COVID-19 in non-healthcare workplace settings in NSW, Australia

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on behalf of the NSW Public Health Network

Abstract

Objectives: To describe patterns of SARS-CoV-2 transmission in non-healthcare workplace settings during the first six months of COVID-19 spread, in New South Wales (NSW), Australia.

Methods: Locally acquired COVID-19 cases between February 2020 and August 2020 were reviewed to determine the: total number of workplace-associated cases and clusters; workplace type; and modes of transmission.

Results: There were 72 COVID-19 workplace clusters with 231 cases and an additional 11 workplace-acquired cases who were not part of a cluster. Workplaces most associated with clusters included construction, manufacture and trade (31%, 22 clusters), office and clerical (25%, 18 clusters) and retail (14%, 10 clusters). Most transmission events were best explained by direct transmission, with two workplace clusters demonstrating evidence of partial indirect spread.

Conclusions: Findings demonstrate workplace settings, particularly construction, office and retail settings have heightened risk of transmission.

Implications for public health: The risk of infectious disease transmission is well understood for healthcare workers, despite other workplace types representing higher volumes of workers with less risk controls. This study should assist policy makers and the public to understand COVID-19 transmission in workplaces and the heightened risks associated with certain workplace settings.

Key words: COVID-19, workplaces, public health, outbreak

The policy response to preventing and controlling COVID-19 transmission in most countries moved rapidly from targeted to broad travel restrictions and included limits to physical movement and working from home orders. Globally, restrictions related to workplace settings have varied. As restrictions eased, the risk of COVID-19 transmission in workplace settings remained present, with limited reports to guide policy directions. Lan and colleagues[1] investigated public COVID-19 records for six Asian countries to determine workplace settings associated with COVID-19 transmission. The study identified 103 individuals experiencing workplace transmission. Healthcare workers were most affected with 15% of cases arising from contact with COVID-19 positive patients.[1] Other occupations also signalled heightened risk in this cohort, including drivers and transport workers, sales workers and cleaning or domestic workers.[1]

While healthcare workers (HCWs) are known to be at high risk for contracting COVID-19,[2,3] appropriate use of personal protective equipment (PPE) and other infection prevention and control practices confer a decreased risk of transmission.[4] In NSW between 1 January and 28 July 2020, 86 HCWs were determined to have health facility acquisition which was heavily clustered in March 2020. Most cases were in public hospitals, with nurses and doctors making up two-thirds of cases.[5]

COVID-19 transmission risks in non-healthcare workplace settings have been rarely quantified in comparison to healthcare workers. In Singapore, among the first 25 cases of local COVID-19 transmission, close to 70% were associated with workplace exposure, particularly in retail and hospitality, construction and transportation workplaces.[6] In the United States, an estimated 10% of all workers were exposed to any infectious disease at least weekly. The majority of exposures occurred in healthcare settings, but other sectors most associated with exposure were emergency services, office workers, education and construction workers.[7]

We describe the patterns of local COVID-19 transmission in non-healthcare workplace settings in New South Wales, (NSW), Australia; to investigate the risks associated with various workplace settings; and in relation to changes in public health policies for workplace settings. The findings may guide the policy

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response for easing restrictions according to workplace setting.

Methods

Study design, study population and data source

This retrospective cohort study includes all locally acquired COVID-19 cases notified to NSW Health with an onset date between 1 February 2020 and 7 August 2020. Cases were identified and data extracted from the NSW Notifiable Conditions Information Management System (NCIMS). NCIMS is a statutory register for the collection of notifiable diseases data notified to the NSW Ministry of Health by laboratories, hospitals, medical practitioners, schools, and childcare centres. It includes information on socio-demographic characteristics, testing, exposure setting, source and transmission, symptoms and outcomes of COVID-19 cases. SARS-CoV-2 detection was made a laboratory notifiable condition under the *Public Health Act 2010* (NSW) in January 2020. In Australia, a confirmed COVID-19 case is a person who has tested positive on a validated SARS-CoV-2 nucleic acid test, or has a demonstrated seroconversion in the absence of vaccination.[8] As all public and private laboratories notify, reporting rates are expected to be 100%.

