A national study of the health effects of insulating homes: the baseline data (Report 2)

He Kainga Oranga
Housing and Health Research Programme
Department of Public Health
Wellington School of Medicine and Health Sciences,
University of Otago

August 2002

Philippa Howden-Chapman, Helen Viggers, Anna Matheson, Julian Crane, Nick Waipara, Tony Blakely, Malcolm Cunningham, Chris Cunningham, Alistair Woodward, Des O'Dea, Kay Saville-Smith, Jeroen Douwes, Cara Marshall, Pounamu Skelton

CONTENTS PAGE

A national study of the health effects of insulating homes: the baseline data (Report 2)

SUMMARY

This is the second of a series of reports from the *National Study of the Health Effects of Insulating Homes*. Report 1 describes the baseline data for the study from the Head of Household questionnaire. This report looks at differences between the regions in responses to the Head of Household Questionnaire and the findings from the baseline dust collection analyses.

Head of Household questionnaire by region

The housing stock

- In every region with the exception of Otara, more than 90% of the dwellings are separate houses.
- There is a marked variation between the regions in the age of the dwellings (70% of houses in Christchurch were built before 1959, but under 20% in Taranaki).
- In Otara and Porirua a high proportion of people did not know the age of their house.
- In every region, those who rented were less likely to know the age of their dwelling than those who owned their home.
- Dwellings in Otara, Eastern Bay of Plenty (EBP) and Porirua were more likely to be reported as in 'poor' or 'very poor' condition.
- Dwellings in Mahia/Nuhaka and Hokitika were more likely to be reported as in 'good' or 'excellent' condition.
- The reported 'sunniness' of the dwelling varied by region.
- Those in Mahia/Nuhaka were most likely to report that their dwelling received 'plenty of sun'.
- Those in Eastern Bay of Plenty were most likely to report that their dwelling received 'little' sun.

Tenure and Occupancy

- The proportion of households that owned their own dwelling ranged from a low of 45% in Otara to a high of 88% in Taranaki.
- Most HNZC owned houses were in the urban centres Otara, Christchurch, Porirua. This pattern reflects the location of HNZC houses nationally and how the selection criteria for the study was applied in each community.
- Houses in Otara had, on average, more people living in them than other regions.
- Houses in Mahia/Nuhaka and Christchurch had the least number of people living in them.
- Using the number of bedrooms per person as a measure of crowding, study houses in Otara were the most crowded followed by Porirua and Eastern Bay of Plenty.
- Houses rented from non-HNZC landlords were found to be the most crowded and house the most children compared to other types of tenure.

Behaviour, heating, cold and damp

- Eastern Bay of Plenty reported the least number of functioning smoke alarms.
- The proportion of houses where a participant had smoked inside over the winter period varied from 24% in Christchurch to 55% in Eastern Bay of Plenty.
- The most common form of energy use for heating in all regions was electricity. This was followed by gas heaters and open fires.
- The proportion of households that use unvented LPG heaters ranged from 14.3% in Hokitika to 49% in Porirua.
- The proportion of households using dehumidifiers in their home ranged from 7% in Eastern Bay of Plenty to 31% in Christchurch.
- Most households in each region reported dampness due to condensation.
- Bedrooms were reported to be the dampest rooms in all regions.
- An association was found between having an unflued gas heater and reporting that the living room was damp.
- People in the urban centres (Otara, Christchurch, Porirua) were the most likely to report having the house colder than they would have liked over the winter.

Dust collection

- A wide range of indoor fungal species were found to be associated with dust particles.
- The mean fungal biomass (CFUs) was highly variable between households, but there was no overall difference between the three geographic regions surveyed.
- Aerial fungi were ubiquitous across all households, for example Cladosporium spp was the dominant fungus obtained from household dust.
- Potentially mycotoxic and allergenic species were obtained from all household samples.
- Limited regional variation in fungal biodiversity was observed.

1. INTRODUCTION

This is the second in what will be a series of reports on the *National Study of the Health Effects of Insulating Homes*. The first report describes the baseline data for the study from the Head of Household questionnaire. This second report examines the differences between the regions in responses to the Head of Household Questionnaire and the findings from the baseline dust collection analyses. The sample is not representative of the general New Zealand population because people with respiratory symptoms were deliberately targeted in the sample.

1.2 Study Objectives

(a) To establish the relationship between poor health and damp cold housing among people with existing respiratory problems;

(b) To test whether insulation makes the houses drier and warmer;

(c) To investigate whether insulating the houses improves the occupants' health, well-being and comfort;

(d) To investigate whether insulating the houses affects energy consumption;

(e) To carry out cost-benefit and cost-effectiveness analyses of the results;

(f) To investigate the effect of insulation on mould, endotoxins & house dust mite allergens; and

(g) To investigate regional variations in mould, endotoxins & house dust mite allergens.

1.3 Regional Differences

The seven areas involved in this study are Otara, Eastern Bay of Plenty, Nuhaka and Mahia, South Taranaki, Porirua, Hokitika and Christchurch. The different areas were selected to include regional differences in climate, geography and community. There are three urban centres in the study, Otara, Porirua and Christchurch. Otara clearly has a warmer climate than the other two and the households in the study are more dispersed over a wider area. Households in the Eastern Bay of Plenty (Opotiki, Kaingaroa, Murupara, Whakatane, Kawerau, Te Teko, Taneatua, Minginui, Ruatahuna, Edgecumbe, Awakeri) and South Taranaki (Hawera, Opunake, Patea, Parihaka) are located within a number of smaller rural towns within the region. Those in the Eastern Bay of Plenty are the most widely dispersed of any of the regions, with interviewers having to travel by road for up to two hours to make contact with participants. Nuhaka and Mahia are small east coast communities where people are often known to each other and live in close proximity. Participants around Hokitika, on the wetter west coast of the South Island, also live in relative close proximity but they do extend to Ross and Kumara.

1.4 The key players

The study involves numerous players both supporting and carrying out the research. Following are the major contributors and their roles.

- **WSMHS – researchers** (study design, obtaining funding, strategic direction, management, community relations, funder relations, quality control, data collation, data entry, data analyses, reports, publications and advocacy).

- **Building Research Association of New Zealand) BRANZ** – responsible for implementation and analysis of the objective housing condition surveys.

- **Local organisations** (see Appendix A for list of organisations and main contact people) support, interest, coordination and oversight of interviewers.

- **Local interviewers** (see Appendix B for full list of names), over the 2001 winter there were 22 interviewers employed to carry out the data collection. 13 of last years interviewers remained this year. Over winter 2002, there are 25 employed to carry out the data collection.

- **Smart Power** – overall coordination, management and quality control of retrofit subcontractors.

- **Retrofit contractors** (see Appendix C for a list of retrofit contractors) – subcontracted to carry out retrofitting of the houses involved in the study.

- **Funders** – support and interest (see funding page).

2. WINTER 2002 DATA COLLECTION

Overall the study is going extremely well and the challenges that implementation brings are largely being overcome. As detailed in Baseline Report 1, the data collection for winter 2001 was completed in October last year and soon after were entered into an Access database. Questionnaires from 2001 are currently being double entered to ensure greater accuracy of the data. In October 2001 the intervention, that is the insulation, began to be installed in the houses in the Experimental group. All interventions were completed by 1 June 2002, ready for the second year's data collection to begin.

The second winter of data collection began in June 2002. Local interviewers were recruited in May to collect the data from participants over June, July, August and September. Data loggers were again installed in 10% of the homes. Householders were asked to complete a temperature monitoring form over the three winter months and participants were asked to complete questionnaires about their household, behaviour and their health. Data on energy use, number of GP visits and the number of hospitalisations over the winter months is also being collected.

Interviewers in each community were assigned a number of households from which they were to collect information via questionnaires. Interviewers were given clear instructions on how to ensure that unique identifiers were allocated accurately for the face-to-face administered Head of Household questionnaire and the self-administered individual health questionnaires. The interviewers are working to the timeframe of having all the interviews completed before the end of September. It is looking likely however that some may not be completed until early October.

2.1 Data loggers (measuring temperature and relative humidity)

The data-loggers in 10% of houses have been recording data for the second winter. The instructions recommend changing the battery before launching if the battery level is less than 30% but we found that all battery levels were greater than 75% on launching so batteries were not changed.

The *internal loggers* were launched to take measurements every half hour for 82 days. In the previous winter they were set to take measurements every 15 minutes for 41 days. The longer period was chosen for this winter to maximise the chance of comparable weather conditions occurring during the measurement period. During the first winter the dataloggers in the different regions logged data for slightly different periods, the dates for this winter were chosen so that every region's data logging dates entirely overlapped with last winter's data logging dates in the same region.

Table 1

Region	Internal Data logging 2001	Internal Data logging 2002
Christchurch	13 July – 23 August	10 June – 31 August
Hokitika	20 July – 30 August	10 June - 31 August
Mahia/Nuhaka	20 July – 30 August	10 June - 31 August
EBP	12/17 July – 22/27 August	10 June - 31 August
Otara	20 July – 30 August	10 June - 31 August
Porirua	27 July – 6 September	16 June – 6 September
Taranaki	8 August – 18 September	28 June – 18 September

The *external loggers* have a larger memory than the internal loggers and were all set, this winter, to collect data from the 1st of June onwards.

Table 2

Region	External Data logging 2001 from	External Data logging 2002 from
Christchurch	13 July	1 June
Hokitika	20 July	1 June
Mahia/Nuhaka	20 July	1 June
EBP	12 July	1 June
Otara	20 July	1 June
Porirua	27 July	1 June
Taranaki	8 August	1 June

2.2 Subjective monitoring forms

The subjective monitoring forms where people were asked to record whether they felt 'warm', 'cold' or 'ok' each day over the months of winter were again introduced to the households this year. We asked that (where possible) the same person fill these forms in who filled them in last year.

2.3 Energy data

The collection of the energy (electricity and gas consumption) data is proving more difficult than anticipated. So far we received the energy data on 237 of the houses mainly from Christchurch, Porirua, Taranaki and Otara regions. The data from other areas is proving more difficult to gather. There are a number of reasons for the difficulties including:

a) difficulty in tracking down most appropriate person within the energy company, due to unique nature of request, staff passing on responsibility, or lack of definition as to whose "area of work" this task lies;

b) difficulty in cooperation or following through by many energy companies, due to; seeing this as "volunteer work" and non-profitable for their company (ie relying on goodwill), someone in company agreeing to complete task, then delegating to other members who may not see it as priority or know what it is for, being "too busy", staff turnover, and other issues particular to each company;

c) high turnover of customers switching energy companies; and

d) several power companies merging or being bought by other energy companies within last year.

We are still hopeful of getting the data for most of the households. We have been asking interviewers to read the electricity meters in the homes and record this on the monitoring forms. In Christchurch Orion are measuring energy consumption directly from the meters of the Christchurch participants. Both these sources of information will enrich what energy information we receive.

2.4 Community contact and interviewer training

Twenty-three interviewers were employed on a part time basis over the period of June until October 2002. It was important that the interviewers had local knowledge of their community, and suitable skills and experience to carry out the requirements of the job.

The researchers visited each area in both May and August to make face to face contact with community coordinators, to discuss any issues that may have arisen since last contact, and to provide training to the interviewers. The training covered what was required of interviewers during the monitoring phase of the research including

how and where to install the relative humidity and temperature data loggers, how participants should fill in household temperature monitoring charts, reading electricity meters, interviewing techniques and an overview of the four different questionnaires they were to carry out. Other topics covered during the two days of training included employment contracts, interviewer safety and timeframes for completing the data collection.

The training time gave the interviewers and community liaisons an opportunity to discuss specific issues that they, or their community, were concerned about. A broad range of other issues were discussed including the retrofitting, the increase in power unit prices in some communities and how the research generally was progressing. A common concern across the communities was the difficulty of making contact with some households in order to collect information. The training sessions and the face to face contact are proving very valuable for strengthening the relationship between the research team and the local liaisons and interviewers. The contact provides an opportunity for the research team to convey the importance of the research and the importance of the communities' participation, as well as giving people a chance to air any concerns.

2.5 Consent forms

In preparing for the collection of information about GP visits and hospitalisations we found that in some instances we did not have consent forms for each individual which was a departure from our research protocol. This required the interviewers, when they returned to the households in September, to ensure they had signed consent forms from each household member filling in a health questionnaire. In most communities this was a very minor task as most individuals had already signed a consent form, but in others it was a larger task as only the nominated 'head of household' had signed a consent on behalf of the others. This highlights for us as researchers some of the difficulties with long lines of communication between the decision making and the implementation of the research. Although we were asking another task of our community contacts, this was accepted graciously by both interviewers and participants as necessary for the research to be successful.

3. BASELINE – HEAD OF HOUSEHOLD BY REGION

The results presented in this section are preliminary only, as the data have only been single-entered. All questionnaires are currently being double entered by two different data entry people in order to minimise any systematic errors, and thus provisional only. The analysis here covers 1313 fully identified households. It includes households that are known to have withdrawn from the study but these are still included here to facilitate a later analysis of whether the number of households differ systematically from those that did not withdraw in any way.

The following descriptive statistics is also based on questionnaires that the participants themselves have answered. They are therefore a 'subjective' view of the characteristics we enquire in contrast to the 'objective' measures we are using such as the housing condition survey, the data loggers, the energy data and GP visits and hospitalisations.

