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**Seasonal influenza vaccine uptake among people with disabilities: a nationwide population study of disparities by type of disability and socioeconomic status in France**

**People with disabilities and flu vaccine**

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## **Abstract**

People with disabilities use various preventive health services less frequently than others, notably because of a lower socioeconomic status (SES). We examined variations of seasonal influenza vaccine uptake according to type/severity of disability and SES. We analyzed (in 2016) data from the 2008 French national cross-sectional survey on health and disability (n=12,396 adults living in the community and belonging to target groups for seasonal influenza vaccination). We defined seasonal influenza vaccine uptake during the 2007-2008 season by the self-reporting of a flu shot between September 2007 and March 2008. We built scores of mobility, cognitive, and sensory limitations, and an SES score based on education, occupation, and income. We performed bivariate analyses and then multiple log-binomial regressions. The prevalence of vaccine uptake was 23% in the 18-64 group and 63% in the  $\geq 65$  group. In bivariate analyses, it was higher among people in both age groups who had mobility and/or cognitive limitations and in the  $\geq 65$  group among those with sensory limitations. In the multiple regression analyses, only the presence of major mobility limitations in the 18-64 group remained significant. The probability of vaccine uptake was higher in the highest SES category than in the lowest. Among at-risk groups, people with disabilities were more frequently vaccinated than others, mainly because of their higher levels of morbidity and healthcare use. Socioeconomic inequalities in access to vaccination persist in France. Future research is needed to monitor the trend in vaccine uptake in institutions.

**Keywords:** Influenza Vaccines; Disabled Persons; Socioeconomic Factors; Social Determinants of Health; France

## **Introduction**

People with disabilities, especially neurological and neurodevelopmental conditions and disabilities related to problems with muscle tone, weakness, or handling of secretions, are at high risk of influenza-related complications.<sup>1–3</sup> Many countries thus recommend vaccination against seasonal influenza for these populations;<sup>1,4,5</sup> since 2011, this includes France.<sup>6</sup>

Evidence from the literature – mainly from the United States (US) – shows that use of various preventive health services is less frequent among people with, compared to without, disabilities.<sup>7–14</sup> Apart from physical barriers to access to health care, major contributors to these inequities include attitudinal barriers associated with healthcare providers' perceptions of people with disabilities.<sup>15,16</sup> They also include socioeconomic barriers; lower socioeconomic status (SES) is more common among people with disabilities<sup>16</sup> and is independently associated with less frequent use of several preventive care services (e.g., cancer screening).<sup>14,17,18</sup>

The few studies that have addressed seasonal influenza vaccine uptake among people with disabilities took place in the US,<sup>10,11,19</sup> Australia,<sup>20</sup> and Taiwan;<sup>21</sup> their results suggest that disability is associated with a higher probability of vaccine uptake. This question has not been studied in Europe, and in particular not in France (see Appendix Table S1 for the bibliographic search). Findings about the association between seasonal influenza vaccine uptake and SES are more controversial.<sup>22–24</sup> Lower SES has been found to be correlated with lower vaccination uptake in some countries, but a reverse gradient has been found in others (e.g., among older people in Italy).<sup>25</sup> In France, a study in the general population found no significant SES gradient in vaccine uptake<sup>26</sup> while among people treated for diabetes, those with a low income were less likely to be vaccinated regularly against seasonal influenza than more affluent individuals.<sup>27</sup>

In France as in many other developed countries, reducing social health inequalities (i.e., avoidable and unfair differences in health status/health determinants between different population groups) has become a priority.<sup>28</sup> According to the conceptual framework set forth by the World Health Organization Commission on Social Determinants of Health, these inequalities arise from: 1) structural determinants: macro-level social and political mechanisms that generate and maintain social hierarchies and stratification by income, education, occupation, and other factors; and 2) intermediary determinants (e.g., health system, material circumstances, behaviors, beliefs) through which the structural factors shape health outcomes.<sup>28</sup> In France, the influenza vaccine is available free of charge for people in at-risk groups through vouchers, but a significant fraction of the at-risk population escapes this system.<sup>27</sup> Nevertheless, little is known about the social health inequalities in seasonal influenza and vaccination against it.

Using data from the French national survey on health and disability among people living in the community (*Enquête Handicap Santé-Ménages*, HSM survey), we sought to examine associations between seasonal influenza vaccine uptake and 1) the presence of disabilities, while distinguishing their type and severity; and 2) individual SES.

## **Materials and Methods**

### **Sampling and data source**

The HSM cross-sectional survey was conducted from April through September 2008 by the French national institute of statistics and economic studies (INSEE) and the Ministry of Social Affairs office of research, studies, evaluation and statistics (DREES).<sup>29,30</sup> This survey aimed to measure the prevalence of various forms of disabling situations, assessed according to the concepts of disability developed by the World Health Organization (WHO).<sup>31</sup>

It was preceded in 2007 by a filter survey – the Everyday Life and Health Survey (*Enquête Vie Quotidienne et Santé*, VQS survey) – that allowed the HSM sampling frame to be built.<sup>29</sup>

During the VQS survey, 101,930 households and around 260,000 individuals (for an 80% response rate from the initial sample of 127,176 households) answered a 26-item questionnaire, either by mail (about half) or in telephone or face-to-face interviews to assess the presence or absence of recognized disabilities and difficulties in accomplishing certain tasks. Respondents were then classified into four levels of disability severity, previously used in French studies.<sup>13,30</sup>

Among these respondents, 39,065 were randomly selected to participate in the HSM survey. Because people with disabilities are relatively rare in the general population, they were intentionally overrepresented in the HSM sample, through the use of a sampling coefficient that increased with the presence and severity of disabilities.<sup>32</sup> Professionals conducted face-to-face interviews at respondents' homes, using a computer-assisted personal interviewing (CAPI) system. A proxy respondent (e.g., a relative or friend or neighbor) could answer for HSM participants not able to answer alone. Finally, 29,931 subjects participated in the HSM survey (response rate: 76.6%).