Study context

New South Wales is the most populous state in Australia with over 8 million residents.[9] In late January, the first four cases of COVID-19 were simultaneously detected in Australia, three of whom returned from China to Sydney. This led to travel restrictions from selected high-risk countries from 30 January, and subsequent border closures and mandatory 14-day hotel quarantine by 28 March 2020. In mid-March, a broad range of government orders were introduced restricting: the size of indoor and outdoor gatherings (including sport); visits to aged care facilities and hospitals; elective surgeries; travel to remote Aboriginal communities; restaurant dine-in, beauty and personal care services; and some public spaces (e.g. libraries).[10] Those who could work from home were required to do so and schools were closed. Many of these restrictions were then relaxed in May 2020 except for those related to domestic and international travel.

In NSW after the first peak of COVID-19 cases, planning for easing restrictions commenced. Health authorities consulted with industry and government to create a series of legislated mandatory and non-mandatory plans, or checklists, to guide the safe re-opening of businesses. These plans focused on broad principles of outbreak prevention and management, targeted mostly at patrons, including physical distancing, hygiene, wellbeing measures and procedures to support rapid and comprehensive contact tracing. When these plans were introduced, mask use was not widespread practice for customers, or a requirement for staff. There appeared to be high uptake of COVID-19 safety plans implemented by businesses across the range of sectors, but evaluation measures for the impact on COVID-19 transmission were not incorporated in the roll-out. In some sectors, workers were relatively more likely to be furloughed, underpaid or to become unemployed as a result of the identification of a COVID-19 case in their workplace.

Occupational case definition and data ascertainment

Data were ascertained and based on a snapshot taken from the NCIMS database on 3 September 2020 and then enhanced with a later data snapshot taken on 25 October 2020.

Case records were screened for inclusion as workplace associated and then individually reviewed to gather variables of interest. The screening procedure involved three authors reviewing each cluster independently. Where there was unanimous agreement, the cluster record was progressed for further review. Where there was initial disagreement, further record review was undertaken with notes from case interviews and using narrative sources (both in NCIMS) to make a final determination to include for a detailed review.

Detailed review involved gathering variables from a range of sources including: the standardised NSW COVID-19 case questionnaire;[11] the NCIMS free text notes; the NSW Public Health Response Branch operations team cluster management notes; and whole genome sequencing reports produced by the Centre for Infectious Disease Microbiology – Public Health.[12]

A workplace-acquired case was defined as a case who had an epidemiological link with another confirmed case in their workplace or in their line of work (for example, contact with a customer). Workplace clusters were defined in control guidelines as two or more cases linked to each other in a workplace setting within two incubation periods (28 days). Cases sharing a common workplace source but with greater than 28 days between exposures were assessed by public health staff to determine if they were a continuation of a previous outbreak or new outbreak event. Single cases whose exposure was workplace related were also included in the analysis. A case could be employed in a voluntary or paid capacity. Healthcare and aged-care workers were excluded. Non-workers who acquired their infection in a workplace (e.g. hospitality patron in a restaurant) were excluded. Where cases interacted both within a workplace but also socially (for example, after work drinks) the type and duration of the interaction was assessed to determine the more likely setting of transmission.

Workplace exposure categories

Workplace categories were based on the International Labour Office's International Standard Classification of Occupations (ISCO),[13] but expanded by authors due to limited workplace types identified at the higher-level classification. Where a workplace location or type (e.g. construction site) poorly captured the work being performed (e.g. administrative work in an office on a construction site), the type of work being performed was coded preferentially at the cluster level. Workplace coding occurred by analysis of individual case interview notes, cluster descriptions and other available narrative sources. Where there was uncertainty, a second review was conducted by another author. Adapted workplace categories and their descriptions are shown in Table 1. Workplaces were also coded by an industry classification system, the Australian and New Zealand Standard Industrial Classification (ANZSIC) 2006,[14] to allow for comparison of classifications systems. Primary analyses were completed using the ISCO adapted classification, however analyses are also presented by ANZSIC are available in Supplementary Table 1.

