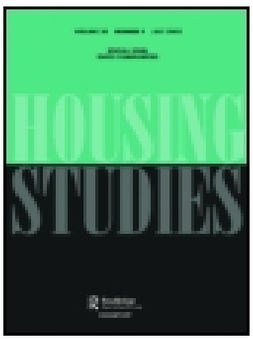

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Cold housing: evidence, risk and vulnerability

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ABSTRACT

Cold housing is not widely recognized as a problem that occurs in mild-climate countries like Australia. But emerging evidence suggests that it is an important, albeit under-acknowledged, problem that may contribute to high rates of ill health and mortality during the winter months. We bring together two historically important theoretical developments to better understand the social and economic distribution of cold housing. Drawing on nationally representative data from the Household, Income and Labour Dynamics in Australia survey between 2001 and 2016, we find that the characteristics of households unable to adequately heat their homes strongly reflects known patterns of inequality across, for example, tenure, employment and health, but that there are also more unexpected trends in age and income. Critically, our analyses demonstrate that individuals' vulnerability to cold housing risk can be anticipated, which has important implications for public policy and community-based interventions.

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Cold housing; risk; health; well-being; housing provision

Introduction

Widely recognized as a warm country with a relatively benign climate, few people consider cold housing as a problem in Australia. Nevertheless, Australia is a nation with a notably high burden of ill health and mortality in wintertime (Australian Bureau of Statistics (ABS), 2018). Anecdotally, immigrants from northern hemisphere, cold-climate countries say that their first winter in Australia is often the coldest that they have ever experienced. This is because the Australian housing stock, compared with that of cold-climate countries, offers little protection from the prevailing weather conditions due to poor thermal building standards (Moore *et al.*, 2019); a paradox highlighted in the recent World Health Organisation Guidelines for Housing and Health (World Health Organisation (WHO), 2018). Also contributing to the lack of awareness of cold housing, there is little, or no, public health messaging around the risks of indoor cold, with attention focussing instead on the acute risks of extreme heat. This Australian preoccupation with how our homes are able to protect us and

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our health in hot conditions is perhaps reflective of the dominant narrative over the last two decades of housing performance research in Australia: climate change, mitigating it by reducing greenhouse gas emissions and adaption to a warming climate (e.g. Hatvani-Kovacs *et al.*, 2018). So while a growing body of empirical evidence suggests that there is a real risk associated with cold in housing (Daniel *et al.*, 2019; Hitchings *et al.*, 2015; Willand *et al.*, 2019), there is not a widely *perceived* housing risk, so the problem has remained largely hidden and unaddressed. Public debate around 'energy poverty'[1] (ACOSS, Brotherhood of St Laurence and The Climate Institute, 2017; Hogan and Salt, 2017) and the need for governments to address escalating energy costs (Chester & Morris, 2011; Willand & Horne, 2018) has failed to draw attention to the broader social conditions that have led to the coalescence of thermally inefficient homes, financial hardship and individual vulnerability for some households. Therefore, there is a need to better document the burden of risk associated with cold in homes and provide evidence to inform improved public policy.

In Australia, it is cold more than heat that kills (and makes people sick)

While Australia is perceived as having a relatively benign or even summer-dominated climate, the majority of the population live in climates where it takes more energy to keep comfortably warm in winter than comfortably cool in summer (Bureau of Meteorology (BOM), 2016). Additionally, a rapidly growing body of work demonstrates strong associations between wintertime conditions and high seasonal mortality rates (e.g. Gasparrini *et al.*, 2015; Huang *et al.*, 2015). Across Australia's five largest cities, the death rate from 1988 to 2009 was 20% to 30% higher in winter than in summer (Huang *et al.*, 2015). Huang and coworkers also found that non-stationary winter weather patterns (i.e. unusually colder or dry) in the same five cities (Sydney, Melbourne, Brisbane, Perth and Adelaide) significantly increased mortality risk but that non-stationary summer weather patterns (i.e. hotter or more humid) did not. Surprisingly, the wintertime mortality rate in Australia is also higher than that of several colder-climate countries, including Canada, the USA and Sweden (Gasparrini *et al.*, 2015, p. 372). Howden-Chapman *et al.* (2017) offer succinct explanation of this phenomenon:

> 'Winter mortality is greater in countries with milder climates than in those with more severe winter conditions, which suggests that countries with mild winters often have homes characterized by poor thermal efficiency that are harder to heat than well insulated houses in more extreme climates.' (p. 4)

Several studies have observed the role of housing conditions in seasonal mortality and ill health. For example, in concluding their review and comparison of hypothermic deaths in South Australia and Sweden, Bright *et al.* (2014) suggest that poorly insulated and heated homes may be an important, underlying factor in the high rate of hypothermic deaths in South Australia, which predominantly occur in the home. Studies from other countries have also made similar observations of the relationship between housing conditions and health outcomes during cold weather. For example, living in rental tenure or being located in an urban area have been shown to increase the risk of winter death in New Zealand ($n = 75{,}138$ eligible mortality records from five censuses from 1981 to 2011) (Hales *et al.*, 2012). While the specific casual

mechanisms were not explored, the authors implicate lower indoor temperature and household crowding in the increased likelihood of negative health outcomes. In their study of extreme-cold exposure in Barcelona from 1986 to 2012, Peralta *et al.* (2017) present mixed findings. They suggest that energy-efficiency and façade retrofitting may have acted as a protective factor for females, but as a risk factor for males ($n = 2{,}552$). Gendered smoking and socializing behaviour was offered as a possible explanation of these differentiated effects (i.e. greater levels of indoor pollutants due to reduced incidental ventilation post-retrofit). Overall, internationally, and especially in Australia, more evidence is needed on the drivers of cold indoor conditions and the implications for health and well-being.

