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## Surveillance summary

# High COVID-19 attack rate among attendees of wedding events in Bali, Indonesia, March 2020

Bhavi Ravindran, Freya Hogarth, Kirsten Williamson, Rose Wright, Martyn Kirk, Craig Dalton

## Abstract

### Background

Large gatherings are associated with the spread of coronavirus 2019 disease (COVID-19); however, transmission dynamics are not well understood. We investigated a cluster of COVID-19 cases in returning Australian residents who attended wedding events in Bali, Indonesia, during 15–21 March 2020. Attendees participated in various social events and were in close proximity, providing multiple opportunities for transmission.

### Methods

We conducted a retrospective cohort study of the 41 attendees, of whom 17 participated in a structured interview that included history of illness, risk exposures and event attendance. We obtained data for the remaining 24 participants through corroborative histories and public health unit case investigations.

### Results

COVID-19 was identified in 56% of attendees (23/41), with illness onset between 21 March and 2 April 2020. One secondary case was identified in a household contact of an attendee. The median age of cases was 31 years (range 3–64). One case was hospitalised and did not require critical care. There were no deaths. No cases occurred among six attendees who left prior to the actual wedding day. Guests attended multiple events and participated in high-risk transmission behaviours such as shaking hands, kissing, dancing, sharing drinks and sharing shisha (water pipes). Attack rates ranged from 64% to 87% for different exposures. We could not identify a single risk exposure that accounted for all cases; it is therefore likely there were multiple episodes of transmission.

### Conclusion

Our investigation identified a high attack rate of COVID-19 among a cohort of wedding event attendees. Attendees engaged in close physical contact, shared drinks and shisha, and were in close proximity during the wedding events, which may have contributed to the high attack rate. This outbreak highlights the significant role social events can play in transmission of COVID-19 and underscores why it is important to limit gatherings and close physical contact to control the spread of the virus.

**Keywords:** Smoking, shisha, SARS virus, risk factors, Indonesia, coronavirus disease 2019 (COVID-19), Australia, public health, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), outbreak

## Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), first identified in Wuhan, China in December 2019, has resulted in a pandemic of the associated disease, coronavirus disease 2019 (COVID-19).<sup>1</sup> Accumulating evidence suggests that large social events such as weddings,<sup>2</sup> church services,<sup>3</sup> and choir practices<sup>4</sup> are implicated in the spread of SARS-CoV-2; however, public health agencies are still learning about transmission dynamics and epidemiological features.

On 24 March 2020, we were notified of a confirmed COVID-19 case in an Australian resident who had recently attended a wedding in Bali, Indonesia. Investigations by health departments in other Australian states and territories identified a cluster of cases amongst attendees of the same wedding. Early case interviews revealed that attendees stayed in close proximity and socialised together before and after the wedding day, thus providing multiple opportunities for SARS-CoV-2 transmission.

We conducted a retrospective cohort study of the 41 attendees of the wedding events. The report examines the risk factors associated with transmission at the wedding events.

## Methods

### Study design

We conducted a retrospective cohort study of attendees who participated in at least one event that was (a) associated with the wedding and (b) took place during 15–21 March in Bali. All attendees were non-residents of Bali, Indonesia, and travelled only to attend the wedding events.

Semi-structured, hypothesis-generating interviews were conducted via telephone with a subset of four attendees. A structured questionnaire was designed using the *OzFoodNet* salmonella and NSW Health COVID-19 case questionnaires,<sup>5,6</sup> informed by the initial public health case investigation and aforementioned hypoth-

esis-generating interviews. Questions encompassed: demographic information; history and duration of illness; event attendance; potential risk activities; and protective behaviours, such as handwashing.

Respondents either were interviewed via telephone or completed an online questionnaire. Study data was collected and managed using REDCap electronic data capture tools hosted at Hunter New England Health.<sup>7</sup> Information on attendees who were unable to be interviewed was obtained from initial case investigations; from contact tracing interviews; and from attendees whom we were able to contact, through corroborative histories. Public health units actively monitored all close contacts for symptoms of COVID-19, and they were tested if they became symptomatic.