In this report "region" is used to refer to the seven areas that the study participants live in. It is important to remember that the participating households were chosen as uninsulated houses in which the inhabitants had health problems that might respond to a warmer environment; they were **not** chosen to be representative of the area as a whole. There may also be differences between regions in the way participants were selected although there were set selection criteria, the community selection committees could exercise some discretion. Thus caution should be used if wishing to use these statistics to:

a) compare inter-regional differences in the study households and extrapolate to inter-regional differences in non-study households; and

b) compare study households in a region with the average New Zealand statistics and extrapolate to the region in general.

3.1 House type and age

The majority of dwellings in all regions are "separate" houses or flats as opposed to "a separate house divided into flats" or "a house joined to another house" or "within a block of flats". In every region but Otara over 90% of the dwellings in the study are fully detached dwellings.

Although every householder in four of the regions (Mahia/Nuhaka, Porirua, Christchurch and EBP) answered the question on type of dwelling, 3% of householders in Otara and Taranaki did not answer the question and neither did 0.5% of householders in Hokitika. The percentage of those who did answer the question and reported living in different kinds of housing are shown in Table 3. Although the frequency of the three least common forms of dwelling vary by region their rates averaged over the whole country are similar.

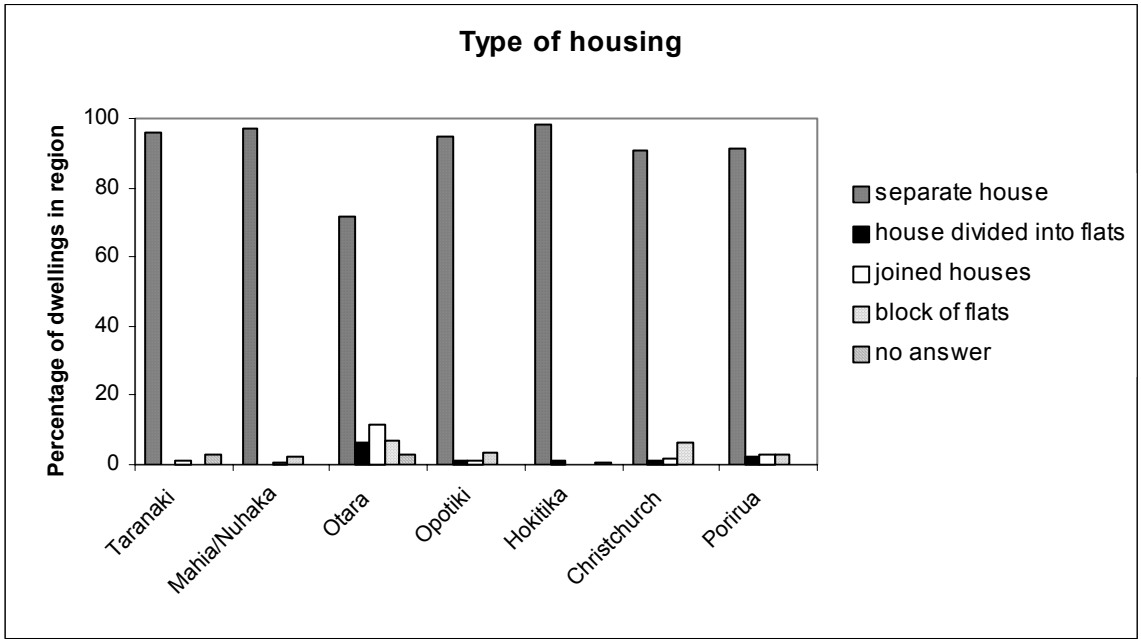


Figure 1

Table 3

	House type, if reported			
	separate house %	house divided into flats %	joined houses %	block of flats %
Taranaki	98.7	0.0	1.3	0.0
Mahia/Nuhaka	97.0	0.0	0.5	2.5
Otara	74.3	6.6	12.0	7.1
Opotiki	94.7	1.1	1.1	3.2
Hokitika	98.9	1.1	0.0	0.0
Christchurch	91.0	1.1	1.6	6.4
Porirua	91.4	2.5	3.0	3.0
Overall	**92.2**	**1.8**	**2.8**	**3.2**

The ages of the dwellings varied by region. This probably reflects a real difference in the housing stock in each region but the 2001 census data will give an opportunity to do more in-depth comparisons. It is notable that 40.7% of the householders in Otara did not know when their dwelling was built – this is by far the largest proportion of the householders in any region, however 22.7% of those in Porirua also did not know. We are exploring the possibility of obtaining these data from the property titles.

Figure 2

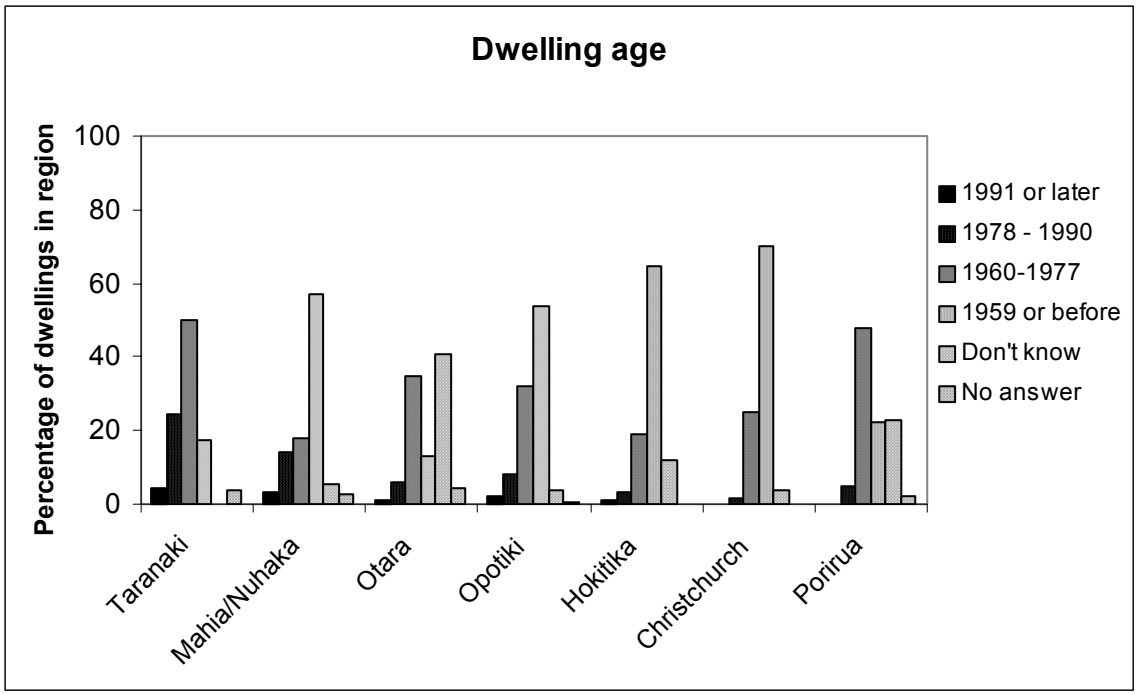


Table 4

	Dwelling age, if reported, by region			
	1991 or later %	1978 – 1990 %	1960-1977 %	1959 or before %
Taranaki	4.5	25.6	51.9	17.9
Mahia/Nuhaka	3.3	15.4	19.2	62.1
Otara	1.9	10.6	63.5	24.0
EBP	2.2	8.3	33.3	56.1
Hokitika	1.2	3.6	21.7	73.5
Christchurch	0.0	1.7	25.8	72.5
Porirua	0.0	6.7	63.8	29.5

Of those who did know the age of their dwelling, and did answer the question, there was considerable inter-regional variation. Few houses, in the study, in any region were built after 1990. In four of the regions – Mahia/Nuhaka, EBP, Hokitika and Christchurch - over half the reported upon houses were built before 1959, and for three regions – Taranaki, Otara, Porirua - over half the reported upon houses were built between 1960 and 1977. The differences between regions is quite marked – over 70 % of the Christchurch dwellings were built before 1959, but under 20% in Taranaki were built before 1959.

3.2 Dwelling Condition and Sunniness

We asked participants to rate the overall condition of their dwelling. Residents of Hokitika and Otara the were most likely to report their dwelling in "excellent" condition, and those in Taranaki to report their dwelling "very poor".

Figure 3

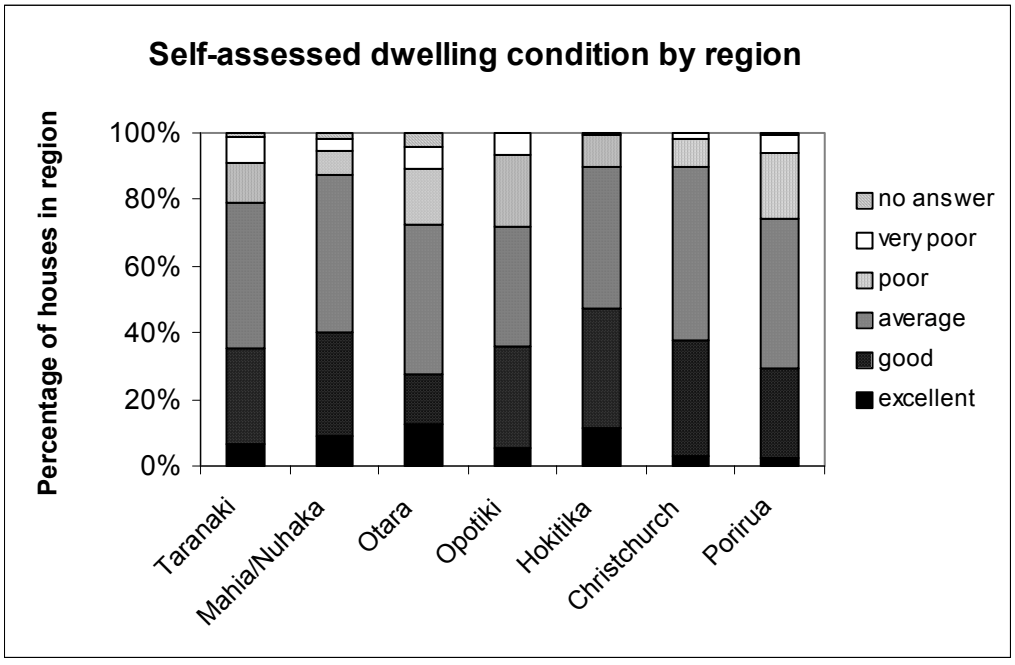


Table 5

Self Assessed House Condition, by region					
	Excellent %	**Good %**	**Average %**	**Poor %**	**Very poor %**
Taranaki	6.9	28.8	44.4	11.9	8.1
Mahia/Nuhaka	9.2	31.3	48.2	7.2	4.1
Otara	13.3	15.5	47.0	17.7	6.6
EBP	4.8	29.3	33.4	20.2	6.4
Hokitika	11.1	36.0	42.9	9.5	0.5
Christchurch	3.2	34.4	52.4	8.5	1.6
Porirua	2.5	26.9	45.2	19.8	5.6

Dwellings in Otara, EBP and Porirua were more likely to be reported as in "poor" or "very poor" condition than those in the sample as a whole; those in Hokitika, Mahia/ Nuhaka, and Christchurch were less likely to be reported to be in "poor" or "very poor" condition. Likewise those in Mahia/Nuhaka and Hokitika were more likely to be reported in "good" or "excellent" condition than the sample as a whole, and those in Otara and Porirua less likely to be reported to be in "good" or "excellent" condition.

Figure 4

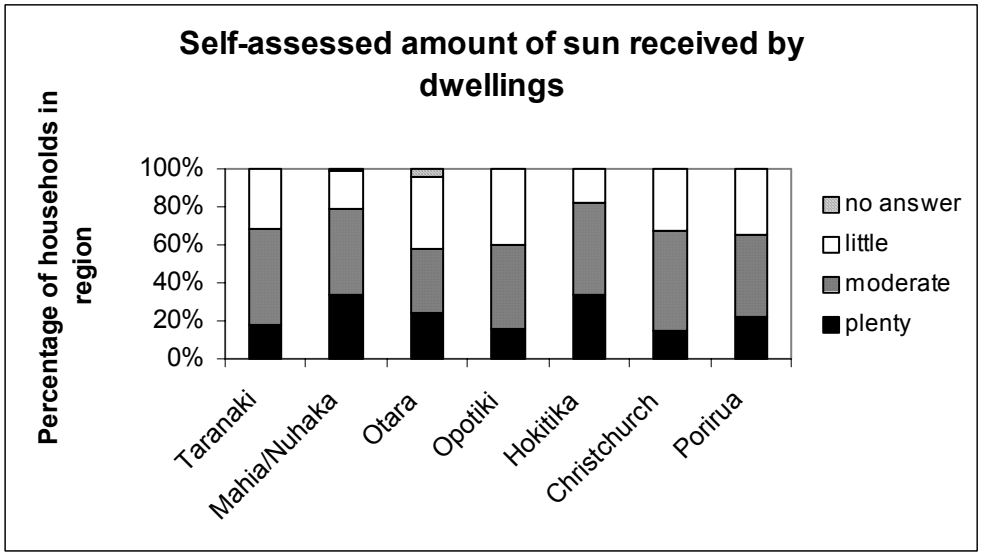


Table 6

Sunniness of dwellings, if answered.			
	Plenty %	**Moderate %**	**Little %**
Taranaki	17.9	50.0	30.9
Mahia/Nuhaka	33. 7	45.9	20.4
Otara	25.3	35.2	39. 6
EBP	15.4	44.7	39. 9
Hokitika	33.3	48.7	18.0
Christchurch	14.3	53.4	32.3
Porirua	22.3	43.7	34.0

We also asked people to rate the amount of sun their dwelling got. Residents in Mahia/Nuhaka and Hokitika were the most likely to report that their dwelling received "plenty" of sun. Those in EBP and Christchurch were the least likely to report "plenty" of sun. Those in EBP were most likely to report "little" sun, and those in Mahia/Nuhaka and Hokitika least

likely to report "little" sun. Here, also, the responses will have been partly informed by expectations, from knowledge of the local area and possibly other houses that the inhabitants had previously lived in.