Winter risk and the dominance of energy poverty in the literature

ALhough few Australian studies have investigated wintertime housing conditions and their effects, there has been a recent increase in focus on the effects of energy costs and hardship (e.g. Azpitarte *et al.*, 2015; Moore *et al.*, 2017). This is unsurprising in an era of rapid and sustained increases in energy prices. For example, Chester & Morris (2011) explore the relationship between rising electricity prices (due to a recent liberalization of the Australian electricity sector) and resultant energy poverty. They find that energy poverty is widespread not only among the poorest households but also among those on more moderate incomes. More recent work by Azpitarte *et al.* (2015), using the longitudinal Household, Income and Labour Dynamics in Australia (HILDA) survey, assesses a number of indicators of energy poverty (or *fuel* poverty) and proposes a number of key groups who are likely to be vulnerable. Importantly, however, these key vulnerable groups appear to be differen – and somewhat contradictory – depending on the measure of energy poverty used.

Looking to the international literature, Liddell & Morris' (2010) systematic review of the impacts of fuel poverty expands the framing of this problem to assess health effects. They find that both adults and children are affected; children are especially prone to physical impacts, while there appears to be a strong relationship between fuel poverty and mental health effects among adults. More recent work by Hernández (2016) is particularly interesting. It describes a period of increasing energy costs and energy insecurity in the USA, as can similarly be observed in Australia over the same period, and squarely regards energy as an increasingly important health concern. This qualitative study analyses the experience of energy poverty for 72 families and charts a common pathway from energy poverty to disease and disadvantage (Hernández, 2016, p. 7). Effects are categorized in this study across health, social and environmental consequences, and span asthma, chronic stress, hazardous exposures and residential instability. Others have more formally documented the direct and indirect pathways by which energy poverty impacts on health (e.g. Marí-Dell'Olmo *et al.*, 2017; Thomson & Thomas, 2015; Willand *et al.*, 2017). While their conceptual models vary in specific detail, three main determinants are commonly cited: poor condition and energy-inefficient housing, low household income and high-energy costs.

Warm housing interventions where they are most needed

Various governments, particularly in colder-climate countries, have acted to address problems of inefficient housing and energy poverty. In the UK, for example, one of the criteria of the Government's Decent Homes Standard for public housing is that the home 'provides a reasonable degree of thermal comfort' (Department for Communities and Local Government, 2006, p. 12). Similar work completed by industry and the not-for-profit sector in Scotland, expressed via The Living Home Standard, lists effective heating and that the home is free of damp and mould as essential criteria for decent conditions (Shelter et al., 2019). Closer to home, sustained policy effort supported by research and community engagement, has worked to address New Zealand's legacy of poor quality housing stock (Howden-Chapman *et al.*, 2011). Importantly, analysis of a community trial of insulation retrofitting in New Zealand reported a cost-benefit ratio of 2:1 (Howden-Chapman *et al.*, 2011; Preval *et al.*, 2010), suggesting an economic case for warm housing, particularly for key vulnerable groups. Evaluation studies of such intervention programs also reveal important outcomes for health and well-being; for example, improvement in asthmatic symptoms (Free *et al.*, 2010; Howden-Chapman *et al.*, 2011), general health (Lloyd *et al.*, 2008; Howden-Chapman *et al.*, 2011), children's nutrition (Frank *et al.*, 2006) and blood pressure (Lloyd *et al.*, 2008). Following a systematic review of this body of literature, Thomson *et al.* (2009) observe that potential health benefits are dependent on baseline housing conditions and careful targeting of the intervention to the most vulnerable. This is similarly reflected in a review of housing policy and energy poverty literature by Marí-Dell'Olmo et al. (2017), who proposed three key characteristics for policy intervention: that the program is free for the target population, that the target population are the most vulnerable and that any intervention must be adaptable to users' needs. These criteria for intervention reflect an important distinction in understanding vulnerability to cold housing (or, indeed, other forms of housing disadvantage): the difference between the *risk* of exposure and *actual* lived experience. This distinction is critical in how we might frame policy responses; perhaps we need not be overly concerned for individuals who are only briefly exposed to cold housing but are then able to improve their situations by drawing on social, economic and personal resources. Instead, we might be more attentive to those who are persistently vulnerable, and where negative impacts on health and well-being are more likely.