### Case definition

We defined a primary case as any person who attended the wedding events in Bali Indonesia during 15–21 March 2020 and who tested positive to a SARS-CoV-2 real-time reverse transcription-polymerase chain reaction (RT-PCR) assay within 14 days of 21 March 2020 (the upper limit of one incubation period for COVID-19).<sup>8</sup> A secondary case was defined as any person who tested positive on SARS-CoV-2 RT PCR assay after the 14 day period and who was a close contact of a COVID-19 case from the wedding events. A close contact was defined as face-to-face contact for greater than 15 minutes cumulative in the period extending from 48 hours before onset of symptoms in a confirmed case; or sharing of a closed space with a confirmed case for a prolonged period of time in the period extending from 48 hours before onset of symptoms in a confirmed case.<sup>9</sup>

### Data analysis

We conducted data analysis using Stata version 13 (Statacorp., USA). We calculated proportions and attack rates (AR). We performed univariate analysis to calculate relative risks (RR), risk difference (RD) and associated 95% confidence

intervals (CI) to examine associations between event attendance or activities and subsequent SARS-CoV-2 infection.

### Ethical considerations

The investigation was undertaken as part of the public health emergency response under the *NSW Public Health Act 2010*;<sup>10</sup> therefore, ethics approval was not required. Informed consent was obtained from all participants prior to interviews. Permission was granted from relevant jurisdictions for use of case data collected by public health units. The Australian National University Human Research Ethics Committee (Protocol 2017/909) has a standing approval for outbreak investigations involving staff and students.

### Results

A total of 41 people attended wedding events from 15 to 21 March 2020, with guest attendance varying for each of the seven events. Among the

attendees, 56% (23/41) met the primary outbreak case definition. There was one secondary case in a household contact of a primary case, after that case had returned to Australia. None of the six guests who left Bali the day prior to the wedding day contracted COVID-19. All attendees who returned to Australia after 15 March 2020 were required to undertake 14 days of quarantine.<sup>11</sup>

The majority of attendees (78%, 32/41) were aged 20–39 years; 75% of cases (18/24) were in this age group. The median age of cases was 31 years (range 3–64 years), which was similar to non-cases at 30 years (range 3–71 years). There was no difference in attack rates between males and females.

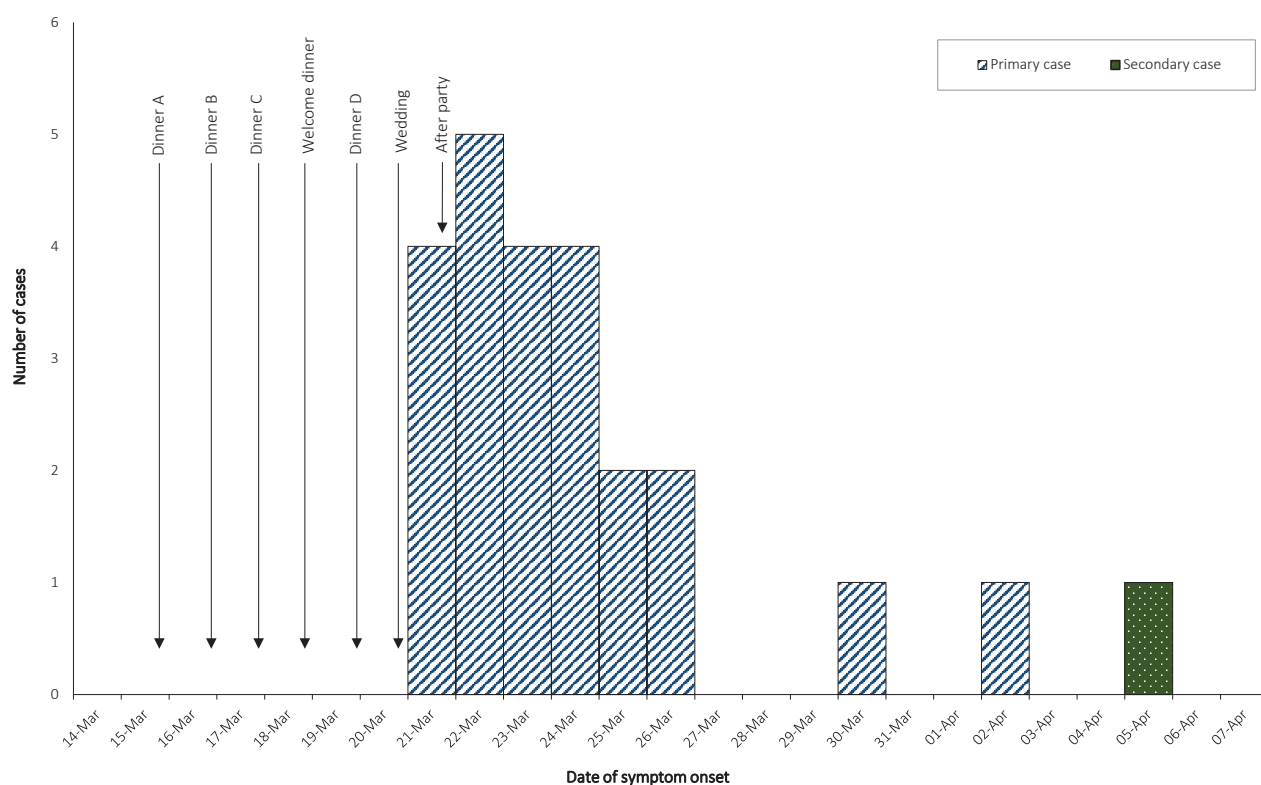
Demographic and limited exposure information was available for 41 attendees. Seventeen attendees (11 cases and 6 non-cases) participated in the study interview (14 attendees) or online questionnaire (3 attendees). Varying symptom data were available for the 12 of the remaining 13 cases, from public health unit case investigation