Dwelling Size

Figure 5

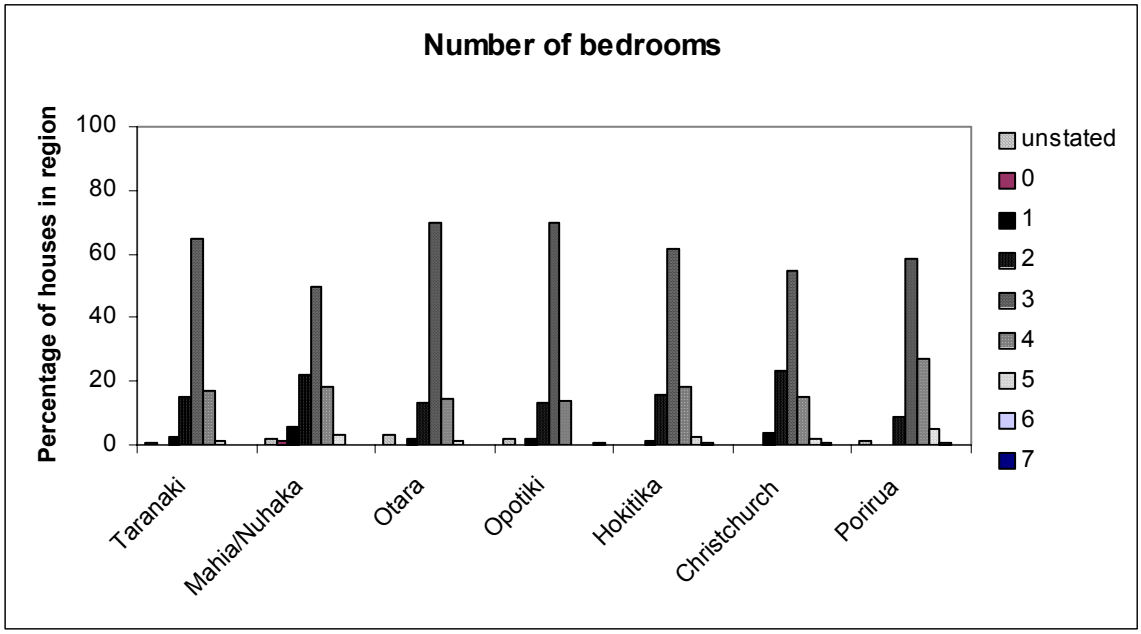


Table 7

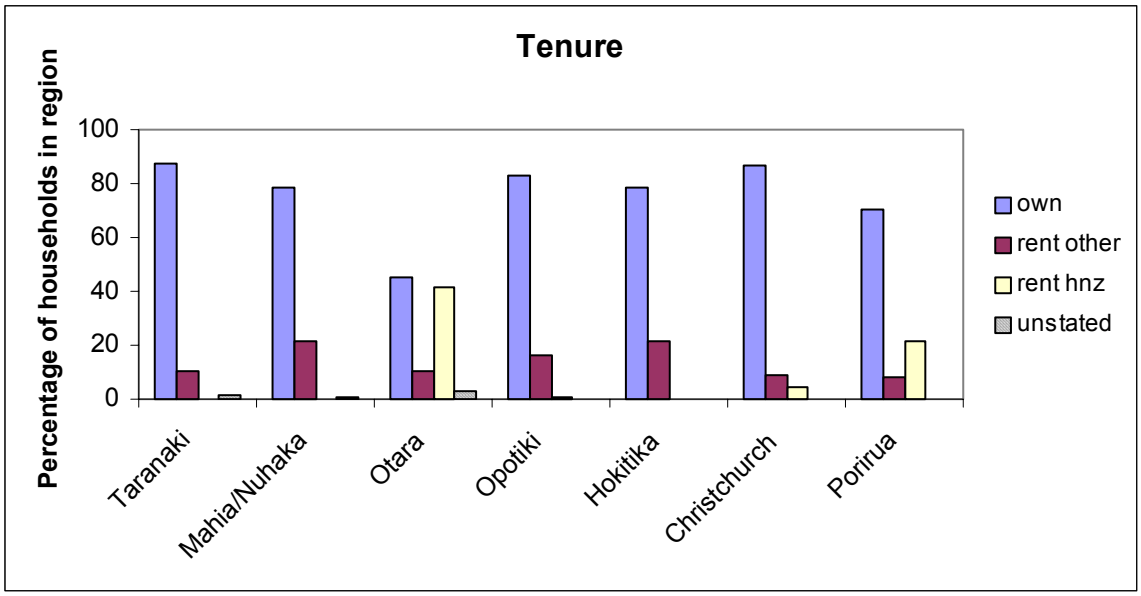
Bedrooms by region, if answered	mean number of bedrooms	standard error	standard deviation
Taranaki	2.99	0.05	0.68
Mahia/Nuhaka	2.88	0.07	0.91
Otara	3.00	0.05	0.62
EBP	2.99	0.05	0.67
Hokitika	3.07	0.05	0.73
Christchurch	2.90	0.06	0.81
Porirua	3.30	0.05	0.72
Overall	**3.02**	**0.02**	**0.75**

Home sizes did not differ much between regions. In every region the modal number of bedrooms per dwelling was three. The mean number of bedrooms per dwelling, was also close to three. Dwellings in Porirua had, on average, more bedrooms than dwellings in other regions.

3.3 Tenure

The proportion of participating households that owned their own dwelling ranged from a low of 45% in Otara to a high of 88% in Taranaki. Those participants who were tenants or living in rented accommodation, were also asked whether the houses were owned by Housing New Zealand Corporation (HNZC). Porirua and Otara reported a high proportion of HNZC houses reported but did not have an increased rate of other rentals, indeed these areas showed slightly fewer private sector rentals than the other areas.

Figure 6



The high level of renting in Otara and Porirua gives some explanation for the lack of knowledge about the age of the dwellings in those regions (figure 2) as in every region those who rented were less likely to know the age of their dwelling than those who owned it (not shown). In Otara, Taranaki and Porirua over half the householders who rented did not know when their dwelling was built. Nearly all of the houses reported as being owned by HNZC were built before 1978, however there are clearly differing patterns in ages of the houses between regions.

Figure 7

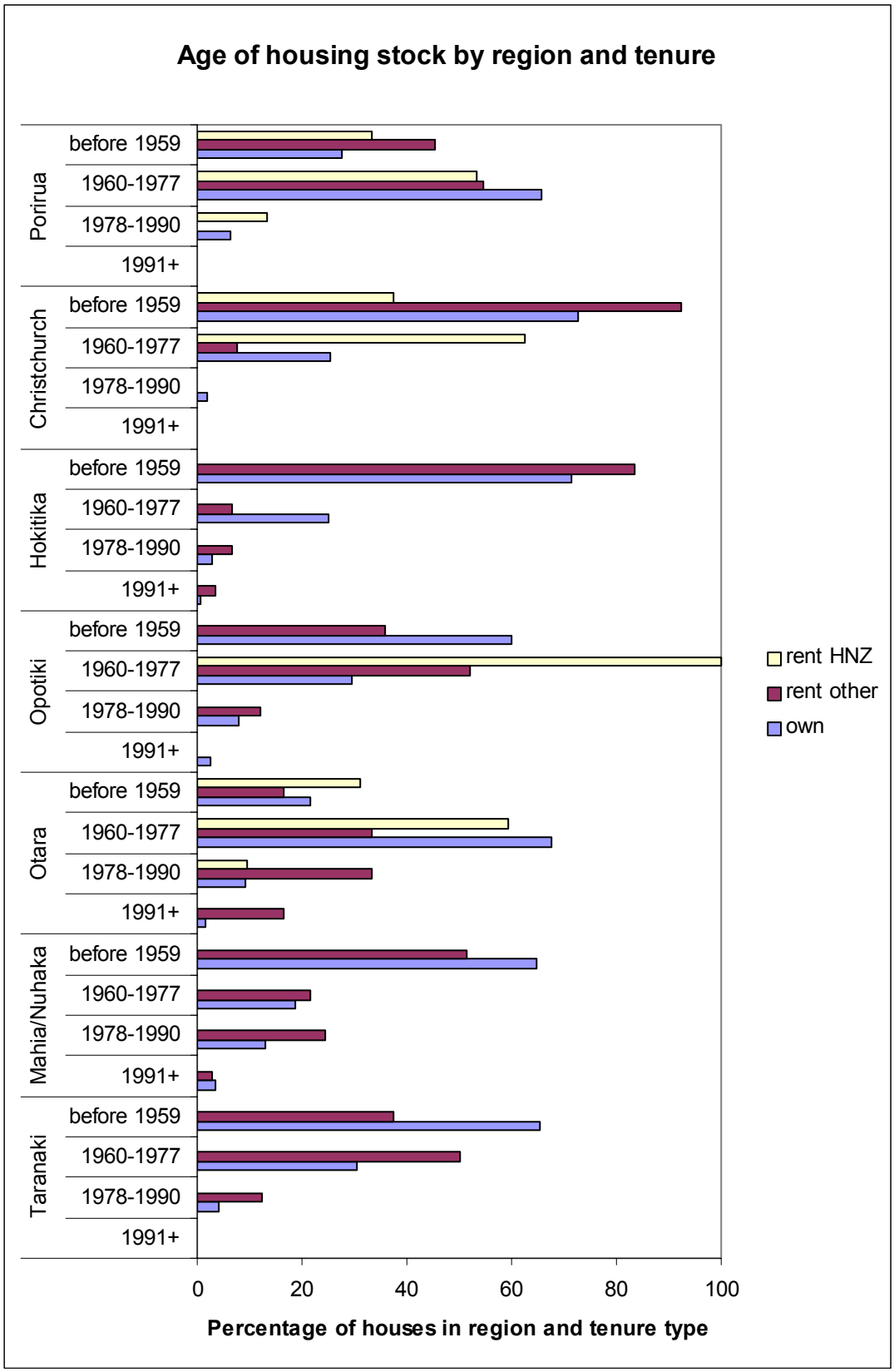
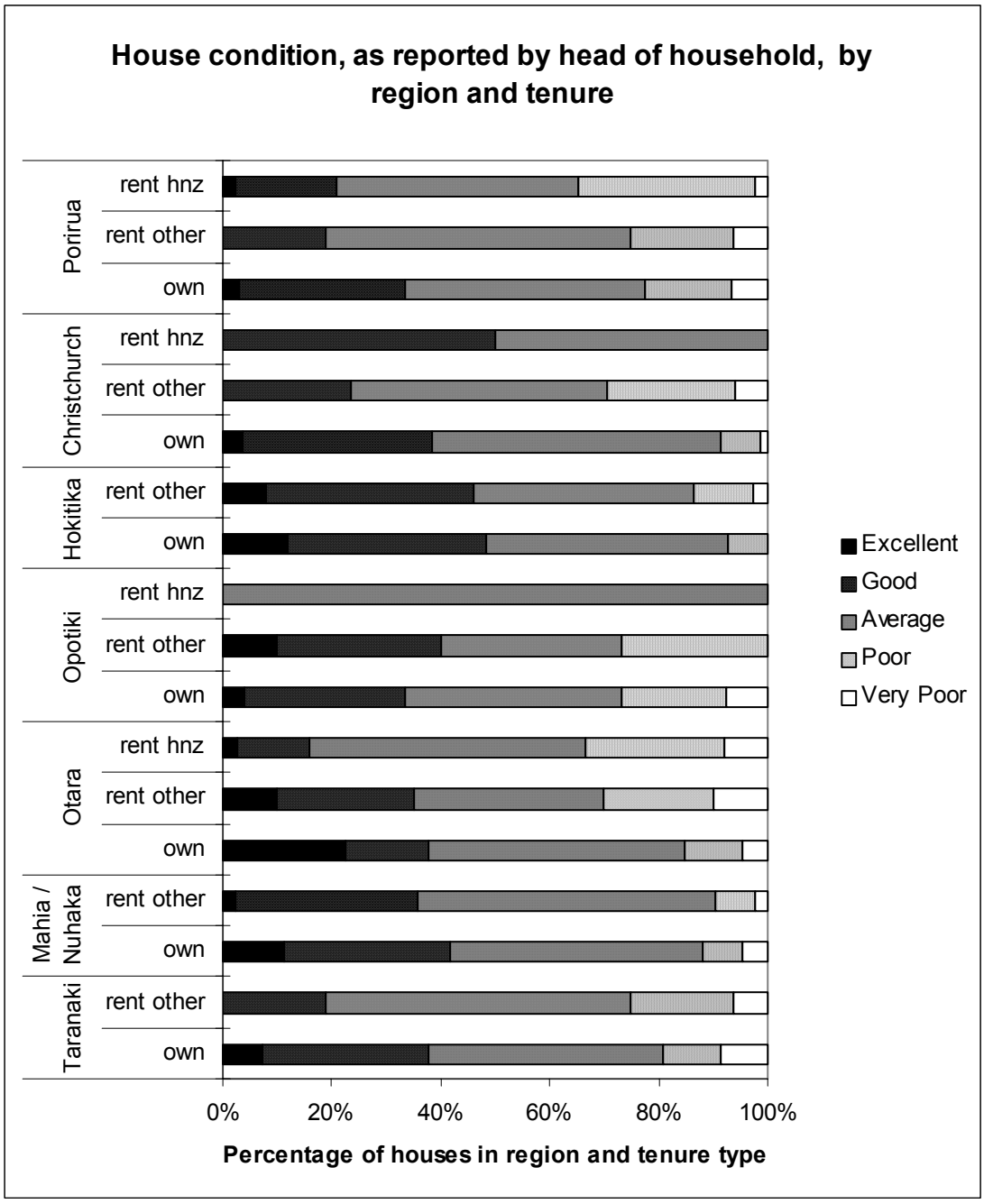
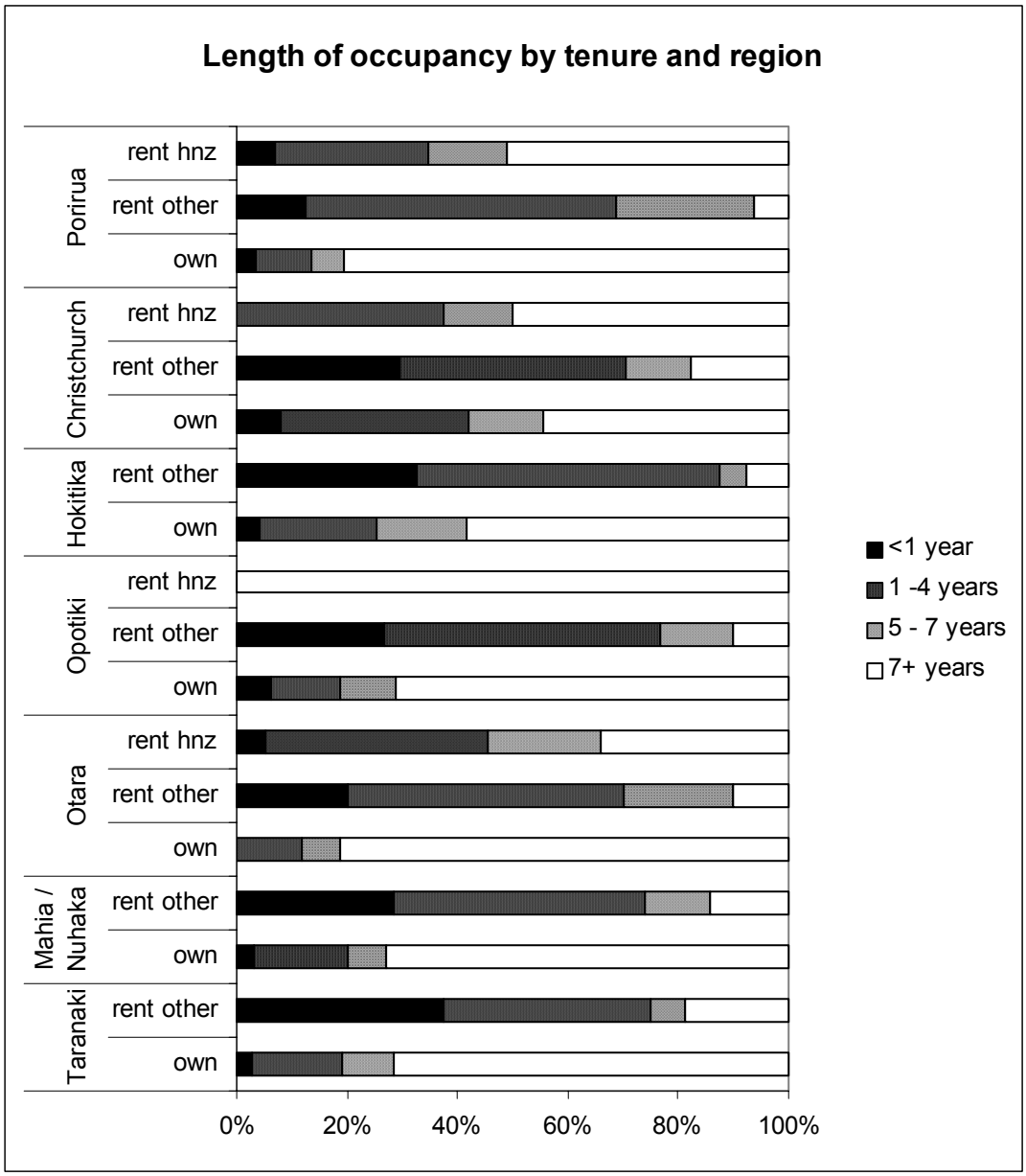

