Linking administrative data on natural disasters to the Longitudinal Study of Australian Children

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Abstract

This paper introduces a new data set on Australian natural disasters obtained from the Australian Government Department of Home Affairs' Disaster Assist website (DisasterAssist.gov.au). Disaster Assist contains information on natural disasters declared by State and Territory governments under the Australian Government's Disaster Recovery Funding Arrangements. We discuss how this data can be linked to the restricted release of the Longitudinal Study of Australian Children (LSAC) at the Local Government Area level. The association between survey respondent's self-reports of their local area's exposure to natural disasters, and administrative disaster declarations contained in Disaster Assist, is considered and the reasons for the modest strength of this association discussed. The paper concludes with a discussion of the key lessons for LSAC Data Users in using the linked LSAC-Disaster Assist data.

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Acronyms

ABS	Australian Bureau of Statistics
DRFA	Disaster Recovery Funding Arrangements
LGA	Local Government Area
LSAC	Longitudinal Study of Australian Children
NDRRA	Natural Disaster Releif and Recovery Arrangements

Contents

Tables

Figures

1 Introduction

While all members of a community can be negatively affected by natural hazards and disasters, children are often disproportionately affected (Cerna-Turoff, Fischer, Mayhew, & Devries, 2019; Dyregrov, Yule, & Olff, 2018; Kousky, 2016; Masten & Narayan, 2012). To date the evidence on the impact of natural hazards and disasters on children has largely been based on examining particular geographic areas within one country and on particular types of disasters (e.g. Gibbs et al. (2019) but see Edwards, Gray and Borja (2021a)). Kousky (2016) noted that there is a need to examine the effects of multiple natural hazard-related disasters on children in many geographic areas rather than in a high-risk geographic area.

In this paper we explore the feasibility of the linkage of administrative data on disasters to the Longitudinal Study of Australian Children and the viability of self-reported disaster data to capture disaster exposures. We address several research questions.

1. Does residential mobility between waves impact on the capacity to successfully link administrative disaster data?
2. Does the timing of fieldwork periods and 12 month recall periods lead to underestimates of disaster exposure?
3. What is the concordance of administrative data of disasters and retrospective recall of disaster exposure? Should they be highly correlated?
4. How common are disasters that warrant government support to residents in the local areas where Australian children live? What are the most commonly occurring of these disasters?

2 Data

2.1 Disaster Assist

Disaster Assist is an Australia Government website[1] containing information on natural disasters. More specifically, natural disasters declared by State and Territory governments under the Australian Government's Disaster Recovery Funding Arrangements (DRFA). Under the DRFA, the Australian Government reimburses state governments a percentage of their expenditure on assistance to households and businesses in disaster affected areas and for the restoration of essential public assets (Productivity Commission, 2014a). Assistance to small businesses and primary producers can take the form of concessional loans or interest subsidies and/or clean-up and recovery grants. Assistance to households can include the provision of income support payments such as the Disaster Recovery Allowance and the Disaster Recovery Payment (Department of Home Affairs, 2020; Department of Home Affairs, 2021).

The Disaster Assist site provides a catalogue of disasters under which state and territory governments provided assistance under the DRFA since March 2006[2]. The site provides data on the date the disaster began[3], the type of disaster, the name given to the disaster and the geographical area within the state or territory that was declared disaster affected. This geographical information mostly provides the names of the LGAs deemed to have been impacted by the disaster. To our knowledge ours is only the second paper to link Disaster Assist data to Australian survey data following the work of Johar et al. (2022) who link disaster declarations to waves 9 to 18 of the Household, Income and Labour Dynamics in Australia survey.

2.2 The Longitudinal Study of Australian Children

The Longitudinal Study of Australian Children (LSAC), also known as *Growing Up in Australia*, is a longitudinal cohort study of Australian children that began in 2004. The purpose of LSAC is to track the development and life course trajectories of children in Australia's economic, social and political environment with the aim of informing public policy that supports them and their families[4] (Mohal, et al., 2020). To this end the study follows two birth cohorts of children: the K-Cohort, born between March 1999 and February 2000, and the younger B-Cohort, born between May 2002 and April 2004. The parents of these children were first interviewed between March and November 2004[5]. Since this initial data collection (wave) in 2004, families have been followed up every two years such that at the time of writing LSAC spans 9 waves of data collection[6].

At present the study follows the B-Cohort between the ages of 0-1 to 16-17 and the K-Cohort between the ages of 4-5 and 20-21. The Disaster Assist data described in the previous sub-section was extracted in March 2021, prior to the release of the ninth wave of LSAC in the following July. For this reason, the focus of this paper is on the first eight waves of the LSAC cohorts. However, there is no reason why a more recent Disaster Assist extraction could not be linked to the ninth or future waves of LSAC.

As the focus of the study is the developmental pathways of two cohorts of Australian children, it is the study child that is the sampling unit of interest. The LSAC children sampled (study children) were selected from Medicare Australia's enrolment database, considered the most comprehensive database of Australia's population (Soloff, et al., 2005). The LSAC sample is a clustered design, based on postcodes, with stratification across capital cities and balance of state for each state and territory. More specifically, children were selected from the population of children who resided in 311 post codes[7] that were carefully chosen to ensure the sample was distributed across the metropolitan and non-metropolitan areas of each state and territory in the same proportions as children in the population of the target birth cohorts: children aged 0-1 and 4-5 in 2004. This approach was taken to allow for the measurement of community level effects whilst reducing the cost of the LSAC fieldwork which involves face-to-face interviewing (Soloff, et al., 2005). As with all longitudinal surveys, there is attrition of the initial sample over the course of the waves. The first wave of LSAC included data on 5,107 children sampled for the B-Cohort and 4,983 children for the K-Cohort. The eighth wave of LSAC retains 61.2% of the original B-Cohort and 60.9% of the initial K-Cohort.

The survey question of key relevance to this paper is contained in the 'Life Events' section of the LSAC questionnaire which has been included in the survey since wave 4. LSAC respondents are asked 'In the last 12 months, have any of the following happened to you?' and presented with a list of important life events. The focus of this paper is on the response to the event: 'Had your home or local area affected by bushfire, flooding or a severe storm'.

In the earlier waves of LSAC most of the survey responses were provided by the child's primary caregiver who is termed 'parent 1'. As the children grew older, they were given greater opportunity to respond themselves. For this reason, the questions on life events included in waves 4 to 7 are asked of parent 1. The same is true for the B-Cohort in wave 8 (14-15 years old) while the K-Cohort includes the reports of both parent 1 and the study child (aged 18-19 years)[8]. The data on disasters affecting the study child's local area in this paper are mostly provided by the study child's parent 1. However, we use the study child's response where this is available.

In order to avoid the identification of specific children and families within the LSAC data, the most highly disaggregated geographical indicator provided with the LSAC data is the postcode of the child's residence[9]. Since the LGA of the child's residence is not provided in LSAC this must be inferred from the child's postcode. Where the study child's postcode is fully contained within an LGA there will be a unique mapping from the child's postcode to their LGA of residence[10]. However, this will not be the case where a child's postcode spans multiple LGAs. Of the 1,558 postcodes in which an LSAC child resided between waves 4 and 8, all span at least one LGA. However, 55.5% of these postcodes span two or more LGAs and 20.8% span three or more. In those instances where a postcode spans multiple LGAs, there is typically one that spans more of the area of the postcode than the others. Among those postcodes that span multiple LGAs, 53.3% span an LGA that accounts for more than 90% of the postcodes' area. For this reason, we assign an LGA to each study child according to whichever contributes the greatest area to the child's postcode of residence[11]. Study children's LGA of residence could be more accurately assigned if the restricted release of LSAC contained information on the child's LGA allocated using the identifying data that is only accessible by the data custodians.

3 Methodology

3.1 Transitions in study child location between waves

Both LSAC and Disaster Assist contain spatial information relevant to their sampling unit. The Disaster Assist data contains the names of the LGAs declared 'disaster affected' for each disaster event and LSAC provides the postcode of the study child's residence at the time of the wave, from which the child's LGA of residence can be inferred with some accuracy. In addition, both data sets contain temporal information about their sampling units. Disaster Assist provides start dates for each disaster event while LSAC contains the families 'date of interview' giving an indication of the time the characteristics of study children and their families were measured for each wave.

