Survey on the Likely Behavioural Changes of the General Public in Four European Countries During the 2009/2010 Pandemic

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Abstract In order to assess the likely impact of public health interventions, it is important to predict the acceptance of control measures, as well as the behavioural changes that may occur among the general public in response to epidemics, in particular lethal ones. The emergence of 2009 pandemic allowed us to assess the general public's behaviour during the pandemic, via two surveys: one at the beginning and one after the first wave of the 2009 pandemic, in four European countries.Results showed some differences between participating countries in previous behaviours relating to seasonal flu and in beliefs and knowledge about 2009 pandemic influenza. No substantial differences were detected among the four countries in the first survey

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with respect to the intended behaviours in anticipation of the spread of the pandemic virus. However, results from the second survey showed differences within and among the four participating countries. The two surveys were useful in showing differences between behavioural intentions and actual actions related to the 2009 pandemic influenza. To our knowledge this is the first study investigating the actual behaviour of the population in four EU countries and provides crucial descriptions of pandemic impact on social-network dynamics parameters which can be included in mathematical models.

1 Background

Novel influenza viruses with pandemic potential have emerged every few decades, and the fear of rapid global transmission of a deadly pathogen, as experienced during the influenza pandemic in 1918, has shaped research and public health policies in this area. Moreover, in the last two decades, the emergence of health threats, such as the highly virulent avian A/H5N1 virus in 1997 [28], the SARS [3] in 2003 and the A/H1N1 pandemic influenza virus in 2009 [4], has made pandemic preparedness a crucial issue for public health worldwide especially with regard to population behaviour and population compliance with public health measures. Spontaneous behaviour change by the population, which alters transmission risk in a pandemic, may affect the impact of organized control measures. In fact, during outbreaks, one of the major problems has always been to communicate with the population in order to influence behaviours and reduce the spread of disease [2].

For centuries, the response strategy adopted by health authorities dealing with outbreaks was mainly based on restrictive non-pharmaceutical measures (quarantine, isolation, compulsory hospitalization) and, in case of non-adherence to response measures recommended, sanctions for non-compliant individuals (Balinska et al. 2009). The increasing recognition that human behaviour (compliance with recommended response measures) critically influences infectious disease transmission has led to a greater effort to communicate with the public and enlist their help in reducing disease transmission.

In March 2009 a new influenza virus emerged in Mexico [29] and rapidly spread around the world in the first influenza pandemic of the twenty-first century [6]. As the number of 2009 pandemic influenza cases increased and spread and as extensive media coverage and government advertising campaigns began to appear, the behaviour of the population changed [1]. Higher perceived risk of infection and higher perceived severity of infection were associated with greater use of recommended behaviours in the UK [24]. Other studies have examined the behavioural changes and initial response to the 2009 pandemic in China [30], Hong Kong [5], India [16] and Europe [12] and internationally [15].The FluModCont project, a collaborative project funded by the Seventh Framework Programme (FP7), started in 2008 and ended in May 2011 (www.flumodcont.org). Main objective of the project was to arrive at an accurate and data-based modelling of the expected

course of an influenza pandemic and of the impact of public health measures on its scale and severity. Aims of the project include the study of the social acceptability of public health measures during a pandemic and of the behavioural changes that are to be expected in such circumstances. Within the FluModCont project we investigated how populations would react to respond to and comply with interventions foreseen in national pandemic preparedness plans, which aim to produce accurate and data-based modelling of the potential course of an influenza pandemic and of the impact of public health measures on its scale and severity.

A cross-sectional survey had been planned among adults in four EU countries: Finland, Italy, Romania and the UK. As the 2009 pandemic influenza virus began to spread in EU countries during the development of the common questionnaire for the survey, we decided to conduct two surveys at different times in order to assess behaviour during the pandemic. In particular, the objectives of the surveys were to investigate behavioural responses and social acceptance of mitigation measures, and to assess the reliability and validity of behavioural intentions regarding public health interventions, declared at the beginning of the 2009 influenza pandemic, through comparison with real behavioural responses to the 2009 pandemic, at the end of the pandemic wave in 2010 in order to obtain behavioural relevant parameters to be included in modelling the expected course of an influenza pandemic.

2 Materials and Methods

2.1 Sampling Procedures

In Italy, Romania and the UK, a two-stage stratified sampling with unequal probabilities of sampling was used: (1) a stratified sample of household telephone lines was selected through random digit dialling (RDD); (2) the adult (18 years or over) with the most recent birthday (to the date of the interview) was selected from each sampled household according to predefined quota (Table 1). A detailed study protocol was prepared and distributed to the four participating countries.

Table 1 Sample description of the two FluModCont surveys conducted

	Number of respondents successfully interviewed		Proportion of re-contacted individuals in the 2nd survey (%)	Response rate (%)	
Country	1st survey	2nd survey		1st survey	2nd survey
Finland	681	683	73	42	–
Italy	1,025	1,025	32	12	–
Romania	1,025	1,025	43	37	–
UK	1,025	1,000	24	15	–

In order to mitigate the fact that certain social groups are more likely to be at home (i.e. older people and women) and so may be over-represented in the eventual sample, the interviewers were instructed, in case the household member with the most recent birthday was not at home, to skip to the next household instead of replacing him/her with another household member. Moreover, in order to reduce this possible bias, the interviews were conducted between 6.00 PM and 8.00 PM, when people are more likely to be at home. The sample size for these three countries was fixed at 1,025 individuals in order to estimate a compliance of 80 % for the main behaviour measures with a precision of ±3 %, while assuming a confidence level equal to 95 % and in order to improve standard variance estimators in health surveys, based on previous studies, a design effect equal to 1.5 [13].

