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# Smoking and older age associated with mumps in an outbreak in a group of highly-vaccinated individuals attending a youth club party, the Netherlands, 2012

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We describe a mumps outbreak in a highly-vaccinated population attending a party at a youth club. In a retrospective cohort study with 60 of approximately 100 participants responding, vaccination status was verified for 58/59 respondents, of whom 54 were vaccinated twice and four once. The attack rate was 22% (13 cases, all vaccinated), with smoking at the party (risk ratio (RR) 3.1; 95% confidence interval (CI): 1.6–6.0,  $p=0.001$ ) and age  $\geq 21$  years (RR 4.7; 95% CI: 2.1–10.2,  $p<0.0001$ ) as risk factors for disease in the binomial regression analysis. Mild upper respiratory illness was also highly prevalent in those who did not meet the mumps case definition ( $n=46$ ) after the party, suggesting that mumps virus infection may cause mild disease in vaccinated individuals. Our investigation adds to evidence that crowded social events and smoking may facilitate spread of mumps virus among vaccinated populations, with waning immunity playing a role. The suggestion that mumps virus infection in vaccinated individuals may manifest as mild upper respiratory illness could have implications for transmission and warrants further investigation.

## Introduction

Mumps is caused by a paramyxovirus infection and is characterised by acute swelling of the parotid and other salivary glands. Although usually mild, complications such as orchitis, pancreatitis, meningitis and deafness can occur. Routine mumps vaccination has been implemented in the Netherlands since a measles-mumps-rubella (MMR) vaccine containing the Jeryl Lynn virus strain was introduced into the National Immunisation Programme in 1987. This vaccine is offered as a two-dose schedule at 14 months and nine years of age. Although vaccination coverage with two doses has consistently exceeded 93% [1], several outbreaks in highly vaccinated populations have occurred recently, particularly in students [2–4]. These incidents contribute to growing evidence that high vaccine coverage may not suffice to prevent outbreaks [5,6].

In spring 2012, a mumps outbreak occurred in a Dutch village with 25 cases notified to the municipal health service (MHS). Dates of onset for the notified cases ranged from 17 February to 2 April 2012, and three of these cases were laboratory-confirmed as infected with mumps virus genotype G5. Of 23 cases who could be contacted by the MHS, 22 were confirmed to have been vaccinated twice (the remaining case was born outside the Netherlands and had no accessible vaccination record). Eighteen of the 23 cases reported attending a party with approximately 100 guests at a youth club on 9 March 2012. We conducted a retrospective cohort study to investigate attack rates (AR) and risk factors for mumps disease at the party, and to explore the hypothesis that infection of vaccinated individuals may manifest as mild upper respiratory illness (URI).

## Methods

We used an online questionnaire (Questback), publicised largely through social media, and active from 4 May to 4 June 2012, to collect information from party attendees regarding demographics, vaccination status, party-related activities (see Table 1), mumps history, and symptoms of mild upper respiratory illness/mumps-like illness within 25 days of the party (the maximum incubation period) and also at the time they completed the questionnaire [7]. We defined cases as respondents with self-reported mumps (swelling of one/both cheeks with symptoms lasting  $\geq$  two days) within 12 to 25 days after the party (the minimum and maximum incubation period), i.e. between 21 March and 3 April 2012. Vaccination status was verified using the national register. We explored associations between risk factors and mumps using univariable analysis and then binomial regression, entering all variables with  $p<0.20$  into the model. To investigate the prevalence of mild respiratory illness around the time of the outbreak, we used McNemar's test to compare the prevalence of URI-specific (runny nose, sore throat, cough, and swollen cervical lymph nodes) and other

**TABLE 1**

Questions about party-related activities included in questionnaire sent to people who had attended a youth club party in a village in the Netherlands on 9 March 2012