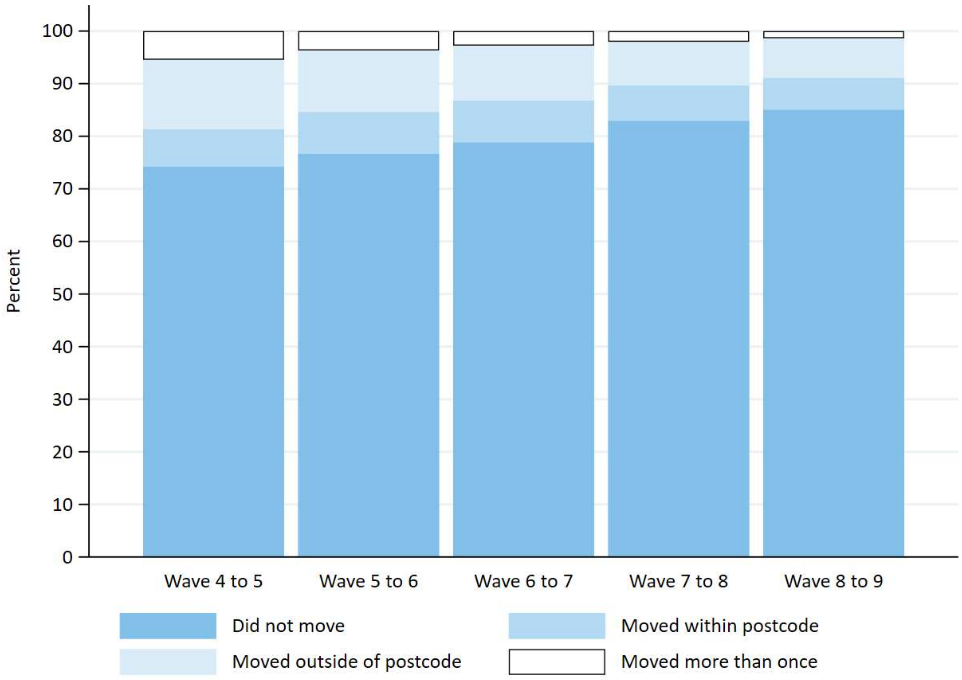
This sub-section outlines how the spatial and temporal data contained in LSAC and Disaster Assist is used in the linkage of the two data sets. In this, LSAC presents a challenge that Disaster Assist does not. Disasters are events specific to the locations that they impact. Once the LGAs deemed to have been affected by a disaster event have been determined by the relevant state authority, a full account of the disaster's geography has – whether accurate or not – been decided. However, the same cannot be said for the children sampled in LSAC. Just as the membership of a child's household may change over time the same is true of the location of the child's household. The spatial mobility of children over the two years that separate successive waves of LSAC presents a potential problem for data linkage efforts that rely on the location of the study child. This sub-section provides a description of the extent of study child mobility between waves 4 and 8 of LSAC with an emphasis on the implications of this for the data linkage methodologies outlined later.

Figure 1 presents a description of the residential mobility of the LSAC cohorts over the course of waves 4 to 8. Most study children remain in the same residence, and hence the same postcode, between waves. Just under three-in-four of the B Cohort lived in the same residence between waves 4 and 5 (74.3%) with 85.1% remaining in place between waves 7 and 8 (panel (A))[12]. Clearly children who remain in the same residence remain in the same postcode, however it is also possible for children to move residence within the same postcode. Overall, the percentage of the B Cohort who remain in the same postcode, between successive waves, ranges from 81.3% and 91.1% between waves 4 and 8.

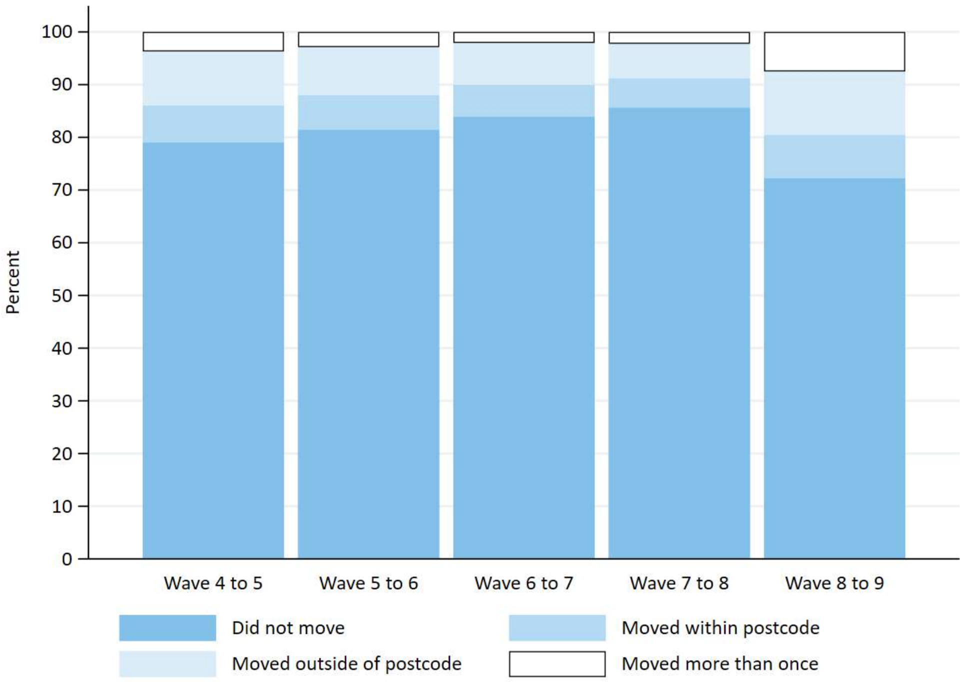
As indicated in the previous section, we assign an LGA to each study child according to that which contributes the greatest area to the child's postcode. Children who remain in the same postcode between waves will therefore be assigned the same LGA. For these children we can ascertain which of the disasters recorded in Disaster Assist will have impacted the child's community between any two waves. Where children move between postcodes in the time between waves, we can still assign disaster declarations to the (likely) LGA of residence provided we can be certain: (a) the study child has moved house no more than once; and (b) the date at which the child moved house. Where the child has experienced a single house move, we know the postcodes in which they resided for the entire period between the waves. Provided we know when the child moved postcodes, we can assign disasters affecting the LGA associated with the earlier postcode prior to the move, and disasters affecting the LGA associated with the later postcode thereafter.

Figure 1 **Between wave residential mobility of LSAC study children, waves 4 to 8**

(A) B Cohort



(B) K Cohort



Source: Longitudinal Study of Australian Children waves 4 to 8 (B and K cohorts).

Unfortunately, the LSAC data does not provide a full account of the child's location between waves for all children. For children who move more than once between waves there will be an indeterminate period of time where the child's postcode of residence is unknown. Fortunately, Figure 1 suggests this issue impacts a relatively small percentage of study children in any given wave ranging from 5.5% of the B Cohort in wave 4 to just 1.4% in wave 8.

The K Cohort exhibits a similar downward trend in the percentage of children moving more than once between waves 4 and 6, from 3.7% to 2.1%, prior to an abrupt increase between waves 7 and 8 to 7.5%. This appears to reflect greater residential mobility among older study children who have moved out of the family home prior to wave 8. In wave 7 the K Cohort were aged 16-17 years, unsurprisingly 98.6% still lived with their parents. By the time they were interviewed in wave 8, when aged 18-19 years, 15.6% no longer lived with a parent. Those who had moved out of the family home by wave 8 reported having lived at 2.3 different addresses, on average, since wave 7 compared to just 1.6 for those who still live with a parent.

3.2 Linking Disaster Assist disaster declarations to LSAC

The disaster declarations contained in Disaster Assist are linked to the LSAC survey data where two criteria are met:

1. The disaster declaration encompassed the LGA associated[13] with the child's postcode of residence.
2. The disaster began while the child was known to live in an LGA associated with the child's postcode of residence.

The application of these linkage criteria is straightforward for study children who reside within the same postcode for the entire period between successive waves. As indicated earlier, a study child moving outside of the postcode within which they resided at the previous wave does not pose a problem for the data linkage since LSAC contains data on both postcodes, in addition to the date at which the transition occurred. This enables us to determine which disaster declarations are relevant to where the child is located at a given point in time.

However, a challenge arises where we observe children to move house more than once between waves. While it is possible to ascertain the latest possible date at which the child could have left their previous residence (and their postcode) we cannot be certain of the date at which they began living there. There is also no way of knowing when the study child left the address (and postcode) in which they resided at the previous wave[14]. For these study children we can only link disaster declarations that occur within the study child's LGA of residence at the wave where the disaster began, subsequent to their move into the LGA.

Of the 36,387 'child waves' of LSAC data collected from waves 4 to 8, 50.4% pertain to a child and wave where at least one disaster event could be merged (18,343 child waves). Of the 8,685 children followed over the course of waves 4 to 8, 82.8% are likely to have resided in an LGA that was the subject of a disaster declaration between March 2009 and April 2019 (7,190 study children).

3.3 Disaster Assist disaster declarations versus self-reported exposure to disasters

The survey question on disasters affecting the LSAC respondent's local area is broad, referring to three distinct types of natural disasters: bushfires, floods or storms. The Disaster Assist data can be used to supplement the survey question and potentially provide an insight into which specific type of disaster may have affected the study child's 'local area'. Since the survey question refers to disasters that affected the respondent's 'home or local area' in the previous 12 months, only the more recent disaster events to have occurred within the child's LGA will be relevant to self-reported disaster exposure. This sub-section describes the LSAC data collection process, commonly referred to as 'fieldwork', and its implications for the association between survey estimates of self-reported exposure to natural disasters provided in LSAC with disaster exposure as measured by the linked Disaster Assist data.

LSAC fieldwork typically begins in March of the survey year with the number of interviews increasing over the course of the year, usually peaking in July or August. The third and final columns of Table 1 provide the first and last date of LSAC interviews for waves 4 to 8. The final column indicates that some of the LSAC fieldwork bleeds into the following year. While most of the wave 4 interviews were conducted in 2010, 0.38% were conducted in early 2011, the latest of which was conducted on the 16th of February. These delayed interviews were rare prior to wave 7 but have since accounted for approximately 13% of total interviews.

Table 1 Beginning and end of LSAC fieldwork for waves 4 to 8

Wave	Beginning of reporting period	Earliest date of interview	Latest date of interview
4	17 March 2009	25 March 2010	16 February 2011
5	28 March 2011	29 March 2012	27 May 2013
6	25 March 2013	25 March 2014	25 February 2015
7	2 April 2015	1 April 2016	10 July 2017
8	7 March 2017	7 March 2018	13 April 2019

Source: Longitudinal Study of Australian Children waves 4 to 8 (B and K cohorts).