The national commission for computer data and individual freedom (Commission Nationale de l'Informatique et des Libertés, CNIL) approved this study.

### **Study population**

This study analyzed data from the HSM participants aged 18 or more at the time of the interview who lived in metropolitan France and belonged to target groups for seasonal influenza vaccination in France for the 2007-2008 season.<sup>33</sup> The French guidelines<sup>33</sup> recommend this vaccination for all people aged 65 years or over, people with specific chronic diseases, and health and other professionals in regular and extended contact with them (see Appendix Box S1). The HSM survey used a standardized list of 51 diseases presented to the participants during the interview to record the presence of diseases. The study population

included 12,396 respondents (see Appendix Table S2 for the number of persons per target group).

### **Dependent variable: seasonal influenza vaccine uptake**

Participants were asked “*Have you ever had the flu vaccine?*” and “*If yes, when did you have your last flu shot?*” (year, month).<sup>20</sup> As the survey took place from April through September 2008, we defined the dependent variable, *seasonal influenza vaccine uptake during the 2007-2008 season (yes/no)*, hereafter referred as vaccine uptake, by the report of a seasonal influenza vaccine shot between September 2007 and March 2008.<sup>34</sup>

### **Variables of interest**

#### Type and severity of disability

The questionnaire collected information about respondents’ functional limitations in three domains (see Appendix Box S2 for more details): 1) mobility limitations (7 items, e.g., level of difficulty in walking 500 meters on flat ground); 2) sensory limitations (3 items, e.g., level of difficulty in seeing, even with eyeglasses or contact lenses, the printed letters in newspapers); and 3) cognitive limitations (8 items, e.g., level of frequency of difficulty in acquiring new knowledge or skills, in school, professional training, or leisure activities). Following a methodology commonly used in the literature,<sup>35</sup> we built a score of limitation severity for each kind of limitation by summing respondents’ answers to the corresponding items, then dividing the sum by the number of items, and finally rounding the resulting score to the nearest integer to preserve the initial form of the limitation categories. The mobility and sensory scores ranged theoretically from 1 to 4, and the cognitive score from 1 to 3. Because few respondents were in the highest categories, the first two scores were then re-coded into three categories (1: no limitation; 2: moderate limitations; 3 or 4: major limitations), and the latter into two categories (1: no limitation; 2 or 3: moderate/major limitations).

We also used one question about whether the respondent received family assistance in performing daily living activities to evaluate disability severity.

### Socioeconomic status

The socioeconomic variables included were: education level (did not complete high school, completed high school, some higher education); occupation (including but not limited to: not in the labor force, such as homemakers and people with disabilities; workers, such as farmers, artisans, factory workers, and office/sales/service workers; professionals and managers, including middle management and other intellectual workers); and equivalized household income (EHI) per month, which incorporates household size and composition.<sup>36</sup> According to a methodology already published (see Appendix Box S3),<sup>37,38</sup> we used these three variables to calculate an individual composite SES indicator ranging from 0 (lowest SES) to 6 (highest SES). Because only a few respondents younger than 65 had an SES score of 0, they were grouped with those in category 1.

### **Other variables**

The HSM questionnaire also assessed the following sociodemographic characteristics: gender; age (four categories, Table 1); living with a partner (*yes/no*); and type of residence area (*urban/rural*).

Data on health status and healthcare use included self-reporting of chronic diseases (i.e., those lasting 6 months or more) and number of visits to a general practitioner in the previous 12 months (dichotomized around the median = 4).

### **Statistical analysis**

All HSM respondents were assigned a weight that reflected their probability of selection (depending on disability severity and geographic area of residence) and response. Final weights were calculated with a calibration procedure ensuring that the data were



representative of the French population living in the community for gender, age, and geographic area of residence.<sup>32</sup>

First, we performed bivariate analyses with chi-square tests to describe variations of the prevalence of seasonal influenza vaccine uptake according to the variables of interest (the three limitation scores, family assistance, and the SES score), and other characteristics described above. Second, we performed weighted multiple log-binomial regression models to measure associations between seasonal influenza vaccine uptake and the variables of interest. Based on Andersen's behavioral model of health services use,<sup>39</sup> multiple regression models were adjusted for various factors: predisposing (age, gender, or living with a partner), enabling (type of residence area, as a proxy for availability of health services), and need (health status, number of visits to a general practitioner, and use of a proxy respondent). All these variables may be associated with both the variables of interest and vaccine uptake.<sup>22,40</sup> Associations were measured with adjusted risk ratios (aRRs) and their 95% confidence intervals (95% CI). We performed log-binomial rather than logistic regressions because vaccine uptake is not rare (>10%); in this situation, odds ratios estimate risk ratios poorly; specifically, they overestimate them. Moreover, compared to the Robust Poisson method, the log-binomial method yields slightly less biased estimates, higher power, and smaller standard errors in most common situations.<sup>41</sup>

Chronic disease and healthcare use were strongly and positively correlated with both disabilities and seasonal vaccine uptake<sup>19,22</sup> and may help explain the higher probability of vaccine uptake among people with disabilities.<sup>10,11,19–21</sup> To explore the role of these two variables in the associations of interest, we performed two successive multiple regression models, first without and then with adjustment for these variables. We also tested interactions between SES and each of the three limitation scores.

All analyses were stratified by age (18-64/ $\geq$ 65 years) for the two reasons. First, influenza vaccine coverage differs very substantially between these two groups.<sup>27</sup> Second, the national health insurance fund sends all people aged 65 or more a free vaccination voucher; although at-risk people aged 18-64 are also supposed to receive this voucher, a significant fraction escapes this system.<sup>27</sup>

All analyses were based on two-sided p values, with  $p < 0.05$  indicating statistical significance; they were conducted in 2016 with SAS 9.4 statistical software (SAS Institute, Cary, NC).