Activity	Possible response
Time of arrival at party	HH:MM (24h clock)
Time of departure from party	HH:MM (24h clock)
Number of people you spoke for >5 minutes at the party	<10 10-20 21-30 >30
Did you spend time with friends before going to the party?	Y/N
Did you go to another party/bar after leaving the youth club party?	Y/N
During the party, did you do any of the following things:	
Smoke a cigarette	Y/N/Don't know or prefer not to say
Share a cigarette/cannabis joint	Y/N/Don't know or prefer not to say
Share a drink (e.g. drink from a glass or bottle that another person had used)	Y/N/Don't know or prefer not to say
Share food with someone (e.g. use a fork or plate that another person had used)	Y/N/Don't know or prefer not to say
Kiss someone	Y/N/Don't know or prefer not to say

N: no; Y:yes.

symptoms (stomach ache, myalgia, fever and loss of appetite) within 25 days of the party to the point prevalence of these symptoms at time of questionnaire completion, excluding mumps cases from this analysis. We performed analysis using Stata 11. The study adhered to national ethical guidelines for health research [8-10].

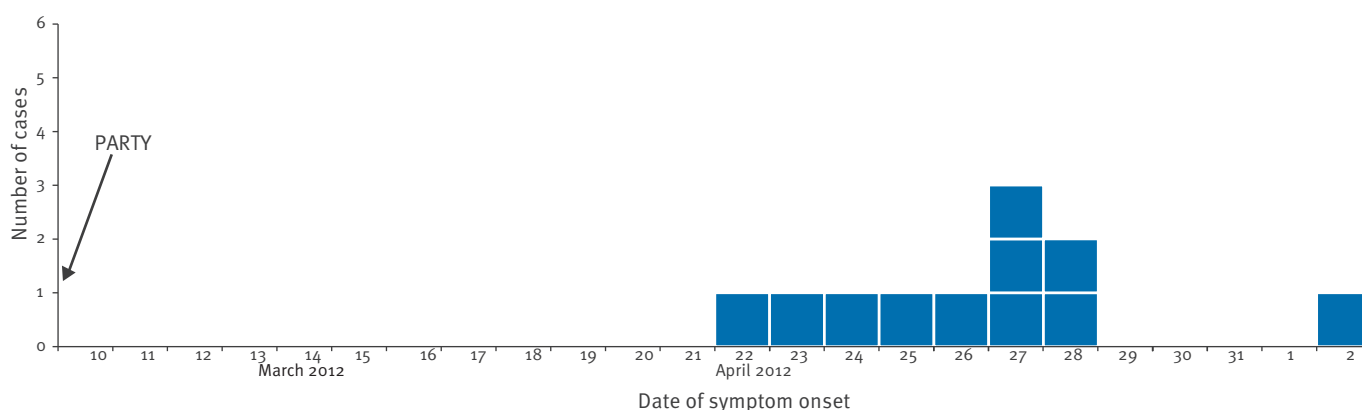
## Results

In total, 60 eligible questionnaires were returned. The exact number of people who attended the party is not known, but was estimated to be about 100. We do not know how many people saw the questionnaire, but the approximated response rate is 60%. One individual with confirmed mumps with date of onset before January 2012 was excluded from analyses. The age

range of the respondents was 15–25 years old (median 18), and 51% were male (n=30). Vaccination status was verified for 58/59 (98%) respondents, of whom 54 were known to have been vaccinated twice and four at least once. The remaining respondent's vaccination status was unknown. Thirteen respondents met our case definition for mumps, equivalent to an AR of 22%. Nine of these cases had been notified to the MHS. One case had been laboratory-confirmed and eight reported confirmation by a physician. Incubation period ranged from 13 to 24 days (i.e. date of onset between 22 March and 2 April 2012), with a median of 18 days and a peak at 17–18 days (27–28 March 2012, see Figure). All 13 cases had been vaccinated twice. None of the

**FIGURE**

Number of cases of mumps associated with attending a village youth club party on 9 March 2012, by date of symptom onset, the Netherlands, March–April 2012 (n=11)



Thirteen cases were reported by questionnaire respondents, but dates of onset were not available for two cases.