The distribution of LSAC interviews over the course of a wave creates variation in the period of time that respondents refer to when providing their report of whether their local area was affected by a disaster. The first respondent interviewed for wave 5 on the 29th of March 2012, when asked has '…your home or local area [been] affected by bushfire, flooding or a severe storm?' in the previous 12 months, will be reporting on disasters that began on or after the 28th of March 2011. The respondent who provided the final interview for the wave will be reporting on disasters that must have occurred on or after the 27th of May 2012. We will henceforth refer to this 12 month period as the respondent's 'reporting period'. The wording of the LSAC disaster question ensures that every LSAC respondent's reporting period is 12 months in length. The respondent's date of interview within a wave determines when the reporting period begins and when it ends. The second column of Table 1 provides the earliest start date among LSAC respondent's reporting periods for each wave.

Insofar as our objective is to assess the association between survey reports of exposure to disasters, with that inferred from the linkage of Disaster Assist to LSAC, it makes sense to consider only those disaster declarations that meet a third criteria:

3. The disaster began within the respondent's reporting period for the wave.

The exposure time implicit in the survey question, 12 months, is half that of the (approximately) two years between LSAC surveys. If disaster events were uniformly distributed between waves, one would expect the percentage of LSAC respondents reporting their 'local area' to have been affected by a disaster to be half that suggested by the linked Disaster Assist data. However, as we will observe in the following section, the relationship between the survey responses to the question on natural disasters and the disaster declarations is more complex than first appears.

4 Results

4.1 Disaster Assist

Table 2 presents the frequency of each type of disaster in the Disaster Assist data since 2006 as of March 23 2021. Disaster declarations under the DRFA appear to have been relatively infrequent prior to 2011. Since then, more than 42 disaster events have been declared each year. It is not entirely clear whether the paucity of declarations prior to 2011 reflects fewer disaster events or merely fewer instances of state governments seeking assistance under the DRFA. According to the Productivity Commission (2014a, p. 75) "Over time, the range of measures that are eligible for reimbursement has increased, especially in revisions to the NDRRA Determination in 2006 and 2007". This suggests some of the temporal variation in DRFA disaster declarations may be explained by the policy settings of the time and not exclusively the occurrence of disaster events. With this in mind, we suggest caution be exercised in the use and interpretation of the pre-2011 Disaster Assist data.

Disaster events in the Disaster Assist data can involve more than one type of disaster occurring simultaneously. For instance, floods are often precipitated by storms and so it is not uncommon for a disaster event to be described as both a flood and a storm in the 'disaster type' field. It is for this reason that the column titled 'Total' in Table 2 exceeds the number of disaster events in every year as the former counts types of disasters whereas the latter counts disaster events[15]. Since 2006 the most ubiquitous types of disasters associated with disaster declarations have been floods (208), storms (167) and bushfires (166). Tornados and landslides are relatively uncommon types of disasters in the Australian context.

Figure 2 provides a time series of the number of bushfires and the number of non-bushfire disaster events for each month since January 2009[16]. In contrast to other disaster types, bushfires do not coincide with other types of disasters for a given disaster event and so the figure can be interpreted as disaster events rather than the count of disaster types. Figure 2 suggests a considerable overlap in the timing of bushfires and other disasters however, there are certain time periods where bushfires are more common than other disasters. Bushfire declarations were relatively common between August 2012 and May 2013 in which 39 bushfires were declared out of a total of 57 disaster declarations. Other disasters were more common over the period August 2010 to July 2011 in which there were 43 disaster declarations of which only one was a bushfire.

Figure 3 provides an insight into the seasonality of bushfires over the course of a calendar year in each state and territory. The figure presents the probability of the occurrence of at least one bushfire in each month of the year since August 2010 for each state or territory. The occurrence of storms and floods, which make up most of the non-bushfire disasters, are provided for comparison. NSW has had the most bushfire declarations over this period with 38 bushfires, more than double Victoria's 17 and Queensland's 11. Despite this, bushfire declarations are less frequent in the three largest eastern states compared to floods and storms with NSW experiencing 53, Victoria 54 and Queensland 44. While WA had fewer bushfire declarations, at just 9, floods and storms are only slightly less common than in Queensland (41). The remaining states and territories contribute smaller numbers

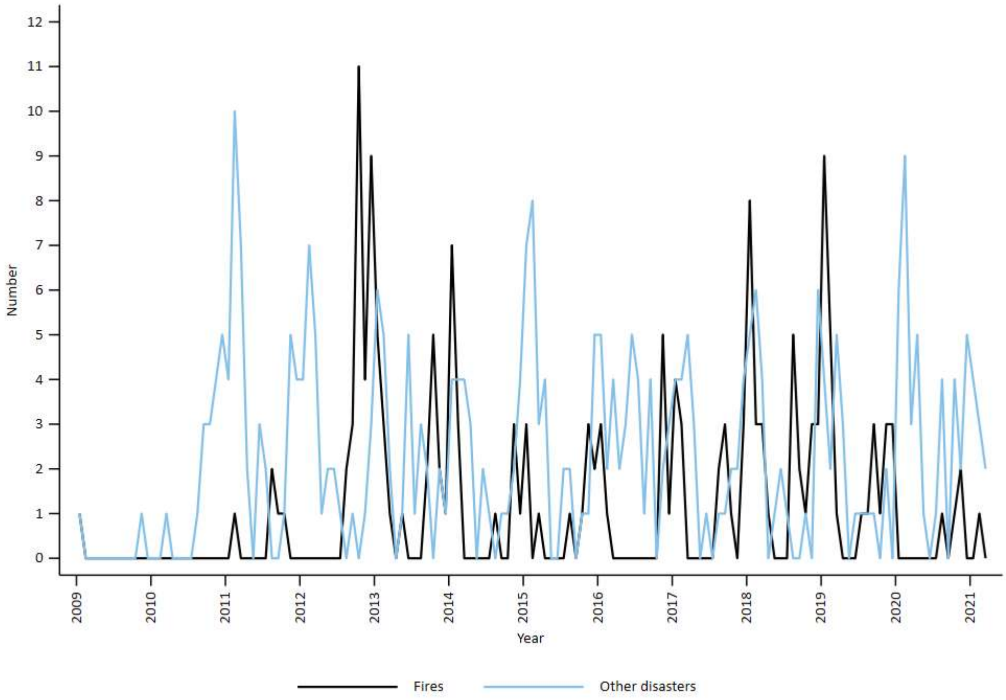
Table 2 Number of each type of disaster by year, 2006 to 2020

Year	Fires	Cyclones	Floods	Lows	Troughs	Rainfall	Storms	Weather Events	Landslides	Tornados	Total	Events
2006	0	0	0	0	0	0	0	0	0	0	1	1
2007	0	2	0	0	0	0	0	0	0	0	2	2
2008	0	0	2	0	0	0	0	0	0	0	2	2
2009	1	0	1	0	0	0	0	0	0	0	2	2
2010	0	0	13	0	1	0	1	1	0	0	16	16
2011	5	4	24	0	2	1	13	2	0	0	51	43
2012	29	3	18	5	1	3	9	0	0	0	68	55
2013	20	4	13	2	1	1	12	4	1	3	61	47
2014	15	4	15	1	2	5	10	0	0	0	52	41
2015	11	6	18	2	4	5	10	2	0	0	59	43
2016	10	0	26	2	1	5	19	1	0	0	65	45
2017	16	3	19	1	1	1	20	0	0	0	61	42
2018	28	6	14	0	1	0	15	0	0	0	64	53
2019	26	3	12	0	0	0	18	0	0	0	59	45
2020	4	2	27	0	0	0	35	0	0	0	68	43

Notes: Storms includes storms, storm surges and thunderstorms. Total refers to the row sum of the columns to the left. Events indicates the number of unique disaster declarations. The numbers in the total column are larger than those in the events column in most years as declared disasters can involve more than one disaster type. See Table A1 for a complete and mutually exclusive listing of the disaster type field in DisasterAssist.gov.au.

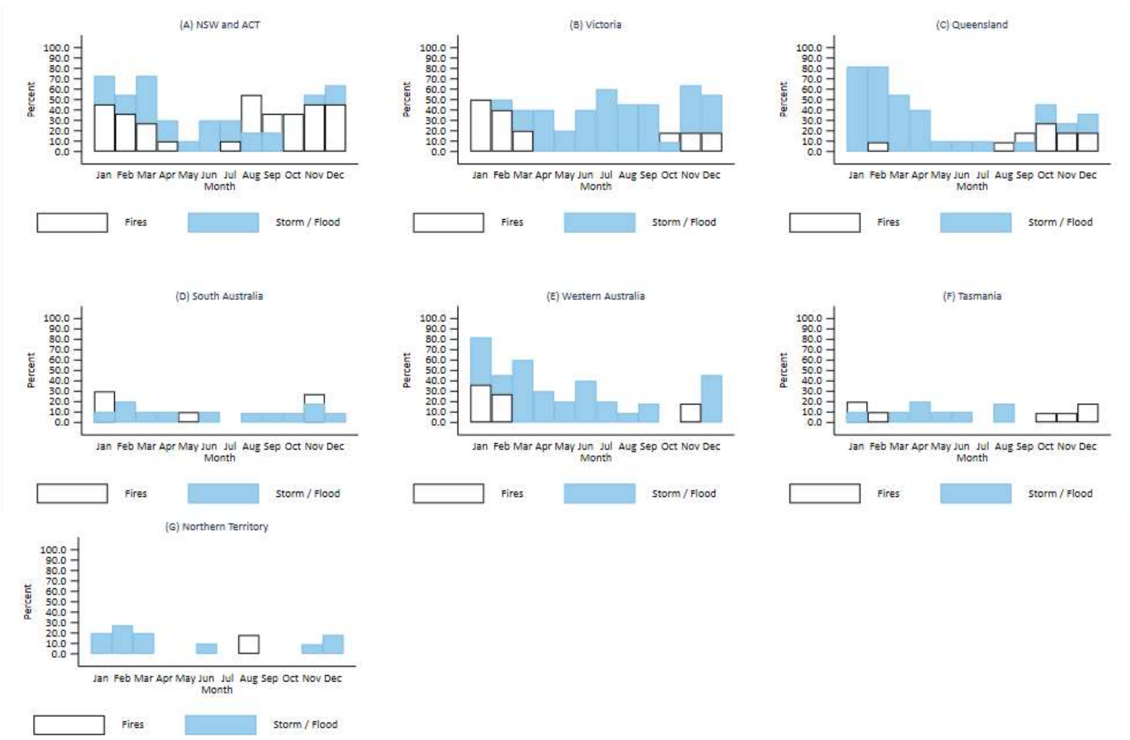
Source: DisasterAssist.gov.au.