Risk, uncertainty and cold in homes

One way to understand people's vulnerability to cold housing is to view housing disadvantage through a risk lens. Beginning in the early 1990s, social theorists such as Beck (1992, 2000) and Giddens (1999) began to focus on the emergence of what they labelled a 'risk society' within advanced economies. They argued that change within economic and social relationships and institutions had removed the certainties of the immediate post-war era and resulted in a process of 'individualization', where individuals and households were increasingly exposed to the risks – and opportunities – of rapid change. Giddens (1999) argued that key social institutions, including governments and large-scale employers, sought to better manage their own risk by stepping away from many aspects of the comprehensive welfare state and instead

emphasizing 'mutual obligation' and a self-help ethos (Beer *et al.*, 2005). As Beck (2000) noted, the rise of the risk society gives individuals the opportunity to 'script their own lives'. For some, a 'risk society' offers greater choice with respect to lifestyle, employment and living arrangements, as well as better opportunities to earn a high income. Others are left exposed to a relatively insecure labour market, where social institutions, government and community provided supports are inadequate.

The risk society perspective represents a 'theory about housing' in the categorization developed by Ruonavaara (2018). It is an example of the import of theoretical resources from other domains into the housing sphere. As a conceptual construct, it is important because it highlights the process of individualization across the life course and the likelihood of greater inequality in housing and labour market outcomes. Particularly, useful for our conceptualizations of housing issues is the concept of 'manufactured uncertainty'; that is, a recognition that the critical risks faced in the contemporary world are those generated through human action, rather than as a consequence of the natural environment. From this perspective, individuals are at risk in their homes not because of adverse natural events (external risks) – extreme cold or heat, fire or flood – but because social and economic structures are accepting of inequality and the potential for some members of the community to experience harm. A contemporary example may be the societal acceptance of both high and low quality dwelling conditions in the private rental sector, where people trade-off affordability for quality. In cold weather (a clear external risk), uninsulated homes constitute a manufactured risk. Thus, we are motivated to consider the wider combination of societal conditions that expose people to risk, rather than simply the material conditions of the dwelling or broader external risk.

The risk society literature has developed since its early formulation, and much of this development is helpful for our understanding of people's vulnerability to cold housing. While Beck's thesis essentially argues that risk is democratic, Abbott *et al.* (2006), for example, suggest that risk is unevenly distributed because not all groups within society have the capacity to understand the risks confronting them nor respond appropriately. Similarly, extending our recognition of the importance of acknowledging risk, Higgins & Natalier (2004) view risks as socially derived 'rather than simply objective phenomena waiting to be discovered' (p. 81). These developments are important, as they imply that society needs to acknowledge a risk, accept that it causes harm, and develop a discourse that sees a causal relationship between the object and the imposition of harm on individuals. By implication, phenomena that are not acknowledged as harmful are not a 'risk'. In a mild-climate country such as Australia, we have not typically seen indoor cold as a risk, nor a harm, because of our collective belief that our housing stock is of good quality (Baker *et al.*, 2016; Paris, 1993) and that our wintertime conditions are not severe enough to warrant concern (Hitchings *et al.*, 2015).

Important also to our understanding of the (uneven) distribution of risk is its coalescence among those with fewer economic, social, political and personal resources. For example, Curran (2013a, 2013b, 2018) has drawn together a number of critiques of Beck's work arguing that the original risk society thesis ignores the continuing impact of class within contemporary society. Broadly, Curran (2013a, 2013b) notes that risk remains

unevenly distributed, and those most likely to be adversely affected remain the poor and otherwise disadvantaged. More specific to housing research, Stonehouse *et al.* (2015) similarly argue that 'housing risks' are 'unequally apportioned due primarily to economic and social stratification' (p. 389). That is, those with wealth and control of productive assets are better able to manage and avoid social and environmental 'bads'. We can see this plainly in the context of housing, where the amount that a household pays for their housing determines quality, condition and location. For example, Clair *et al.* (2019) and Baker *et al.* (2019) both draw on the risk society thesis in their interpretation of the social processes involved in generating disadvantaged housing outcomes. Such work clearly demonstrates the need to acknowledge long-established patterns of inequality, while also emphasizing the challenge of understanding how society comes to acknowledge (and construct) a risk. Importantly, from this perspective, the incidence of cold in Australian homes may not be an accepted risk within our community because of the failure to unearth evidence and establish causative links that document the degree of harm.

Critically, the original conceptions of Beck's risk society perspective appears relatively blind to the unequal structuring of society and all that it implies for the distribution of risk by socioeconomic status, gender, ethnicity and faith. To a degree then, we argue that it may make its greatest conceptual contribution when paired with other perspectives that more fully address the structuring of society and the determination of material outcomes. In particular, to more effectively understand adverse housing outcomes, we need to better understand how these outcomes have been generated, and one potentially productive pathway is to explore the marrying of the risk society perspective with a focus on housing production and housing production systems. Beginning in the 1980s, a small group of theorists (Ball, 1983, 1986; Ball *et al.*, 2000; Kemeny, 1987) began to debate the most appropriate theoretical focus for housing research – a production or consumption based research agenda. Michael Ball (1986) suggested, in his structures of housing provision thesis, that there is first and foremost need to understand the social and economic conditions under which housing is constructed, as the type and quality of housing built has a long-term impact on outcomes. Ball (1983) argued that housing could only be understood with reference to the social relationships which determine the nature of housing provision within market-based societies. That is, the relationships that structure housing outcomes and, by implication, determine how an individual's housing situation affects their quality of life. Ball (1983) contended that there is a need for a theoretical framework that involves:

> '… seeing housing provision at any point in time as involving particular social relations. Housing provision … is the product of particular, historically determined social relations associated with the physical process of land development, building production, the transfer of the completed dwelling to its final user and its subsequent use. They can be defined as the structures of housing provision' (Ball, 1983, p. 17).