**TABLE 2**

Characteristics of and risk factors for mumps disease among questionnaire respondents after a youth club party in a village, the Netherlands, 9 March 2012 (n=59)

Variable		N	Cases (n)	Attack rate (%)	Univariable analysis		Binomial regression	
					Risk ratio (95% CI)	p value	Risk ratio (95% CI)	p value
Sex	Male	30	8	27	1.5 (0.5-4.0)	0.534	NA	NA
	Female	29	5	18	Reference	-	-	-
Age group	<21 years	48	7	15	Reference	0.005	4.7 (2.1-10.2)	<0.0001
	≥21 years	11	6	55	3.7 (1.5-8.7)	-	-	-
Vaccination status against mumps	Two doses	54	13	24	-	-	-	-
	Vaccinated but number of doses unknown	4	0	0	-	-	NA	NA
	Unknown status	1	0	0	-	-	-	-
Education	Full time	45	8	18	0.5 (0.1-2.0)	0.385	-	-
	Part time	8	3	38	1.1 (0.3-4.8)	-	NA	NA
	None	6	2	33	Reference	-	-	-
Smoked cigarette at party	No	44	7	16	Reference	0.050	3.1 (1.6-6.0)	0.001
	Yes	13	5	42	2.6 (1.0-6.8)	-	-	-

CI: confidence interval; NA: not applicable; Reference: reference group; -: denotes a result that cannot be calculated

For one respondent, information on self-reported mumps symptoms was missing, therefore ARs and RRs are calculated with n=58 as denominator

respondents reported complications (meningitis, orchitis, pancreatitis or deafness) or hospitalisation.

Table 2 shows the results of the univariable and multivariable analyses. Respondents aged ≥21 years had a significantly higher AR (54.6%) than those under 21 (14.9%), (risk ratio (RR) 3.7; 95% CI: 1.5–8.7, p=0.005). Respondents who smoked at the party also had a higher AR (41.7%) than non-smokers (15.9%); this result approached significance (RR 2.6, 95% CI 1.0–6.8, p=0.05). No other variables had p < 0.20 in univariable analysis. Both factors remained significant in

binomial regression: RR for age ≥21 years was 4.7 (95% CI: 2.1–10.2, p<0.0001), and for smoking at the party 3.1 (95% CI: 1.6–6.0, p=0.001).

Table 3 shows the results of the symptoms analyses. Symptoms that were significantly more prevalent in the 25 days after the party compared to the time of questionnaire completion were all URI-specific, namely sore throat (p=0.0016), cough (p=0.0082) and swollen cervical lymph nodes (p=0.0455).

**TABLE 3**

Prevalence of mild upper respiratory and non-respiratory symptoms in non-mumps cases after a youth club party in a village on 9 March 2012, and at time of questionnaire completion (May–June 2012), the Netherlands (n=46)

	9 March – 3 April 2012 (up to 25 days after the party)	4 May – 4 June 2012 (at time of questionnaire completion)	McNemar chi-squared
	n (%)	n (%)	p value
<b>Upper respiratory illness symptoms</b>			
Runny nose	8 (17)	4 (9)	0.2059
Sore throat	11 (24)	1 (2)	0.0016
Cough	8 (17)	1 (2)	0.0082
Swollen cervical lymph nodes	4 (9)	0 (0)	0.0455
<b>Other symptoms</b>			
Stomach ache	2 (4)	1 (2)	0.5637
Myalgia	2 (4)	1 (2)	0.5637
Fever	3 (7)	1 (2)	0.3137
Loss of appetite	0 (0)	1 (2)	0.3137

NA: not applicable

## Discussion

We describe a mumps outbreak with a 22% AR following a party at a youth club where over 90% of outbreak investigation participants had received two doses of MMR vaccine. Smoking at the party and age  $\geq 21$  years were independent risk factors for mumps: smokers were three times more likely to become ill than non-smokers, and individuals aged  $\geq 21$  years were almost five times more likely to become ill than individuals under 21. In addition to classic mumps disease, our results suggest that prevalence of mild URI was significantly higher around the time of the outbreak compared to a baseline prevalence at the time of questionnaire completion.