Data analysis

Descriptive statistics and narrative descriptions summarising the characteristics of cases were conducted, including total number of cases associated with a cluster; the index and primary cases for the cluster (if available); and the type of workplace and

work being carried out. Socio-demographics including median age, sex and severity of illness, captured by hospitalisation and intensive care unit (ICU) or high-dependency unit (HDU) admission were also determined. For larger clusters of three or more cases, a cluster description was provided by considering: predominant transmission pathways between cases (for instance, in the workplace or during transport activities associated with work); risk activities in the workplace (including confined spaces, indoor vs. outdoor work, high-volume customer interaction and shared equipment use) and most plausible mode of transmission based on interview notes (direct: close range, face-to-face contact from large, medium or small (aerosol) droplet route; and indirect: fomite or longer-range aerosol transmission).[15] Mode of transmission assessments were conducted by noting the level and type of contact between individuals, for example face-to-face conversations, eating together at shared tables during lunch breaks or sharing enclosed spaces for prolonged periods where contact within 1.5 metres was likely, was assumed to be direct transmission. In cases where longer-range aerosol or fomite spread was suspected, this was based on comments by cases or their interviewers regarding extremely limited contact, shared equipment only, or no contact being established.

An epidemiological curve depicting the number of workplace-associated cases and all other locally acquired cases in NSW was generated. COVID-19 restrictions, public health orders and lockdown measures, including the Oxford Stringency Index (OSI)[16] were overlaid onto the epidemiological curve to highlight the relationship between cases and public health policies. The OSI measures nine indicators of pandemic response policies, including work and school closures, travel bans and other national markers and assigns a value of 0 to 100, with 100=the strictest position. All analyses and figures were conducted using R version 3.6.3.[17-20] No statistical tests were performed, as estimates of risk were not possible in the context of a lack of denominator data and small case numbers.

Role of the funding source

No specific funding was provided for this research including awards or grants. The collection of data occurred in the course of routine public health follow-up. All authors had access to the raw data. The corresponding author had full access to all the data and the final responsibility to submit for publication.

Results

After exclusion of non-workplace-related cases and duplicates, 242 non-healthcare, workplace-associated COVID-19 cases were identified, and there were 72 clusters (Figure 1).

Of the 242 workplace-associated cases, 179 contracted COVID-19 directly at work or in their line of work and 63 cases had a source outside the workplace but introduced the virus into the workplace. The most affected workplace category was construction, manufacture and trades with a total of 72 associated cases (Table 2), followed by clerical and office (46 associated cases). Defence and agriculture workplace categories had the highest median number of cases (12 and 8 respectively), however this only represented three clusters. The median age of cases was

Table 1: Workplace categories and descriptions. Adapted from the International Standard Classification of Occupation.(13) Industry type mapping according to the Australia New Zealand Standard of Industrial Classification, 2006.(14) See supplementary Table 1 for full industry classification and sub-classification.