**Table 1: Symptom profile of 23 confirmed cases<sup>a</sup> of COVID-19 among attendees of the wedding event, Bali, 15–21 March 2020**

Symptom	Frequency	Percent (%)
Cough	19/23	83
Chills/rigors	16/20	80
Loss of taste	10/13	77
Headache	16/23	70
Loss of smell	9/13	70
Fatigue	14/20	70
Fever	12/23	52
Arthralgia or myalgia	10/23	44
Sore throat	9/23	39
Rhinorrhoea	7/23	30
Shortness of breath	6/23	26
Diarrhoea	6/23	26
Chest pain	4/23	17
Vomiting	0/23	0
Diagnosed with pneumonia	0/23	0

a No clinical symptom information was available for one of the 24 cases.

**Figure 1: Epidemic curve of COVID-19 cases by onset date at wedding events in Bali, Indonesia, 15–21 March, 2020**



forms. Of the cases, 83% (19/23) reported cough, 80% (16/20) chills/rigors, 77% (10/13) loss of taste, 70% (10/13) loss of smell, 70% (16/23) headache, and 52% (12/23) fatigue (Table 1).

The median time from onset of any symptom to the onset of loss of taste was 4.5 days (range 1–7), and from any symptom onset to the onset of loss of smell was 4 days (range 1–7). The median duration of illness was 10.5 days (range 3–23 days). One case was hospitalised but did not require critical care, and there were no deaths.

The estimated attack rates at the different wedding events ranged from 61 to 77% (Table 2). The excess risk for COVID-19 among those who attended the wedding day was 66% (95% CI 50–81%). All attendees participated in activities resulting in potential exposure, such as shaking hands, kissing, dancing, sharing drinks and sharing shisha (smoking water pipes), with estimated attack rates ranging from 64 to 87% (Table 2). Attendees sharing shisha at least once over the wedding events were twice as likely to be cases (RR = 2; 95% CI: 0.99–4.75).

During their trip to Bali, approximately 88% (15/17) of attendees reported hand washing always before meals, 24% (4/17) used a facemask at least once, and none (0/17) of the attendees used gloves.

## Discussion and conclusion

We describe transmission of SARS-CoV-2 among a cohort of people attending wedding events involving multiple high-risk activities. Guests attended several social gatherings where they engaged in close physical contact, shared drinks and smoking utensils, and shared indoor and outdoor spaces for prolonged periods during the wedding events. We postulate that these repeated exposures contributed to the high attack rate amongst attendees. Our findings are consistent with other reports suggesting physical contact during social gatherings poses a risk for rapid transmission.<sup>12</sup> Indirect contact (e.g. via fomite and sharing drinks) is thought to facilitate transmission of COVID-19.<sup>13</sup>

**Table 2: Estimated attack rates of COVID-19 among attendees at wedding events, Bali, Indonesia, 15–21 March 2020<sup>a</sup>**