As Ruonavaara (2018) observed, the structures of housing provision thesis is best thought of as a 'meta theoretical framework' and that research 'should always start from mapping the structure of social relations of housing provision (p. 186)', after which the researcher is at liberty to develop additional theoretical positions.

Adapting Ball's perspective, cold housing in Australia is a product – not inevitable, but a consequence of historical and societal processes – of how housing is provided in this nation (as well as the degree of welfare support provided by the state), and there is a need for greater analysis of the economic and other drivers that have delivered this outcome. The structures of housing provision thesis provide the meta narrative within which analysis is located, while the risk society thesis has the capacity to generate research questions and insights at the micro level that can be tested empirically and further refined (Duncan & Ley, 1982). Critically, Australia as a nation has produced – over multiple generations – housing that is cold in winter and potentially harmful to health. This has occurred despite numerous cycles of reform to building codes at the national level (Moore *et al.*, 2019), and we need to understand how this adverse outcome has persisted. Overall, there is a substantial program of research to be completed around how the thermal efficiency and performance of housing in Australia has been 'framed' and how Australia has failed to adopt many of the innovations evident in other nations that keep homes warm and safe in winter. In a very real sense, the housing produced in Australia represents a 'risk' for the population and this article represents an early attempt to bring together these two theoretical perspectives and shed new light on the production of potentially unhealthy housing (Baker *et al.*, 2017, 2019).

Addressing the problem of cold in Australian housing requires an understanding of whether we indeed have a cold housing problem, who it affects, and the relative vulnerability of people to the harms of indoor cold exposure. The article is thus framed by two research questions:

RQ1: Who in Australia is unable to heat their home?
RQ2: Can we anticipate future risk from people's current characteristics?

Methods

Data

The analyses described here use data from the HILDA survey, a large annual panel survey of Australian households and individuals undertaken since 2001. It is based on a nation-wide probability sample and collects information about income, employment, health and well-being, and other individual attributes from a representative sample of Australian householders using face-to-face interviews and self-completion questionnaires (Summerfield *et al.*, 2017). Our analysis draws on 16 annual waves of data. Waves 1–16 were pooled ($n = 193{,}492$ observations), representing an average of 12,521 individuals and their households each wave.

Variables

We focus this analysis on households who self-identify as being unable to heat their homes in the HILDA dataset. This is captured in the dataset in the following question:

> 'Since January 20xx [12 months prior to the survey] did any of the following happen to you because of a shortage of money? -Was unable to heat home'.

Across 15 annual waves of the survey (noting that this question was not included in wave 10), a relatively consistent (∼3%) of people responding to this question identified that they were unable to heat their homes. While subjective in nature, this variable represents a valuable proxy measure for self-assessed cold housing, capturing the assessment of cold, alongside the inability to afford to alter it (see Azpitarte *et al.*, 2015 for a discussion of the utility of objective and subjective measures in this area).

Approach

The analysis comprises of two stages. We first undertook a descriptive analysis to compare cohort characteristics of individuals experiencing cold housing and those unaffected. This step of the analysis enables us to characterize Australians who are able and unable to heat their home. To determine more formally whether these two cohorts are distinct, we test differences between the sociodemographic, housing and health characteristics. We performed the two types of tests: mean differences were tested using a *t*-test with unequal variance assumption; and median differences were tested using a Fisher's exact test (similar results were obtained using a Pearson's chi-squared test, results not reported).

We then undertook a simple analysis drawing on waves 11–16 to compare differential vulnerability among those experiencing persistent cold housing problems. Because longitudinal datasets like HILDA contain detailed information about the living, working and residential conditions of people at (usually annual) data collection points, over time, we can follow their exposures, effects and outcomes. Longitudinal data allows us powerful insight into the persistence of risk. If we initiate our analysis from a previous point in time (before risk is apparent), we are then able to observe the drivers of risk, and 'prospectively' assess who is vulnerable, and who appears protected.

The second stage of analysis focusses on all responding individuals in the dataset who were unable to heat their home in 2011. One reason to start the second stage of the analysis from wave 11 onwards is that there was a top-up sample of 2000 households in wave 11, capturing changes in the Australian population structure (Watson, 2011). Additionally, and as noted above, information that whether individuals' ability to heat their home was not collected in wave 10, preventing us from measuring the persistence of cold housing problems through the entire period from wave 1 to wave 16.

We classify this analytical group into two comparison cohorts on the basis of their future ability or inability to heat their homes to 2016:

- Risk Cohort Persist: persistently unable to heat for the next 5 years and
- Risk Cohort Never: never again affected by the inability to heat their home.

To retain sufficient individuals in our two cohorts, up to two missing cases were allowed for each individual.

Results

This section presents the results of the two stages of analysis. First, a descriptive analysis compares cold-affected and unaffected cohorts based on 15 annual waves of pooled data (waves 1–16), and second, a prospective analysis examines the risk profiles of people who will go to be persistently exposed to cold housing problems over a 6-year period (2011–2016).

