Factors affecting non-household contact rates and indoor crowd exposure prior to the COVID-19 pandemic – an analysis of Flu Watch data 2006/7-2009/10.

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Background

Contact patterns are important to understanding the transmission of COVID-19 and the potential effectiveness of control measures. Although it is well understood how these vary by age and gender there is limited information about how they vary according to levels of social deprivation, area of the country, employment, day of week or season. It is often stated that the number of contacts increases during the winter when people spend more time indoors and that this contributes to increased rates of infection during the winter. However, there is little direct evidence of changes in contact patterns or crowd exposure during the winter. There is considerable debate about intergenerational transmission – data on contact patterns between age groups can help to inform this. There is considerable focus on reducing transmission through minimising social interactions between households and in settings such as hospitality. Information on the relative importance of work based, vs social contact can help to inform this debate.

This is an analysis of over 6000 contact diaries collected by the FluWatch cohort between 2006 and 2010. – Detailed methodology and findings are below.

Key findings

Mixing by age. Although those aged over 65 had the lowest numbers of contacts all age groups had significant levels of contact with those aged over 65yrs illustrating the challenge of preventing spread of disease across generations. (Table 1)

Approximately 2/3 of non-household contacts was in work/education settings, rather than with friends/relatives or strangers. This illustrates the importance of interventions to reduce workplace contact. (Table 2)

Contact rates were lower on Sundays, and higher during the autumn/winter than in spring/early summer (adjusted IRR 1.21 (1.11-1.33) p<0.001). This suggests increased social mixing in colder months which may increase transmission. Those aged over 75 and those aged under 5 had the lowest contact rates with the highest contact rates in older children and young adults. This corresponds with data on population infection rates by age. Females reported higher contact rates than males – (Adjusted IRR 1.14 (1.04-1.25) p=0.005). Those in work or education reported higher contact rates than those not working. (Adjusted IRR 1.56 (1.38-1.77) p<0.001) illustrating the importance of work-based interventions to lower contacts.   Those in the North West had the highest levels of reported contact (this may help explain current high infection rates in the North West). There was no evidence of significant differences in contact rates by index of multiple deprivation. (Table 3)

Methodology. In 2006/7 to 2009/10 Flu Watch collected data on contact patterns from cohort participants. Participants used diaries to collect weekday and weekend day contacts

and activities. There were 2 rounds of data collection – baseline (autumn/early winter) and towards the end of follow up (spring/early summer). Adults were asked to complete diaries for children who were unable to do this.

For the contact diary, participants were asked to identify contacts with whom they had face to face conversational contact or physical contact and to classify these contacts by whether they occurred in the household, with friends or relatives, with work colleagues or with strangers. Within these settings they were asked to assess the number of contacts in each of the following age categories 0-5, 6 to 16, 17 to 24, 25 to 64 and 65 and above. The number of contacts in each category could be selected in the following groups 0, 1, 2-3, 4-5, 6-10, 11-20, 21-49 and 50 or more. These data were used to calculate the number of non-household contacts for each diary. In this analysis the lower range of the categories used but similar findings are found when upper ranges are used.

Analysis

The main analysis sought to identify risk factors for increased numbers of non-household contacts. Minimum estimates of the average number of non-household contacts were calculated for different categories of risk factors including, day of week, month of year, spring (April, May, June) or Autumn/Winter (October, November, December), age group, sex, IMD quintile, Region, and work status.

To identify factors associated with higher levels of transmission negative binomial regression was used with number of contacts as the dependent variable. This allowed comparison of daily non-household contact incidence rate ratios. Independent risk factors were identified by including factors that were significantly associated with non-household contact in a model that mutually adjusted each factor for confounding by other variables. The effect of clustering by individual (each person had more than one diary) was accounted for by using the Stata cluster command. Negative binomial regression analyses were repeated for maximum non-household contact estimates and for minimum and maximum indoor crowd contact measures.

The data were also used to explore mixing by age group, and the relative contribution of work/education, relatives and friends and strangers to non-household contacts.

Tables

Table 1	Average (95% CI) number of daily non-household contacts with people of different ages by age (minimum estimates).				
Age gp.	0-5	6-16	17-24	25-64	65+
0-5	4.50 (3.74-5.25)	1.80 (1.11-2.48)	0.37 (0.17-0.57)	4.04 (3.54-4.55)	0.19 (0.10-0.29)
6-16	0.45 (0.26-.64)	8.36 (7.58-9.15)	2.25 (1.49-3.00)	5.66 (5.02-6.30)	0.22 (0.11-0.33)
17-24	0.44 (0.20-0 .68)	1.84 (1.30-2.38)	5.39 (4.59-6.21)	7.24 (6.09 -8.39)	1.10 (0.70-1.49)
25-44	0.99 (0.84-1.14)	1.96 (1.66-2.27)	1.41 (1.15-1.66)	7.24 (6.83-7.65)	0.83 (0.64-1.02)
45-64	0.39 (0.30-0.47)	1.05 (0.90-1.21)	1.22 (1.10-1.34)	7.02 (6.67-7.36)	1.47 (1.29-1.66)
65-75	0.20 (0.14-0.25)	0.38 (0.25-0.51)	0.35 (0.27-0.44)	3.65 (3.31-3.99)	2.87 (2.46-3.28)
76+	0.15 (0.06-0.36)	0.11 (0.06-0.16)	0.27 (0.16-0.39)	2.19 (1.78- 2.61)	3.03 (2.45-3.61)

Table 2. The relative contribution of contact in work/education setting compared to non-household contact with relatives, friends and strangers.

