make accepting the recommended prevention measures. Actually, in France, only medical agents are trained and get a knowledge about these prevention measures. Learning could decrease the stress and the fear of the prevention measures application. Hence, by decreasing the individual intangible costs, individuals would be more motivate to spend 11 to 14 days respecting the measures.

From Figure 1, we note that in Situation 1, medical assistance decreases the individual intangible cost by reassuring the individual.[10] On the other hand, isolating people from their relatives and loosing familiar environment increase the individual intangible cost.[11] Providing communication materials, internet access, and/or leaving the possibility to see its relatives, for example, from a sterilized bubble would reduce this sense of abandoning. Moreover, creating a welcoming place with comfortable furniture, books or televisions would increase the comfort and reduce the feeling not to be in a familiar environment. Therefore, with these governmental interventions the individual would be more incentive for accepting the recommended prevention measures.

Another alternative, which may also be compatible with the incentive interventions, would be the mandatory interventions. The government would impose to people to respect the recommended prevention measures. In case of non-respect, a sanction (financial or/and legal) could be applied. Actually, in our study, 63% of the respondents agree for an arrest of a person who do not respect the recommendations.

5 Conclusion

This paper is intended to support public health policy on the epidemic prevention measures. Analyzing the people preferences for these prevention measures enlightens the policy makers on the potential need of interventions for motivating people to respect these measures. Indeed, a non-respect of these measures could be catastrophic at once by involving many deaths and by generating many financial expenses.

We find that governmental intervention is not always necessary for a part of the population, which is willing to spend 11 to 14 days (the recommended period) respecting the different measures. For this recommended period, we show that the measures which

[10] We make a comparison between 'Be called' and 'Call' measures, 'Home Q + Home worker visit' and 'Home Q' measures, 'Hospital Q' and 'Home Q + Avoid contacts' measures.

[11] We make a comparison between 'Home Q + Avoid contact' and 'Home Q' measures, 'Hospital Q' and 'Home Q' measures.

imply a social distancing, or a loss of familiar point of reference, are the less appreciated by the individuals. On the other hand, the individuals like the measures with a medical assistance. The revelation of the individual's preferences allows us to determine the individual intangible costs (psychological costs) for the prevention measures. This cost leads the individual not to voluntarily respect the recommended prevention measures. In this case, governmental intervention is needed. We then propose governmental actions, which may reduce the intangible costs and motivate the individual to apply the recommended prevention measures. In our study, we show that people who have greater experience of emergency measures are more compliant with the recommended prevention measures. Therefore, simulation exercise would be a solution. However, the level of the intangible costs is different according the individuals and the situation. This might lead the government to apply mandatory intervention for making respecting the recommended prevention measures.

Our paper presents some limitations. First, as in all preference revelation approaches, there might be a hypothetical bias and controversies or incorrect messages leading to participants' confusion or misunderstanding in our study. As suggested by Lusk (2003) we have tried to reduce the hypothetical bias with a cheap talk explaining to participants that they should reply as if they would have to spend time respecting the measures. We also try to reduce the confusion by conscientiously detailing the proceedings of each prevention measure. Second, the way to collect data might be discussed. We have used an online study. Online studies allow to save time and efforts in collecting data (Cobanoglu et al, 2001; Couper, 2000; and McDonald and Adam, 2003) and make it possible to get higher quality answers with less 'I do not know' and less unanswered than telephone survey and personal interview survey (Fricker et al, 2005; Kreuter et al, 2008; and Heerwegh and Loosveld, 2008). Therefore, on the quality data collection, online studies do not look to present more disadvantage than other kinds of surveys. Furthermore, our study could be easily replicated in other regions or countries in order to plan the prevention measures to implement in outbreak of epidemic situation.

References

1. Achonu, C., Laporte, A., Gardam, M.A. The financial impact of controlling a respiratory virus outbreak in a teaching hospital: lessons learned from SARS. *Canadian Journal of Public Health.* 2005;96:52-54.

2. Blendon, R., DesRoches, C.M., Cetron, M.S., Benson, J.M., Meinhardt, T., Pollard, W. Attitudes toward the use of quarantine in a public health emergency in four countries. *Health Affairs.* 2006;25(2):15-25.

3. Brouwer, W.B., van Exel, N.J., Koopmanschap, M.A., Rutten, F.F. The valuation of informal care in economic appraisal. *International Journal of Technology Assessment in Health Care*. 1999;15: 147-60.

4. Brouwer, W.B., van Exel, N.J., van de Berg, B., Dinan,t H.J., Koopmanschap, M.A., van den Bos, G.A. Burden of caregiving: evidence of objective burden, subjective burden, and quality of life impacts on informal caregivers of patients with rheumatoid arthritis. *Arthritis and Rheumatology* 2004;51: 570-577.

5. Castro, D., Dillon, C., Machnicki, G., Allegri, R. The economic cost of Alzheimer?s disease: family or public-health burden?. *Dementia e Neuropsychologia*. 2010;4: 262-7.

6. Centers for Disease Control and Prevention (CDC). Interim pre-pandemic planning guidance: community strategy for pandemic influenza mitigation in the United States; 2007.

7. Chao, D.L., Halloran, M.E., Obenchain, V.J., Longini, I.M. FluTE, a publicly available stochastic influenza epidemic simulation model. *PLoS Computational Biology*. 2010;6.

8. Cobanoglu, C., Warde, B., Moreo, P. A comparison of mail, fax, and Web-based survey methods. *International Journal of Market Research*. 2001;43(4): 405-410.

9. Coudeville, L., Van Rie, A., Getsios, D., Caro, J.J., Crpey, P., Nguyen, V.N. Adult vaccination strategies for the control of pertussis in the United States: an economic evaluation including the dynamic population effects. *PLoS One*. 2009;4.