## **Results**

### **Characteristics of the study population**

Among the study population, 57% of people were aged 65 years or more (Table 1). Analysis of SES distribution shows 14% of respondents aged 18-64 and 30% of those aged 65 or older in the two lowest SES categories and 25% and 10%, respectively, in the two highest. Among people aged 18-64 years, 9% reported mobility limitations, 8% sensory limitations, and 7% cognitive limitations; among older respondents, these percentages were 32%, 21%, and 13% (Table 1). In both age groups, respondents with disabilities had a significantly lower SES than the others (see Appendix Table S3).

### **Prevalence of seasonal influenza vaccine uptake and results from bivariate analyses**

Among the study population, 12,365 (99.7%) respondents answered the questions about seasonal influenza vaccine uptake: 44% reported a shot during the 2007-2008 season (63% among those aged 65 years or more; 23% among the at-risk members of the younger group). In both age groups, vaccine uptake prevalence was higher among men, older people, and those living with a partner. Only in the younger age group did we find better coverage in those with the highest SES category. It was also higher among people who had mobility and/or cognitive limitations in both age groups, and, only among the older age group, those who had sensory limitations (Table 2).

### **Multiple log-binomial regression analyses**

The probability of vaccine uptake was higher among people with moderate or major physical limitations in both age groups, and among those aged 18-64 years with cognitive limitations; it was slightly lower in the younger group with moderate sensory limitations (Tables 3 and 4 and Tables S4 and S5 for results for covariables). After adjustment for chronic disease and healthcare use, only major physical limitations among people aged 18-64 years remained significantly associated with a higher probability of vaccine uptake (aRR=1.37 [1.02;1.84]). Those in the highest SES category had a higher probability of vaccine uptake than those in the lowest SES category, in both age groups (18-64: aRR=1.51 [1.25-1.81];  $\geq 65$ : aRR=1.11 [1.02-1.21], Tables 3 and 4).

We found no significant interaction between the SES score and any of the limitation scores.

### **Discussion**

In this study based on a representative sample of the French population living in the community, the prevalence of seasonal influenza vaccine uptake during the 2007-2008 season was 23% among at-risk respondents aged 18-64 and 63% among the older group (all at risk, by definition). In unadjusted analyses, uptake prevalence was higher among people with mobility and/or cognitive limitations; among people aged 18-64 only, it was also higher among those with the highest SES. After adjustment, especially for health status and health care use, only severe mobility limitations among people aged 18-64 and the highest SES category in both age groups were associated with a higher uptake prevalence.

Our estimates of the prevalence of seasonal influenza vaccine uptake during the 2007-2008 season were consistent with those of a previous study based on reimbursement data for the same season in the entire French population (24% among people aged 18-64 at risk of chronic disease; 63% among those at risk because aged 65 or older).<sup>34</sup> Their results confirm that, just before the 2009 A/H1N1 pandemic,<sup>42,43</sup> influenza vaccine uptake was lower than the target of

75% set by the WHO and the French Public Health Policy Act of 2004 in 2007-8, although the target was close to achievement (71%) among people aged 65 years or more with mobility limitations.

Consistently with previous studies,<sup>10,11,19-21</sup> we found that rates of seasonal vaccine uptake were higher among people with physical or cognitive limitations, despite their lower SES (a risk factor for non-immunization), than among the general population. We also showed that this higher rate was due in part to their higher morbidity level and more regular health care than that of the rest of the population.<sup>8,11,19</sup> After adjustment for these factors, seasonal influenza vaccine uptake remained higher only among a very small group of people aged 18-64 with major physical limitations (2% of the study population). Some of them may have severe neurological diseases or neuromuscular conditions<sup>30</sup> that entitled them to a free vaccination voucher from the French National Health Insurance Fund several years before their conditions were listed as targeted in the official French guidelines in 2011.<sup>44</sup> This feedforward measure may have contributed to a greater attention by physicians to the vaccination of these patients. Although flu vaccination is recommended for people with significant cognitive/intellectual disabilities in some countries (e.g., the UK),<sup>4</sup> this is not the case in France.

Our study suggests that the general tendency for people with disabilities to receive fewer preventive services (e.g., cervical and breast cancer screening)<sup>7-14</sup> does not apply to seasonal influenza vaccination. Greater awareness by physicians of these patients' risks of seasonal flu than of their needs for other preventive services might partly explain this result.<sup>45</sup> There may also be fewer physical barriers to influenza shots than to cancer screening and dental cleaning, which may require medical equipment specifically adapted to people with disabilities.<sup>11</sup> Our results suggest the persistence of socioeconomic inequalities in seasonal influenza vaccine uptake in France involving especially people with disabilities, due to their SES, which

is generally lower than among the general population. The international literature about the existence of these inequalities is inconsistent;<sup>25</sup> inequalities have already been reported for this vaccine in France among people with diabetes<sup>27</sup> and for pneumococcal vaccine among children (partially free of charge).<sup>46</sup> The French National Health Insurance Fund identifies members of at-risk groups and sends them a free vaccination voucher; they thus do not pay for their seasonal influenza vaccine. But financial barriers still remain for people in at-risk groups not eligible for a voucher and/or those who have to pay the consultation fee.<sup>27</sup> Adjustment for complementary health insurance (*yes/no*), a traditional enabling factor of health service use,<sup>39</sup> did not modify these results (results not shown). These inequalities may also reflect SES differences in other predisposing factors of health services use,<sup>39</sup> such as health-related knowledge, attitudes, and beliefs, and more specifically cognitive determinants of vaccine behaviors (e.g., beliefs in vaccine efficacy and safety, and fear of side effects). A previous French study reported greater reluctance about vaccination in general among low SES people than among the affluent.<sup>47</sup> Previous studies in the field of cancer prevention (e.g., cancer screening<sup>17</sup> and sun-protection behaviors<sup>38</sup>) have showed that cognitive factors play a role in mediating SES differences in health behaviors. Further research is needed to verify whether this also applies to vaccination behavior.