In Finland, a simple random sampling of adults from the population register with a link to telephone numbers was used. The sample size, under the same assumptions made for the other three countries with the exception of design effect, was fixed at 683 individuals. For the second survey we planned to re-contact the sample of the 1st survey and depending on the response rate in each participating country to 'top up' the sample using an identical sampling procedure as used in the initial sample until we reached n=1025 for Italy, Romania and UK (two stage stratified sampling), and n=683 for Finland.

2.2 Data Collection

The surveys were conducted in comparable period of time in the four countries (Fig. 1) and were conducted by market research companies in each country.

The interviews for the first survey were conducted using a four-stage questionnaire to collect information on (1) health status and behaviour during seasonal influenza, (2) beliefs and level of knowledge about the new A/H1N1 influenza, (3) behavioural intentions (i.e. social distancing measures, pre-pandemic vaccination and attitude to use antivirals) according to different scenarios of disease severity (worst and mild) and (4) socio-demographic characteristics. Beliefs, knowledge and behavioural responses were measured on 4-point Likert scales.

For the second survey a second specific questionnaire based on the first one was developed including questions on actual behavioural responses to the A/H1N1 pandemic (experience of taking pandemic vaccine and antiviral medications, following public health advice, isolation at home).

Before the surveys, the questionnaires, originally developed in English, were translated into the languages of the population to be surveyed and then back-translated by a different native speaker to verify consistency. The questionnaires were pretested for qualitative purposes on a small number of participants (from 10 to 15) in all the four countries involved in the studies.

All individuals recruited in the first survey were re-contacted and requested to answer to the second; in case of refusal, new household telephone lines were randomly selected using the RDD methodology above described (Table 2).

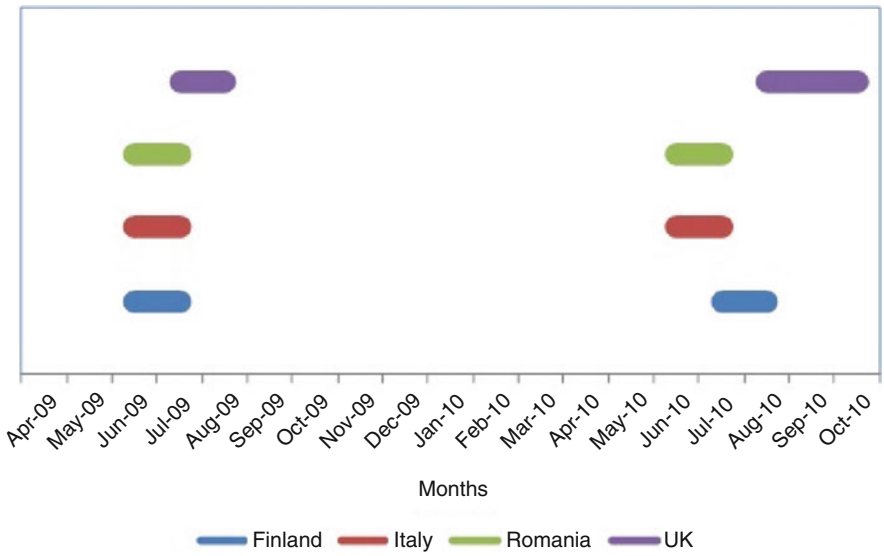

Fig. 1 Timing of the behavioural surveys

The study protocol and the standard questionnaires have been revised in order to be applicable and conform to ethical standards in all countries for both surveys.

2.3 Data Analysis

Data were checked for validity of values, ranges and consistency, cleaned and made anonymous at the research centre of each participating country. The databases were then sent to the coordinating research centre in Italy for analysis.

For both surveys in Italy, Romania and the UK, the individual probability to be sampled, based on the number of adult household members and the number of working telephone lines available in the household, has been considered for data weighting. Moreover, data were also weighted to reflect the socio-demographic structure of the national adult populations. No weights were applied to data collected in Finland.

Variables measured on 4-point Likert scales were re-coded into two categories for the analysis (e.g. "very likely" and "fairly likely" were grouped together in a unique category, as well as "not very likely" and "not at all likely"). Values coded as "don't know" were considered as "negative" outcomes (e.g. "no", "unlikely", "not willing") and included in the analysis, while missing values and values coded as "not applicable" were excluded from the analysis.

Univariate analysis was performed using percentages and 95 % confidence interval (CI). Differences between percentages estimated in 2009 and those estimated

in the whole sample in 2010 were evaluated using logistic regression models while controlling for sex, age, education, occupation, level of information about "swine flu", and household composition (when appropriate) as potential confounders.

For Italy, Romania and the UK, the analysis was conducted accounting for survey design and data weighting in order to improve standard variance estimators [13]. The post-survey estimate of the average design effect among the main outcome measures for these three countries was 1.53, 1.51, and 1.81, respectively, thus supporting the assumption made for sample size calculation.

