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Supplemental Material for

Social contacts, vaccination decisions and influenza in Japan

By Yoko Ibuka, Yasushi Ohkusa, Tamie Sugawara, Gretchen B. Chapman, Dan Yamin, Katherine E. Atkins, Kiyosu Taniguchi, Nobuhiko Okabe, and Alison P. Galvani

Supplement S1. Previous studies on social contacts

Authors	Year	Country(ies) of analysis	Population studied	Sample size (study participants)	Disease(s) studied	Data collection methods
Edmunds et al. [13]	1997	United Kingdom	Adults, university staff and student and their family and friends	65	None, but potential application with measles and rubella	Interview
Wallinga et al. [3]	2006	The Netherlands	All age, in Utrecht	1,813	Mumps, 1957 influenza pandemic	Interview
Mossong et al. [5]	2008	Belgium, Denmark, Finland, UK, Italy, Luxemburg, The Netherlands, Poland	All age	7,290	A hypothetical disease	Paper diary
Zagheni et al.[6]	2008	United States	All age	No specific number is given in the paper	Chicken pox	Estimates from national representative surveys
Horby et al. [7]	2011	Vietnam	All age, in a rural Vietnam	865	None	Paper diary
Johnstone-Robertson et al. [S1]	2011	South Africa	All age, in a township community	571	Influenza	Paper diary
van Hoek et al. [S2]	2013	United Kingdom	Children aged 12 months or younger	115	Suggest potential application to pertussis	Paper diary
Read et al. [8]	2014	China	All age, in Guangdong China	1821	None	Interview

Supplement S2. Survey Questionnaire on Influenza and Social Contacts

We translated the survey questionnaire from the original Japanese into English and provided it below. When necessary, we added explanations that were not part of the original survey in *italics*.

**Part I: Individual Characteristics and Household Structure**

Q1. What is your gender?

1. Male
2. Female

Q2. What is your age?

(    ) years old

Q3. What is your primary occupation? Choose the most appropriate answer.

1. Work for a private firm
2. Government officer
3. Self-employed
4. Part-time job
5. Housewife
6. Student
7. Unemployed
8. Other (    )

Q4. [For those who responded 1, 2, 3, or 4 to Q3] What industry do you work in? Choose the most appropriate answer.

1. Agriculture and fishery
2. Mining
3. Construction
4. Manufacture
5. Electricity, gas, or water supply
6. Information technology
7. Transportation
8. Sales
9. Finance
10. Real estate
11. Restaurant or hotels
12. Medicine or health care

13. Education
14. Postal services
15. Other services (other than 14 or 16)
16. Public services (other than 14 or 15)
17. Other

Q5. What is your education level attainment? Choose the most appropriate answer.

1. High school graduate
2. Associate degree
3. Bachelor's degree or higher
4. Technical college degree
5. Current student

Q6. What is your current health status compared to someone your own age? Choose the most appropriate answer.

1. Very good
2. Good
3. Fair
4. Bad
5. Vary bad

Q7. Do you visit a medical institute for the treatment of any of the following diseases or conditions? Choose all answers that apply.

1. Respiratory diseases
2. Gastrointestinal system
3. Cardiovascular diseases
4. Mental disorder
5. Urological system
6. Musculoskeletal system
7. Endocrine system
8. Eyes, noses, or ears
9. Other
10. No diseases or conditions

Q8. Do you have a family doctor?

1. Yes

2. No

Q9. What is the level of primary nursing care requirement authorization under your health insurance?

Choose one.

1. Independent
2. Person requiring support
3. Long-term care level 1
4. Long-term care level 2
5. Long-term care level 3
6. Long-term care level 4
7. Long-term care level 5
8. I do not have authorization yet but need care

**Please answer about yourself**

Q10. Did you have any influenza-like symptoms between September 2010 and March 2011?

1. I did have a symptom and visited a clinic/hospital to seek care.
2. I did have a symptom but did not visit a clinic/hospital to seek care.
3. I did not have any symptoms.