	Average daily contacts (weekdays – minimum estimates)		
Table 2	Work/education	Relatives/Friends	Strangers
0-5	5.37 (4.38-6.34)	1.98 (1.32-2.64)	0.24 (0.07-0 .40)
6-16	9.49 (8.70-10.29)	2.30 (1.82-2.79)	0.67 (0.44-0 .91)
17-24	9.25 (7.46-11.04)	2.63 (1.83-3.43)	1.60 (0.89-2.31)
25-44	7.31 (6.40-8.23)	2.09 (1.80-2.37)	1.88 (1.58-2.17)
45-65	5.12 (4.61-5.64)	2.24 (1.98-2.50)	2.32 (2.03-2.60)
65-75	1.36 (0.97-1.75)	2.47 (2.16- 2.78)	2.03 (1.70-2.36)
76+	0.47 (0.25-0.69)	2.24 (1.66-2.82)	1.87 (1.15-2.59)

Table 3 Risk factors for non increased numbers of daily contacts

	Observations	Mean Non-Household Contacts	IRR (95% CI) p	Adjusted IRR (95% CI) p
Monday	734	9.98 (8.80-11.15)	1.49 (1.28-1.74) p<0.001	1.31 (1.10-1.57) p=0.003
Tuesday	703	10.26 (9.01-11.51)	1.53 (1.289-1.82) p<0.001	1.58 (1.29-1.94) p<0.001
Wednesday	740	9.63 (8.68-10.58)	1.44 (1.24-1.67) p<0.001	1.36 (1.15-1.62) p<0.001
Thursday	2155	8.13 (7.73- 8.54)	1.21 (1.08-1.37) p<0.001	1.22 (1.05-1.43)p=0.011
Friday	639	9.26 (8.34-10.19)	1.38 (1.20- 1.60) p<0.001	1.28 (1.09-1.51) p=0.003
Saturday	726	9.55 (8.38-10.72)	1.43 (1.21-1.67) p<0.001	1.29 (1.08-1.53) p=0.005
Sunday	1080	6.70 (5.99-7.40)	1	1
April	249	7.62 (6.30- 8.94)	1	
May	2825	7.76 (7.40-8.13)	1.02 (0.84-1.23) p=0.851	
June	587	9.60 (8.38-10.81)	1.26 (1.00-1.59) p=0.051	
October	820	9.40 (8.33-10.46)	1.23 (1.00-1.52) p=0.050	
November	1494	9.23 (8.51-9.96)	1.21 (0.99-1.48) p=0.062	
December	644	10.55 (9.28-11.83)	1.38 (1.11-1.73) p=0.004	
Spring	3661	8.05 (7.69-8.40)	1	1
Autumn/Winter	2958	9.57 (9.02- 10.11)	1.19 (1.11-1.27) p<0.001	1.21 (1.11-1.33) p<0.001
0-5	113	7.65 (6.47- 8.83)	1.66 (1.28-2.15) p<0.001	0.13 (0.10-0.17) p<0.001
6-16	284	13.44 (11.96-14.93)	2.92 (2.30-3.71) p<0.001	1.91 (1.30-2.82) p<0.001
17-24	333	13.48 (11.63-15.33)	2.93 (2.24- 3.84) p<0.001	1.83 (1.38-2.43) p<0.001
25-44	1246	9.81 (9.01- 10.60)	2.13 (1.71- 2.66) p<0.001	1.36 (1.07-1.73) p=0.011
45-64	2439	9.35 (8.79-9.92)	2.03 (1.65- 2.51) p<0.001	1.40 (1.11-1.75) p= 0.004
65-74	1124	6.19 (5.57- 6.80)	1.34 (1.07-1.68) p=0.01	1.31 (1.05-1.64) p=0.016
75+	472	4.60 (3.76-5.44)	1	1
Male	2848	8.47 (7.99- 8.96)	1	1
Female	3168	9.23 (8.75-9.70)	1.09 (0.99-1.20) p= 0.074	1.14 (1.04-1.25) p=0.005
Employ/ student	3151	10.60 (10.07-11.13)	1.80 (1.63- 1.99) p<0.001	1.56 (1.38-1.77) p<0.001
Not working	2120	5.89 (5.47-6.32)	1	1
East Midlands	459	7.67 (6.84-8.50)	0.88 (0.76-1.02) p=0.079	0.92 (0.78-1.09) p=0.351
East of England	1049	7.95 (7.26-8.64)	0.91 (0.81-1.03) p=0.135	0.95 (0.846-1.07) p=0.398
London	411	10.42 (8.73-12.12)	1.19 (0.95-1.50) p=0.131	1.17 (0 93- 1.46)p=0. 178
North East	20	7.1 (4.85-9.35)	0.81 (0.60-1.10) p= 0.178	1.06 (0.78-1.43) p=0.718
North West	381	11.78 (10.05-13.51)	1.35 (1.10-1.65) p= 0.003	1.23 (1.02- 1.49) p=0.031
South East	883	9.25 (8.38- 10.12)	1.06 (0.92- 1.23) p= 0.436	1.09 (0.93-1.27) p=0.270
South West	2080	8.73 (8.15- 9.32)	1	1
West Midlands	507	7.80 (6.88-8.71)	0.89 (0.77-1.04) p= 0.149	0.81 (0.69-0.94) p=0.007
Yorkshire and Humber	230	10.2 (7.78-12.62)	1.17 (0.90-1.52) p = 0.251	1.10 (0.79-1.52) p=0.583
IMD 1 most deprived	264	11.06 (8.77-13.35)	1.22 (0.94-1.60) p= 0.139	
IMD2	631	9.70 (8.38-11.02)	1.07 (0.88-1.31) p=0.477	
IMD3	1796	8.28 (7.69-8.87)	0.92 (0..81-1.03) p=0.152	
IMD4	1803	8.72 (8.15-9.29)	0.96 (0.86-1.) p= 0.534	
IMD5	1526	9.03 (8.39-9.68)	1	