10. Couper, M.P. Web surveys: A review of issues and approaches. *The Public Opinion Quarterly*. 2000;64(4):464-494.

11. Drummond, M.F., Sculpher, M.J., Claxton, K. et al, Methods for the Economic Evaluation of Health Care Programmes. 4th ed. Oxford University Press, Oxford, UK; 2015.

12. Fricker, S., Galesic, M., Tourangeau, R., Yan, T. An experimental comparison of Web and telephone surveys. *The Public Opinion Quarterly*. 2005;69(3):370-392.

13. Gupta, A.G., Moyer, C.A., Stern, D.T. The economic impact of quarantine: SARS in Toronto as a case study. *Journal of Infection*. 2005;50:386-393.

14. Halder, N., Kelso, J.K., Milne, G.J. Analysis of the effectiveness of interventions used during the 2009 A/H_1N_1 influenza pandemic. *BioMed Central*. 2010;10.

15. Hastrup, L., van den Berg, B., Gyrd-Hansend, D. Informal caregivers in mental illness feel more burdened? A comparative study of mental versus somatic illnesses. *Scandinavian Journal of Public Health*. 2011;39:598-607.

16. Heerwegh, D., Loosveldt, G. Face-to-face versus Web surveying in a high-Internet coverage population: differences in response quality. *The Public Opinion Quarterly*. 2008;72(5):836-846.

17. Jeanrenaud, C., Pellegrini, S. Valuing Intangible Costs of Alcohol Dependence: a Contingent Valuation Study. *Revue d'économie politique*. 2007;117.

18. Kelso, J.K., Milne, G.J., Kelly, H. Simulation suggests that rapid activation of social distancing can arrest epidemic development due to a novel strain of influenza. *Public Health*. 2009;9.

19. Kobelt, G., Berg, J., Lindgren, P., Fredrikson, S., Jnsson, B.. Costs and quality of life of patients with multiple sclerosis in Europe. *Journal of Neurology, Neurosurgery and Psychiatry*. 2006;77:918-26.

20. Kreuter, F., Presser, S., Tourangeau, R. Social desirability bias in CATI, IVR, and Web surveys: The effects of mode and question sensitivity. *The Public Opinion Quarterly*. 2008;72(5):847-865.

21. Liang, W., Feng, L., Xu, C., Xiang, N., Zhang, Y., Shu, Y., Wang, H., Luo, H., Yu, H., Liang, X., Li, D., Lee, C.K., Feng, Z., Hou, Y., Wang, Y., Chen, Z., Yang, W. Response to the first wave of pandemic (H_1N_1) 2009: experiences and lessons learnt from China. *Public Health*. 2012;126:427-36.

22. Lusk, J.L. Effects of cheap talk on consumer willingness to pay for golden rice. *American Journal of Agricultural Economics*. 2003;85(4): 840-856.

23. McDonald, H., Adam, S. A comparison of online and postal data collection methods in marketing research. *Marketing Intelligence and Planning*. 2003;21(2):85-95.

24. Milne, G.J., Kelso, J.K., Kelly, H.A., Huband, S.T., McVernon, J. A small community model for the transmission of infectious diseases: comparison of school closure as an intervention in individual-based models of an influenza pandemic. *PLoS One*. 2008;3.

25. Montgomery, R., Gonyea, J., Hooyman, N. Caregiving and the experience of subjective and objective burden. *Family Relations*. 1985;43:19-26.

26. Mubayi, A., Zaleta, C.K., Martcheva, M., Castillo-Chvez, C.. A cost-based comparison of quarantine strategies for new emerging diseases. *Mathematical Biosciences and Engineering*. 2010;7:687-717.

27. Mulvaney-Day, N. Using willingness to pay to measure family members' preferences in mental health. *Journal of Mental Health Policy and Economics*. 2005;8:71-81.

28. Newall, A.T., Beutels, P., Wood, J.G., Edmunds, W.J., MacIntyre, C.R. Cost-effectiveness analyses of human papillomavirus vaccination. *The Lancet Infectious Diseases*. 2007;7:289-96.

29. Olsson, I.M. The Cost of Inaction - A Socioeconomic analysis of costs linked to effects of endocrine disrupting substances on male reproductive health. Nordic Council of Ministers. 2014.

30. Pérez Velasco, R., Praditsitthikorn, N., Wichmann, K., Mohara, A., Kotirum, S., Tantivess, S., Vallenas, C., Harmanci, H., Teerawattananon, Y. Systematic review of economic evaluations of preparedness strategies and interventions against influenza pandemics. *PloS One*. 2012.

31. Rheinberger, C.M., Herrera-Araujo, D., Hammitt, J.K. The value of disease prevention vs treatment. *Journal of Health Economics*. 2016;50:247-255.

32. Tarricone, R. Cost-of-illness analysis: What room in health economics?. *Health Policy*. 2006;77:51-63.

33. Uribe-Sánchez, A., Savachkin, A., Santana, A., Prieto-Santa, D., Das, T.K. A predictive decision-aid methodology for dynamic mitigation of influenza pandemics. *OR Spectrum*. 2011;33(3):751-786.

34. Xie, F., Thumboo, J., Fong, K.Y., Lo, N.N., Yeo, S.J., Yang, K.Y., Li, S.C. A study on indirect and intangible costs for patients with knee osteoarthritis in Singapore. *Value Health*. 2008;11:84-90.

35. Zhu, C., Sano, M. Economic considerations in the management of Alzheimer's disease. *Journal of Clinical Interventions in Aging*. 2006;1:143-54.

36. Zhu, G., Chen, G., Fu, X. Effects of active links on epidemic transmission over social networks. *Physica A*. 2017;468:614-621.