Descriptive analysis

When we compare the broader population characteristics of people affected and unaffected by cold housing problems, there are both expected and unexpected patterns. There appears to be little correlation between age and likelihood of experiencing cold housing problems (Table 1). The data from this nationally representative survey suggest that from early adulthood (20–29 years), through middle age (30–49 years) and to latter middle age (50–59 years), people are significantly more likely to be unable to heat their homes ($p = .034$, $<.000$ and $<.000$, respectively). The comparison in Table 1 also suggests that females are more vulnerable to experiencing cold housing problems than males ($p \leq .000$). Just less than 60% of women were unable to heat their home, compared to 40% of men. Summary statistics for health characteristics highlight significant differences between the populations who are able, and unable, to heat their homes. The majority (75%) of people experiencing cold housing problems rate their health as 'fair or poor' ($p \leq .000$). People who are unable to heat their homes are also much more likely to have a long-term disability or health condition ($p \leq .000$).

The income comparison shown in Table 1 is particularly striking. It suggests that, while cold housing problems are concentrated among people with lower incomes ($p \leq .000$), people report cold housing problems at all levels of the income distribution. This finding is consistent with other large-scale studies; for example, the Household Energy End-use Project in New Zealand (French *et al.* 2007). We also note that while the mean household energy expenditure of people who cannot (AUD$14,350) afford to heat their homes is lower than that of those who can (AUD$16,700), energy expenditure represents a larger proportion of total expenditure for low income households.

Relative differences in employment status shown in Table 1 suggests that people experiencing cold housing are much more likely to be out of the labour force than participating in it ($p \leq .000$). This is an interesting finding considering the age characteristics described above: that the population most affected by their inability to warm their houses is relatively young. Table 1 also summarises household composition, showing that lone person and lone parent households are significantly less likely to be able to heat their homes than couples with or without children ($p \leq .000$).

People unable to heat their homes are much more likely to express dissatisfaction with their housing and are more likely to be housed in the rental sector (both $p \leq .000$). The finding that cold affected individuals are much more likely to express dissatisfaction with their housing is important because it suggests that financial inability to adequately heat may be exacerbated by poor housing conditions.

Table 1. Personal, household and housing characteristics for affected and affected cohorts.

Variable		Unaffected (%)	Unable to heat home (%)	*p* value
Gender	Male	47.0	40.4	.000
	Female	53.0	59.6	.000
Age cohort (years)	15–19	8.7	6.1	.000
	20–29	16.7	17.8	.034
	30–49	35.4	38.1	.000
	50–59	16	18.3	.000
	60–75	17.2	15	.000
	75+	5.9	4.6	.000
Income decile	1	11.3	29	.000
	2	10.4	18.4	.000
	3	9.9	15.2	.000
	4	9.6	11	.000
	5	9.5	8	.000
	6	9.7	6	.000
	7	9.6	4.1	.000
	8	9.9	3.8	.000
	9	10.1	2.9	.000
	10	10.1	1.6	.000
Tenure	Owner	71.7	40.6	.000
	Rent - public	3.6	15.3	.000
	Rent - private	21.3	39.9	.000
	Other	3.3	4.2	.001
Labour market status	Employed	64.4	41.5	.000
	Unemployed	3.4	9.6	.000
	Not in the labour force	32.2	48.9	.000
Household structure	Couple with children	35.3	22.2	.000
	Couple no children	36.9	21.6	.000
	Lone parent	8.3	19.2	.000
	Lone person	14.9	29	.000
	Other	4.6	8	.000
Education	Degree+	23.1	11.3	.000
	Diploma/Adv. Diploma	9	8.7	.526
	Cert III & IV	20.2	25.1	.000
	Year 12	15.1	12.2	.000
	Year 11 and below	32.6	42.7	.000
Long-term disability or health condition	No long-term disability	73.8	49.3	.000
	Long-term disability	26.2	50.7	.000
General health	Fair or poor	51.7	75.1	.000
	Good or above	48.3	24.9	.000
Mental health	Average MCS score	49	39.6	.000
Physical health	Average PCS score	49.6	43.9	.000
State	NSW	29.6	29.8	.725
	VIC	24.9	21.3	.000
	QLD	20.8	17.9	.000
	SA	9.2	13.1	.000
	WA	9.5	11.1	.000
	TAS	3.2	5.7	.000
	NT	0.7	0.1	.000
	ACT	2.1	0.9	.000
Location	City	65.6	58.5	.000
	Regional	32.8	40.5	.000
	Remote	1.6	1	.000
House satisfaction	Totally dissatisfied	0.6	3.3	.000
	Somewhat dissatisfied	2.1	7.2	.000
	Neither satis. nor dissatis.	13	24.3	.000
	Somewhat satisfied	40.4	35.6	.000
	Totally satisfied	44	29.6	.000

Similarly, a higher proportion of cold affected households in the rental sector corroborates emerging evidence on the especially poor condition and energy *in*efficiency of rental properties (e.g. Baker *et al.*, 2019).