### **Limitations and strengths**

This study has several potential limitations. First, as in most previous studies exploring associations between disabilities and influenza vaccination,<sup>7,8,11,19,20,40</sup> we used self-reported data on vaccine uptake, without physician confirmation. The prevalence of vaccine uptake here, however, was very close to that calculated from reimbursement (thus objective) data in France for the same season.<sup>34</sup> Second, no study since 2008 has explored associations between disability and influenza vaccination. This raises a question about whether its results apply today. That study was implemented before the 2009-2010 controversy about the safety of the

A/H1N1 pandemic vaccine,<sup>48</sup> which has durably affected seasonal influenza vaccine uptake in several countries. In France in particular, uptake has progressively decreased to reach, in 2015-16, levels lower than those in 2007-8.<sup>49</sup> There is no reason to think that this has affected the association between uptake and physical limitations, however, given the absence of any recent major changes in disability trends.<sup>50</sup> The social differentiation of attitudes towards vaccination in general in France increased between 2005 and 2010, with low SES becoming more predictive of unfavorable attitudes in 2010.<sup>51</sup> The long-lasting consequences of the 2008 economic crisis in France may have contributed to an increase in social inequalities. These observations suggest that our results about SES differences in vaccine uptake are likely to continue to exist and might even be greater today.

Major strengths of this study include the size of the sample and its representativeness of the French population. Moreover, its design enabled us to obtain robust results about population subgroups by type and severity of disability, which has been a weakness of previous studies on preventive care use among people with disabilities.<sup>8</sup> Using a SES score combining three different measures (education, occupation, and income) is likely to have limited potential misclassification related to each separate variable.

## **Conclusions**

Our study suggests that the poorer use of prevention among people with disabilities previously observed for several types of preventive care does not exist for seasonal influenza vaccination. Among the at-risk groups, people with disabilities were more frequently vaccinated than other people, mainly because of their greater level of morbidity and healthcare use. After adjustment for these factors, only a few people with major mobility limitations were more likely to be vaccinated than those without limitation. Nonetheless, our results highlight the persistence of socioeconomic inequalities in vaccination that affect people with disabilities despite the existence of a free voucher system. These results should

prompt public health professionals, in collaboration with other partners, to continue to combat health inequalities and to consider the different social determinants of health more globally. Future research is needed to improve our understanding of the reasons for these differences and to examine influenza vaccination uptake among people with disabilities living in institutions.

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## **Highlights**

- Influenza vaccine uptake is more frequent among people with mobility limitations.
- After adjustment for morbidity, this is true only for a few with major limitations.
- Socioeconomic inequalities persist in influenza vaccine uptake.

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**Table 1.** Characteristics of the study population, by age group (France, 2008 HSM survey,  $n=12,396$ )<sup>a</sup>

	18-64 years ( $n=5,297$ )		$\geq 65$ years ( $n=7,099$ )	
	<i>n</i>	%	<i>n</i>	%
<b>Demographic and socioeconomic characteristics</b>				
Gender				
Men	2,295	43.3	2,930	41.3
Women	3,002	56.7	4,169	58.7
Age (years)				
18-45	2,159	40.8	-	-
46-64	3,138	59.2	-	-
65-74	-	-	3,639	51.3
75 or more	-	-	3,460	48.7
Living with a partner				
No	1,440	27.2	2,752	38.8
Yes	3,857	72.8	4,347	61.2
Type of residence area				
Rural	1,647	31.1	2,278	32.1
Urban	3,650	68.9	4,821	67.9
Socioeconomic status (SES) score [0-6] <sup>b</sup>				
0-1 (lowest SES)	710	13.5	2,113	29.9
2	1,294	24.6	2,413	34.3
3	1,305	24.8	1,241	17.6
4	654	12.4	563	8.0
5	493	9.4	336	4.8

6 (highest SES)	804	15.3	394	5.6
<b>Health status and healthcare use</b>				
Number of visits to a general practitioner in the last 12 months				
Between 1 and 4	3,029	57.2	3,455	48.7
5 or more	1,769	33.4	3,323	46.8
Don't know	499	9.4	320	4.5
Chronic disease <sup>c</sup>				
No	1,834	34.6	1,927	27.2
Yes	3,462	65.4	5,168	72.8
<b>Disabilities</b>				
Mobility limitations <sup>d</sup>				
No limitation	4,837	91.3	4,805	67.7
Moderate limitations	353	6.7	1,503	21.2
Major limitations	106	2.0	791	11.1
Sensory limitations <sup>e</sup>				
No limitation	4,878	92.1	5,616	79.1
Moderate limitations	392	7.4	1,242	17.5
Major limitations	26	0.5	241	3.4
Cognitive limitations				
No limitation	4,900	92.5	6,149	86.6
Moderate/major limitations	397	7.5	950	13.4
Needs family assistance for performing daily living activities				
No	4,731	89.3	5,307	74.8
Yes	566	10.7	1,792	25.2
Answered to the question him/herself				

No	266	5.0	793	11.2
Yes	5031	95.0	6,306	88.8

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<sup>a</sup> Weighted data items.

<sup>b</sup> 73 missing data items.

<sup>c</sup> 5 missing data items.

<sup>d</sup> 1 missing data item.

<sup>e</sup> 3 missing data items.