Workplace category	Industry classification (ANZSIC)	Description
Agriculture	A1	People who perform operations to grow and harvest crops, fruit, plants, or who breed, tend or hunt animals for sale or delivery. Labourers perform simple and routine farming tasks requiring the use of simple hand-held tools and very often, considerable physical effort.
Clerical and office	E30, G42, I52, J59, K62, K63, K64, M69, N72, N73, P82, Q87	People who record, organise, store and retrieve information related to the work in question. Tasks include computer use, record keeping, wide ranging general clerical duties. There is often use of shared office spaces.
Construction, manufacture and trades	C20, C22, C24, E30, E32, F34, F37, I46, I51, I52, I53, N72, N73	Trades and construction: people who apply their specific knowledge and skills in the fields of construction and building, metal, machinery and related trades and precision, handicraft, printing and related trades. Their work is carried out by hand or hand-powered and other tools. Manufacture: people who operate and monitor industrial and agricultural machinery and equipment or assemble products from component parts.
Defence	O76	People currently serving in the armed forces, including auxiliary services, whether on a voluntary or compulsory basis. They can carry out a range of specific occupations within this context.
Education, childcare and religious professionals	P80, Q87, S95	Education and teaching professionals design and prepare curricula and give lessons to their students. Childcare workers may furthermore be required to assist children to bath, dress and feed themselves and play games or entertain children. Religious professionals conduct religious services and ceremonies, undertake administrative and social duties and prepare religious sermons and preaching.
Gyms and recreation	R91	Gyms: professionals in these roles perform retail functions such as speaking with customers and may also be involved in training and demonstration to gym patrons. Recreation: people who are responsible for functions associated with recreational facilities such as sports grounds and halls. Work may include training, general administrative duties and cleaning.
Hospitality	H45, N73, R90	This includes housekeeping and restaurant services workers who carry out cleaning, preparing and cooking meals and serving food and beverages. This may be in a private households or commercial establishment such as a restaurant or café. This includes waiters, waitresses and bartenders.
Retail	G42, G42, I49, I52, K62, N72, N73, Q86, S95	Shop salesperson and demonstrators sell goods to customers in retail establishments. This may include handling cash, assisting customers, packing and arranging goods or supervision of other workers. In this categorisation, retail also include personal services, such as hairdressers, beauticians and those providing personal caring services.
Transport	I46, I49	Motor vehicle drivers that may include private vehicle drivers (car, taxi, ride-share and van) or bus drivers. The tasks performed include driving and tending to a car, bus or van in order to transport goods or passengers.

38 years. The lowest median age was 31 years among those from defence clusters and the highest median age was for those working in agriculture at 56 years. The highest number of hospitalisations was among cases in construction, manufacture and trade, with intensive care or high dependency unit admissions rare across all workplace settings.

There were 11 single cases that were not part of a cluster who contracted their infection in their line of work. This was most associated with transport (5/11 cases) and retail (3/11 cases). Workplaces where most cases were female included agriculture (100% female), education, childcare and religious professionals (85% female). A higher proportion of males were represented in defence (96% male) and construction, manufacture and trade (69% male) workplace categories.

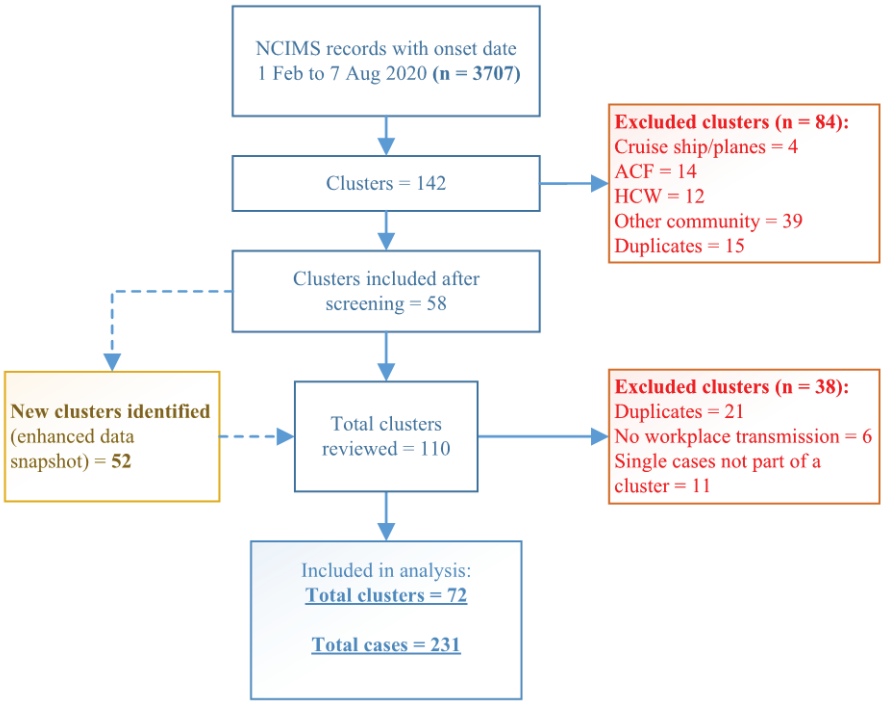
Workplace associated cases and clusters were also analysed by industry type using the ANZSIC and presented in Supplementary Table 2. Similar to the adapted ISCO, when categorised by industry type, people employed in construction related occupations (including manufacturing, warehousing, and wholesale trades) made up most outbreaks (17%). This was followed by transport, postal and warehousing (subclassifications of road and air transport) (11%). Of single cases, transport dominated single cases not associated with clusters (9 of 11 cases).