The observation that older age was a risk factor for mumps adds to previous evidence suggesting that waning of vaccine-derived immunity may prompt outbreaks [11–14]. As our investigation was conducted online and several weeks after the outbreak, it was not possible to use serology to explore the role of primary versus secondary vaccine failure in more detail through avidity studies; however, IgG avidity testing following a mumps outbreak in a class of highly vaccinated 17–18 year-olds at a Korean school demonstrated that 73.3% of the cases had secondary vaccine failure [15]. Together with the previous studies that also found older age groups to be at increased risk in mumps outbreaks, we conclude it is likely that waning immunity was the most likely explanation for older individuals being at higher risk of mumps in our study. A possible explanation for smoking being associated with increased risk could be that the practice of sharing cigarettes may transmit mumps virus via saliva; however, this behaviour was not commonly reported by study participants (data not shown). Alternative explanations could be that smoke may act as a vehicle for inhalation of droplets carrying mumps virus, putting anyone who breathed the contaminated air at increased risk, or simply that smokers were in contact with each other more frequently than were non-smokers. As smoking indoors at the party was prohibited, it is likely that smokers congregated together outside the youth club to smoke, which would support the two latter explanations. Nonetheless, smoking was not identified as a risk factor in similar outbreaks investigated previously [3,4].

Our AR of 22% seems high in comparison to other studies that found ARs of 2.2–3.6% in populations vaccinated with the Jeryl Lynn virus strain [5]. It is possible that our study overestimated AR for two reasons: firstly, mumps was self-reported and not confirmed serologically, allowing misclassification. However, in an outbreak context it can be expected that persons experiencing mumps-like symptoms within the incubation period are highly likely to be true cases. Secondly, mumps cases may have been more likely to participate, introducing bias. However, of the 16 cases notified to the MHS who did not respond to the survey and whose date of onset fell within the incubation period,

ten reported attending the party. If these ten cases are included in the numerator and all other non-responders are assumed to be non-mumps cases (i.e. making the denominator all the people at the party, estimated to be 100), the estimated AR remains similar at 23%. Two studies in the Netherlands which investigated mumps outbreaks in highly-vaccinated populations following parties found comparable ARs in attendees of 16% [3] and 23% [4]. It is likely that intense crowding and perhaps environmental factors at parties contribute to high ARs.

The finding of a significantly higher prevalence of mild URI in non-mumps cases after the party may be suggestive that some infected individuals may present with mild disease and perhaps contribute to further transmission. This hypothesis is further supported by no similar apparent pattern for non-respiratory symptoms. However, care must be taken in interpretation, as numbers were small and mild URI can be expected to be more common in early spring than in summer. Indeed, routine surveillance data suggest that in 2012, more upper respiratory pathogens were circulating in the Netherlands in weeks 10–14 than in weeks 18–23 (personal communication, Rianne van Gageldonk, September 2012), and unfortunately it was not possible to confirm or refute mumps virus infection serologically.

In summary, our study suggests that intense social mixing, waning immunity and smoking contributed to an outbreak of mumps in a highly-vaccinated population attending a party. Crowded social events appear to facilitate high attack rates among vaccinated populations, especially among age groups where there is no natural immunity and where several years have passed since vaccination. Our finding that mumps virus infection of vaccinated individuals may manifest as mild URI may have implications for transmission and warrants further investigation in future studies where serological confirmation is a possibility. Ongoing studies in the Netherlands will study the role of asymptomatic or mild mumps infections in onwards transmission.

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## Conflict of interest

None declared.

## Authors' contributions

GL wrote the outbreak investigation study protocol, participated in the outbreak investigation, analysed the data, and wrote the manuscript SO and TW led the outbreak investigation at the local level and contributed to and reviewed the manuscript RB and HB led the laboratory investigations and contributed to and reviewed the manuscript SH supervised the overall project, contributed to the outbreak investigation study protocol, and contributed to and reviewed the manuscript.

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