Age of housing stock by region and tenure
Porirua
Christchurch
Hokitika
Opotiki
Otara
Mahia/Nuhaka
Taranaki
before 1959
1960-1977
1978-1990
1991+
rent HNZ
rent other
own
0
20
40
60
80
100
Percentage of houses in region and tenure type

Figure 8



In areas where there is a significant proportion of HNZC rental properties only in Christchurch and EBP (where there were very few HNZC houses) did the head of HNZC house report that their home was in better condition than those in private rental accommodation. In Porirua, most householders reported that overall their housing was in poor condition. In all areas, those householders who owned their own home reported their housing to be in better condition, on average, that those in social or private rental accommodation - with the exception of Porirua. However, it is possible that houseowners are less objective with their assessments of dwelling condition than renters. BRANZ inspectors reports will be compared with the self-assessed house condition in a future analysis.

Figure 9



In all regions, those householders who owned their own home had lived in their home for the longest period.

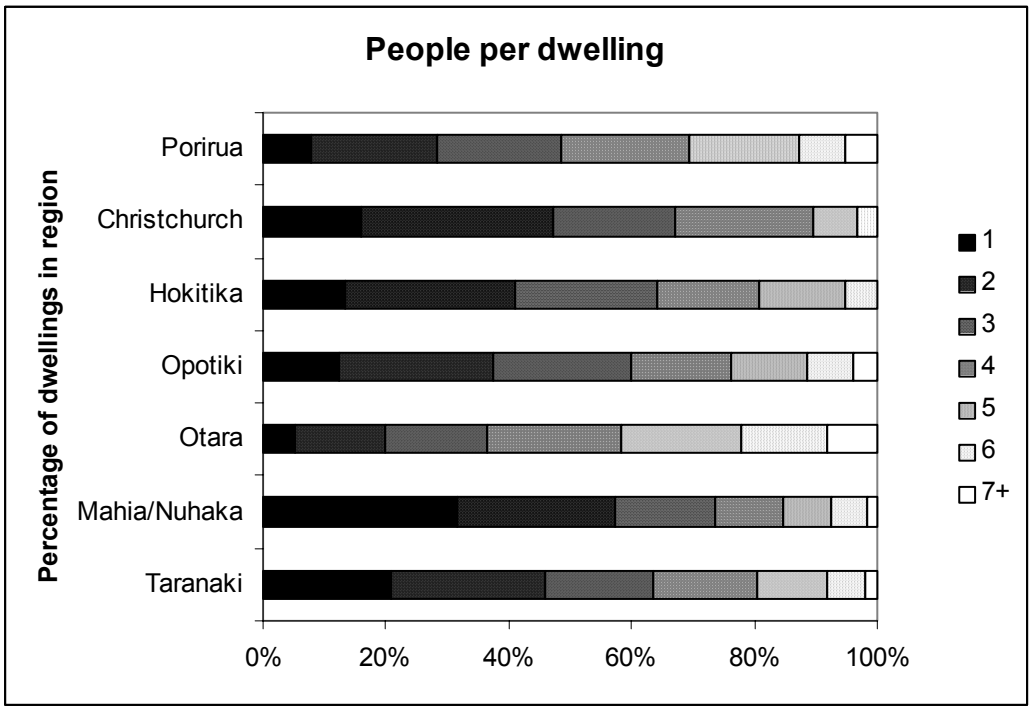
3.3 Occupancy

We asked householders how many people lived in their house. Previous research has indicated that this question is not always answered accurately[1]. Households which included 'overstayers'[2] may not have counted all (or any), shared custody children may have been included even though they spent only one night a week (or less) in the dwelling, and some people who did not wish to fill in health forms may not have been listed on the overall form (though attempts were made to minimize this).

[1] Morrison, P.S. (1994) Housing Occupancy and the changing size of households and dwellings in New Zealand 1951-1991

[2] This is a contentious issue

Figure 10



No dwelling was reported to have more than twelve occupants, and 195 (15% overall) reported only one occupant.

Figure 10 shows the cumulative reported dwelling occupancy rate by region. Households in Otara had, on average more people than those in other parts of the country. This is consistent with the 1996 census where the average Auckland dwelling had more occupants than those in the rest of the country[3]. Households in Christchurch and Mahia/Nuhaka were the smallest with around 70% of households in both areas reported as containing three or fewer people.

This study considers that a dwelling is crowded or overcrowded when the people living in the dwelling exceed the dwelling's ability to provide appropriately for those people. It is known that people living in crowded dwellings are at greater risk of infectious diseases, and crowding is also associated with poverty. However what people consider to be crowding has cultural as well as physical components.

New Zealand has an official method it uses to determine crowding[4] however that requires knowledge of the size of bedrooms as well as the age, sex, and relationship of the occupants. Other methods of estimating crowding include people-to-room ratios, people-to-bedroom ratios, adult equivalents or a "crowding index" which includes knowledge of the relationships of the household occupants.[5] One method of measuring crowding is bedroom occupancy. Tables 8 and 9 show the percentage of households in each region and tenure type which reported a bedroom occupancy of more than two people per bedroom, or more than two adult equivalents per bedroom

[3] "New Zealand Now Housing", Statistics New Zealand, 1998
[4] Housing Improvement Regulations 1947
[5] "New Zealand Now: Housing", Statistics New Zealand, 1998

(a child under 12 is considered to be half of an adult equivalent, those over 12 years are counted as adults). These figures, of course, do not represent the way the rooms are actually divided up in the homes. By these measures, too, Otara was the most crowded region, followed by Porirua and EBP.

Table 8

Percentage of dwellings by region and tenure with more than 2 people per bedroom			
	own	rent other	rent HNZC
Taranaki	3.6	0	__
Mahia/Nuhaka	5.9	0	__
Otara	10.6	15.0	13.0
EBP	7.2	13.8	0
Hokitika	0.7	0	__
Christchurch	1.2	0	0
Porirua	4.4	6.3	7.1

Table 9

Percentage of dwellings with more than 2 adult equivalents per bedroom			
	own	rent other	rent HNZC
Taranaki	2.1	0	__
Mahia/Nuhaka	3.3	0	__
Otara	5.9	5.0	2.6
EBP	2.6	3.5	0
Hokitika	0	0	__
Christchurch	0.6	0	0
Porirua	1.5	0	0

Although Otara had the greatest number of people in the houses, its average number of bedrooms per dwelling was close to the study average, while Porirua had substantially more bedrooms per dwelling on average, thus reducing the bedroom occupancy rate for Porirua toward the study average. Figures 11 and 12 show the distribution of bedroom occupancies. By both the analyses, people-per-bedroom and adult-equivalents-per-bedroom criteria, Otara still appears to be the most crowded area. Figure 13 shows the mean number of people per dwelling in each region and tenure type and the 95% confidence intervals on that mean. There is little difference between the types of tenure inside each region, but differences exist between the regions.

When the analysis splits "people" into the children under 12 years and adults over 18 years a different pattern emerges. There is a trend across all regions for more children in houses rented from non-HNZC landlords than in houses owned by the occupant (Figure 14). There is also a trend for there to be more adults (over 18 years) in owned homes than in rented homes in the same region. Houses rented from HNZC were intermediate between owned houses and those rented from private landlords.