Most clusters (n=44) comprised two cases only, and 26 of the 44 were related to construction, manufacture and trades, and office and clerical workplaces. There was an outlier cluster related to a Defence workplace.

The trend in workplace cases matched trends in locally acquired cases in NSW (Figure 2). Cases peaked in March and to a smaller degree, in July. Of all locally acquired cases in the review period, 11% were due to non-healthcare workplace acquisition, and 8% were due to potential healthcare workplace acquisition (19% combined workplace acquisition). Case numbers were inversely related to increasing stringency.

Patterns of spread are described in Supplementary Figure 1, where there were three or more cases associated with a cluster. Most ongoing transmission appeared to be associated with direct face to face contact, consistent with droplet or short-range aerosol spread. There were two workplaces where there was inadequate evidence to suggest direct contact or where there was limited contact. In both clusters there was evidence of shared equipment that may have contributed to fomite spread for a proportion of cases. Some clusters were important sentinel events for rapid secondary and tertiary transmission outside the workplace setting. Cluster 9 and cluster 20 (Supplementary Figure 1) resulted in 18 and 57 additional linked cases, respectively, with multiple generations of spread.

Figure 1: Flow chart of cluster and case review process. Clusters are defined as 2 or more workplace associated cases, where the primary case's source may be non-workplace related. ACF: aged-care facility; HCW: healthcare worker.



Discussion

This review has confirmed the importance of workplaces as a source for COVID-19 transmission and provides a comprehensive account of risk categorisation of workplace types. During the review period, 11% of all locally acquired cases reported in NSW were non-healthcare workplace acquired, in contrast with 8% of cases likely acquired in health or aged care workplaces. Males comprised 60% of non-healthcare workplace-related cases, and the highest risk of COVID-19 clusters was in construction, manufacture and trade (31% of total non-healthcare workplace clusters), office and clerical (25%) and retail (14%). Most clusters occurred in indoor workplaces and most were associated with close range contact and direct spread. Seven percent (7%) of all workplace acquired cases were hospitalised, with three per cent requiring ICU or HDU care.

Strengths and limitations

This review employed a mixed methods approach to identify and classify workplace transmission events. Routine surveillance data in NSW and many other jurisdictions focus on setting of transmission only. The integration of clinical, epidemiological and laboratory data adds a dimension that allowed conclusions to be drawn regarding the most probable transmission event where there may have been multiple exposures, commonly seen during the first wave of COVID-19 infections in NSW. Comparatively low rates of community transmission in Australia combined with high case ascertainment allowed the source of each case to be ascribed with greater confidence than would have been possible in the setting of multiple epidemiologically unlinked cases. Detailed examination of the type of work being performed, which was in some circumstances incongruent with the workplace setting was also possible with this dataset and review method. A further strength of this work is the comprehensiveness of data capture and use of multiple levels of surveillance output, including cluster designations, workplace settings and workplace acquisition fields. Lastly, this review was able to integrate operational intelligence gathered at the time

of responding to each cluster as all authors were involved in the investigation and coordination of the clusters described. We believe this method will have captured the majority of laboratory detected cases where workplace acquisition was likely.