Figure 2 Number of fires and other disasters, January 2009 to March 2021



Source: DisasterAssist.gov.au.

Figure 3 Probability of fire and storms or floods occurring at least once in each month of the year, August 2010 to March 2021 by state and territory



Notes: NSW = New South Wales, ACT = Australian Capital Territory.
Source: DisasterAssist.gov.au.

of the bushfires, floods and storms to the total in Disaster Assist.

The seasonal distribution of disaster declarations is easier to observe in Figure 3 than in Figure 2. In the three largest eastern states – those most prone to bushfire declarations – bushfires are most likely to begin in the warmer months at the beginning, and towards the end of, the calendar year. However, in NSW bushfires are not uncommon between August and October. In Queensland bushfires are most likely to occur towards the end of the year in contrast to Victoria where they are most common in the earlier months.

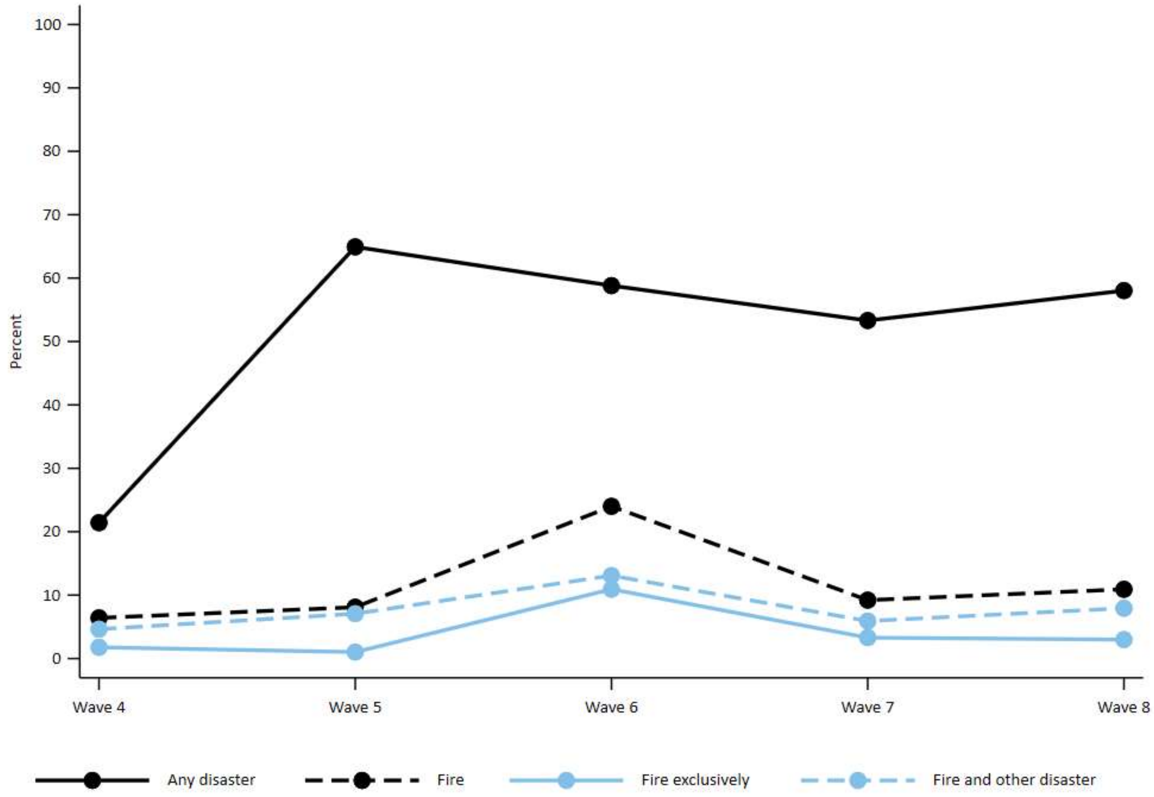
In comparing the seasonal distribution of bushfires with that of storms and floods, it is clear in Figure 3 that there is considerable overlap in the timing of floods and storms with that of bushfires. Floods and storms are by far the most common types of disaster and spread throughout the year despite occurring less frequently in the middle of the year in most states. While one would expect that bushfires are more common in the warmer months, it is not the case that bushfires are the only disasters to occur in these months. The temporal overlap of bushfires with storms and floods suggests that the timing of a survey respondent's report of having been affected by a bushfire or flood is insufficient to infer whether the disaster was a bushfire or some other type of disaster.

4.2 LSAC study children's exposure to natural disasters in Disaster Assist

The focus of the previous sub-section has been on various aspects of the Disaster Assist dataset. We now turn to a discussion of how the Disaster Assist data relates to the LSAC survey data collection. The analysis thus far has presented statistics formed exclusively from the Disaster Assist data. This sub-section presents estimates from the combined B and K cohorts of LSAC, incorporating information on disaster affected LGAs from the Disaster Assist dataset merged onto waves 4 to 8 of LSAC as outlined in section 3.3. This includes all the disaster declarations relevant to the LGA in which LSAC study children resided between the date of interview in wave 3 up until the date of interview in wave 8.

Figure 4 presents the percentage of study children who resided in an LGA associated with a disaster declaration between each wave. The percentage of children residing in a disaster affected LGA is approximately one-in-five between waves 3 and 4 owing to the small number of disaster declarations in Disaster Assist prior to 2011 (21.4%). The prevalence of disaster declarations in LSAC LGAs is highest between waves 4 and 5 at 64.9%. This largely reflects children exposed to disasters other than bushfires and is consistent with the results in Figure 2 and Table 2. The period between waves 5 and 6 is associated with the highest level of exposure to bushfires, at just under one-in-four children, and a comparatively higher percentage of children exposed to bushfires events in the absence of other disasters (10.9%). The key message is that from wave 5 onwards over 50% of children were exposed to at least one disaster from 2012 through to 2018.

Figure 4 **Percentage of LSAC study children living in disaster affected Local Government Areas, waves 4 to 8**



Source: Longitudinal Study of Australian Children waves 4 to 8 (B and K cohorts); DisasterAssist.gov.au.

4.3 Disaster Assist disaster declarations relevant to the survey reporting period

As indicated earlier, the LSAC survey includes a question on whether the respondent's local area had been impacted by a bushfire, flood or storm. It is therefore natural to enquire: Are the disaster declarations captured in the Disaster Assist data reflected in LSAC respondent's self-reports of their local area being affected by a disaster? Before assessing the strength of the association between these two measures of disaster exposure, it is worthwhile considering the extent to which the disaster declarations relevant to the respondent's survey reporting period are representative of the population of disasters captured in Disaster Assist.

There are two implications of the LSAC fieldwork methodology, and the wording of the survey question pertaining to natural disasters, for the extent of the overlap between disaster declarations relevant to the reporting period and disaster declarations more broadly. The first is that disasters that occur after the final interview for a wave, but before the earliest start to a reporting period in the subsequent wave, will not fall within the 12-month reporting period referenced in the survey question. For example, if a disaster is declared to begin on the 28th of May 2013 there will be no LSAC respondent in the wave 5 fieldwork with an active reporting period to report being affected by that disaster (see Table 1). Even if the last respondent interviewed for this wave lived in an LGA declared to be disaster affected, they will have been interviewed prior to the onset of this disaster. Similarly, a disaster that began in early March 2011 will not fall within any of the respondent's reporting periods as there were no reporting periods in wave 5 that extended back to this date. Even if the first wave 5 respondent, interviewed on the 29th of March 2012, resided in an LGA declared to have been affected by a disaster, their local area will not have been affected in 'the previous 12 months' to which the survey question refers.

The second implication of the LSAC fieldwork methodology is that disasters, even among those declared between the dates in the second and final column of Table 1, do not have an equal probability of being reported on in the survey data. The reason for this is the uneven distribution of interviews dates over the course of a wave. The typically small number of interviews conducted in the first quarter of the year of an LSAC wave ensure that there are fewer reporting periods active in the first quarter of the previous year. Disasters declared in these months are therefore less likely to be reported on even when the LGAs declared disaster affected contain an LSAC study child. This is less of a concern for disasters declared in the fourth quarter of the year *before* an LSAC wave, and those declared in the first quarter of the year *of* an LSAC wave, as these are the months when the proportion of the LSAC sample with an active reporting period are at their peak.