Exposure activity	Exposed			Unexposed			RR	95% CI
	Cases	Total	AR%	Cases	Total	AR%		
Shared shisha	13	15	87	4	10	40	2.2	[0.99–4.75]
Kissed	10	13	77	0	3	0	–	–
Shared drinks	9	13	69	1	4	25	2.8	[0.49–15.71]
Danced	9	14	64	1	3	33	1.9	[0.37–10.01]
Shook hands	8	12	67	2	4	50	1.3	[0.46–3.84]
<i>Event attendance</i>								
Dinner A	7	9	78	7	13	54	1.4	[0.82–2.68]
Dinner B	5	7	71	9	15	60	1.3	[0.70–2.22]
Dinner C	7	9	78	7	13	54	1.4	[0.82–2.68]
Welcome party	23	41	56	0	0	–	–	–
Dinner D	14	22	64	0	6	0	–	–
Wedding day	23	35	66	0	6	0	–	–
After party	11	18	61	5	12	42	1.5	[0.68–3.15]

a Exposure and event attendance information were obtained from questionnaires and corroborative histories.

We hypothesise that smoking shisha, which is considered a possible transmission vehicle of infectious disease<sup>14</sup> such as tuberculosis,<sup>15</sup> may have assisted SARS-CoV-2 transmission and therefore contributed to the high attack rate. To date, there is limited evidence documenting the contribution of shisha use in the spread of COVID-19. Our results represent the poor understanding of risks and preventative measures to minimise the spread of COVID-19 amongst the wedding attendees.

In this cohort, we observed a high attack rate of a relatively low-severity illness. Importantly, 11 cases questioned specifically about loss of taste (77%) and smell (70%) reported these as symptoms. Although these symptoms are known predictors of mild and early SARS-CoV-2 infection,<sup>16,17</sup> our findings support limited evidence that loss of taste and loss of smell develop later in illness.<sup>18</sup>

Based on the shape of the epidemic curve and the known serial interval,<sup>19</sup> it is possible that

multiple points of infection occurred within the cohort in Bali and it remains unlikely there was a single point-source exposure. Australia's mandatory quarantine of returned travellers, and attendees' compliance with these regulations, minimised ongoing transmission from the cases in our cohort to the broader Australian community.

Our investigation findings are subject to some limitations. Firstly, we had only a moderate response rate for follow-up interviews, meaning we had insufficient power to assess the importance of some risk behaviours and subsequent SARS-CoV-2 infection. Secondly, initial case interviews were conducted by multiple public health units that collected differing symptom and exposure information. Thirdly, participant interviews were conducted up to 4 weeks after the wedding; recall bias may have affected the quality of the data collected. Hotel and event staff in Indonesia were not tested or interviewed to identify potential source cases for the wedding cluster. We were also unable to investigate

whether any of the cohort were asymptomatic cases, due to Australia's testing criteria at the time that limited testing to persons with symptomatic illness. Despite these limitations, we still demonstrate that frequent and prolonged interactions can contribute to the high attack rates of COVID-19 in this cohort.

Our study highlights the important role which social gatherings play in transmission of COVID-19 and underscores the importance of physical distancing to control the spread of COVID-19. The findings support Australian public health recommendations at this point in the epidemic to not shake hands or exchange physical greetings, and wherever possible for persons to stay 1.5 metres apart to reduce SARS-CoV-2 transmission.<sup>20</sup> We emphasise the importance of public health messaging to discourage sharing of smoking utensils, drinks, food and other vehicles that may transmit SARS-CoV-2.