Limitations of this review include the potential for missed workplace transmission events, particularly during the first wave of COVID-19 transmission in NSW. Whilst the authors attempted to make the search strategy as sensitive as possible, the volume of case interviews being conducted at this time is likely to have attributed links rapidly and may have missed exploring multiple levels of exposure. The combined impact of both these factors could result in an under or overestimation of workplace transmission. Misclassification bias may have also occurred due to underreporting of workplace exposures due to not being tested (and therefore not confirmed or interviewed as a case). We were not able to definitively calculate risk or attack rates for

Table 2: Workplace associated clusters of 2 or more cases and single workplace acquired cases. ICU: intensive care unit; HDU: high-dependency unit.

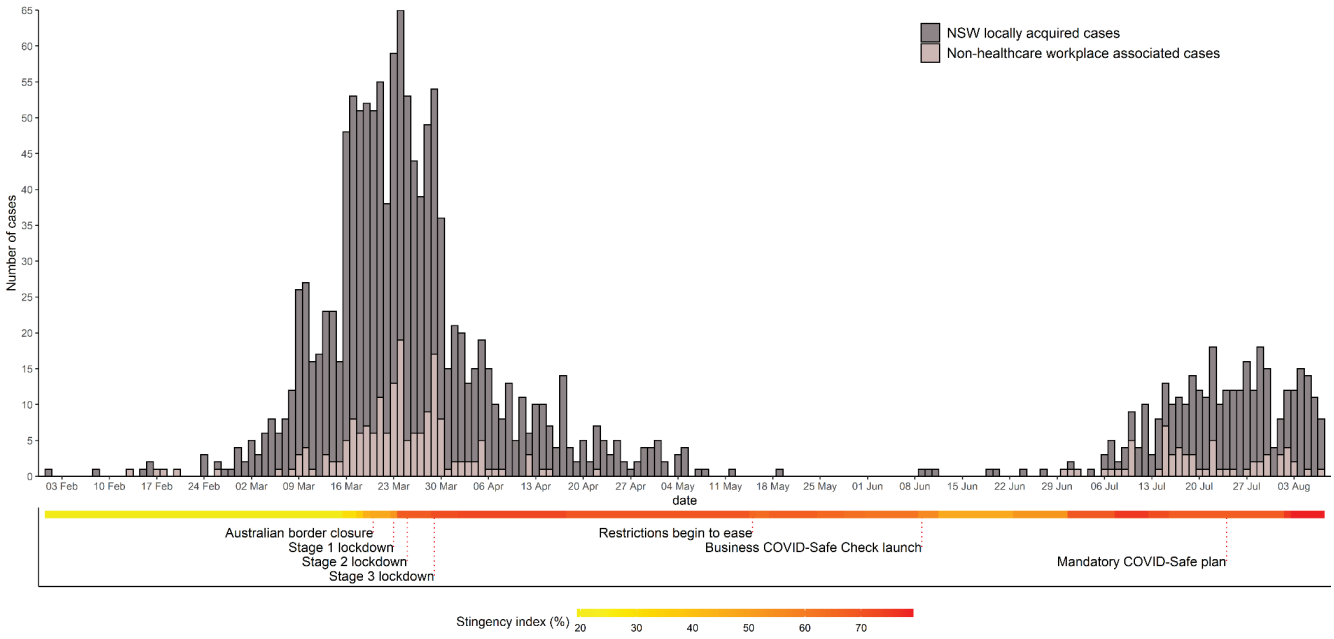
	Clusters (%)[a]	Cases	Median number of cases	Range	Median age	Female (%)[b]	Male (%)[b]	Hospitalised	ICU/HDU
Cluster cases (workplace associated)									
Agriculture	1 (1%)	8	8	8	56	8 (100%)	0 (0%)	1	0
Clerical and office	18 (25%)	45	2	2-7	38	22 (49%)	23 (51%)	4	2
Construction, manufacture and trades	22 (31%)	71	2	2-10	38	22 (31%)	49 (69%)	5	2
Defence	2 (3%)	24	12	3-21	31	1 (4%)	23 (96%)	0	0
Education, childcare and religious professionals	4 (6%)	13	2	2-7	38	11 (85%)	2 (15%)	3	2
Gyms and recreation	2 (3%)	5	3	2-3	40	1 (20%)	4 (80%)	0	0
Hospitality	9 (13%)	28	3	2-7	46	12 (43%)	16 (57%)	1	1
Retail	10 (14%)	29	2	2-5	34	12 (41%)	17 (59%)	1	0
Transport	4 (6%)	8	2	2	49	2 (25%)	6 (75%)	1	0
Total (row %)	72 (100%)	231	2		38	91 (39%)	140 (61%)	16	7
Non-cluster cases (workplace acquired)									
Clerical and office	..	1	1	1	55	0 (0%)	1 (100%)	0	0
Construction, manufacture and trades	..	1	1	1	44	0 (0%)	1 (100%)	0	0
Hospitality	..	1	1	1	39	0 (0%)	1 (100%)	0	0
Retail	..	3	1	1	28	2 (67%)	1 (33%)	0	0
Transport	..	5	1	1	53	3 (60%)	2 (40%)	2	1
Total (row %)	..	11	1		52	5 (45%)	6 (55%)	2	1
GRAND TOTAL (row %)	**72**	**242**	**2**		**38**	**96 (40%)**	**146 (60%)**	**18**	**8**