(For those who answered 1 or 2)

Q11. When did you have the symptom?

( )

Q12. What was the maximum body temperature?

( ) degrees

Q13. How many days did you have to stay in bed?

( ) days

Q14. How many times did you visit a clinic or hospital for treatment?

( ) times

Q15. Were you diagnosed with influenza?

1. Yes
2. No

Q16. Did you receive anti-influenza virus medication (including oseltamivir)?

1. Yes
2. No

Q17. Were you hospitalized due to influenza infection?

1. Yes
2. No

[For everyone]

Q18. Did you get a flu shot last fall?

1. Yes
2. No

[For those who answered yes to Q18]

Q19. When did you get a shot? If you received two shots, please answer regarding both.

- ( )  
( )

Q20. How much did you pay to get a flu shot? If you received two shots, please provide the average of the two payments.

( ) yen

*Respondents were asked to answer all questions from Q10 to Q20 for each member of their household.*

### **Back to about yourself**

Q21. How many persons in your household had influenza-like symptoms between September 2010 and March 2011?

( ) person(s)

[For those who answered 1 or more to Q21]

Q22. How many days did you have to take off from work to care for family member(s) infected with influenza? If you cared for 2 or more people, please provide the total number of days that you were absent from work.

( ) days

### **Part II: Social Contact Patterns**

*Each respondent was required to answer about himself/herself or a household member based on pre-assignment. Below, “you” is the person who is supposed to answer about him/herself, that is, a survey participant.*

Influenza is transmitted through non-physical contact between humans. Understanding social mixing patterns in Japan is key to making a good prediction of how influenza spreads. However, there are no currently available data regarding social contacts among Japanese, and therefore researchers collect information on social contact. You will be asked about the number of contacts you had conversation(s) with between 12 am and 12 pm yesterday.

Q1. How many people did you have conversations with between 12 am and 12 pm yesterday? Please list the number of contacts by age group below.

Age of contacts	Total number of contacts
0-2	
3-5	
6-11	
12-14	
15-19	
20-29	
30-39	
40-49	
50-59	
60-69	
70-79	
80 or above	

Note:

1. Please count the number of persons you had contact with, not the number of conversations. That is, you count one if you had multiple conversations with a single person.
2. Conversations are defined as face-to-face talking within a 2-m distance. Contacts do not include conversations over the phone. Contacts include not only those who you know personally but also those who you met for the first time (such as sales people or customers) as long as you conversed



with them within the defined distance. For a classroom or meeting room situation, please count the number of persons with whom you had conversations within a 2-meter distance.

3. Please make a best guess if you do not know the exact age of the contacts.

Q1-1. For what date did you provide your answers regarding the number of contacts? Provide month, day, and year.

We would like to obtain further details regarding your contacts. Will you agree to proceed? This will take 10 to 15 additional minutes. We will give you 100 points if you answer the additional questions.

1. Yes (Proceed to Q2)
2. No (Finished)

Q2. For each person you had contact with yesterday, please provide the contact's age, total duration of the contact, and location of the contact by selecting an appropriate answer from the provided multiple choices.

Contact (Number)	Age of the contact	Total duration of contact	Location of contact (multiple answers accepted)

*On the original survey website, the choices were provided as dropdown menus rather than as the tables below, which show the choices for age group, total contact duration, and contact location.*