The analysis was conducted using Stata 11.2 software (Stata Corporation, College Station, TX).

3 Results

3.1 Demographic Characteristics

Table 1 shows the sample sizes and response rates for the two surveys. The response rates, calculated as the percentage of valid interviews out of the valid interviews plus refusals and missed appointments during the first survey, varied across countries, as did the percentage of the successfully re-contacted individuals in the second survey.

The socio-demographic characteristics of respondents (shown in Table 2) were similar among the four countries in both surveys, except for religion (about 50 % of respondents in the UK described themselves as religious compared with more than 80 % in the other countries) and household composition (almost 30 % of respondents in Finland were single compared with about 10 % or less in the other three countries). Most of the respondents in all countries in both surveys had a secondary level of education and about half said that they were working at the time of interview and living in a household with no children.

3.2 Past Behaviour and Beliefs

During the 2009 survey, respondents from Italy and Romania reported having sought medical advice last time they had flu more frequently than respondents from the UK and Finland, mainly through home visit by or visit to a doctor.

About one-third of respondents in Italy, Romania and the UK and about two-thirds in Finland had the seasonal flu vaccine in the past. Those who had never had the seasonal flu vaccine reported their low likelihood of catching flu and their good health status as the main reasons for this.

In case of need, most of the respondents to the 2009 survey from all the four countries said they would seek health advice about swine flu from their local GP/nurse and other local and national health authorities. However, about half of

Table 2 Socio-demographic characteristics

	Italy		Romania		UK		Finland	
	2009	2010	2009	2010	2009	2010	2009	2010
	$n = 1,025$	$n = 1,025$	$n = 1,025$	$n = 1,025$	$n = 1,025$	$n = 1,000$	$n = 681$	$n = 683$
	%		%		%		%	
Sex								
Male	48.0	48.8	49.2	49.7	47.7	49.8	45.7	45.4[a]
Female	52.0	51.2	50.8	50.3	52.3	50.2	54.3	54.6[a]
Age group								
18–34 years	23.7	30.1	35.7	33.3	35.2	34.5	19.5	19.5[a]
35–54 years	40.3	34.5	36.1	35.1	35.2	36.4	31.7	31.4[a]
55–74 years	27.7	27.1	25.2	28.9	24.9	29.1	48.5	47.6[a]
75 years	8.3	8.3	3.0	2.7	4.7		0.3	1.6[a]
Education								
Primary or lower	11.8	13.8	3.4	2.5	13.8	16.3	23.5	23.3
Secondary	73.1	71.6	64.3	61.5	53.2	48.3	38.0	40.5
University or higher	15.1	14.6	32.3	36.0	33.0	35.4	38.5	36.1
Religion								
Christian	91.0	89.4	94.0	91.3	48.7	50.1	82.4	85.1[a]
Other	0.7	0.2	5.2	7.5	18.8	18.4	2.1	2.2[a]
None	8.3	10.4	0.8	1.2	32.5	31.5	15.5	12.7[a]
Occupational status								
Working	57.5	59.1	48.6	44.6	63.3	67.7	53.2	50.5
Not working	34.9	34.0	41.5	46.1	32.1	28.0	43.2	47.4
Student	7.6	6.9	9.9	9.3	4.6	4.3	3.6	2.1
Household composition								
Single	5.6	4.0	3.8	3.8	10.0	11.2	26.7	25.2
Only adults	65.9	69.6	58.2	59.2	58.3	53.9	50.8	53.3
With children	28.5	26.4	38.0	37.0	31.7	34.9	22.5	21.5
Weekly time spent away from home for working/studying								
None	34.1	NA	35.9	NA	33.7	NA	44.0	NA
<35 h	19.6	NA	15.7	NA	33.7	NA	14.3	NA
35–44 h	22.2	NA	26.2	NA	21.2	NA	35.4	NA
≥45 h	24.1	NA	22.2	NA	11.4	NA	6.3	NA
Availability towork/study fromhome for 7–10 days[b]								
Yes	24.6	NA	32.1	NA	29.4	NA	23.7	NA
No	75.2	NA	66.3	NA	70.5	NA	74.1	NA
Don't know	0.2	NA	1.6	NA	0.1	NA	2.1	NA

NA not available

[a]Percentages among the 185 new respondents in Finland (data not available for the 498 old respondents)

[b]Among those who reported to work/study some time in a week away from home

the respondents from the UK and Finland also reported the media and internet as a source of information, thus partly explaining the fact that they were more likely to perceive themselves as well informed about A/H1N1 than respondents from Italy and Romania. Subsequently, during the 2010 survey, respondents from Finland, Romania and the UK were less likely to report that their local GPs and nurse were their main source of information about swine flu, with the media being a more prominent source (proportion reporting the media: 26.9 % vs. 77.0 % in Finland; 7.2 % vs. 55.8 % in Romania; and 16.3 % vs 67.6 % in the UK in 2009 and 2010, respectively) (Table 3). Most respondents in all countries thought that, in case of need, it would be possible to get antiviral medication through a chemist (with or without a GP prescription), hospitals or health authorities.