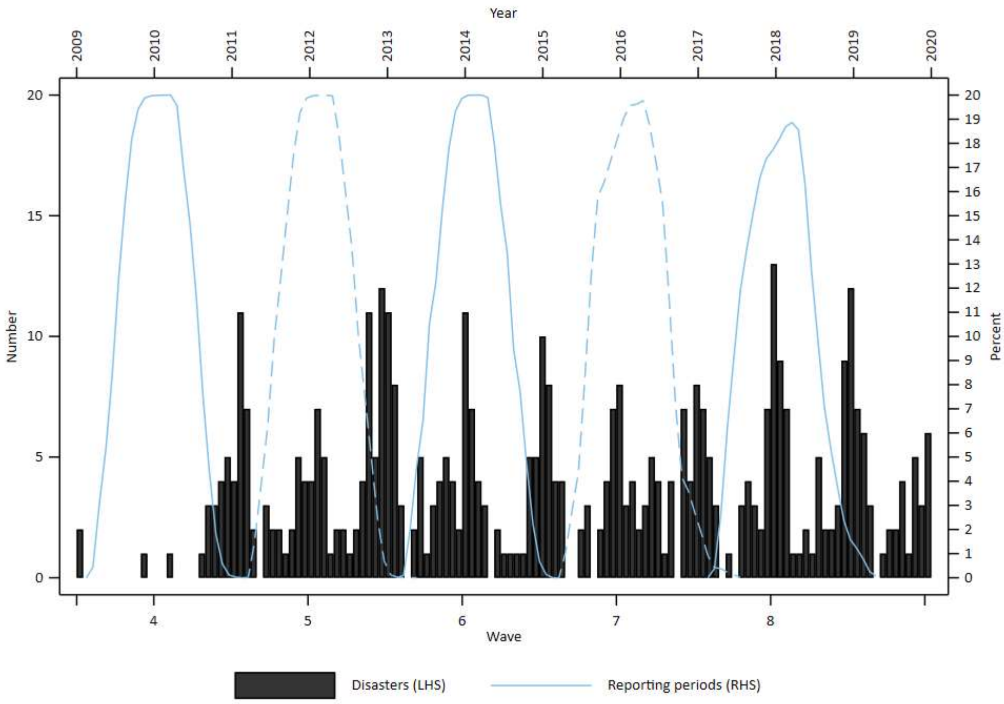
Figure 5(A) presents the distribution of reporting periods for each wave of LSAC (right vertical axis) against the frequency of all disaster declarations (left vertical axis) between January 2009 and early 2019. The figure illustrates how the distribution of interview dates over the period manifests in the distribution of active reporting periods which peak in the early months of the year of the wave and the later months of the previous year. The lengthening of the LSAC fieldwork that began in wave 7, described in section 3.3, is reflected in the widening of the distribution of the reporting periods for waves 7 and 8 in Figure 5.

An important implication of Figure 5(A) is that we need not observe a strong association between the percentage of respondents who report their local area being disaster affected by a disaster in the past 12 months and the number of disaster declarations made around the time of a wave. Furthermore, this association may be modest even if it were the case that all of the LGAs declared disaster affected contained at least one LSAC study child. The correlation between the number of disaster declarations, and the percentage of LSAC respondents who report disasters, will depend greatly on the timing of the disaster declarations within the fieldwork of the LSAC wave.

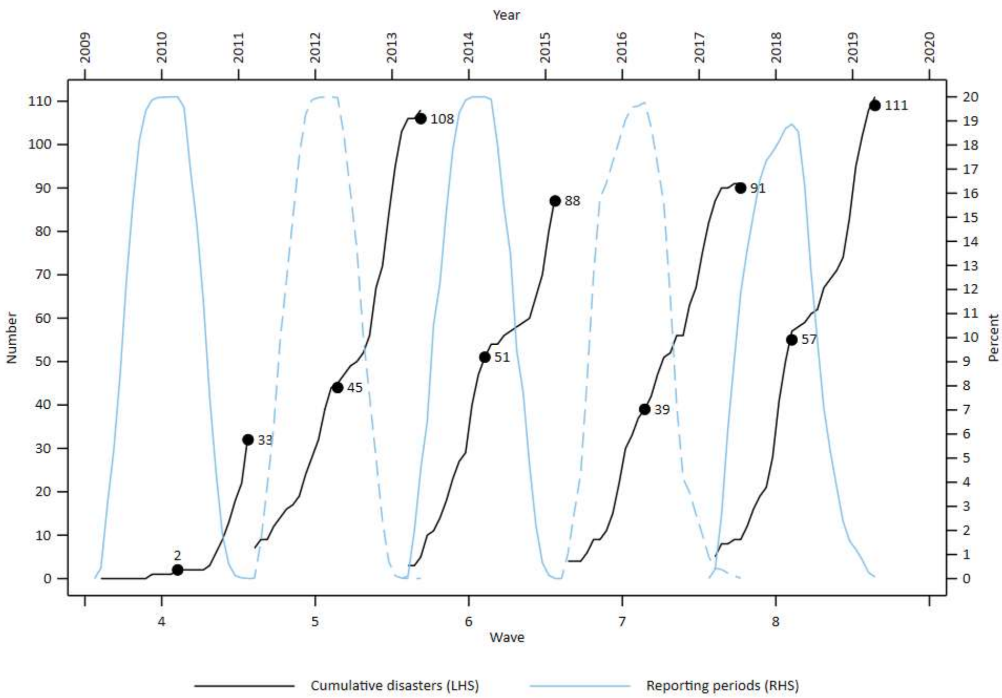
The relationship between the timing of disaster declarations and the LSAC fieldwork can be more easily observed in Figure 5(B) which provides the cumulative number of disasters that have occurred since the beginning of the earliest reporting period for each wave (left vertical axis). The figure indicates a larger number of disaster declarations surrounding the LSAC fieldwork for waves 5 and 8, 108 and 111 declarations respectively. The period encompassing the lead up, and implementation of the wave 6 and 7 fieldwork had comparatively fewer declarations. It is therefore tempting to conclude that the survey reports of disasters for waves 5 and 8 would be

Figure 5 **LSAC disaster reporting periods and start dates of disasters captured in Disaster Assist, January 2009 to February 2019**

(A) Numer of disasters



(B) Cumulative disasters since the earliest reporting period for each wave



Notes: LHS = Left Hand Side, RHS = Right Hand Side. Tick points on the top horizontal axis indicate the beginning of a calendar year. Tick points on the bottom horizontal axis indicate the wave whose fieldwork is principally contained within the calendar year.

Source: Longitudinal Study of Australian Children waves 4 to 8 (B and K cohorts); DisasterAssist.gov.au.

higher than those for waves 6 and 7. However, when one looks more closely at the timing of the disasters, the figure suggests many of the declarations made around the wave 5 and 8 fieldwork were made as the percentage of LSAC respondents with active reporting periods was beginning to decline as the fieldwork for the waves was wrapping up. Consequently, the percentage of LSAC respondents reporting disasters in these waves may not necessarily be higher than that of any other wave. To emphasise this, the figure marks out the cumulative number of disaster events at the peak of active reporting periods for each wave in addition to the total number of disaster events at the conclusion of the fieldwork.

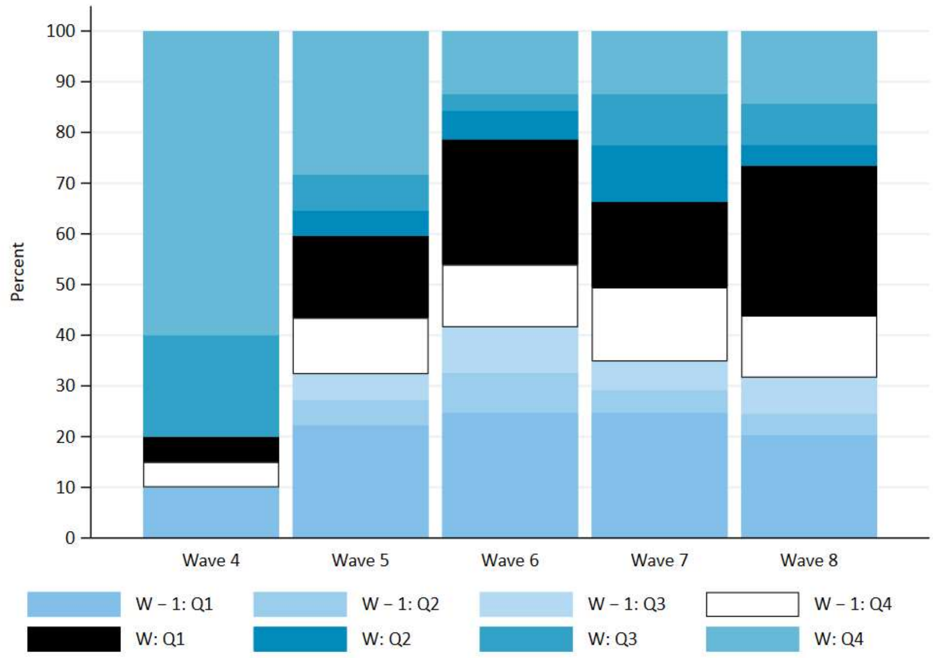
Wave 5 had 108 disasters in total, the second highest of the waves depicted in the figure while wave 6 had just 88. However, 63 of these wave 5 disasters events occurred following the peak in wave 5 reporting periods at which time 45 disasters had been declared. This is somewhat less than the 51 disasters that had occurred prior to the peak in wave 6 reporting periods. With this in mind, it is possible that wave 6 may be associated with a higher rate of self-reported disasters by virtue of the timing of those disasters within the wave 6 fieldwork despite being associated with a smaller number of disasters overall.