Figure 11

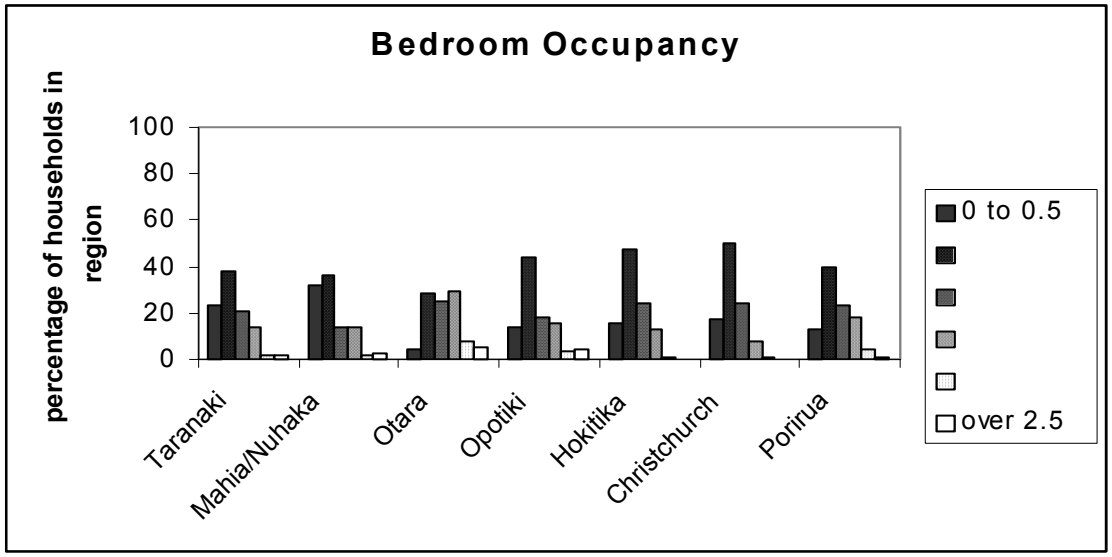
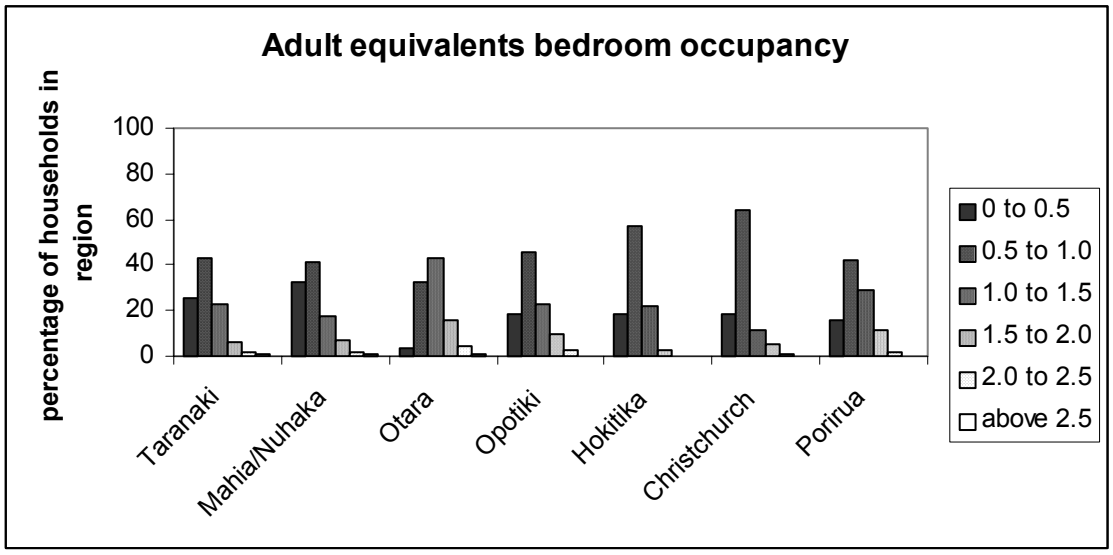


Figure 12



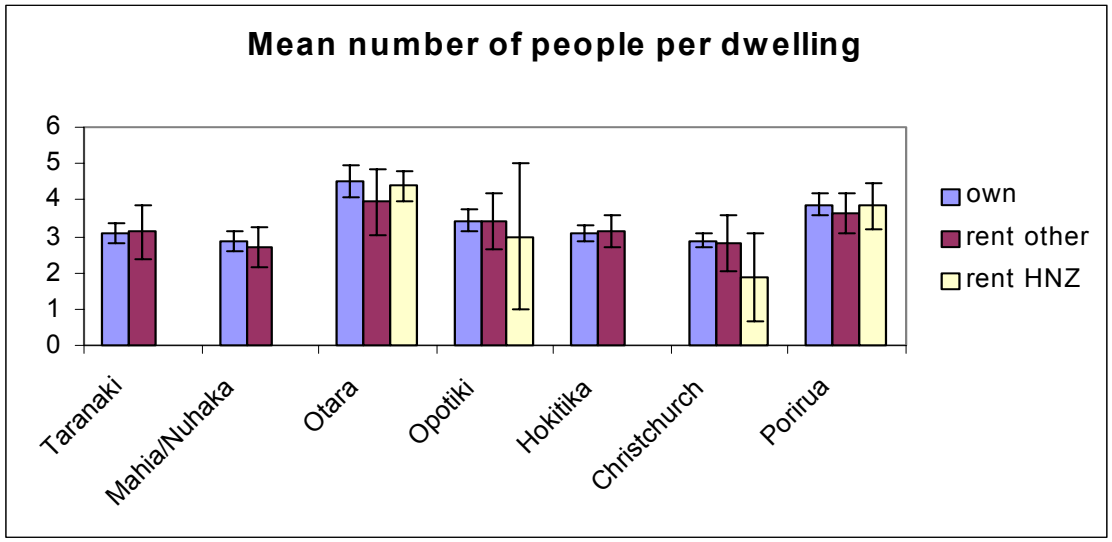


Figure 13

Figure 14

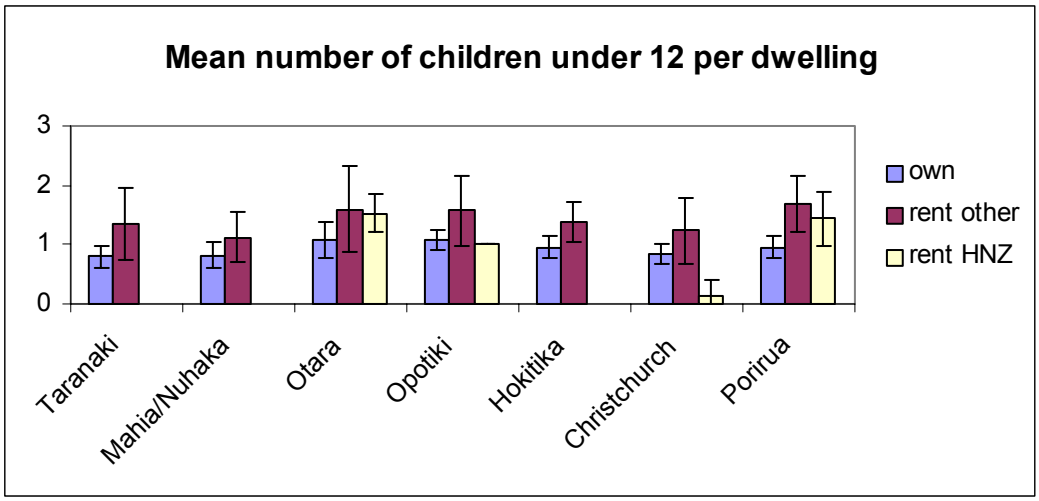
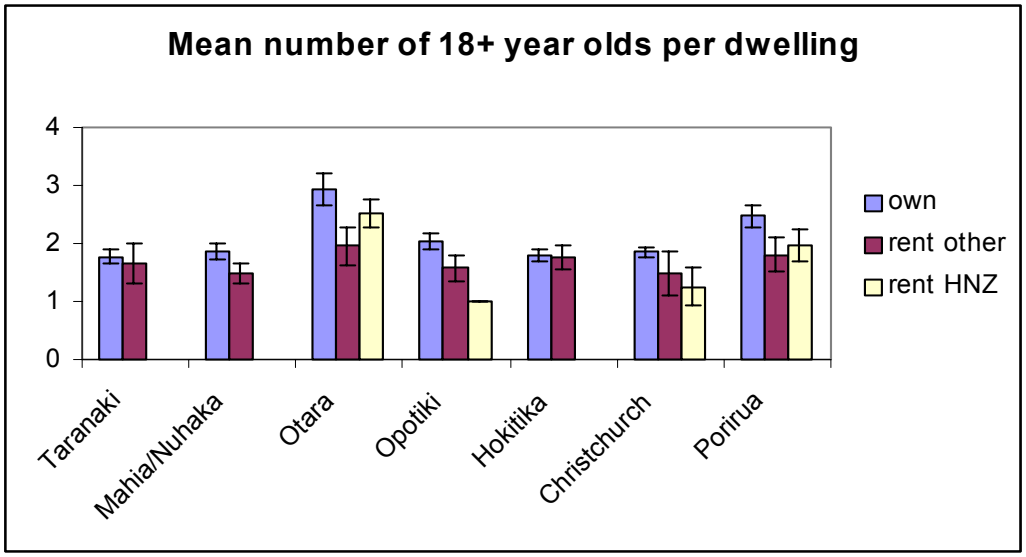


Figure 15



3.6 Behaviour

We asked people about certain behaviours within the house that may affect the microclimate of the house. Over 90% of households in all regions reported having curtains that they pulled shut in the evening.

Table 10

Percentage of households where the power company had ever turned off power to dwelling	
Taranaki	12.3
Mahia/Nuhaka	4.5
Otara	7.9
EBP	21.8
Hokitika	5.3
Christchurch	5.8
Porirua	10.1

Participants were asked if the power company had ever turned off the power to their dwelling. The question did not ask respondents to specify a reason why the power company might have done so. In rural areas such as Mahia/Nuhaka and EBP a strong write-in answer indicated that some of the times that the power went off were due to local weather conditions rather than non-payment of bills. The non-response rate varied between 0 and 3% for this question.