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**Table 2.** Prevalence of seasonal influenza vaccine uptake during the 2007-2008 season according to the respondents' characteristics and age group (France, 2008 HSM survey,  $n=12,365^a$ )

	18-64 years ( $n=5,277$ )	$\geq 65$ years ( $n=7,088$ )
	% [95% CI] <sup>b</sup>	% [95% CI] <sup>b</sup>
<b>Total sample</b>	23.4 [21.0;25.7]	63.3 [61.9;64.7]
<b>Demographic and socioeconomic characteristics</b>		
Gender		
Men	25.4 [23.7;27.2]	64.8 [63.0;66.5]
Women	21.8 [20.3;23.3]	62.3 [60.8;63.7]
Age (years)		
18-45	15.1 [13.4;16.8]	-
46-64	29.1 [27.6;30.5]	-
65-74	-	56.7 [54.9;58.4]
75 or more	-	70.3 [68.9;71.7]
Living with a partner		
No	21.0 [19.1;23.0]	61.3 [59.6;63.0]
Yes	24.3 [22.9;25.7]	64.6 [63.1;66.0]
Type of residence area		
Rural	23.8 [21.5;26.1]	63.6 [61.4;65.8]
Urban	23.2 [21.9;24.5]	63.2 [61.8;64.5]
Socioeconomic status (SES) score <sup>c</sup>		
0-1 (lowest SES)	24.7 [22.3;27.0]	62.4 [60.5;64.3]
2	22.7 [20.6;24.8]	62.7 [60.7;64.6]
3	20.0 [17.6;22.4]	64.3 [61.5;67.1]

4	20.9 [17.4;24.4]	67.0 [62.7;71.3]
5	22.6 [18.0;27.2]	64.4 [58.7;70.0]
6 (highest SES)	31.5 [27.3;35.7]	62.2 [56.6;67.7]
<b>Health status and health care use</b>		
Number of visits to a general practitioner in the last 12 months		
Between 1 and 4	20.7 [19.0;22.4]	58.2 [56.3;60.1]
5 or more	29.2 [27.5;30.9]	71.8 [70.4;73.1]
Don't know	18.9 [14.6;23.2]	30.1 [24.3;36.0]
Chronic disease <sup>d</sup>		
No	18.4 [16.0;20.9]	55.3 [52.4;58.1]
Yes	26.0 [24.7;27.3]	66.3 [65.1;67.5]
<b>Disabilities</b>		
Mobility limitations <sup>e</sup>		
No limitation	22.7 [21.3;24.0]	60.4 [58.7;62.1]
Moderate limitations	29.0 [26.2;31.7]	68.5 [66.5;70.6]
Important/severe limitations	37.9 [33.3;42.6]	71.1 [69.0;73.1]
Sensory limitations <sup>f</sup>		
No limitation	23.4 [22.1;24.6]	62.5 [61.1;63.8]
Moderate limitations	23.2 [20.1;26.2]	66.3 [64.0;68.6]
Important/severe limitations	31.8 [22.8;40.7]	66.7 [62.9;70.6]
Cognitive limitations		
No limitation	23.0 [21.8;24.3]	62.6 [61.3;63.9]
Moderate/important limitations	28.0 [25.2;30.8]	67.8 [65.6;69.9]
Needs family assistance for performing daily living activities		
No	22.9 [21.6;24.3]	61.1 [59.5;62.6]



Yes	27.3 [25.1;29.6]	69.9 [68.3;71.4]
Answered to the questions him/herself		
No	23.1 [19.1;27.2]	68.9 [66.5;71.3]
Yes	23.4 [22.2;24.6]	62.6 [61.3;63.9]

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<sup>a</sup> Weighted data.

<sup>b</sup> 95% confidence intervals.

<sup>c</sup> 72 missing data.

<sup>d</sup> 5 missing data.

<sup>e</sup> 1 missing data.

<sup>f</sup> 3 missing data.

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**Table 3.** Associations between seasonal influenza vaccine uptake during the 2007-2008 season and type and severity of disability, and socioeconomic status, among people aged 18-64 years: results from multiple log-binomial regression models (France, 2008 HSM survey<sup>a</sup>)

	Model 1 <sup>b</sup>	Model 2 <sup>c</sup>
	<i>n</i> =5,239	<i>n</i> =5,238
	aRR [95% CI] <sup>d</sup>	aRR [95% CI] <sup>d</sup>
<b>Socioeconomic status (SES) score [0-6]</b>		
0-1 (lowest SES)	1.00 (ref.)	1.00 (ref.)
2	0.89 [0.79;1.00]	0.92 [0.77;1.09]
3	0.83 [0.73;0.94]	0.87 [0.72;1.04]
4	0.89 [0.77;1.03]	0.93 [0.76;1.15]
5	1.03 [0.88;1.20]	1.10 [0.88;1.37]
6 (highest SES)	1.39 [1.23;1.58]	1.51 [1.25;1.81]
<b>Disabilities</b>		
Mobility limitations		
No limitation	1.00 (ref.)	1.00 (ref.)
Moderate limitations	1.17 [1.02;1.34]	1.07 [0.88;1.31]
Major limitations	1.48 [1.21;1.82]	1.37 [1.02;1.84]
Sensory limitations		
No limitation	1.00 (ref.)	1.00 (ref.)
Moderate limitations	0.84 [0.73;0.96]	0.82 [0.67;1.00]
Major limitations	0.93 [0.62;1.39]	0.93 [0.51;1.68]
Cognitive limitations		
No limitation	1.00 (ref.)	1.00 (ref.)
Moderate/major limitations	1.17 [1.03;1.33]	1.13 [0.94;1.36]

Needs family assistance for performing daily  
living activities

No	1.00 (ref.)	1.00 (ref.)
Yes	1.02 [0.90;1.16]	0.96 [0.80;1.14]

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<sup>a</sup> Weighted data. Missing data were excluded from the analysis.

<sup>b</sup> Model 1 was adjusted for gender, age, living with a partner, type of residence area, and for whether the respondent answered him/herself or not.

<sup>c</sup> Model 2 was adjusted for gender, age, living with a partner, type of residence area, whether the respondent answered him/herself or not, number of visits to a general practitioner in the last 12 months, and chronic disease.