Figure 5 suggest the disaster events reported by LSAC respondents are less likely to reflect disaster declarations made after the first quarter of the year of an LSAC wave and those declared in the earlier quarter of the previous year. Figure 6 examines the extent of this by comparing the distribution of the disaster start dates in Disaster Assist (panel (A)) with the start dates of those disasters that begin within the survey reporting periods from wave 4 to 8 (panel (B)). More specifically, the figure provides the percentage contribution of each quarter of disaster declarations made in the year prior, and the year of, each wave of LSAC. Panel (A) indicates the vast majority of disaster declarations are made in the first and final quarters of a calendar year. Putting aside wave 4, panel (A) indicates that first quarter disasters make up 15-25% of all disasters surrounding the fieldwork of waves 5 to 8, final quarter disasters also make up a significant proportion of total disasters contributing between 11.2% and 28.6% of the total.

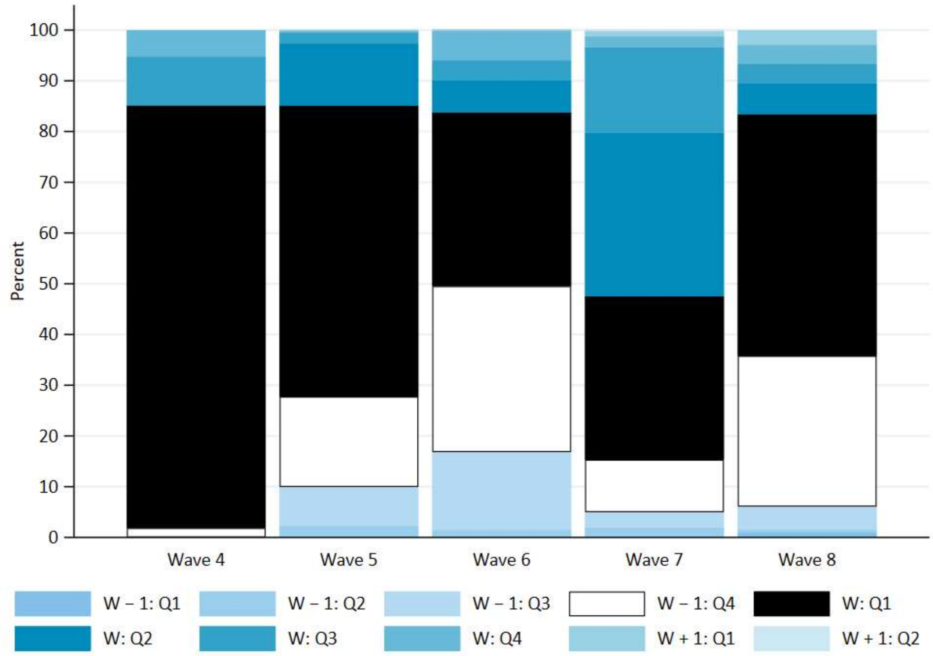
With disasters beginning in the first and final quarters of the year making up the lion’s share of disaster declarations, it is not surprising that we observe these quarters contributing a large percentage of the disasters that fall within the survey reporting period in panel (B). However, when we compare the percentage of disasters occurring within the survey reporting periods that began in the first quarter of the year of a wave, with the corresponding percentage in panel (A), it is quite clear that these disasters are disproportionately represented. For example, between 2013 and 2014 disaster declarations made in the first quarter of 2014 made up a quarter of the total and those made in the final quarter of 2013 contributed one eighth. In panel (B) we find disasters declared in these quarters combine to make up two-thirds of those relevant to the survey reporting periods for wave 6. The pattern is broadly the same for waves 5 and 8. Wave 7 stands out in having the second quarter of 2017 contributing a larger percentage of disasters falling in the survey reporting periods than the second quarter in the other waves. Whether the over representation of disasters occurring in these quarters illustrated in Figure 6 presents a problem for an analysis of the data depends upon the nature of the research question.

Figure 6 **Comparison of quarter of disaster start dates for disaster declarations in the 12 months prior to LSAC interviews with all Disaster Assist disasters, January 2009 to February 2019**

(A) All Disaster Assist disasters



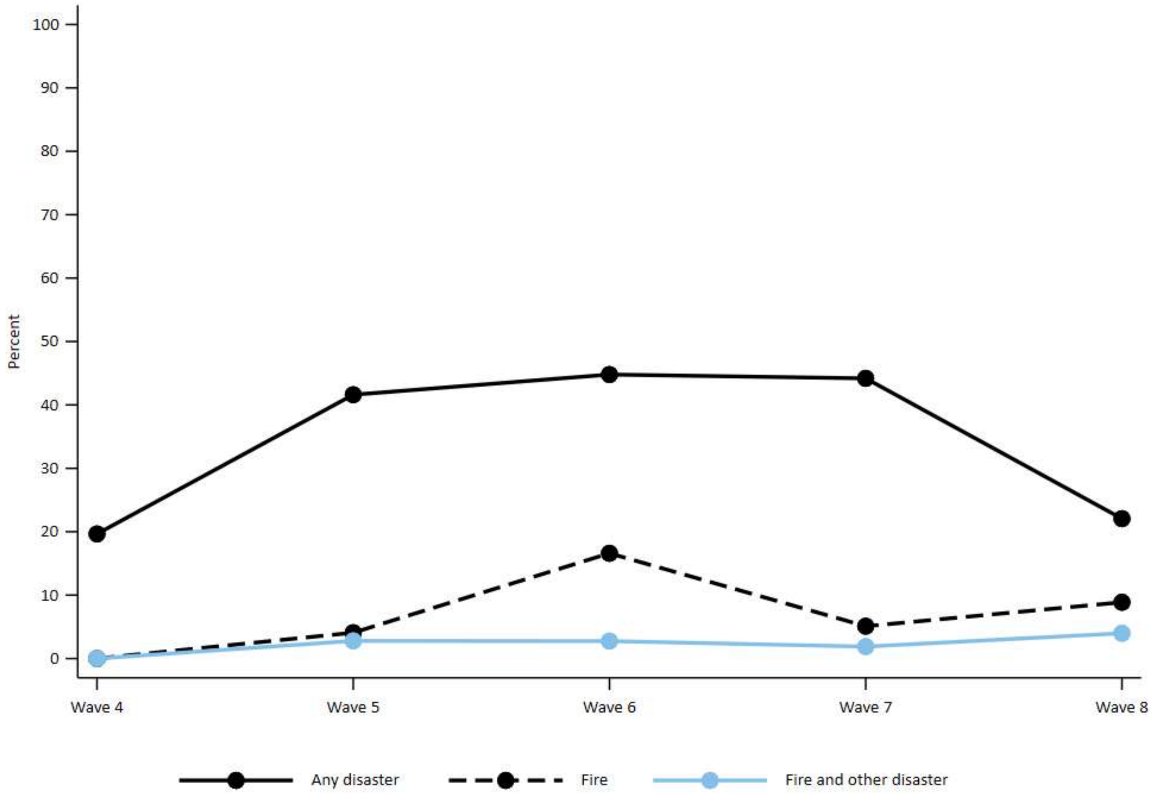
(B) Disaster declarations 12 months prior to LSAC interviews



Notes: W indicates the year associated with most of the interviews for each wave. For example, W = 2010 in wave 4 since the vast majority of wave 4 interviews are conducted in 2010 and so W – 1 = 2009 and W + 1 = 2011. Q indicates the quarter of the calendar year.

Source: Longitudinal Study of Australian Children waves 4 to 8 (B and K cohorts); DisasterAssist.gov.au.

Figure 7 **Percentage of LSAC study children living in Local Government Areas with disaster declaration within LSAC respondent's reporting periods, waves 4 to 8**



Source: Longitudinal Study of Australian Children waves 4 to 8 (B and K cohorts); DisasterAssist.gov.au.

Figure 7 presents the percentage of LSAC respondents who resided in an LGA that was declared disaster affected during the respondent's reporting periods. In contrast to Figure 4, Figure 7 includes only those disasters with start dates beginning within respondent's reporting periods. The figure emphasises the importance of the timing of a disaster in the period between the waves for whether the disaster is reflected in survey respondents reporting periods. Waves 6 and 7 have the highest percentage of children residing in LGAs declared disaster affected despite having a smaller number of total disaster declarations relative to waves 5 and 8. As indicated in Figure 5(B), this reflects an abrupt increase in disaster declarations towards the end of the wave 5 and 8 fieldwork when the percentage of the LSAC sample with active reporting periods was declining.

For data users the key message is that the timing of self-reported disaster 'windows' in combination with the timing of the fieldwork will lead to underestimates of the exposure to natural disasters over the life course. To the extent that contemporaneous disaster exposure in the last 12 months is most important to human development this may not be an issue. Nevertheless, this is an important limitation of the self-reported disaster exposure data in the LSAC dataset.

4.4 Association between self-reports of local areas affected by disasters and administrative disaster declarations

The focus of the previous sub-section was on the implications of the LSAC fieldwork methodology for which disasters in the Disaster Assist data are likely to be relevant to survey respondent's reports of their local area being disaster affected. In what follows we explore the strength of the association between disaster declarations made in the study child's LGA and the LSAC respondent's self-reports of whether their local area had been affected by a bushfire, flood or storm within this linked data set.