The proportion of individuals worried about catching swine flu during both surveys is reported in Fig. 2. The level of worry significantly decreased in Italy and Finland, remained stable in Romania and increased in the UK from 2009 to 2010.

3.3 Behavioural Intentions

In all countries, about 70–80 % of respondents, during the 2009 survey, stated they would get vaccinated against swine flu and would take antivirals as precautionary measure, assuming both treatments were free of charge (Table 3). A higher proportion of respondents would be willing to give the same treatments to their children if recommended by health authorities. In 2010, the proportion of respondents reporting to be willing to take the antiviral drugs as a preventive measure significantly decreased to 36.7 % in Italy and 68.8 % in the UK, while remaining stable at about 70 % in Romania and Finland.

Concerning non-pharmaceutical measures, approximately 63 % (range 56–66 %) of respondents to the first survey in each country reported spending some time away from home for working/studying and, among them, approximately 27 % (range 24–32 %) would be able to stay at home for 7–10 days if needed (Table 2). Of these more than 80 % of both singles and respondents living with other persons stated they would be available to stay at home for 7–10 days, if recommended by health authorities; this was true both if they had been in contact with someone who has swine flu or if they had themselves symptoms of swine flu. More than 70 % of respondents living with other people said they would be able to isolate a sick adult from other household members in a separate room, and about half of single respondents reported that they would be able to find someone to take care of them for 7–10 days if they caught swine flu.

During 2009, more than 60 % would take time off from work/school for 7–10 days in case of symptoms, as recommended by health authorities. These proportions significantly increased in Romania and the UK in the 2010 survey to 70 % and 71 %, respectively.

Furthermore, about 80 % stated they would stay away and keep children away from large gatherings if the new influenza outbreak spread, with no significant

Table 3 Comparison between 2009 and 2010 data reported by all respondents

	Italy		Romania		UK		Finland	
	(2009: $n = 1,025$) (2010-all resp.: $n = 1025$) (2010-old resp.=328) (2010-new resp.=697)		(2009: $n = 1,025$) (2010-all resp.: $n = 1,025$) (2010-old resp.=442) (2010-new resp.=583)		(2009: $n = 1,025$) (2010-all resp.: $n = 1,000$) (2010-old resp.=247) (2010-new resp.=753)		(2009: $n = 681$) (2010-all resp.: $n = 683$) (2010-old resp.=498) (2010-new resp.=185)	
	%	95 % CI	%	95 % CI	%	95 % CI	%	95 % CI
Previous flu and vaccination								
Ever had flu	82.9	79.8–85.5	95.4	93.6–96.7	76.8	73.0–80.2	63.1	59.4–66.8
Took time off of work/school last time with flu[a,b]	77.1	72.6–81.0	28.3	24.2–32.8	56.4	51.2–61.5	63.2	58.6–67.8
Sought medical advice last time with flu[a]	71.1	67.0–74.9	60.8	56.8–64.6	37.9*	32.8–43.2	38.8	34.2–43.5
Ever been offered the seasonal flu vaccine	52.8	48.9–56.5	51.5	47.5–55.4	45.8	41.6–50.0	55.8	52.1–59.5
Did have the seasonal flu vaccine	30.3	27.1–33.7	44.6	40.7–48.5	39.1	35.0–43.3	65.5	60.7–70.3
Belief and level of knowledge								
Heard of A/H1N1	97.1	95.2–98.3	98.2	96.6–99.1	91.9	89.2–94.0	100.0	95.4–100.0
Well informed about swine flu								
- 2009	51.5	47.7–55.2	55.2	51.2–59.1	88.4	85.1–91.0	91.6	89.5–93.7
- 2010 (whole sample)	62.5	58.3–66.5	65.7	61.8–69.4	81.1	77.5–84.1	96.9	95.6–98.2
- 2010 (previously interviewed)	67.8	60.0–74.8	68.3	62.5–73.6	88.1	82.6–92.0	97.2	95.7–98.6
- 2010 (newly interviewed)	60.2	55.1–65.0	63.6	58.2–68.6	79.0	74.8–82.7	96.2	93.4–99.0
Swine flu is transmitted only from someone who clearly shows symptoms								
- 2009	59.2	55.4–62.8	62.3	58.4–66.0	82.5	79.4–85.2	63.9	60.3–67.5
- 2010 (whole sample)[i]	44.0	39.8–48.3	53.1	49.0–57.2	65.7	62.2–69.1	46.9	43.0–50.7
- 2010 (previously interviewed)[i]	41.7	34.1–49.8	58.5	52.5–64.3	69.8	63.2–75.7	46.7	42.2–51.2
- 2010 (newly interviewed)[i]	44.9	39.9–50.1	48.7	43.1–54.3	64.5	60.3–68.5	47.2	39.8–54.6

(continued)

Table 3 (continued)