3.7 Smoke alarms

Figure 16

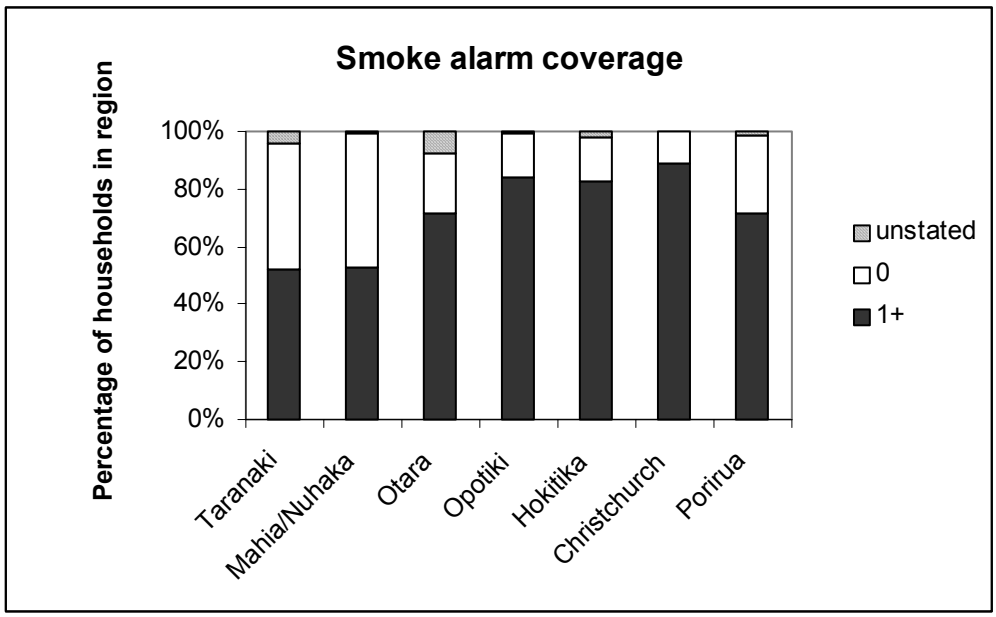


Figure 17

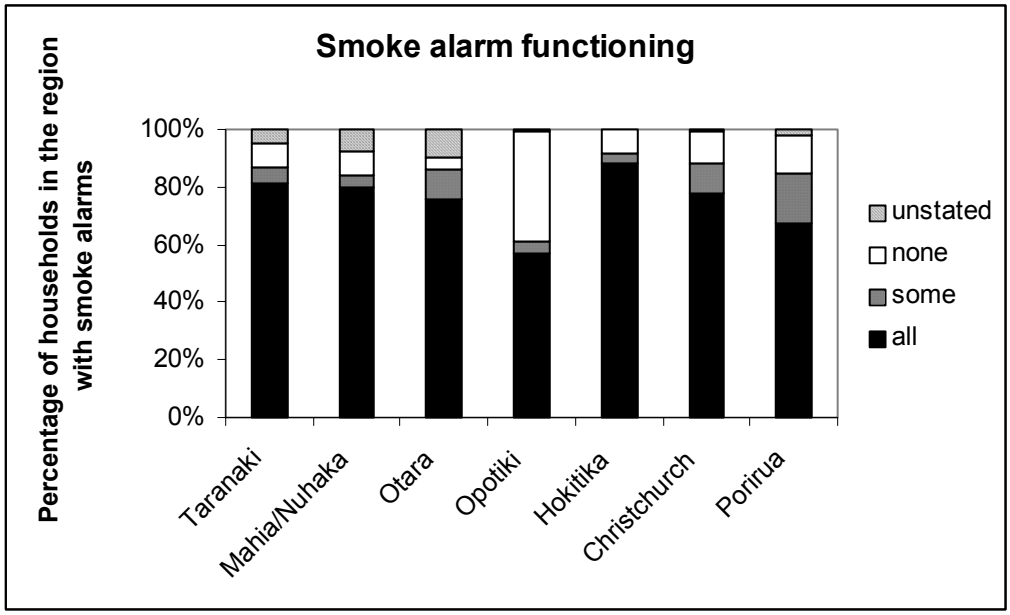


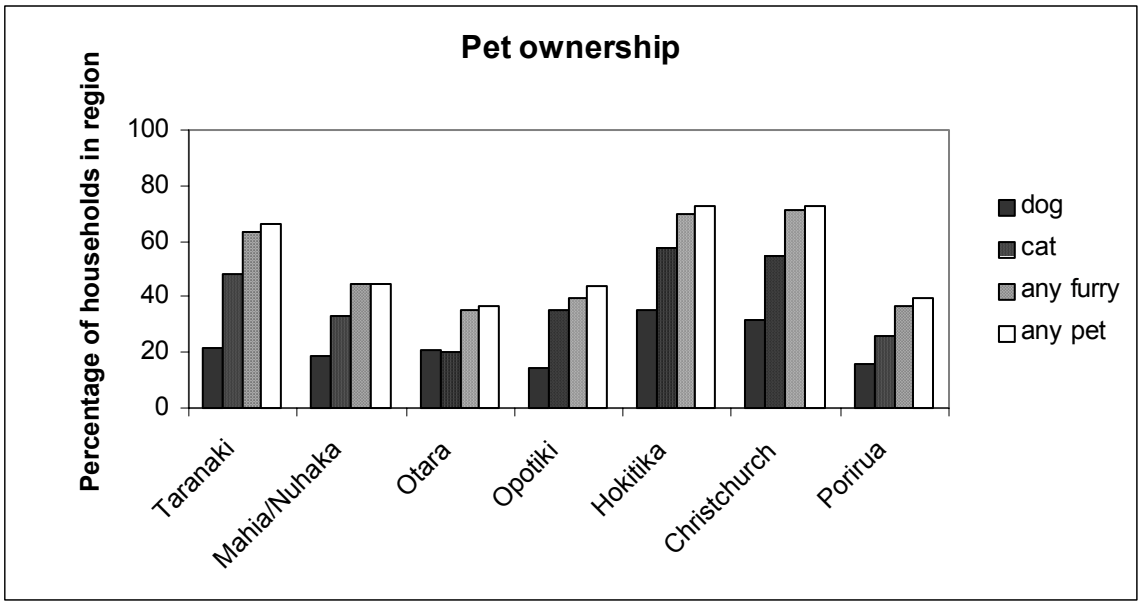
Figure 17 shows the percentage of the households that reported they had at least one alarm and which also stated that the alarm was functioning. If the proportion of working smoke alarms was not filled in then if numbers were written in both spaces "none" "some" or "all" was calculated from that, otherwise "unstated" was used. Overall this suggests a low rate of adequate smoke alarm coverage.

The questions on smoke alarms were not always fully answered. Two questions were asked, the first asked how many smoke alarms were in the house, and the second how many of these were functioning ("none", "some" or "all" were working, if "some" was chosen the participant was then asked how many). These questions had a relatively high non-completion rate – those who answered one question did not

always answer the other. Figure 16 shows the proportion of dwellings in each region that reported having at least one smoke alarm.

3.8 Household pets

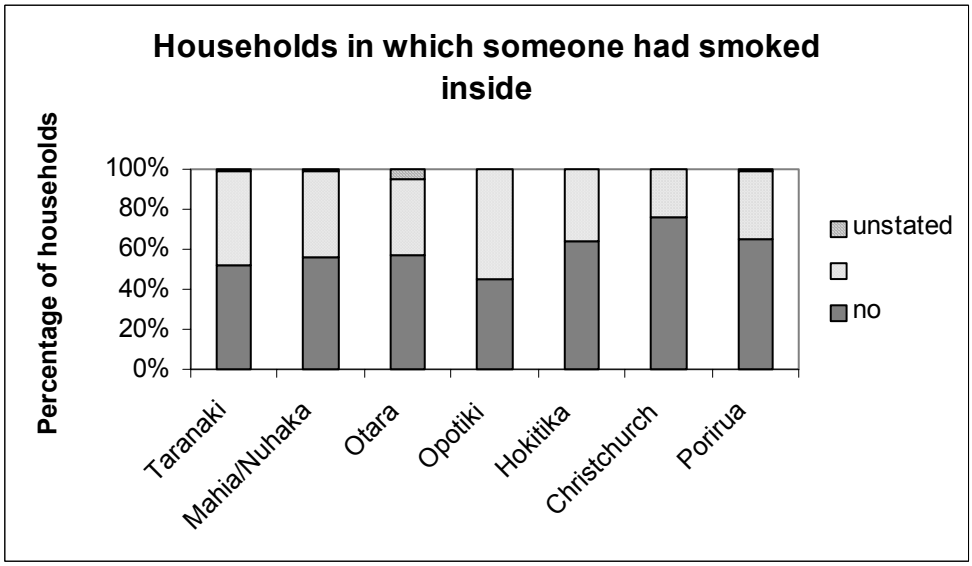
Figure 18



Pets, especially furry pets, drop dander that can be allergenic. Other literature shows companion animals may provide health benefit for people who live alone[6]. We found that the rate of pet ownership varied over the regions – with Otara and Porirua reporting the fewest pets and Christchurch and Hokitika the most. There may be rural/urban differences and cultural differences in the definition of a 'pet' and whether or not non-'pet' animals are invited inside.

3.9 Smoking

Figure 19



[6] Edney, A. "Companion animals and human health: an overview". J R Soc Med 1995;88:704-708

The proportion of houses in which someone had smoked inside during the winter varied from 24% in Christchurch to 55% in EBP. Although not directly comparable, the 2001 Household Economic Survey[7] reported that 28% of all New Zealand households spent money on tobacco products.

3.10 Fuels

We asked householders what fuels had been used to heat their homes over the winter. Fuels are a potential source of both irritants (if solid fuels are burnt on an open fire, or some gas combustion products) and moisture – especially from unvented gas appliances.

The Kent/Woodburner option was a write-in choice, there was a "wetback" option given, but many people chose to write in "Woodburner" instead so may be under-reported. In the second year's data collection "enclosed fire" is given as a separate option.

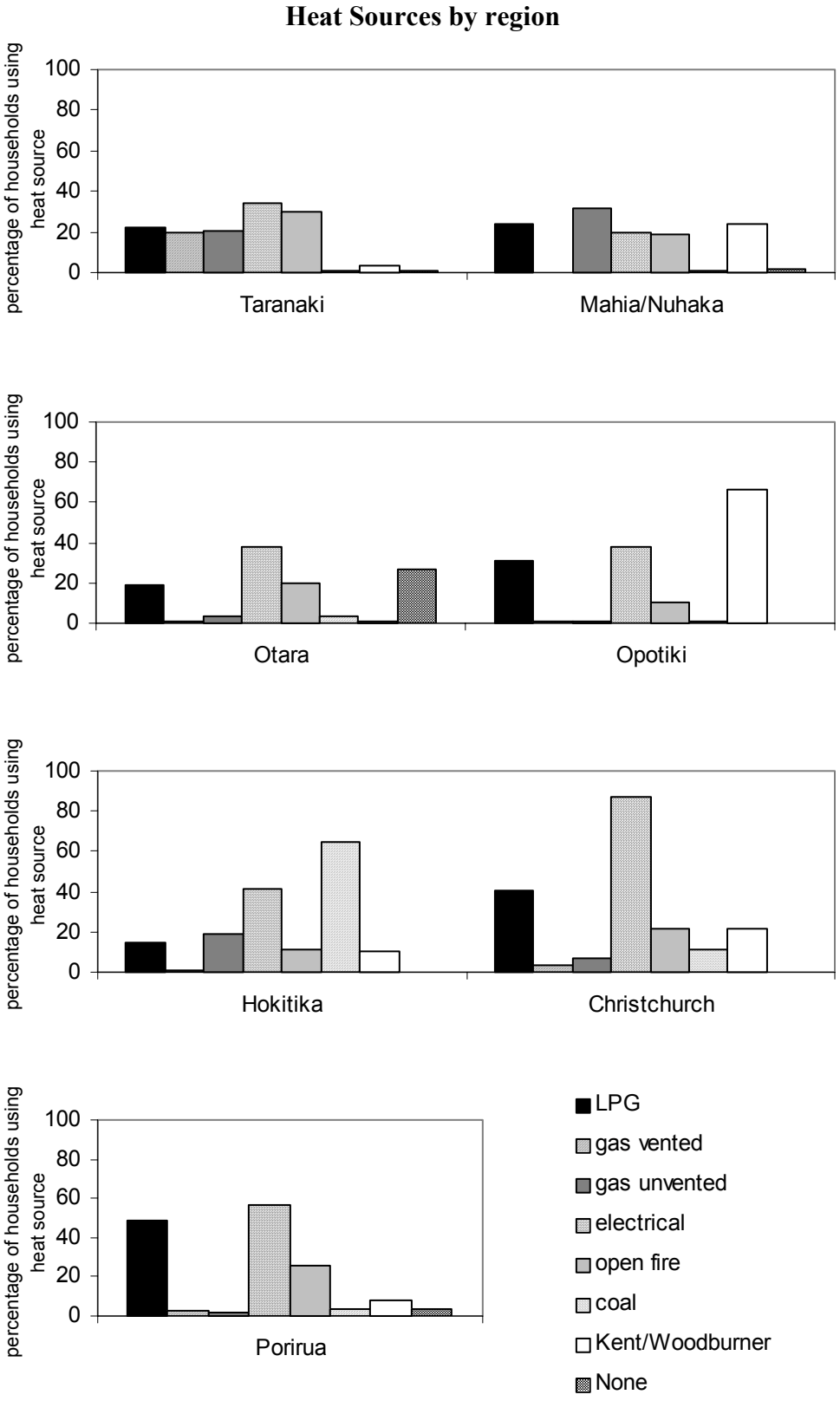
Table 11

Heat Source by region								
	LPG	**gas vented**	**gas unvented**	**electrical**	**open fire**	**coal**	**Kent/ Woodburner**	**None**
Taranaki	22.2	19.8	20.4	34.6	29.6	1.2	3.7	0.6
Mahia/Nuhaka	23.7	0	31.8	19.7	18.7	0.5	23.7	2.0
Otara	19.1	1.1	3.2	37.6	20.1	3.2	1.1	26.5
EBP	30.9	1.1	0.5	37.8	10.6	1.1	66.0	0
Hokitika	14.3	0.5	19.1	41.8	11.1	65.1	10.1	0
Christchurch	40.7	3.7	6.9	87.3	21.2	11.1	21.7	0
Porirua	49.0	3.0	2.0	56.6	25.3	3.5	7.6	3.5

Table 11 shows the same information as figure 20. The most common source of heating varied by region. In Christchurch, electricity was used by nearly 90% of the study households, whereas 66% of those in EBP reported they used a Kent/Woodburner, 65% of those in Hokitika burnt coal. Porirua had nearly equal proportions of people reporting electricity (56.6%) and LPG (49.0%). Over a quarter (26.5%) of those in Otara reported using no form of heating at all.

[7] Statistics New Zealand

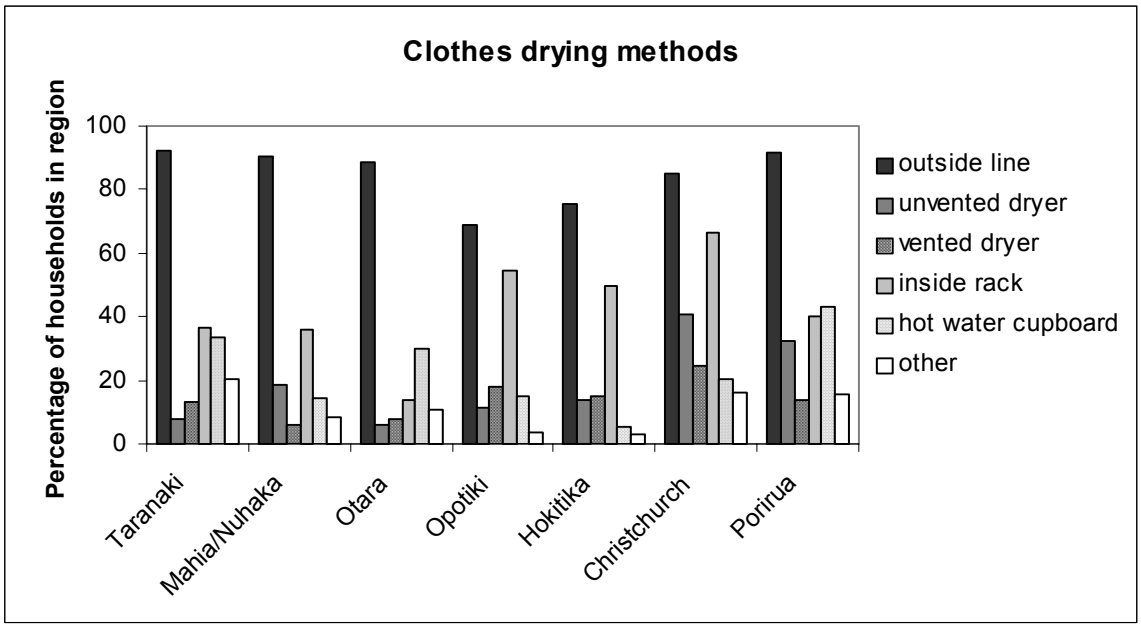
Figure 20


Heat Sources by region
percentage of households using heat source
100
80
60
40
20
0
Taranaki
Mahia/Nuhaka
Otara
Opotiki
Hokitika
Christchurch
Porirua
LPG
gas vented
gas unvented
electrical
open fire
coal
Kent/Woodburner
None

3.11 House Dampness

We asked people a number of questions about behaviour that may contribute to moisture in their home. Moisture in houses is affected by a variety of things – the number of people living there, the frequency of moisture generating activity (eg drying clothes inside) and the efficiency of ventilation in the dwelling. It is also affected by the house itself – the design, condition and materials of the house.