Before assessing the strength of this correlation, it is worth reflecting on whether one would expect a strong association between disaster self-reports and administrative disaster declarations. A priori, there is no reason to assume that LSAC respondents' subjective conception of what constitutes their 'local area' would be consistent with administrative boundaries and research on neighbourhood definitions suggests that individual demographic characteristics are also associated with variation in neighbourhood definitions (Charreire, et al., 2016). An alternative explanation for this could be that the disaster declarations encompass LGAs that are severely impacted by the disaster event in addition to those impacted in more indirect ways not recognised by respondents when responding to the survey question.

Another reason why self-reported experiences of disasters may differ from disaster declarations is that LSAC respondents may not always adhere to the reporting period stated in the survey question. Some may report their local area having been affected by a disaster that occurred 13 to 14 months prior to the date of interview. However, we would expect the earlier a disaster's start date relative to the beginning of a respondent's reporting period, the less likely the disaster is to be that which the respondent is referring to in their response. It may also be that some disasters have a duration of a few months. In these circumstances the disaster may not be linked to the survey data as its start date lies outside of respondent's reporting period despite the disaster's affects being felt – and reported upon – by LSAC respondents within their reporting periods[17].

Provided it is reasonable to assume that LSAC respondent's view their 'local area' as a geographical area that is smaller in size than the LGAs that intersect their locale, we would expect this to manifest as lower rates of self-reporting in LGAs declared disaster affected. That is, we might not expect all respondents residing in LGAs declared disaster affected (at least once) in the respondent's reporting period to self-report that their local area was affected. Figure 8(A) explores this presenting the percentage of LSAC respondents who reported their local area had been affected by a fire, flood or storm among those residing in LGAs declared to be disaster affected in the 12 months prior to interview. The same percentages are provided for those who did not reside in an LGA declared to be disaster affected.

Figure 8(A) suggests there is some association between living in a LGA declared to be disaster affected and respondents reporting their local area to have been affected by a disaster. The percentage of respondents who self-report their local area being affected is higher among those who reside in LGAs declared to be so, compared to those who do not, in each of waves 4 to 8. However, the figure does not indicate a particularly strong association. The rate of self-report is – as one would predict – quite low among those living in LGAs that were not declared disaster affected, at just 2.6-6.2%, however the rate of self-report among those residing in declared LGAs is only a few percentage points higher at 6.5-11.5%. This suggests that LGAs can be declared disaster affected despite a large percentage of LSAC respondents residing therein not viewing their local areas as directly impacted. Or in other words, disaster self-reports do not necessarily reflect whether a disaster warranting a disaster declaration has occurred in an LGA.

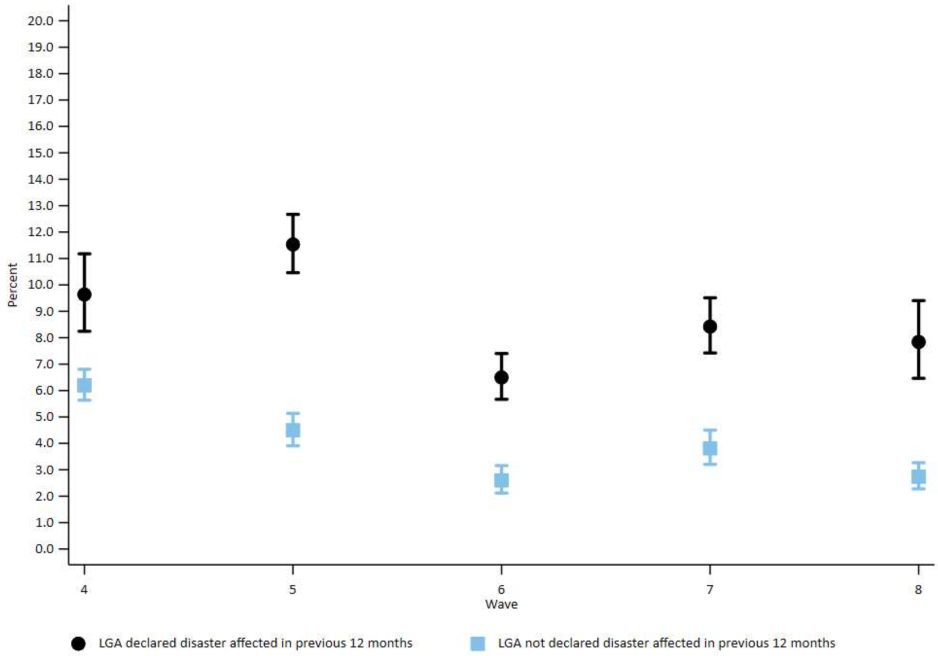
The second issue, that of respondents not strictly adhering to the reporting period implied in the survey question, would manifest differently to that of how respondents view their 'local area'. If respondent's self-reports of their local area being disaster affected includes disasters that begun more than 12 months prior to interview (i.e. prior to the beginning of the reporting period) this would be reflected in lower rates of disaster declarations in the LGAs of those respondents observed to self-report their local area being affected by a disaster. Figure 8(B) explores this by presenting the percentage of LSAC respondents who resided in LGAs declared to be disaster affected in the 12 months prior to interview, among those who reported that their local area was affected by a disaster (in the past 12 months). The same percentage is presented for those who did report their local area to be affected.

Figure 8(B) suggests a reasonable – though far from comprehensive – agreement between administrative disaster declarations and respondent self-reports between wave 5 and 7. Just under 70% of LSAC respondents who report their local areas was impacted by a bushfire, flood or storm resided in a LGA that was also declared to be disaster affected around the time of wave 6 (67.9%). For waves 5 and 7 this percentage is somewhat lower at 65.1% and 63.9% respectively. Despite Disaster Assist maintaining a relatively comprehensive listing of disasters in the lead up to the wave 8 fieldwork, compared to those surrounding wave 4, the percentage of declarations for the LGAs of those who self-report disasters was just 46.9%. As one would expect, the rate of disaster declarations is lower in the LGAs of those who do not report their local area being affected, however this rate still exceeds the approximately one-in-three respondents who did not self-report being disaster affected in each of waves 5, 6 and 7[18].

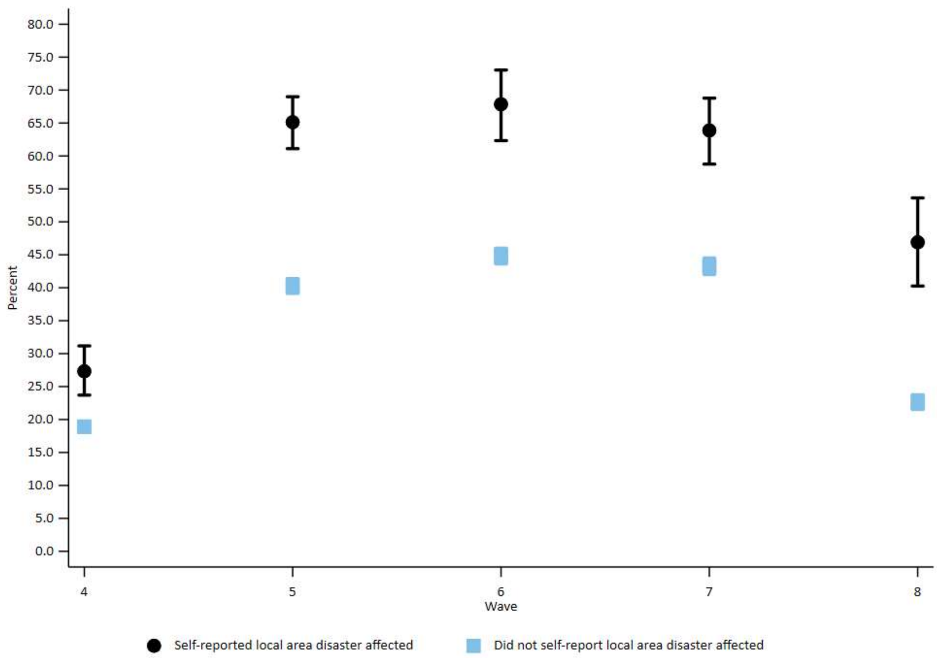
Taken together, both panels of Figure 8 suggest some association between LSAC respondent's self-reporting of disasters, in whatever they deem their local areas to be, with administrative disaster declaration made across the LGAs in which LSAC study children reside. However, Figure 8 does not indicate a particularly strong association between these alternative measures of whether study children have been impacted by natural disasters. In the discussion section we reflect on whether the low correlation between these measures presents a problem for research on how specific types of disaster events impact the development of Australian children.

Figure 8 **Association between disaster declarations in LGA of residence and self-reports of local area affected by a disaster, January 2009 to February 2019**

(A) Self-report of local area affected by a disaster



(B) LGA declared disaster affected in the previous 12 months



Notes: LGA = Local Government Area. Bars indicate 95% confidence intervals. Statistical estimates are not formed using LSAC survey weights.

Source: Longitudinal Study of Australian Children waves 4 to 8 (B and K cohorts); DisasterAssist.gov.au.

5 Accuracy of spatial linkage

Before moving to discussion of key issues that LSAC data users should be mindful of when analysing the linked Disaster Assist data there is one important methodological issue raised in this paper relevant to the linkage of geospatial data to LSAC more generally. As indicated in section 2.2, 55.5% of LSAC children live in postcodes that span more than one LGA. In the absence of an LGA indicator constructed from the child's address, it is inevitable that the use of a postcode-LGA concordance – as implemented in this paper – will result in an unknown percentage of children being assigned to LGAs they do not reside in. However, the need for the accuracy of geo-spatial linkage must be assessed in relation to the risk of study children and their families being identified were LSAC to contain a wider array of statistical geography.