	Italy		Romania		UK		Finland	
	(2009: $n = 1,025$) (2010-all resp.: $n = 1025$) (2010-old resp.=328) (2010-new resp.=697)		(2009: $n = 1,025$) (2010-all resp.: $n = 1,025$) (2010-old resp.=442) (2010-new resp.=583)		(2009: $n = 1,025$) (2010-all resp.: $n = 1,000$) (2010-old resp.=247) (2010-new resp.=753)		(2009: $n = 681$) (2010-all resp.: $n = 683$) (2010-old resp.=498) (2010-new resp.=185)	
	%	95 % CI	%	95 % CI	%	95 % CI	%	95 % CI
Swine flu will become a serious problem in my country in the coming years	41.8	38.1–45.6	56.2	52.3–60.1	73.3	69.1–77.1	29.6	26.2–33.0
Catching swine flu while carrying daily life as usual is likely in case of outbreak								
- 2009	17.2	14.6–20.3	23.8	20.6–27.3	47.1**	42.8–51.5	16.5	13.7–19.3
- 2010 (whole sample)[i]	16.6	13.7–20.0	17.3	14.5–20.5	28.6	25.4–32.0	14.0	11.3–16.6
- 2010 (previously interviewed)[i]	21.0	15.3–28.1	18.4	14.3–23.5	29.1	23.0–36.1	12.7	9.7–15.7
- 2010 (newly interviewed)[i]	14.8	11.7–18.7	16.4	12.9–20.7	28.4	24.7–32.4	17.4	11.8–23.0
Catching swine flu is serious to own health								
- 2009	59.7	55.9–63.4	80.8	77.4–83.8	47.0**	42.7–51.4	59.9	56.2–63.6
- 2010 (whole sample)[i]	37.8	33.7–42.1	71.1	67.1–74.8	57.5	53.8–61.3	41.6	37.8–45.4
- 2010 (previously interviewed)[i]	38.1	30.2–46.6	77.4	72.2–81.8	55.6	48.5–62.5	41.9	37.4–46.3
- 2010 (newly interviewed)[i]	37.7	32.9–42.7	66.0	60.2–71.4	58.1	53.7–62.4	41.0	33.8–48.3
Actual behaviour								
Getting vaccinated against swine flu if free of charge	78.8	75.5–81.7	77.1	73.7–80.1	84.7	81.7–87.3	86.0	83.4–88.7
Getting children vaccinated against swine flu if free of charge and recommended by health authorities[d]								
- 2009	**91.6**	86.9–94.6	**81.3**	75.3–86.2	**87.6**	81.4–91.9	90.8	86.2–95.5
- 2010 (whole sample)	NA	NA	**33.0**	26.5–40.3	**60.1**	52.8–67.0	NA	NA

- 2010 (previously interviewed)	NA	NA	42.5	32.5–53.3	66.0	47.7–80.6	NA	NA
- 2010 (newly interviewed)	**39.3**	n.d.	25.6	17.7–35.6	59.2	51.2–66.7	NA	NA
Taking antivirals as a precautionary measure if free of charge								
- 2009	**64.7**	60.9–68.2	69.3	65.6–72.8	**75.2**	71.4–78.6	74.7	71.5–78.0
- 2010 (whole sample)[i]	**36.7**	32.7–41.0	67.4	63.4–71.1	**68.8**	65.0–72.3	73.7	70.3–77.1
- 2010 (previously interviewed)[i]	39.4	31.5–47.9	71.1	65.4–76.1	72.6	65.9–78.5	77.4	73.6–81.2
- 2010 (newly interviewed)[i]	35.7	31.0–40.6	64.4	58.8–69.5	67.7	63.2–71.9	64.0	57.0–71.1
Giving antivirals to children as a precautionary measure if a member of the household is sick[d]	92.2	87.1–95.4	89.0	83.5–92.8	92.1	86.7–95.4	96.1	93.0–99.2
Staying at home for 7–10 days if the new influenza would spread	80.5	77.4–83.3	85.8	83.0–88.2	92.7***	89.9–94.7	96.3***	94.9–97.7
Keeping children away from large gatherings for 1 month if recommended[d]								
- 2009	83.5	76.3–88.8	86.5	80.8–90.7	70.6	62.5–77.6	82.4	76.2–88.5
- 2010 (whole sample)	76.8	n.d.	84.8	78.2–89.8	73.8	68.4–78.5	85.3	79.4–91.2
- 2010 (previously interviewed)	89.0	n.d.	93.0	84.8–96.9	68.4	53.6–80.3	86.1	79.3–93.0
- 2010 (newly interviewed)	70.3	61.5–77.8	78.4	68.1–86.0	74.6	68.7–79.7	83.3	71.8–94.8
If showing mild symptoms,								
Taking time off of work/school[e]								
- 2009	81.5	77.8–84.7	**60.0**	56.0–63.8	69.1	64.3–73.5	**59.1**	54.5–63.7
- 2010 (whole sample)[i]	76.9	72.5–80.8	**70.0**	65.2–74.3	67.5	63.1–71.6	**71.0**	66.4–75.7
- 2010 (previously interviewed)[i]	75.7	67.2–82.5	73.9	67.3–79.7	71.5	63.0–78.8	73.7	68.4–79.1
- 2010 (newly interviewed)[i]	77.4	72.1–82.0	66.7	59.9–72.8	66.5	61.5–71.2	64.5	55.5–73.6
Avoiding to go to crowded areas (> 20 persons)								
-2009	87.4	84.5–89.8	77.0	73.6–80.1	79.4	75.4–82.9	75.8	72.5–79.0
- 2010 (whole sample)	83.7	80.4–86.5	76.7	72.9–80.1	74.8	71.1–78.1	79.8	76.8–82.9