Figure 21



Moisture can be added to a dwelling's indoor environment by drying clothes inside. Although using an outside line was by far the most common method of drying clothes using unvented dryers or drying clothes on racks inside the dwelling or in the hot-water cupboard were also common. These later methods would contribute to indoor moisture. South Taranaki reported using outside lines with greatest frequency . A relatively high proportion of the Taranaki interviews took place late in the interviewing cycle, when the weather would have improved enough to dry clothes outside with ease, thus although the participants were asked to report their behaviour during winter they may have overestimated their use of outside lines (and underestimated their use of indoor methods).

Figure 22

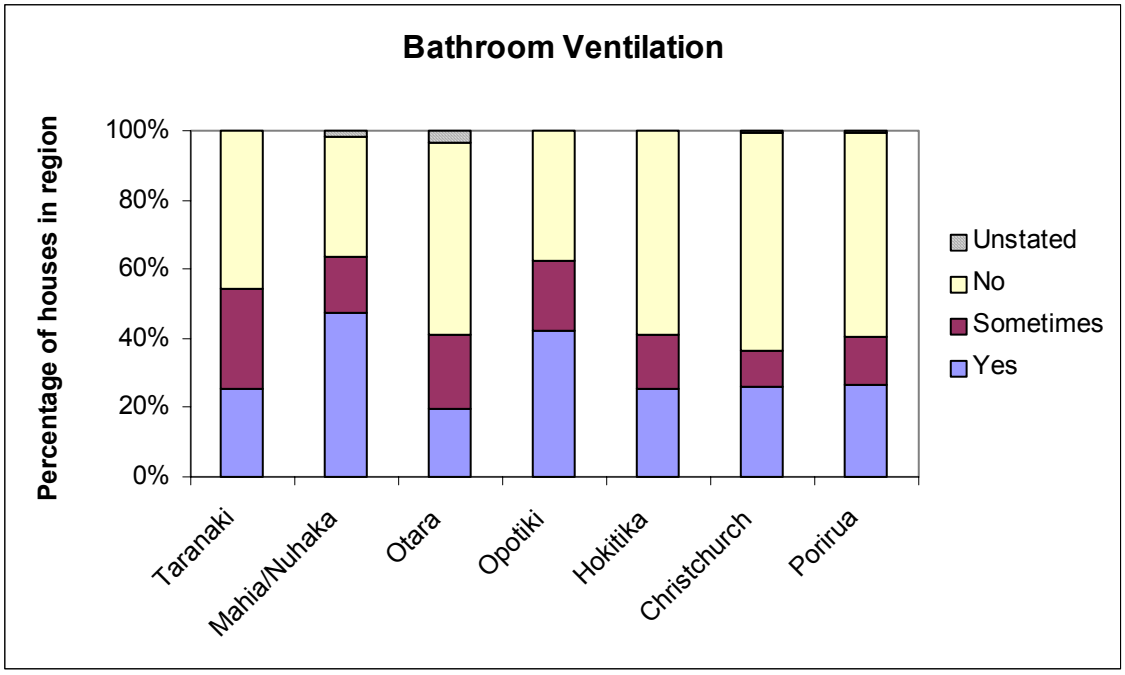
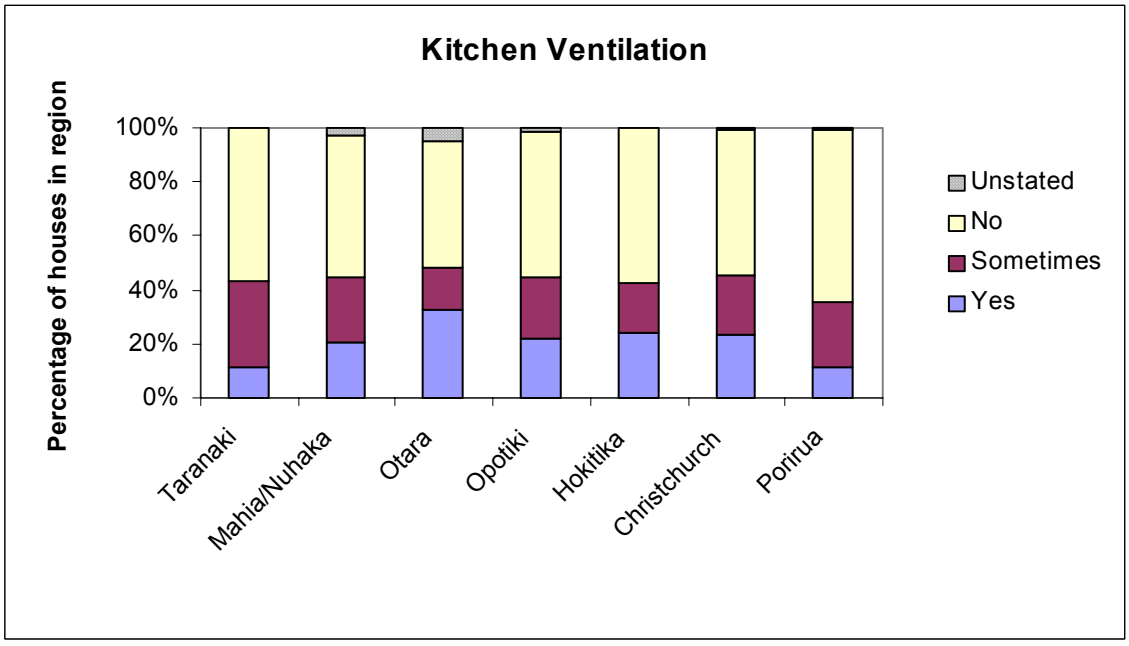


Figure 23



Participants were asked if they ventilated bathrooms and kitchens while showering/cooking. They were asked independently about their opening of windows and use of extractor fans. Figures 22 and 23 show the answers to these questions. The most positive response was used in forming these graphs – thus if a participant "always" opened a window while cooking but only "sometimes" used an extractor fan, then the household was categorised as "always".

Figure 24

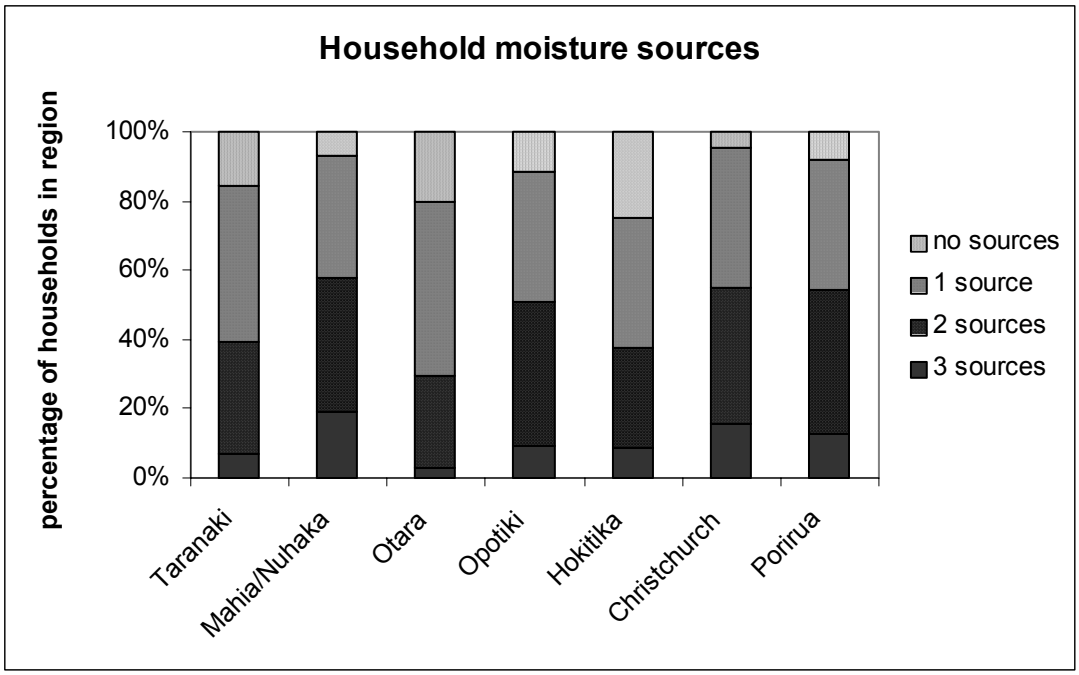


Figure 24 shows the proportions of houses where moisture was added to the microclimate from three broad sources: Clothes drying (reported drying clothes in an unvented clothes dryer, on an inside rack or line or in the hot-water cupboard), Fuel use (reported using an unvented gas heater or an LPG heater) and unventilated shower/kitchen use. This graph probably underestimates the moisture added to the microclimate as the "sometimes" option was classified as ventilating the space, and some "other" methods of drying clothes might well be indoors. However no attempt was made to quantify the amount of moisture added to the dwelling by each of these sources. The relatively small number of unspecified answers (the maximum for any region was the 4% in Otara) were excluded from this graph.

Table 12

Dehumidifier use	
Taranaki	14
Mahia/Nuhaka	2
Otara	5
EBP	7
Hokitika	21
Christchurch	31
Porirua	20

We asked people whether they had used a dehumidifier during the winter. The use of dehumidifiers is one method employed to attempt to rid houses of excess moisture. The rate of dehumidifier usage varied from a low of only 2% in Mahia/Nuhaka to 31% in Christchurch. In every region except Porirua households with dehumidifiers were more likely to at least "sometimes" ventilate their kitchens and bathrooms (the overall relative risk of not ventilating if there was a dehumidifier in the house was 0.77, 95% CI 0.67 – 1.09), however these differences were not statistically significant.

3.12 Dampness and Condensation

Most of the households in each region reported dampness due to condensation (Figure 25) but far fewer households in each region reported dampness due to reasons other than condensation (figure 26).

Figure 25

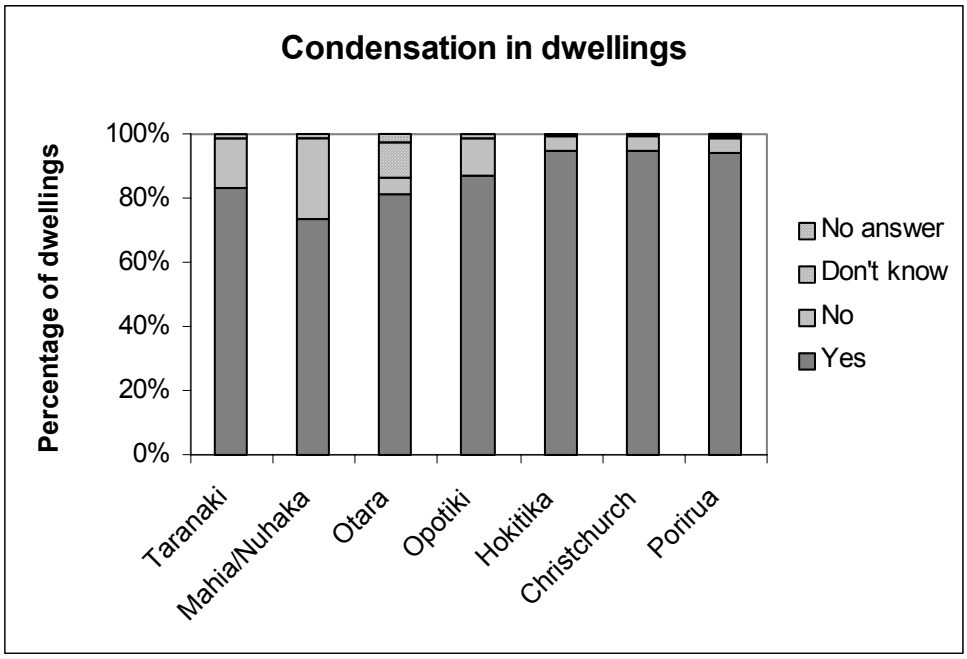
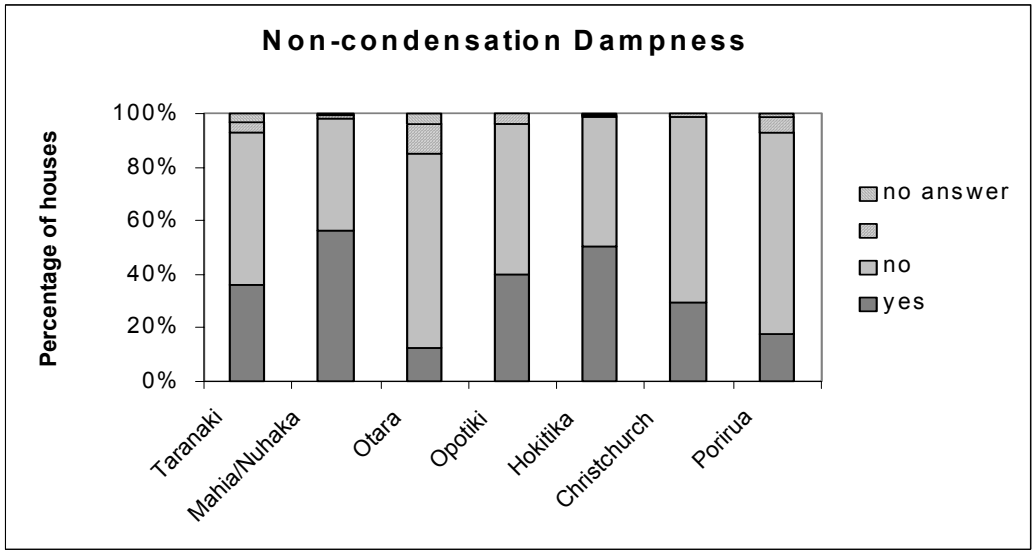


Figure 26



In each region there were some houses that reported that all five types of room (kitchen, bathroom, laundry, bedroom, living rooms) asked after were damp, only 1.5% of those in Mahia/Nuhaka, Hokitika and Christchurch reported all five types of rooms damp, while nearly 12% of those in Otara did. Likewise in each region there were some households that reported none of the types of room were damp – this ranged from a high of over 50% of households in Mahaia/Nuhaka and Hokitika to a low of 22% in Porirua.