Notes:

a: Proportion of clusters with two or more cases per workplace type from all workplace clusters.

b: Proportion of cases per workplace type out of all workplace-related cases.

Figure 2: Epidemic curve of locally acquired COVID-19 cases in NSW by onset date (1 February 2020 to 7 August 2020). OSI: Oxford Stringency Index, representing national policy stringency.



each cluster because many of the earlier clusters used systems that did not allow for accurate disaggregation of close contact type (for example, workplace, compared with household or social links). Attack rates would allow further interpretation of risk in the workplace setting. The authors did not attempt to ascertain work type risk at the workplace level due to the lack of workplace denominator data collected during an outbreak. Additionally, determining the transmission risk at the industry level was not possible due to the confounding of significant changes to employment circumstances, employee numbers and locations (working from home, limited capacity) occurring during the pandemic following national restrictions (e.g. international border closures and agricultural work). Workplace restrictions also rapidly changed, creating an unstable denominator figure as multiple industries ceased or changed operation.

All outbreaks described in this review occurred during the initial COVID-19 wave so incursions of later more transmissible variants are not reflected in this work. Lastly, this review did not attempt to establish any causative links between the impacts of workplace policies and the experience of workplace transmission. Policy measures were broad and occurred in quick succession, furthermore there is no mechanism to measure or report the controls workplaces were implementing.

Despite these limitations, this review has used multiple methods to identify and confirm workplace transmission and made efforts to minimise misclassification of both work type and exposure source that has presented limitations in other studies examining COVID-19 spread in workplace settings.[7,21] While contingent or undocumented workers have also presented challenges for policy and control strategies, the approach taken in this study allowed exploration of both the type of work as well as the common risk behaviours associated with that work type, such as long-distance travel in enclosed vehicles for day work, commonly seen in agricultural work. Lastly, this study has mirrored findings in previous research confirming risk for those workers with high levels of interaction with the public (such as in retail and transport),[1] however this research adds to more recent reviews corroborating the equal if not increased risk associated with work in construction and manufacturing,[22] and signals a requirement for further protective measures for these industries that may be highly casualised and where work from home practices are not possible.