(continued)

Table 3 (continued)

	Italy		Romania		UK		Finland	
	(2009: $n = 1,025$) (2010-all resp.: $n = 1025$) (2010-old resp.=328) (2010-new resp.=697)		(2009: $n = 1,025$) (2010-all resp.: $n = 1,025$) (2010-old resp.=442) (2010-new resp.=583)		(2009: $n = 1,025$) (2010-all resp.: $n = 1,000$) (2010-old resp.=247) (2010-new resp.=753)		(2009: $n = 681$) (2010-all resp.: $n = 683$) (2010-old resp.=498) (2010-new resp.=185)	
	%	95 % CI	%	95 % CI	%	95 % CI	%	95 % CI
- 2010 (previously interviewed) [i]	86.0	80.5–90.2	83.2	78.3–87.2	78.6	72.3–83.8	81.6	78.1–85.1
- 2010 (newly interviewed)[i]	82.8	78.6–86.3	71.2	65.6–76.2	73.7	69.3–77.7	75.3	68.9–81.6
Avoiding to go to church or religious services[f]								
-2009	**87.1**	84.1–89.5	77.6	4.2–80.6	**82.0**	78.2–85.2	83.2	80.2–86.2
- 2010 (whole sample)	**79.6**	75.9–82.9	74.5	70.6–78.0	**71.9**	67.5–75.8	82.5	79.3–85.6
- 2010 (previously interviewed)[i]	80.2	73.0–85.8	80.1	74.7–84.5	75.6	68.0–81.9	85.1	81.6–88.5
- 2010 (newly interviewed)[i]	79.4	74.9–83.3	69.7	64.0–74.8	70.8	65.6–75.5	75.3	68.4–82.3
Scenario A[g]								
Staying at home for 7–10 days								
- People living together with other persons	82.9	79.6–85.8	83.1	79.9–85.8	56.7	51.8–61.4	78.4	74.7–82.0
- People living alone	87.9	80.4–92.7	77.6	68.0–85.0	NA	NA	59.3	52.1–66.5
Staying at home for 7–10 days if recommended by health authorities								
- People living together with other persons	91.0	88.2–93.2	88.2	85.5–90.4	83.6	79.5–87.1	93.4	91.2–95.6
- People living alone	91.0	83.8–95.2	80.5	71.6–87.2	NA	NA	89.0	84.4–93.6
Isolating a sick adult from other household members in a separate room								
- People living together with other persons	73.8	70.1–77.3	83.5	80.3–86.3	76.8	72.2–80.9	69.7	65.7–73.8

Scenario B[h]								
Staying at home for 7–10 days								
- People living together with other persons	87.7	84.5–90.3	84.8	81.9–87.4	77.2	72.7–81.2	78.8	75.2–82.4
- People living alone	89.3	81.4–94.0	78.5	68.6–85.9	82.2	75.9–87.2	84.0	78.6–89.4
Staying at home for 7–10 days if recommended by health authorities								
- People living together with other persons	88.5	85.5–91.0	84.4	81.2–87.2	82.3	77.9–85.9	86.0	82.9–89.0
- People living alone	92.4	85.1–96.2	84.7	75.9–90.7	87.1	81.4–91.2	91.2	87.0–95.3
Having someone who takes care of you for 7–10 days								
- People living alone	78.3	69.0–85.4	55.8	45.0–66.1	46.2	39.6–53.0	46.7	39.4–54.0

Bold-underscored percentages in the section Actual Behaviour indicate the presence of a statistical significant difference ($P<0.05$) between the percentages estimated in 2009 and those estimated in the whole sample in 2010. These differences were evaluated using logistic regression models while controlling for sex, age, education, occupation, level of information about swine flu and household composition (when appropriate) as potential confounders

NA not available, *n.d.* CI not calculated by STATA

*In the UK, the question on medical advice last time with flu was only posed to people who were working at that time

**In the UK, in 2009, the questions on likelihood of catching swine flu were only posed to people who reported to have not had it (31 at q18 and 24 at q19: data are not consistent)

***In the UK and Finland, the question on availability to stay at home for 7–10 days was posed assuming a scenario where the interviewed individuals have developed swine flu (in Italy and Romania the same question was posed only assuming the general spread of swine flu in the general population)

[a]Among those who reported to have had flu at least once in their lifetime

[b]Among those who reported to work/study last time they had flu

[c]The percentage for Finland may represent an overestimate compared with other countries because it has been calculated only among people who were offered the vaccine

[d]Among those living with children

[e]Among those usually working/studying

[f]Among those usually attending church or religious services

[g]Scenario A people living together with other persons: someone within the household has swine flu; People living alone: have been in contact with someone who has swine flu

[h]Scenario B people living together with other persons: after having taken care of someone with swine flu within the household, now they have symptoms; people living alone: have influenza

[i]Among those who have not had swine flu

[l]Among those who have not had or have not been offered/recommended the vaccine against swine flu