Age of contact

1	0-2
2	3-5
3	6-11
4	12-14
5	15-19
6	20-29
7	30-39
8	40-49

9	50-59
10	60-69
11	70-79
12	80 or above

Total duration of contact

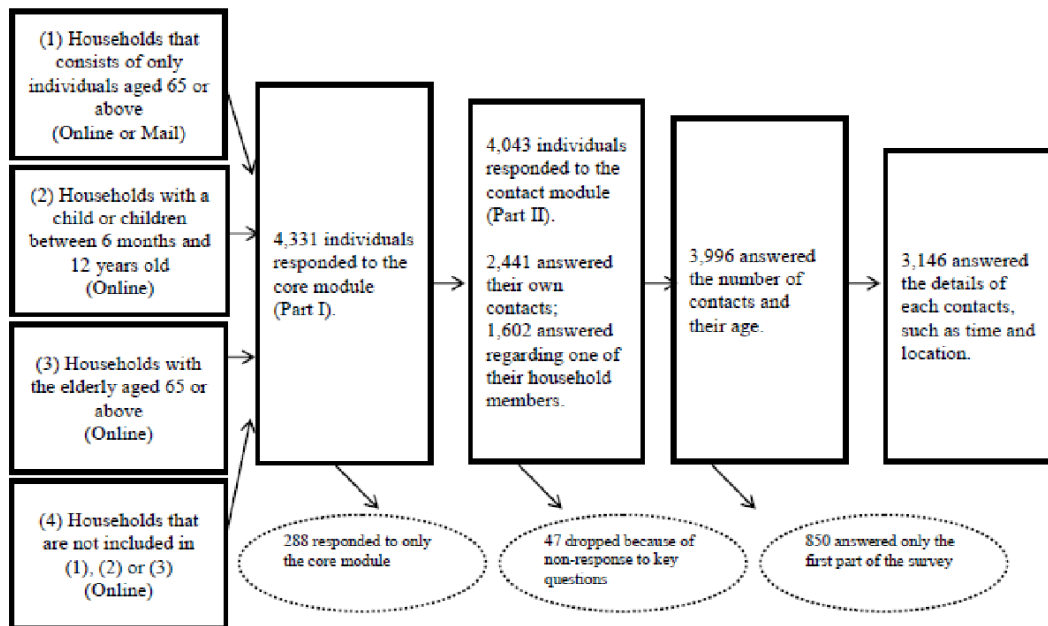
1	Less than 5 minutes
2	5 to 14 minutes
3	15 to 59 minutes
4	1 to 3 hour 59 minutes
5	4 hours or more

Location of contact

1	Home
2	Workplace
3	School
4	Travel
5	Leisure
6	Other

Thank you for participating in the survey.

Supplement S3. Survey design

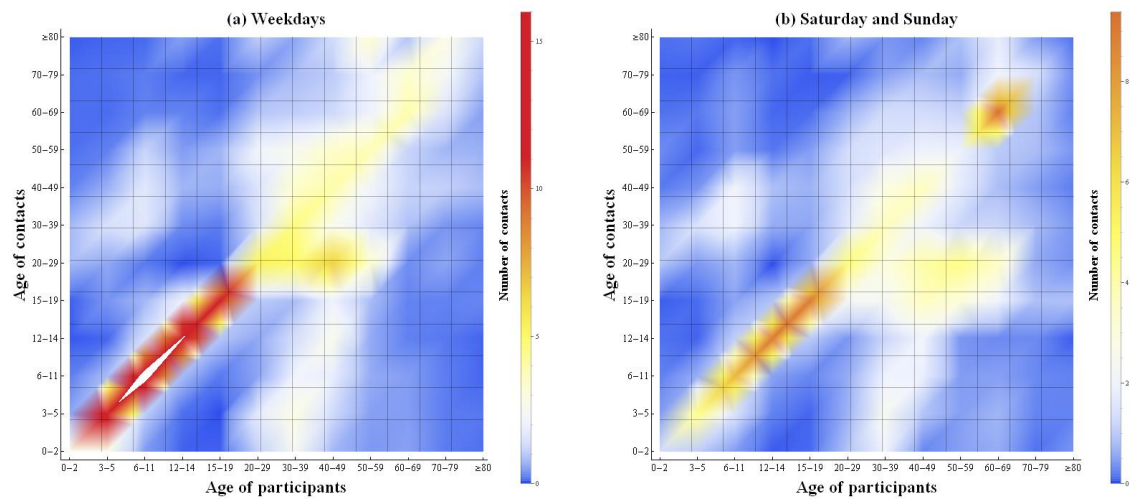


Supplement S4. Ratios of observed mean number of reported contacts to expected number of contacts assuming random-mixing