Implications for public health

The initial public health policy measures implemented were clearly effective in controlling the spread of COVID-19 in NSW but were broad and assumed a level of consistent risk across workplaces. This approach became unsustainable as the balance of infection and economic risks slowly reversed. Tailored risk controls in workplace settings require understanding the patterns and characteristics of transmission. This research demonstrates that certain industries could be considered higher risk, namely construction, manufacture and trades and office and clerical work. This finding was mirrored in the United States context.[22] While the relatively small numbers of cases in NSW during the period reported made analyses of severity by workplace type unfeasible, international evidence suggests differential risks in non-healthcare settings, such as for transportation, material moving, and construction workers in the United States[21] and elementary, leisure and service workers in the United Kingdom.[23] In NSW, the development of a range of rapidly evolving COVID-19 checklists[24] attempted to strike the balance of tailored approaches with safely easing restrictions. These checklists were developed by engaging with key industry stakeholders to understand the variability of work settings and workplace activity across and within industry types. Driven by operational intelligence, practical and effective risk controls were implemented in concert with broader pandemic policies. Stay at home when sick messaging was reinforced in these plans that were supported by access to a pandemic leave disaster payment for workers without sick leave entitlements. Similar checklist-style guidance was developed in the United States, at the federal and state level,[25,26] the United Kingdom[27] and the European Union.[28] Guidance is offered relating to pay-protection, symptom screening, hazard assessments, PPE use and other workforce management issues. This research supports using operational response data to stratify workplace risk and develop rational policy. These policies helped mitigate and prevent sustained transmission in NSW.

Another important policy consideration is the approach to COVID-19 vaccination prioritisation in low prevalence settings such as Australia. While new COVID-19 outbreaks are anticipated, there is currently limited evidence to guide which industries should be prioritised for vaccine outbreak management programs. This might be particularly important in industries such as agriculture, construction, manufacture and trades where work from home approaches are not possible, but which are socially essential. Furthermore, as new COVID-19 variants emerge, rapid transmission has been seen, highlighting the importance of maintaining a flexible policy setting.

Future areas of research

Future research into workplace transmission would benefit from more closely examining the types of activities being carried out when the presumed transmission occurred (for example, describing the distances between those seated in office settings, shared equipment types in construction, and environmental factors such as natural and mechanical ventilation). Given the relatively small numbers of included cases, future research could compare outbreak cases with matched controls of working aged individuals, to decipher potential risk in workplace practices. An analysis of workplace contracting (causal vs. permanent) and its relationship with cluster sizes alongside a calculation of attack rate, may shed further light on tailored, evidence-based approaches in workplaces, as well as to guide enhanced surveillance.

Conclusion

Workplace settings present the conditions for COVID-19 outbreaks. Though this study is limited by lack of denominator data and therefore the ability to definitively calculate risk, descriptive information collected in real-time may be the best data source available to guide workplace controls and policy in a pandemic response. Broad lockdown policies have demonstrated their efficacy but face challenges in terms of sustainability. This study demonstrates that real-time data-driven approaches to rapid policy shifts are possible, and the value of supporting employers with risk controls specific to their workplace types.

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Ethics approval

This work was undertaken as part of the NSW COVID-19 outbreak response. Under the *Public Health Act 2010* (NSW) this work is exempt from requiring ethics approval. This work has been approved for publication by the Executive Director of Health Protection NSW and Chief Health Officer, NSW Ministry of Health.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Supplementary Table 1: Adapted International Standard Classification of Occupations (ISCO) mapped to the Australia and New Zealand Standard Industry Classification (ANZSIC).

Supplementary Table 2: Workplace associated clusters of 2 or more cases and single workplace acquired cases, based on the Australia and New Zealand Standard of Industry Classification (ANSIC). ICU: intensive care unit; HDU: high-dependency unit.

Supplementary Figure 1: Clusters of ≥ 3 COVID-19 cases with descriptions of each cluster. Epidemiological curves for each cluster are presented. Numbers only include employees, or non-employees where they are the primary case and source for the cluster (e.g. customer).