Finally, there appears to be additional locational differences in the likelihood of having cold housing problems across Australia. People who are unable to heat their homes are slightly more likely than people who are unaffected to live in regional areas ($p \leq .000$). There is also a pattern to the distribution across the States and Territories. Standing out in this table are the cases of Tasmania and South Australia, where cold housing is noticeably over represented. While Tasmania has one of the coldest climates in Australia, South Australia's climate is considerably more moderate. The distribution of cold-affected homes across the different states appears to corroborate our earlier proposition that the problem of cold housing in Australia is not simply one of climate. Indeed, in both Victoria and the Australian Capital Territory – with cool or cold-temperate climates – affected households are under-represented. All proportions are significantly different ($p \leq .000$), except for New South Wales, where the number of people able and unable to heat their homes is very similar ($p = .725$).

Prospective risk and vulnerability

Inherent, however, in contemporary understandings of risk is the assumption that people's future risk is driven, to some extent, by the sociodemographic characteristics that they currently possess, and that risk coalesce an ahistorical manner. Building on the basic cross-sectional descriptive analysis presented in the preceding section, longitudinal data allows us a rare opportunity to examine this assumption. In this part of the analysis, we exploit the temporal dimension of the HILDA dataset to look into the future at a population, anticipate who will go on to be persistently affected by cold housing problems, and then test whether they are distinct in their initial sociodemographic characteristics. We do this by following all respondents to the 2011 wave of the HILDA survey who experienced cold housing problems, we then prospectively classify this group by their future (5 year) pattern of exposure to cold housing problems. We identify two groups: people who are never going to be affected again (Risk Cohort Never (RCN)), and people who are going to be persistently affected (Risk Cohort Persist (RCP)). By focussing on a base population who initially experience cold housing problems (in 2011), our analytical sample is to some degree exchangeable, that is, similar. Of the 606 respondents who had cold housing problems in 2011, 43 go on to have persistent problems each year to 2016, and 152 are never again affected. The sociodemographic characteristics of these two groups are strikingly distinct (as summarized in Table 2) and are consistent with the trends suggested in the first part of the analysis.

Both groups have low average mental health scores (RCP = 37, RCN = 43), and this is especially notable considering these measures are standardized for the population to a mean of 50. Furthermore, both groups have an average mental health score below, or very close to, the widely acknowledged cut-off score of 42, used to detect depressive disorders (e.g. Vilagut *et al.*, 2013). Acknowledging the low average scores across the two groups, the persistent group's score is significantly lower ($p = .002$). Average physical health scores

Table 2. Sociodemographic characteristics of persistently exposed and never again exposed cohorts.

Variable (%/average score)		Risk cohort persist	Risk cohort never	*p* value
Gender	Proportion female	66.2	61.8	.546
Age	Average (years)	51	43.7	.002
Income decile	1	38.5	15.1	.001
	2	21.5	9.2	.032
	3	23.1	15.8	.231
	4	3.1	12.5	.007
	5	1.5	9.9	.004
	6	3.1	11.8	.011
	7	4.6	9.2	.194
	8	1.5	7.9	.019
	9	3.1	5.9	.326
	10	0	2.6	.045
Tenure	Owner	50.8	47.4	.649
	Rent – public	27.7	11.2	.009
	Rent – private	20	36.8	.009
	Other	1.5	4.6	.183
Labour market status	Employed	33.8	51.3	.016
	Unemployed	6.2	6.6	.907
	Not in the labour force	60	42.1	.016
Household structure	Couple with children	15.4	27	.047
	Couple with no children	13.8	28.9	.009
	Lone parent	20	15.8	.47
	Lone person	46.2	19.7	.000
	Other	4.6	8.6	.259
Education	Degree+	9.2	9.9	.884
	Diploma/Adv. Diploma	12.3	14.5	.666
	Cert III or IV	21.5	19.1	.685
	Year 12	12.3	19.7	.158
	Year 11 and below	44.6	36.8	.292
Long-term disability or health condition	Proportion with long-term disability	70.8	39.5	.000
General health	Proportion fair or poor	89.1	68.9	.000
	General health average	10.9	31.1	.000
Mental health	Average MCS score	36.7	43.2	.002
Physical health	Average PCS score	37.2	45.1	.000
Location	City	61.5	65.8	.556
	Regional	38.5	31.6	.339
	Remote	0	2.6	.045
House satisfaction	Totally dissatisfied	1.5	2.6	.588
	Somewhat dissatisfied	4.6	2	.358
	Neither satisfied nor dissatisfied	26.2	29.6	.604
	Somewhat satisfied	36.9	34.2	.706
	Totally satisfied	30.8	31.6	.907
Times moved house during the study period	Average (years)	0.5	0.9	.024

are similarly below the expected general population mean for the two groups, although Risk Cohort Never has a substantially higher mean physical health score compared to Risk Cohort Persist (RCP = 37; RCN = 45, $p \leq .000$). The SF-36 measure of general health is a simple, but reliable self-assessed measure of health; here again, there is a substantial difference between risk cohorts ($p \leq .000$). Risk Cohort Never have a substantially higher level of self-assessed general health (RCP = 11; RCN = 31). When respondents in the two cohorts were asked in 2011 to classify their health on a scale from 'Good' to

'Poor', a notably higher proportion (89%) of Risk Cohort Persist classified their health as either 'Fair' or 'Poor', this was significantly higher than for Risk Cohort Never (69%, $p \leq .000$). Correspondingly, almost three quarters (71%) of Risk Cohort Persist have a disability or long-term health condition, compared with just 40% of Risk Cohort Never ($p \leq .000$).