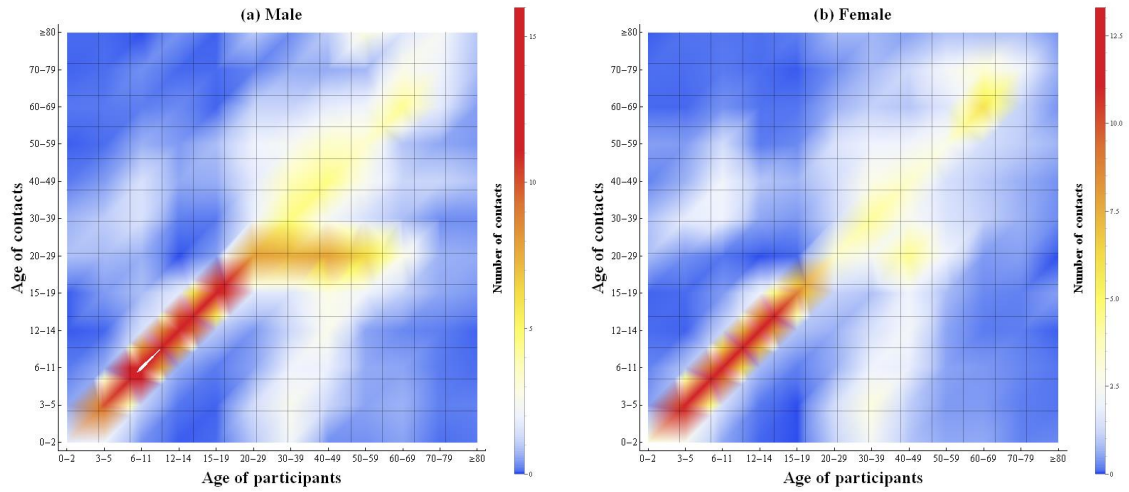
To compare the number of contacts with the expected value, we calculated the ratio of the expected number of contacts to the observed number of contacts under the assumption of random-mixing. Numbers that are greater than one indicate that participants in age group  $j$  had a greater proportion of contacts with those in age group  $i$  than the expected values under the assumption of random-mixing. The numbers that are smaller than one show that participants in age group  $j$  had a smaller proportion of contacts with those in age group  $i$  than the expected values under random-mixing assumptions.

		Age of contacts											
Age of participants		0-2	3-5	6-11	12-14	15-19	20-29	30-39	40-49	50-59	60-69	70-79	80 or older
	0-2	9.32	8.85	0.80	0.08	0.07	0.97	1.65	0.40	0.33	0.35	0.12	0.25
	3-5	0.97	23.09	1.20	0.21	0.02	0.63	1.05	0.41	0.18	0.19	0.08	0.11
	6-11	0.30	1.26	13.02	1.02	0.14	0.23	0.65	0.58	0.19	0.13	0.07	0.06
	12-14	0.06	0.07	1.10	23.86	0.87	0.21	0.44	0.80	0.18	0.06	0.07	0.02
	15-19	0.04	0.45	0.54	2.77	10.97	0.60	0.42	0.79	0.54	0.22	0.16	0.25
	20-29	1.39	0.85	0.26	0.00	0.18	2.14	1.42	1.83	1.32	0.40	0.21	0.13
	30-39	1.88	3.57	2.08	0.85	0.37	0.87	2.05	1.09	0.73	0.41	0.29	0.24
	40-49	0.40	1.26	1.94	1.51	0.78	0.82	1.43	1.70	0.95	0.43	0.48	0.49
	50-59	0.54	0.58	1.16	0.72	0.83	1.17	1.13	1.46	1.76	0.51	0.47	0.49
	60-69	0.24	0.24	0.39	0.44	0.12	0.63	0.64	0.70	1.12	2.95	0.99	0.43
	70-79	0.22	0.28	0.41	0.21	0.07	0.25	0.53	0.70	1.31	2.18	2.00	1.02
	80 or older	0.20	0.33	0.09	1.01	0.18	0.97	0.39	0.67	2.12	1.03	1.94	1.18