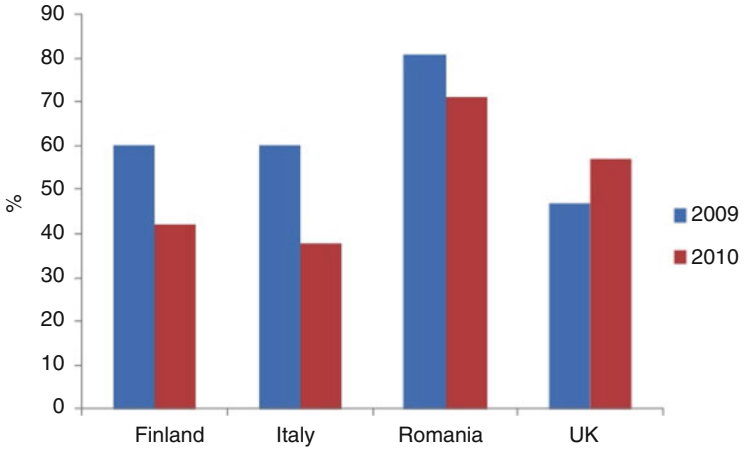

Fig. 2 Comparison of the proportion of individuals worried about catching swine flu by country and survey, 2009–2010

changes in 2010. About 80 %, of those that regularly attend, would avoid going to church or religious services, if showing mild symptoms, in 2009, with a slight reduction for Italy and the UK in 2010.

Few respondents suggested other actions against swine flu in addition to those mentioned in the questionnaire, and among these individuals, washing hands frequently was the most frequently reported behaviour in 2009 and 2010.

3.4 Actual Behaviour

During the 2010 survey, of those individuals who reported having had swine flu, 81 % in Finland, 33 % in Italy, 31 % in Romania and 14 % in the UK reported having been diagnosed through a medical test.

In case of symptoms, more than 70 % of Italian individuals interviewed reported having taken days off from work/school; the proportion decreases to 65 % in Finland and to 23 % in Romania. In Italy, Romania and the UK, 87 %, 62 % and 67 % of individuals, respectively, reported having isolated themselves in a separate room, if not living alone, while symptomatic while in Finland the proportion was lower (34 %).

The proportion of individuals that reported they would be vaccinated against swine flu (intended behaviour) in 2009 was higher than the proportion of those who really had the pandemic vaccine (actual behaviour) in 2010, when offered, in all the four participating countries (Fig. 3),with the lowest difference in Finland and the largest in Italy.

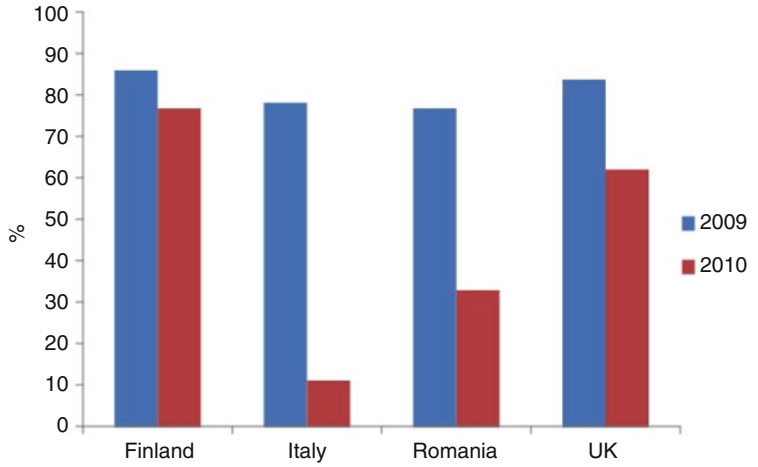

Fig. 3 Comparison of the proportion of individuals getting vaccinated against swine flu if recommended by country and survey, 2009–2010: comparison between intended (2009) and actual behaviour (2010)

The pandemic vaccine was offered to 30 % of respondents in Italy and the UK, to 40 % in Romania and to 50 % in Finland, and of those 14 %, 55 %, 31 % and 60 %, respectively, reported having received it. The reasons accounted for not receiving it, if offered, were mostly related to possible side effects of the vaccine, to the belief that the vaccine was not effective and to the perceived healthy status of the participant. Interestingly, 11 % of individuals in Italy, 5 % in Romania and 3 % in the UK were advised by their GP against getting the pandemic vaccine.

Concerning children, the pandemic vaccine was offered to 16 % in Italy, to 15 % in the UK and to all of them in Finland; 2 %, 19 % and 85 % reported to have vaccinated their children against pandemic influenza, respectively. About 68 % in Italy, 80 % in Romania, 86 % in the UK and 91 % in Finland reported to have given antiviral medications to ill children if offered.

Of respondents, 3.1 % in Italy, 10 % in Romania, 8 % in the UK and 1 % in Finland reported that schools were closed as a result of the swine flu, and in Italy (100 %), Romania (40 %) and the UK (35 %), parents were the main carers of children, while in Finland children took care of themselves (50 %) or were cared by a family member not living in the same household (50 %).

The worry about the possibility of catching swine flu was strongly associated with increased likelihood of performing protecting behaviour with regard to social distancing and vaccination in both 2009 and 2010 surveys except for Italy.

4 Discussion

We conducted a study in four EU countries (Finland, Italy, Romania and the UK) to assess the reliability and validity of behavioural intentions regarding public health interventions through comparison with real behavioural responses to the 2009 A/H1N1 pandemic.