There are broadly two risks associated with an expansion in the geographic indicators included with the LSAC data. The first is related to the granularity of the geographic data provided. In this regard, data on the actual LGA in which a child resides represents a small risk of identification. LGAs are quite large in terms of their spatial area and typically contain large numbers of children in the relevant age groups.

The second risk arises from the longitudinal nature of LSAC in the context of revisions to a specific type of geography. While LGAs generally cover large spatial areas, their boundaries are redrawn over time in accordance with changes in the administration of local government in each state and territory. Were LSAC to include multiple editions of LGA geography, it would be possible to narrow down the location of children who are coded as residing in different LGAs under different editions of the LGA geography as these children must live in the overlap of the alternative sets of boundaries.

The problem of potential identification is compounded by the longitudinal nature of LSAC. If a child is known to remain at the same address for a number of waves, in a location that is subject to multiple LGA boundary changes, the area in which they reside could be narrowed down further. This is problematic if few children in the relevant age ranges reside in the area of overlap.

One way forward would be for the LSAC data custodians to maintain a data file that links the study child's address to each edition of the LGA geography dating back to 2004. Instead of making all of this data available to researchers who wish to link data at the LGA level, researchers could elect to nominate a single edition of the LGA geography that they would like added to a release of data specific to the user. This user specific LSAC data would provide an accurate LGA of residence for each wave under a single edition of the LGA geography. The risk of identification can be mitigated if researchers are only able to access statistical geography of one type and edition at any one time. This approach would protect the privacy of study participants without compromising accurate geographic assignment.

6 Key lessons for LSAC Data Users in using the self-reported disaster and the linked Disaster Assist data

Based on our analyses there are several key lessons that LSAC data users need to be mindful of when examining self-reported disaster exposure and using the linked Disaster Assist data. Firstly, the Disaster Assist data will not accurately capture disaster exposures for study children and their families who move more than once between waves. Fortunately, these underestimates of exposure to disasters only arise when disasters are declared in areas where study children move between adjacent waves. As indicated in Figure 1, these censored disaster declarations apply to no more than 1.4%-5.5% of children in each wave of the B Cohort and 2.1%-7.5% of children in each wave the K Cohort.

Secondly, insofar as LSAC survey respondent's self-reports of local areas being affected by a natural disaster should correspond to disaster declarations made in their LGA of residence, the timing of the LSAC fieldwork and the 12-month recall period of the survey question ensure the disasters to which respondents refer will not be representative of those captured by Disaster Assist more broadly. More specifically, LSAC respondents are far more likely to be referring to declarations made in the first quarter of the year of an LSAC wave and those declared in the final quarter of the previous year. This is not necessarily a problem for the exploration of many research questions for which LSAC data could be deployed. However, it is worth keeping in mind that the disasters impacting LSAC respondents in the 12 months prior to being surveyed may not necessarily be representative of all disasters declared to have impacted their local area since the previous wave (see Figure 6).

Thirdly, in addition to LSAC fieldwork timing and the 12-month recall period of disaster self-reports, the uncertainty about the match between 'local area' and the LGA in which a respondent resides means that the concordance between disaster declarations at the LGA level and self-reported disaster exposure is low (see Figure 7). This does not necessarily mean that either are invalid measures of exposures, or even that one should be seen as more reliable than the other. Each reflects a different component of disaster exposure and which measure is preferrable will depend upon the research question at hand. Given the evidence that community level reporting of natural disasters are robust correlates of the impacts of natural disasters both in the Australian context and internationally (Edwards, Gray, & Borja, 2021a; Hunter, Gray, & Edwards, 2012), both have the potential to provide useful insights into human development in Australia.

Fourthly, the Disaster Assist data suggests that there are three commonly occurring natural disasters in the Australian context: floods and storms and bushfires. Storms and floods commonly co-occur and so the independent effect of each is difficult to delineate. This is in contrast to bushfires which tend to occur independently of other disasters over the LSAC study period.

Finally, the linked Disaster Assist data suggests disaster exposures are widespread with over 50% of children in the LSAC sample living in an area eligible for disaster assistance under the DRFA from 2012 to 2018.

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Appendix

Table A1 Values of the disaster type field in the Disaster Assist data set as of March 2021

Disaster Type	Number of events
Bushfire	165
Flood	83
Storm	58
Flood, Storm	56
Cyclone	17
Flood, Rainfall	12
Storm, Flood	11
Thunderstorm	8
Trough/monsoonal trough	8
Low/tropical low	7
Cyclone, Flood	6
Flood, Thunderstorm	6
Flood, Cyclone	6
Flood, Trough/monsoonal trough	5
Weather event	5
Flood, Low/tropical low	4
Flood, Rainfall, Cyclone	4
Flood, Storm, Storm surge	3
Cyclone, Storm	2
Hailstorm, Storm	2
Flood, Weather event	2
Tornado, Weather event	2
Flood, Storm, Low/tropical low	1
Storm, Thunderstorm	1
Cyclone, Flood, Storm	1
Storm surge	1
Rainfall, Thunderstorm	1
Storm, Flood, Landslide	1
Flood, Storm, Weather event	1
Cyclone, Flood, Storm surge	1
Flood, Low/tropical low, Rainfall	1
Storm, Tornado	1
Flood, Storm, Thunderstorm	1
Bushfire, Storm	1
Flood, Rainfall, Storm	1
Hailstorm	1
Rainfall	1
Cyclone, Trough/monsoonal trough	1
Cyclone, Storm, Flood, Storm surge	1
Rainfall, Flood	1

Source: DisasterAssist.gov.au.

Endnotes

[1] The website can be found at: https://www.disasterassist.gov.au/Pages/home.aspx.
[2] Prior to November 2018 the provision of disaster relief by the federal government was provided under the Natural Disaster Relief and Recovery Arrangements (NDRRA) (Department of Home Affairs, 2020). Prior to the 2007 NDRRA Determination this assistance was provided under the Natural Disaster Relief Arrangements (Productivity Commission, 2014b). Figure 2.3 on p. 74 of Productivity Commission (2014a) provides a schematic of Policy evolution of the Australian Government natural disaster funding arrangements.
[3] The site also provides end dates for some disasters.
[4] LSAC is undertaken in partnership between the Department of Social Services, the Australian Institute of Family Studies and the Australian Bureau of Statistics (Mohal, et al., 2020).
[5] Strictly speaking there was one final interview that took place on the 5th of January 2005.
[6] In addition to the main waves conducted every two years, there have at times been between wave mail surveys conducted to collect information about activities and developments in the time between (Mohal, et al., 2020).
[7] Due to excessive data collection costs, some remote postcodes were excluded from the design (Soloff, et al., 2005).
[8] Wave 8 also includes the reports of the child's secondary caregiver, 'parent 2'. Where the child does not live with both of their parent's reports are also sought from the 'parent living elsewhere'.
[9] The study child's actual postcode is only included in the less confidentialised 'restricted release' of the LSAC data. The more highly confidentialised general release of LSAC contains a postcode indicator that has been confidentialised in such a way that provides information on which children live in the same postcodes whilst not identifying the actual postcode. The postcode indicator in the restricted release of LSAC is necessary for the linkage of the survey data to datasets that contain data on the characteristics of the child's postcode.
[10] Postcodes are mapped to LGAs using ABS (2018).
[11] An alternative approach would begin by gathering Census data on the spatial distribution of children in the LSAC age ranges at a more finely grained level of geography relative to a postcode – for instance mesh blocks or Statistical Area 1s. This data could be used to form estimates of the percentage of children within a postcode who are likely to reside in each of the postcode's spanning LGAs. Child could then be assigned to the LGA where children in the appropriate age range are most likely to live rather than that with the greatest spatial overlap. This approach would result in a more accurate assignment of children to LGAs in those postcodes where children's residences are not uniformly distributed across the postcode's area. Biddle (2009) provides a more detailed description of this methodology. Gray, Taylor and Edwards (2011) present an application to LSAC data.
[12] While this may reflect a trend towards less mobility for families with children in the B Cohort's age group, this trend could equally arise from the survey attrition of highly mobile families who are more difficult to trace.
[13] Associated in the sense that where a child's postcode spans multiple LGAs the LGA allocated to the child is that which spans the greatest proportion of the postcode's area. This will not necessarily be the LGA in which the child resides. See earlier discussion in sub-section 2.2.
[14] A recent innovation relevant to waves 7 and 8 of the K Cohort is the Events History Calendar which contains the start and end dates for all of the addresses the study child lived at between the waves. These data can be used to ascertain when the study child left the address they lived at in the previous wave. However, in the absence of a full history of the study child's postcodes we would still be unable to determine where the child was located during their time spent at any between-wave addresses.
[15] Table A1 provides the raw frequencies of the disaster type field in Disaster Assist. While bushfires are mutually exclusive with respect to other disaster types there is considerable overlap of floods, storms and cyclones.
[16] The allocation of disasters to month is done on the basis of the start date of the disaster recorded in the Disaster Assist.
[17] This potential problem could be overcome if the recording of disaster end dates in Disaster Assist were more comprehensive.
[18] The approximately one-in-three refers to the difference between the estimates depicted by the circular dots in panel (B) and 100%.