<sup>d</sup> Adjusted risk ratio (aRR) and 95% confidence intervals (95% CI).

**Table 4.** Associations between seasonal influenza vaccine uptake during the 2007-2008 season and type and severity of disability, and socioeconomic status, among people  $\geq 65$  years: results from multiple log-binomial regression models (France, 2008 HSM survey<sup>a</sup>)

	Model 1 <sup>b</sup>	Model 2 <sup>c</sup>
	<i>n</i> =7,051	<i>n</i> =7,048
	aRR [95% CI] <sup>b</sup>	aRR [95% CI] <sup>b</sup>
<b>Socioeconomic status (SES) score [0-6]</b>		
0-1 (lowest SES)	1.00 (ref.)	1.00 (ref.)
2	1.01 [0.96;1.06]	1.00 [0.96;1.05]
3	1.05 [1.00;1.11]	1.03 [0.97;1.09]
4	1.08 [1.01;1.15]	1.06 [0.99;1.14]
5	1.05 [0.97;1.14]	1.05 [0.96;1.14]
6 (highest SES)	1.06 [0.97;1.15]	1.11 [1.02;1.21]
<b>Disabilities</b>		
Mobility limitations		
No limitation	1.00 (ref.)	1.00 (ref.)
Moderate limitations	1.06 [1.01;1.11]	0.99 [0.94;1.04]
Major limitations	1.08 [1.01;1.15]	1.01 [0.94;1.08]
Sensory limitations		
No limitation	1.00 (ref.)	1.00 (ref.)
Moderate limitations	1.01 [0.97;1.05]	1.00 [0.95;1.04]
Major limitations	0.95 [0.87;1.05]	0.95 [0.86;1.05]
Cognitive limitations		
No limitation	1.00 (ref.)	1.00 (ref.)
Moderate/major limitations	0.98 [0.93;1.04]	0.98 [0.93;1.04]

Needs family assistance for performing daily  
living activities

No	1.00 (ref.)	1.00 (ref.)
Yes	1.04 [1.00;1.09]	1.01 [0.97;1.07]

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<sup>a</sup> Weighted data. Missing data were excluded from the analysis.

<sup>b</sup> Model 1 was adjusted for gender, age, living with a partner, type of residence area, and for whether the respondent answered him/herself or not.

<sup>c</sup> Model 2 was adjusted for gender, age, living with a partner, type of residence area, whether the respondent answered him/herself or not, number of visits to a general practitioner in the last 12 months, and chronic disease.

<sup>d</sup> Adjusted risk ratio (aRR) and 95% confidence intervals (95% CI).

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**Table S1.** Keywords used for Medline search

<p>#1 Vaccination</p> <p>vaccin*[Title/Abstract] OR immunis*[Title/Abstract] OR immuniz*[Title/Abstract]</p>
<p>#2 Seasonal Influenza</p> <p>Influenza Vaccines [MeSH] OR Influenza, Human/prevention and control [MeSH] OR seasonal influenza vaccine [Title/Abstract] OR seasonal influenza vaccines [Title/Abstract] OR flu [Title/Abstract] NOT pandemic NOT epidemic</p>
<p>#3 Disabilities, functional limitations</p> <p>Disabilit*[Title/Abstract] OR disabled persons [MeSH] OR functional limitations [Title/Abstract]</p>
<p>#4 Final Search</p> <p>#1 AND #2 AND #3</p>

**Box S1.** Target groups for seasonal influenza vaccination, according to the French recommendations for the 2007-2008 season<sup>1</sup>

- People aged 65 years or over
- Professionals at risk of exposure
  - Health professionals and professionals in regular and extended contact with people with specific underlying diseases (see below)
  - Staff working on cruise boats and airplanes and those who work in the travel industry as guides)
- People with specific underlying diseases
  - Chronic bronchopulmonary conditions including asthma, bronchopulmonary dysplasia, and cystic fibrosis
  - Poorly tolerated congenital heart disease and severe heart failure and valvulopathies
  - Serious chronic nephropathy, pure and primary nephrotic syndromes
  - Homozygous and S/C heterozygous sickle-cell anemia, sickle-cell thalassemia
  - Diabetes mellitus, type 1 or type 2, that cannot be managed by diet alone
  - Cellular immunodeficiencies (in people with HIV infection, to be indicated the team caring for the patient)
  - Children and adolescents (from 6 months to 18 years) whose health status requires prolonged treatment aspirin treatment (essentially complicated Kawasaki syndrome and chronic juvenile arthritis).
- People living in health institutions

1. [http://www.invs.sante.fr/beh/2007/31\\_32/beh\\_31\\_32\\_2007.pdf](http://www.invs.sante.fr/beh/2007/31_32/beh_31_32_2007.pdf)



**Box S2.** Items included in the questionnaire of the 2008 HSM survey to measure functional limitations

Items selected to assess functional limitations were based on the Nagi Disability Scale,<sup>1</sup> the WHO Disability Assessment Schedule 2.0 (WHODAS 2.0),<sup>2</sup> some disability-related questions from the U.S. National Health Interview Survey<sup>3</sup> and also inspired by previous studies<sup>4-6</sup>:

- Mobility limitations: level of difficulty (4-point Likert-type scale from *no difficulty* = 1 to *unable to perform* = 4) in performing seven tasks without any aid according to a methodology already published: 1) walking 500 meters on flat ground; 2) walking up and down a flight of stairs; 3) stopping, crouching and/or kneeling; 4) lifting or carrying a bag as heavy as 5 kilograms for a distance of 10 meters; 5) raising the arms, e.g. taking an object from an elevated location; 6) grasping or holding an object in the hands; 7) using the hands and fingers with normal dexterity, e.g. turning on a faucet or using a pencil.
- Sensory limitations: level of difficulty (4-point Likert-type scale from *no difficulty* = 1 to *unable to perform* = 4) in performing three tasks: 1) seeing, even with eyeglasses or contact lenses, the block characters of a newspaper; 2) or somebody's face standing 4 meters away; 3) and hearing a conversation between several persons.
- Cognitive limitations: level of frequency (3-point Likert-type scale *never* = 1, *sometimes* = 2, *often* = 3) of eight challenges: 1) has difficulty in acquiring new knowledge or skills, in school, professional training or leisure activities; 2) has difficulty in analyzing and finding solutions to problems in day-to-day life, e.g., identifying an itinerary or counting money; 3) has difficulty in concentrating or doing something for ten minutes; 4) has difficulty in remembering or has memory

lapses; 5) has difficulty in understanding what people say; 6) has periods of confusion or loses track of time; 7) endangers themselves because of their behavior; 8) is impulsive and/or aggressive.