Comparable surveys in a number of different countries have been previously conducted in order to make inter-country comparisons and assess factors that may lead to precautionary actions for SARS, avian influenza [7, 8, 25] and 2009 pandemic [5, 12, 15, 16, 30]. However, few have investigated reliability and validity of behavioural intentions regarding public health interventions, declared at the beginning of the 2009 influenza pandemic, through comparison with real behavioural responses at the end of the pandemic wave in 2010. The lay public's behavioural responses during a disease outbreak play an important role in bringing the outbreak under control and should be considered in the development of mathematical models that have been and are largely used to evaluate and inform infectious disease prevention and control policy. Behavioural changes of the population can significantly affect the epidemic spread both quantitatively (mainly slowing the epidemic spread or determining different final epidemic size) and qualitatively (mainly varying the epidemic dynamics). Including parameters that account for spontaneous behavioural changes in mathematical models could be very useful for giving insight to public health policy makers, for planning public health control strategy (e.g. vaccination, antivirals) and better estimating the burden for health-care settings over time. In one, recently published, study it has been demonstrated that the estimation of key epidemiological parameters (in particular the reproductive number) could be largely modified by human behavioural changes [21].

During the 2009 pandemic, because of the mild nature of most cases [17] and the existing immunity in the elderly [14, 20, 23], the initial fears of a moderately severe pandemic with a 1918-like case fatality rate [10] declined. Public behaviour is likely to be similar in some respects (waning compliance with prevention measures as worry declines), but it is difficult to determine the respective effects on the population of the ongoing heightened perception of personal health and exposure to risk.

In our study, we have been able to assess the beliefs and the behavioural intentions before the actual beginning of the epidemic wave, at least for 3 of the countries involved (the UK had already seen a first summer wave of A/H1N1 pandemic, before the survey was run), and to compare them with actual behaviour during the epidemic and with stated intentions afterwards.

There were some differences among participating countries in 2009 as for previous behaviours related to seasonal flu, and belief and level of knowledge about A/H1N1 influenza; on the other hand, no substantial differences were observed among the four countries with respect to the expected behaviours should swine flu begin to spread.

However, when comparing results of the two surveys, we observed in all countries a significant reduction in those who reported to be willing to vaccinate their children against swine flu if free of charge and recommended by health authorities, but the reduction ranged from extreme in Italy and Romania to modest in the UK and Finland. A significant reduction with respect to the use of antivirals as a precautionary measure was reported only in Italy and the UK.

On the other hand, when considering non-pharmaceutical measures (e.g. staying at home for 7–10 days and keeping children away from large gatherings) there were no significant changes in population behavioural intentions between the two surveys. Exceptions are that in Romania and Finland the proportion of individuals reporting to take time off from work/school in case of mild symptoms increased; instead, individuals from Italy and the UK significantly reduced their willingness to avoid religious services in case of mild symptoms.

In our study worry about the possibility of catching swine flu was strongly associated with increased likelihood to perform protecting behaviour with regard to social distancing and vaccination in both 2009 and 2010 surveys except for Italy. In most of the participating countries except Finland, peoples' anxiety about 2009 pandemic and the preventive pharmacological measures (both antivirals and pandemic vaccine) they took to avoid infection declined from June to July 2009 to June 2010.

Considering the actual behaviour, Italy, Finland and the UK reported a high proportion of individuals that took days off from work/school in case of influenza symptoms, while in Romania the proportion was low compared to other countries. Except for Finland, a high proportion of individuals reported having isolated themselves in a separate room, if not living alone, in case of symptoms.

Most published studies in the literature report possible behavioural intentions and preventive strategies adopted by the population in the early phase of the 2009 pandemic [5, 12, 15, 16, 24, 26, 30]. Studies on behavioural response to the initial phase of the 2009 pandemic influenza have highlighted an initial high level of anxiety about the pandemic [12] and different behavioural responses to the risk of infection [5, 15, 16, 24, 26, 27, 30]. In the USA, data collected on public response to 2009 pandemic influenza from May 2009 to June 2009 suggest that 16–25 % of Americans avoided mass gathering events, like sporting events, malls or public transportation and 20 % reduced contact with people outside [their] household as much as possible [27].

Published studies have shown a behavioural change in the population against the 2009 pandemic [12, 24] and our results support this. Suboptimal adherence to preventive measures as a function of risk perception has been previously described [18, 19] and is also confirmed by our results showing that the reduction in some avoidance behaviours may indicate a decrease in risk perception with consequent decline in population adherence to public health authorities recommendations.

The role of human behaviours on mathematical model estimation of epidemiological parameters (such as the reproductive number) has previously been discussed [9, 11, 21, 22] because of the possible role of behavioural changes on the contact network and in the virus transmissibility [9]. Recent published studies [21, 22] have

started to investigate the role of spontaneous behavioural changes in the population, not accounted for by the large majority of influenza transmission models showing that individual choices can drastically affect the dynamics, the overall number of cases and epidemic spread, mostly by altering timing.

To our knowledge our study is the only one to have investigated the actual behaviour of the population in EU countries and provides crucial descriptions of pandemic impact on social-network dynamics parameters to be included in mathematical models in order to obtain more accurate and realistic scenarios and for giving better insight to public health policy makers.

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