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## References

1. World Health Organization (WHO). Timeline of WHO's response to COVID-19. [Internet.] Geneva: WHO; 30 July 2020. [Accessed on 10 August 2020.] Available from: <https://www.who.int/news-room/detail/29-06-2020-covidtimeline>.
2. Yusef D, Hayajneh W, Awad S, Momany S, Khassawneh B, Samrah S et al. Large outbreak of coronavirus disease among wedding attendees, Jordan. *Emerg Infect Dis*. 2020;26(9). doi: <https://doi.org/10.3201/eid2609.201469>.
3. James A, Eagle L, Phillips C, Hedges DS, Bodenhamer C, Brown R et al. High COVID-19 attack rate among attendees at events at a church – Arkansas, March 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(20):632–5.
4. Hamner L, Dubbel P, Capron I, Ross A, Jordan A, Lee J et al. High SARS-CoV-2 attack rate following exposure at a choir practice – Skagit County, Washington, March 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(19):606–10.
5. Kirk MD, McKay I, Hall GV, Dalton CB, Stafford R, Unicomb L et al. Food safety: food-borne disease in Australia: the OzFoodNet experience. *Clin Infect Dis*. 2008;47(3):392–400.
6. New South Wales Government Department of Health (NSW Health). *COVID-19 case questionnaire initial interview*. Sydney: NSW Health; 2020. [Accessed on 10 August 2020.] Available from: <https://www.health.nsw.gov.au/Infectious/Forms/novel-coronavirus-case-questionnaire.pdf>.
7. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap) – a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42(2):377–81.
8. Zhang J, Litvinova M, Wang W, Wang Y, Deng X, Chen X et al. Evolving epidemiology and transmission dynamics of coronavirus disease 2019 outside Hubei province, China: a descriptive and modelling study. *Lancet Infect Dis*. 2020;20(7):793–802.
9. Australian Government Department of Health. Coronavirus Disease 2019 (COVID-19) CDNA National Guidelines for Public Health Units. [Internet.] Canberra: Australian Government Department of Health; 2020. [Accessed on 10 August 2020.] Available from: <https://www1.health.gov.au/internet/main/publishing.nsf/Content/cdna-song-novel-coronavirus.htm>.
10. New South Wales Government. *Public Health Act 2010 No 127*. Sydney: New South Wales Government; 22 June 2020. [Accessed on 10 August 2020.] Available from: <https://www.legislation.nsw.gov.au/view/html/in-force/current/act-2010-127>.
11. Prime Minister of Australia. Transcript–Press Conference. [Internet.] Canberra: Prime Minister of Australia; 15 March 2020. Available from: <https://www.pm.gov.au/media/transcript-press-conference>.
12. Pung R, Chiew CJ, Young BE, Chin S, Chen MI, Clapham HE et al. Investigation of three clusters of COVID-19 in Singapore: implications for surveillance and response measures. *Lancet*. 2020;395(10229):1039–46.
13. Bi Q, Wu Y, Mei S, Ye C, Zou X, Zhang Z et al. Epidemiology and transmission of COVID-19 in 391 cases and 1286 of their close contacts in Shenzhen, China: a retrospective cohort study. *Lancet Infect Dis*. 2020. doi: [https://doi.org/10.1016/S1473-3099\(20\)30287-5](https://doi.org/10.1016/S1473-3099(20)30287-5).
14. Knishkowsky B, Amitai Y. Water-pipe (narghile) smoking: an emerging health risk behavior. *Pediatrics*. 2005;116(1):e113–9.
15. Munckhof WJ, Konstantinos A, Wamsley M,

- Mortlock M, Gilpin C. A cluster of tuberculosis associated with use of a marijuana water pipe. *Int J Tuberc Lung Dis*. 2003;7(9):860–5.
16. Menni C, Valdes AM, Freidin MB, Sudre CH, Nguyen LH, Drew DA et al. Real-time tracking of self-reported symptoms to predict potential COVID-19. *Nat Med*. 2020;26(7):1037–40.
17. Boscolo-Rizzo P, Borsetto D, Spinato G, Fabbris C, Menegaldo A, Gaudio P et al. New onset of loss of smell or taste in household contacts of home-isolated SARS-CoV-2-positive subjects. *Eur Arch Otorhinolaryngol*. 2020. doi: <https://doi.org/10.1007/s00405-020-06066-9>.
18. Spinato G, Fabbris C, Polesel J, Cazzador D, Borsetto D, Hopkins C et al. Alterations in smell or taste in mildly symptomatic outpatients with SARS-CoV-2 infection. *JAMA*. 2020;323(20):2089–90.
19. Lauer SA, Grantz KH, Bi Q, Jones FK, Zheng Q, Meredith HR et al. The incubation period of coronavirus disease 2019 (COVID-19) from publicly reported confirmed cases: estimation and application. *Ann Intern Med*. 2020;172(9):577–82.
20. Australian Government Department of Health. Coronavirus (COVID-19) – Keeping your distance. [Internet.] Canberra: Australian Government Department of Health; 20 March 2020. Available from: <https://www.health.gov.au/resources/publications/coronavirus-covid-19-keeping-your-distance>.