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[http://www.cdc.gov/nchs/nhis/nhis\\_disability.htm](http://www.cdc.gov/nchs/nhis/nhis_disability.htm)
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**Box S3. Individual socioeconomic score**

The individual socioeconomic (SES) score was calculated from the respondents' educational level, occupation, and equivalized household income (EHI), according to a methodology already published.<sup>1,2</sup> For each SES indicator, respondents were assigned between 0 (did not complete high school, not in the labor force, lowest EHI respectively) and 2 points (educational level higher than high school level, intellectual worker, highest EHI respectively); the SES score was calculated by summing respondents' points; it could range from 0 (lowest SES) to 6 (highest SES). Because only a few respondents had an SES score of 0 or 6, they were grouped with the categories 1 and 5 respectively.

**References**

1. Stamatakis E, Hillsdon M, Mishra G, Hamer M, Marmot M. Television viewing and other screen-based entertainment in relation to multiple socioeconomic status indicators and area deprivation: the Scottish Health Survey 2003. *J Epidemiol Community Health*. 2009;63(9):734-40.
2. Stamatakis E, Wardle J, Cole TJ. Childhood obesity and overweight prevalence trends in England: evidence for growing socioeconomic disparities. *Int J Obes* 2005. 2010;34(1):41-7.

**Table S2.** Characteristics<sup>a</sup> of the study population according to the criteria of the French recommendations for seasonal influenza vaccination for the 2007-2008 season (France, 2008 HSM survey,  $n=12,396$ )

	18-64 years ( $n=5,297$ )		$\geq 65$ years ( $n=7,099$ )	
<b>Criteria</b>	<b><i>n</i></b>	<b>%</b>	<b><i>n</i></b>	<b>%</b>
$\geq 65$ years without any target disease	/	/	3,176	44.7
Works in the health and social field	1,375	25.96	13	0.19
Has at least one target disease				
Target cardiovascular disease	2,149	40.6	3,071	43.3
Target respiratory disease	1,830	34.6	978	13.8
Diabetes	726	13.7	910	12.8
Other diseases	77	1.5	51	0.7

<sup>a</sup> Weighted data. Each individual can meet several inclusion criteria (e.g., have a chronic respiratory disease *and* diabetes).

**Table S3.** Associations between the socioeconomic status (SES) score and the severity of the limitation by age group and type of functional limitation (% line) (France, 2008 HSM survey)

		SES score [0-6]							
	<i>n<sup>a</sup></i>	0-1	2	3	4	5	6	p-value <sup>b</sup>	
<b>18-64 years (n=5,260)</b>									
All 18-64 years	5,260	13.5	24.6	24.8	12.4	9.4	15.4		
Mobility limitations									
No limitation	4,800	11.5	23.8	25.2	13.0	10.0	16.5	<.0001	
Moderate limitations	353	32.9	32.9	22.6	6.6	2.1	3.0		
Major limitations	106	38.7	34.4	17.0	5.2	3.4	1.3		
Sensory limitations									
No limitation	4,843	12.4	24.0	25.2	12.7	9.7	16.2	<.0001	
Moderate limitations	390	25.2	32.2	21.2	10.4	6.1	5.0		
Major limitations	26	40.2	31.9	15.7	3.1	6.4	2.7		
Cognitive limitations									
No limitation	4,867	11.9	23.9	24.9	13.1	9.9	16.2	<.0001	
Moderate/major limitations	393	32.9	32.9	23.9	4.2	2.8	3.4		
<b>≥ 65 years (n=7,063)</b>									
All ≥ 65 years	7,063	29.9	34.2	17.6	8.0	4.8	5.6		
Mobility limitations									
No limitation	4,781	24.6	33.1	19.5	9.7	5.8	7.3	<.0001	
Moderate limitations	1,492	39.4	36.3	14.0	4.9	2.9	2.5		
Major limitations	790	44.22	36.43	13.15	3.22	1.69	1.28		
Sensory limitations									
No limitation	5,586	27.7	33.7	18.5	8.6	5.2	6.4	<.0001	

Moderate limitations	1,236	37.1	36.9	14.2	6.0	3.2	2.7	
Major limitations	240	44.5	32.0	14.5	3.4	3.70	1.95	
Cognitive limitations								
No limitation	6,118	28.3	34.1	17.9	8.4	5.1	6.2	<.0001
Moderate/major limitations	945	40.7	34.6	15.78	5.1	2.2	1.7	

<sup>a</sup> Weighted data.

<sup>b</sup> Chi-square test.