The household structure characteristics of these two cohorts are also distinct. The group who go on to be persistently exposed are significantly more likely to be lone person (46%, $p \leq .000$), and slightly more likely to be lone parent households (20%, although not significantly different $p = .47$), and the group who go to avoid subsequent cold housing problems are dominantly couples (27%, $p = .047$), or couples with children (29%, $p = .009$). Similarly, examining educational characteristics, the persistently exposed cohort on average have low levels of educational attainment, compared with Risk Cohort Never. The majority of the cohort who avoid subsequent cold housing problems are employed (51%, $p = .016$); this contrasts with the majority of the persistently exposed cohort who are not in the labour force (60%, $p = .016$).

The housing characteristics of these two groups are also distinct. Risk Cohort Persist has a lower level of overall satisfaction with their housing, and they are almost three times more likely than Risk Cohort Never to live in public rental housing ($p = .009$). There is also a geographical correlation, with people in Risk Cohort Never dominantly living in cities (although no significant difference, $p = .556$), and a large proportion of Risk Cohort Persist living in regional areas (39%, no significant difference $p = .339$). While there were no objective measures of housing quality available to us during the 'exposure' period, we see that Risk Cohort Never are significantly less stable throughout the period, with an average 0.9 moves over the 5 years. Finally, people who go on to have persistent cold housing problems are highly concentrated at the lower end of the income distribution, with over 80% of this group classified in the lowest 30% of the national income distribution. In comparison, less than half of Risk Cohort Never sits within the lowest 30% of the national income distribution.

Discussion

Our analysis highlights the varying degrees by which households are affected by cold housing problems; who is likely to be affected and the persistence of their risk position. Reflecting on our findings, using the lenses of the risk society and structures of housing provision theses, attention is drawn to three themes that are important in understanding and responding to our cold housing problem: that intervention is only possible once risk (or the problem) has been acknowledged and prioritized, that individuals' resources determine their vulnerability to persistent risk, and that the persistence of risk (and vulnerability to harms) can be anticipated.

Stonehouse *et al.* (2015) write on the policy discourse of housing risk:

> '… discourse is broadly understood as involving aspects of language and power, and as exerting influence on both ideas (i.e. *what* is to be regarded as a 'problem' requiring intervention, and *how* it is to be understood) and behaviours (i.e. who is responsible for dealing with the problem and in what ways they should respond)' (p. 395).

The discourse around environmental problems in Australia is firmly centred on climate change, where the 'problem' is regarded as one of extreme heat events and increasing temperatures, *not* one of cold despite significant evidence demonstrating that the effects on health and well-being are several magnitudes larger for cold exposure than for heat exposure (e.g. Huang *et al.*, 2015). The strength of research prioritization and policy discourse around climate change (Lovell, 2019), inherently focusses efforts toward future resilience to extreme (hot) weather events. Cities are further identified as the locus of problems within the built environment through the dominance of narratives about urban heat islands. We suggest that by framing our recognition of housing problems in this manner we fail to acknowledge challenges – over and above drought and flooding – outside of our cities. For example, our findings show that more people are unable to heat their home in regional areas, and we suspect that the legacy of poor quality housing in regional and rural areas might play an important role in shaping housing outcomes in these areas (Baker *et al.*, 2016). So we need a discussion that puts the prevailing focus on heat into perspective; too often, we ignore the simple fact that deserts are cold in winter, and that many parts of Australia – Canberra, Armidale, Bendigo, Ballarat and Melbourne – have prolonged periods of low temperature. Even under high-emissions climate change scenarios, cold-related excess mortality is forecast to remain higher than heat-related excess mortality in Australia (Gasparrini *et al.*, 2017). So whether and how our homes protect us from cold exposure – and the potential consequences for health and well-being of failing to deal with this problem – will remain an increasingly critical issue into the future.

Beck's early writings proposed that risk is egalitarian (Beck, 1992). More recently, Curran (2018) has explicated this argument to suggest that risk is only egalitarian when the hazard is unknown but as people become aware of the risk, those with greater economic, social, political and personal resources act to occupy places of relatively lower vulnerability. We suggest that this idea may partially explain the occurrence in our results of cold housing problems even at the top of the income distribution. That is, for example, if there was better public health messaging about the risks of cold housing but no accompanying intervention to reduce the vulnerability of those with relatively lower wealth, we might expect to see the problem more firmly concentrated amongst the most disadvantaged. Following Curran's development of the risk society thesis, greater awareness of the risk would likely see relatively wealthy individuals move to occupy and monopolise less vulnerable positions (e.g. mobility toward more favourable climates, extensive home retrofits and higher indoor temperatures), as they have the capacity to deploy (primarily) economic and personal resources as protective mechanisms. Importantly, the analysis also draws on the structures of housing provision thesis: much of Australia's housing stock has been constructed – physically and putatively – as family housing, and it is lone person and lone parent households, who sit outside this socially constructed 'norm', that experience the greatest incidence and risk of cold in their homes. While these groups are materially disadvantaged in Australia (Beer *et al.*, 2016), they are also invisible in key public discourse which often focuses on the need to accommodate conventional 'families'. The social drive to accommodate the needs of the very young and old might additionally help to explain, within our results, that it is dominantly working age adults (20–60 years) who

experience cold housing problems. Extending this interpretation further, and through the lens of the SHP thesis, we suggest that, through discourse and policy prioritization of ageing-in-place initiatives, the housing outcomes of older and elderly people have been privileged. As researchers and policy makers, we have failed to acknowledge the potential vulnerability of those who are younger.