Supplement S5. Age-specific mixing patterns between 13 age groups in Japan on weekdays and weekends, based on survey data. The Figure shows the reported number of contacts per day between any two age groups. Age groups (in years) are defined as: 0–2, 3–5, 6–11, 12–14, 15–19, 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and 80 or over.



Supplement S6. Supplement S5. Age-specific mixing patterns between 13 age groups in Japan by gender, based on survey data. The Figure shows the reported number of contacts per day between any two age groups. Age groups (in years) are defined as: 0–2, 3–5, 6–11, 12–14, 15–19, 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and 80 or over.



Supplement S7. Ratios of relative frequency of age-specific contacts to relative frequency reported in a previous study conducted in EU countries[5]

To compare the Japanese contact patterns quantitatively with those observed in the EU studies[5], we compared the relative frequency of conversations with age group  $i$  to the total conversations reported by participants in age group  $j$ , and then calculated the ratio of the frequency in Japan to the EU average. Since the purpose of the analysis was to compare the observed contact pattern attributable to the differences in the population age structure between Japan and the EU, we did not adjust for differences in the age distribution. Ratios were calculated as relative frequencies of those in age group  $i$  reported by participants in age group  $j$  in Japan to the corresponding proportion in the EU countries[5]. The relative frequency is defined as the number of contacts with those in age group  $i$  over the total number of contacts reported by participants in age group  $j$ . For each age group of participant, ratios greater than one indicate that participants in age group  $j$  had a higher proportion of contacts with those in age group  $i$  in Japan than in the EU countries. Ratios smaller than one indicate that participants in age group  $j$  had a smaller proportion of contacts with those in age group  $i$  in Japan than in the EU countries.

		Age of contacts											
		0-2	3-5	6-11	12-14	15-19	20-29	30-39	40-49	50-59	60-69	70-79	80 or older
Age of participants	0-2	2.43	1.90	0.66	0.09	0.09	0.65	0.98	0.53	0.45	0.95	0.47	4.10
	3-5	0.46	2.29	0.48	0.25	0.03	0.73	0.75	0.57	0.34	0.53	0.44	1.37
	6-11	0.65	0.77	1.43	0.39	0.25	0.48	0.73	0.72	0.53	0.70	0.50	1.09
	12-14	0.26	0.18	0.69	1.47	0.33	0.49	0.70	0.97	0.53	0.47	0.53	0.28
	15-19	0.17	1.46	0.98	1.28	1.05	0.51	0.74	0.90	1.28	1.89	1.86	6.87
	20-29	2.20	1.28	0.47	0.00	0.10	0.62	1.10	1.83	1.49	1.68	1.45	1.16
	30-39	1.84	2.41	1.46	1.22	0.48	0.62	1.00	0.79	0.83	1.00	1.55	2.40
	40-49	1.27	1.19	2.24	1.26	0.44	0.63	1.00	0.94	0.90	1.22	1.66	2.49
	50-59	1.39	0.72	1.41	0.88	0.75	0.83	0.92	1.07	1.03	0.90	1.51	1.42

	60-69	0.40	0.33	0.55	0.88	0.22	0.61	0.47	0.60	0.86	2.30	1.59	1.13
	70-79	0.75	0.49	0.77	0.30	0.08	0.37	0.59	0.57	1.30	1.64	1.18	2.33
	80 or older	0.25	0.55	0.10	1.41	0.29	1.56	0.58	0.56	1.53	0.96	1.30	1.37



## References

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