**Table S4.** Associations between seasonal influenza vaccine uptake during the 2007-2008 season and type and severity of disability, and socioeconomic status, among people aged 18-64 years: results from multiple log-binomial regression models (France, 2008 HSM survey<sup>a</sup>)

	Model 1 <i>n</i> =5,239	Model 2 <i>n</i> =5,238
	aRR [95% CI] <sup>b</sup>	aRR [95% CI] <sup>b</sup>
<b>Gender</b>		
Men	1.00 (ref.)	1.00 (ref.)
Women	0.87 [0.81;0.93]	0.87 [0.78;0.96]
<b>Age (years)</b>		
18-45	1.00 (ref.)	1.00 (ref.)
46-64	1.93 [1.77;2.10]	1.83 [1.62;2.07]
<b>Living with a partner</b>		
No	1.00 (ref.)	1.00 (ref.)
Yes	1.03 [0.95;1.12]	1.03 [0.91;1.17]
<b>Type of residence area</b>		
Rural	1.00 (ref.)	1.00 (ref.)
Urban	0.97 [0.90;1.05]	0.97 [0.87;1.08]
<b>Socioeconomic status (SES) score [0-6]</b>		
0-1 (lowest SES)	1.00 (ref.)	1.00 (ref.)
2	0.89 [0.79;1.00]	0.92 [0.77;1.09]
3	0.83 [0.73;0.94]	0.87 [0.72;1.04]
4	0.89 [0.77;1.03]	0.93 [0.76;1.15]
5	1.03 [0.88;1.20]	1.10 [0.88;1.37]
6 (highest SES)	1.39 [1.23;1.58]	1.51 [1.25;1.81]

## Disabilities

### Mobility limitations

No limitation	1.00 (ref.)	1.00 (ref.)
Moderate limitations	1.17 [1.02;1.34]	1.07 [0.88;1.31]
Major limitations	1.48 [1.21;1.82]	1.37 [1.02;1.84]

### Sensory limitations

No limitation	1.00 (ref.)	1.00 (ref.)
Moderate limitations	0.84 [0.73;0.96]	0.82 [0.67;1.00]
Major limitations	0.93 [0.62;1.39]	0.93 [0.51;1.68]

### Cognitive limitations

No limitation	1.00 (ref.)	1.00 (ref.)
Moderate/major limitations	1.17 [1.03;1.33]	1.13 [0.94;1.36]

### Needs family assistance for performing daily living activities

No	1.00 (ref.)	1.00 (ref.)
Yes	1.02 [0.90;1.16]	0.96 [0.80;1.14]

### The respondent answered him/herself

No	1.00 (ref.)	1.00 (ref.)
Yes	1.07 [0.91;1.26]	1.09 [0.86;1.38]

### Number of visits to a general practitioner in the last 12 months

1-4	-	1.00 (ref.)
≥5	-	1.32 [1.18;1.47]
Don't know	-	0.95 [0.77;1.17]

### Chronic disease



No	-	1.00 (ref.)
Yes	-	1.20 [1.06;1.36]

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<sup>a</sup> Weighted data. Missing data were excluded from the analysis.

<sup>b</sup> Adjusted risk ratio (aRR) and 95% confidence intervals (95% CI).

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**Table S5.** Associations between seasonal influenza vaccine uptake during the 2007-2008 season and type and severity of disability, and socioeconomic status, among people  $\geq 65$  years: results from multiple log-binomial regression models (France, 2008 HSM survey<sup>a</sup>)

	Model 1 <i>n</i> =7,051	Model 2 <i>n</i> =7,048
	aRR [95% CI] <sup>b</sup>	aRR [95% CI] <sup>b</sup>
<b>Gender</b>		
Men	1.00 (ref.)	1.00 (ref.)
Women	0.97 [0.94;1.01]	0.96 [0.93;1.00]
<b>Age (years)</b>		
65-74	1.00 (ref.)	1.00 (ref.)
$\geq 75$	1.24 [1.19;1.29]	1.21 [1.17;1.27]
<b>Living with a partner</b>		
No	1.00 (ref.)	1.00 (ref.)
Yes	1.10 [1.06;1.14]	1.08 [1.04;1.13]
<b>Type of residence area</b>		
Rural	1.00 (ref.)	1.00 (ref.)
Urban	0.99 [0.96;1.03]	1.00 [0.96;1.04]
<b>Socioeconomic status (SES) score [0-6]</b>		
0-1 (lowest SES)	1.00 (ref.)	1.00 (ref.)
2	1.01 [0.96;1.06]	1.00 [0.96;1.05]
3	1.05 [1.00;1.11]	1.03 [0.97;1.09]
4	1.08 [1.01;1.15]	1.06 [0.99;1.14]
5	1.05 [0.97;1.14]	1.05 [0.96;1.14]
6 (highest SES)	1.06 [0.97;1.15]	1.11 [1.02;1.21]

**Disabilities****Mobility limitations**

No limitation	1.00 (ref.)	1.00 (ref.)
Moderate limitations	1.06 [1.01;1.11]	0.99 [0.94;1.04]
Major limitations	1.08 [1.01;1.15]	1.01 [0.94;1.08]

**Sensory limitations**

No limitation	1.00 (ref.)	1.00 (ref.)
Moderate limitations	1.01 [0.97;1.05]	1.00 [0.95;1.04]
Major limitations	0.95 [0.87;1.05]	0.95 [0.86;1.05]

**Cognitive limitations**

No limitation	1.00 (ref.)	1.00 (ref.)
Moderate/major limitations	0.98 [0.93;1.04]	0.98 [0.93;1.04]

**Needs family assistance for performing daily living activities**

No	1.00 (ref.)	1.00 (ref.)
Yes	1.04 [1.00;1.09]	1.01 [0.97;1.07]

**The respondent answered him/herself**

No	1.00 (ref.)	1.00 (ref.)
Yes	0.99 [0.94;1.05]	0.99 [0.94;1.05]

**Number of visits to a general practitioner in the last 12 months**

1-4	-	1.00 (ref.)
≥5	-	1.18 [1.13;1.23]
Don't know	-	0.53 [0.44;0.64]

**Chronic disease**

No	-	1.00 (ref.)
Yes	-	1.07 [1.01;1.12]

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<sup>a</sup> Weighted data. Missing data were excluded from the analysis.

<sup>b</sup> Adjusted risk ratio (aRR) and 95% confidence intervals (95% CI).

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