Such social and economic inequalities taken together with the findings of this article suggest that it is likely the same people, over and over again, are at risk of housing and other disadvantage. In both of our analyses, we find marked health inequalities across the cohorts; people with disability and long-term health conditions are over-represented among people experiencing cold housing problems. This group is also likely to be more vulnerable to the effects of indoor cold, with clear evidence from a number of studies demonstrating that people with existing health conditions often experience a worsening of their health when living in cold homes (Daniel *et al.*, 2019; Howden-Chapman *et al.*, 2011; Willand *et al.*, 2019). The basic risk society thesis – with contemporary understandings of the implicit relations to patterns of wealth, power, knowledge, and interpersonal resources – gives us some framework for understanding why the same individuals occupy positions of persistent vulnerability, and are therefore unequally and enduringly exposed to risk. This means that unless the underlying 'structural sorting' is addressed, we will continue to see the same individuals exposed to not only existing risk but also to dynamic and evolving risks driven by future social, economic and environmental change. However, it also means that we can, with some degree of confidence, anticipate people's future risk positions. If we articulate this understanding to policy action, our interventions become, instead of reactive, proactive as we are able to anticipate the populations likely most exposed to future risk, as beautifully described by McMichael (1999).

This article is the first to use nationally representative Australian data to better understand cold housing problems. A critical limitation though to continued research in this area is the lack of robust, detailed and representative data on housing conditions in Australia. The HILDA survey represents one of the most useful datasets for Australia housing researchers, though it has very limited information about the material characteristics of respondents' housing. The Australian Bureau of Statistics' Housing Survey was last completed in 1999; recently, researchers have initiated a new cross-sectional survey on Australian housing conditions (Baker *et al.*, 2018); however, the sample is not yet longitudinal. While this research is unable to provide causal evidence nor in-depth examination of specific material characteristics of cold affected homes, as data become available, these are valuable areas for future research. Arguably, the generation of sufficiently robust and representative evidence on the role that the conditions and quality of our housing stock plays in determining the health and well-being of Australians would assist in driving more wholesale reform of the nation's currently weak minimum building standards.

Conclusion

The results presented in this article give us an initial insight into the nature of the problem of indoor cold in Australia and who might be most at risk. The descriptive

statistics suggest that while problems tend to be especially prevalent in the rental tenures (both public and private), many of our other assumptions about who is vulnerable may be wrong. Cold housing is clearly not a problem limited to older households, but is instead much more prevalent in the younger- and middle-ages. Of particular interest, local climatic conditions may not suggest a straightforward risk of living in cold houses. Instead, the results suggest that the bundle of resources (financial, social, personal and political) that individuals' can deploy is more important in accessing and maintaining warm housing. Our more nuanced analysis of persistent vulnerability confirms this and, reflecting as well on the literature, suggests that policy efforts in addressing cold housing must be carefully targeted and tailored to these specific vulnerable cohorts. The higher proportion of persistently cold affected individuals who also have poor health and low income suggests that any improvements to housing could realize important health and economic co-benefits.

This article presents a degree of theoretical experimentation; it represents an early attempt to bring together two historically important theoretical developments to better understand the social and economic distribution of cold housing in Australia. The risk society thesis provides a foundation for understanding how the manufactured risk of cold housing is unevenly distributed across populations, following patterns of existing poverty and disadvantage. The structures of housing provision thesis grounds our understanding of the social and economic factors that have shaped the material conditions of our housing stock over time, resulting in contemporary cold housing problems – for some. Bringing these two foundational theories together enables a focus, not just on the materiality of housing but also – and importantly – the role of social and economic factors in unevenly magnifying adverse outcomes across populations. This combination of conceptualizations suggests rich areas for further theoretically informed research, including work on policy processes and public perception, the circumstances in which risk may manifest as a concrete hazard, and the ways in which the risk of cold is embedded into housing construction practices, both at the national and regional level.

Sitting on the strong foundation of previous work in housing research, this article contributes a new and more nuanced conceptualization of the interaction between people and their housing. It situates housing within the broader landscapes of individual and societal risks. This new conceptualization of risk presents a challenge to housing research, to move beyond analyses that abstract the 'dwelling' from its context and role within people's lives. There is clearly scope for further research on the processes of causation and the level of harm inflicted on society by cold housing. At the same time, we need to bring forward the fact that those most likely to be affected include many of the most vulnerable within society. The 'bads' associated with cold homes are likely to be significant and reinforce long established cleavages in Australian society. Critically, individuals are more likely to die from the impact of a cold home in Australia than in much colder-climate countries, but Australians fail to acknowledge this risk because of the absence of a robust evidence base.

Note

1. We use the term 'energy poverty' in this article in its general sense; i.e. instances where households may have difficulty paying their energy bills on time, where their expenditure on energy leaves inadequate resources for other essential living costs, where they feel like energy is too expensive or a undue burden, or where households have intentionally reduced their energy consumption to inadequate levels to avoid high energy bills.

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