Figure 27

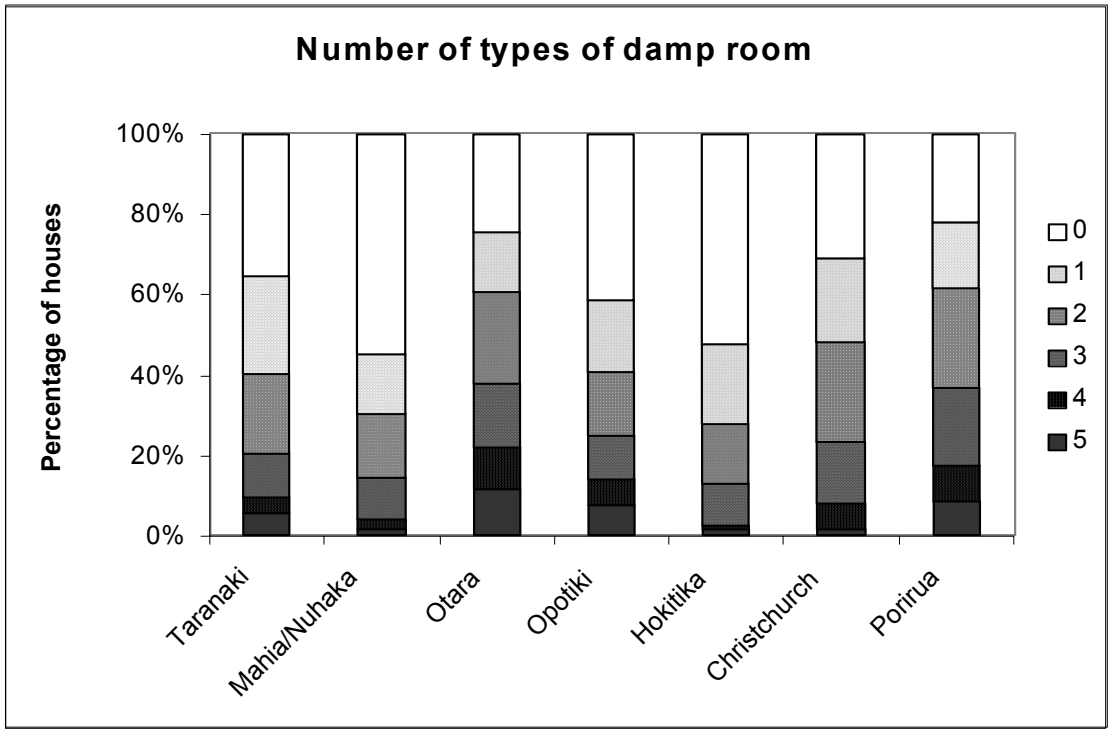
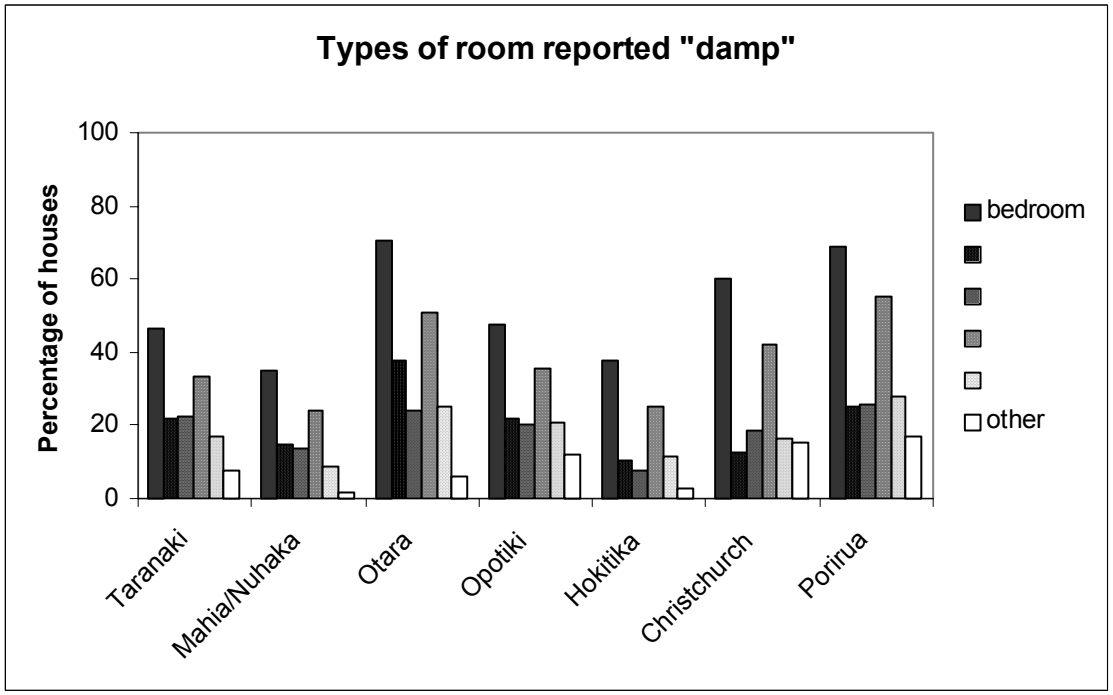
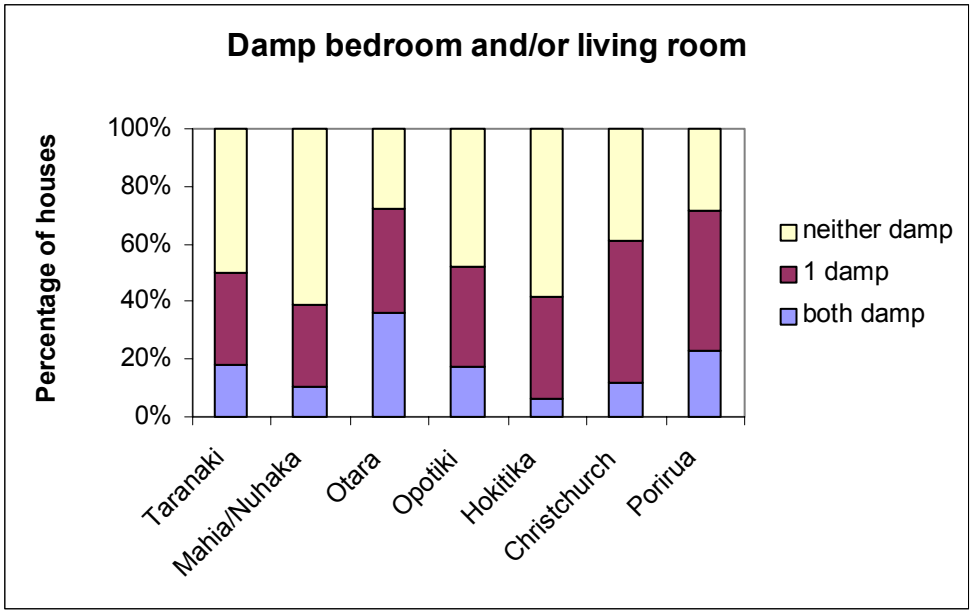


Figure 28



Bedrooms were the room most often reported damp, followed by bathrooms. This trend was true for within each region – although the overall proportion of damp rooms varied with region. In Mahia/Nuhaka only 35% of householders reported a damp bedroom compared with 70% in Otara.

Figure 29



Tables 12 to 17 show the relative risk for reporting a damp living room or bedroom with each of the three main kinds of moisture source. Forty-eight 95% tests of statistical significance were carried out to determine whether moisture sources were a risk factor for dampness in the rooms, and three statistically significant relationships were found. However with this many tests being carried out approximately 2.4 of them could be expected to erroneously state significance, therefore no undue weight should be placed on the "significant" results.

Drying clothes inside appeared to have a slightly protective effect on damp living rooms, that is householders who reported drying clothes inside were less likely to report a damp living room. This could be because people whose living rooms had a propensity to be damp made extra effort not to dry their clothes inside, or those who dried their clothes inside may have used more heating and better ventilation. Using an unvented gas or LPG heater increased the risk of having a damp living room for everywhere but Hokitika. Although only in Christchurch was the difference statistically significant.

Tables 18 and 19 show the relative risks for damp living or bedrooms if there were two or more of the moisture sources in the house. Again, the relative risks tend to be slightly greater than one but not statistically significant.

Table 12

Relative Risk for damp bedroom if water from fuel (LPG or unvented gas)

	RR	95% CI	
Taranaki	1.27	0.92	1.77
Mahia/Nuhaka	1.35	0.91	2.01
Otara	1.11	0.91	1.36
EBP	0.98	0.7	1.36
Hokitika	0.89	0.58	1.36
Christchurch	1.02	0.81	1.29
Porirua	1.17	0.97	1.42
Weighted overall	1.11	1.00	1.23

Table 13

Relative Risk for damp bedroom if water from drying clothes

	RR	95% CI	
Taranaki	1.15	0.81	1.62
Mahia/Nuhaka	1.15	0.77	1.7
Otara	0.86	0.70	1.05
EBP	0.97	0.70	1.32
Hokitika	1.36	0.93	2.00
Christchurch	0.94	0.70	1.25
Porirua	1.14	0.90	1.44
Weighted overall	1.05	0.94	1.17

Table 14

Relative Risk of damp bedroom if water from cooking/showering

	RR	95% CI	
Taranaki	0.79	0.54	1.17
Mahia/Nuhaka	0.98	0.67	1.43
Otara	1.38	1.15	1.67
EBP	1.03	0.76	1.39
Hokitika	0.85	0.57	1.26
Christchurch	1.23	0.98	1.55
Porirua	0.85	0.69	1.05
Weighted overall	1.03	0.93	1.15

Table 15

Relative Risk for damp living room if water from fuel (LPG or unvented gas)

	RR	95% CI	
Taranaki	1.09	0.6	1.97
Mahia/Nuhaka	1.81	0.87	3.78
Otara	0.64	0.37	1.11
EBP	1.04	0.58	1.86
Hokitika	0.81	0.31	2.13
Christchurch	2.61	1.17	5.8
Porirua	1.15	0.71	1.86
Weighted overall	1.13	0.89	1.42

Table 16

Relative Risk for damp living room if water from drying clothes

	RR	95% CI	
Taranaki	1.81	0.93	3.51
Mahia/Nuhaka	0.69	0.35	1.35
Otara	0.83	0.56	1.22
EBP	1.25	0.68	2.28
Hokitika	0.83	0.36	1.91
Christchurch	1.06	0.39	2.89
Porirua	0.71	0.43	1.16
Weighted overall	0.94	0.76	1.18

Table 17

Relative Risk of damp living room if water from cooking/showering

	RR	95% CI	
Taranaki	1.12	0.60	2.06
Mahia/Nuhaka	1.23	0.61	2.49
Otara	1.31	0.90	1.9
EBP	1.27	0.73	2.21
Hokitika	1.36	0.59	3.12
Christchurch	1.29	0.61	2.73
Porirua	1.30	0.80	2.11
Weighted overall	1.27	1.03	1.57

Table 18

Relative Risk of damp bedroom if water from two or more sources

	RR	95% CI	
Taranaki	1.17	0.84	1.64
Mahia/Nuhaka	1.21	0.82	1.80
Otara	1.13	0.93	1.36
EBP	0.92	0.68	1.24
Hokitika	1.02	0.70	1.49
Christchurch	1.05	0.83	1.33
Porirua	1.03	0.85	1.25
Weighted overall	1.06	0.96	1.18

Table 19

Relative Risk of damp living room if water from two or more sources

	RR	95% CI	
Taranaki	1.63	0.91	2.92
Mahia/Nuhaka	1.13	0.56	2.29
Otara	0.85	0.55	1.31
EBP	1.06	0.61	1.83
Hokitika	0.89	0.37	2.14
Christchurch	1.63	0.73	3.62
Porirua	0.82	0.5	1.32
Weighted overall	1.05	0.85	1.31

3.13 Heating and Cold

The householders were asked a variety of questions about how cold they had been during the winter and how they had dealt with this.

Figure 30

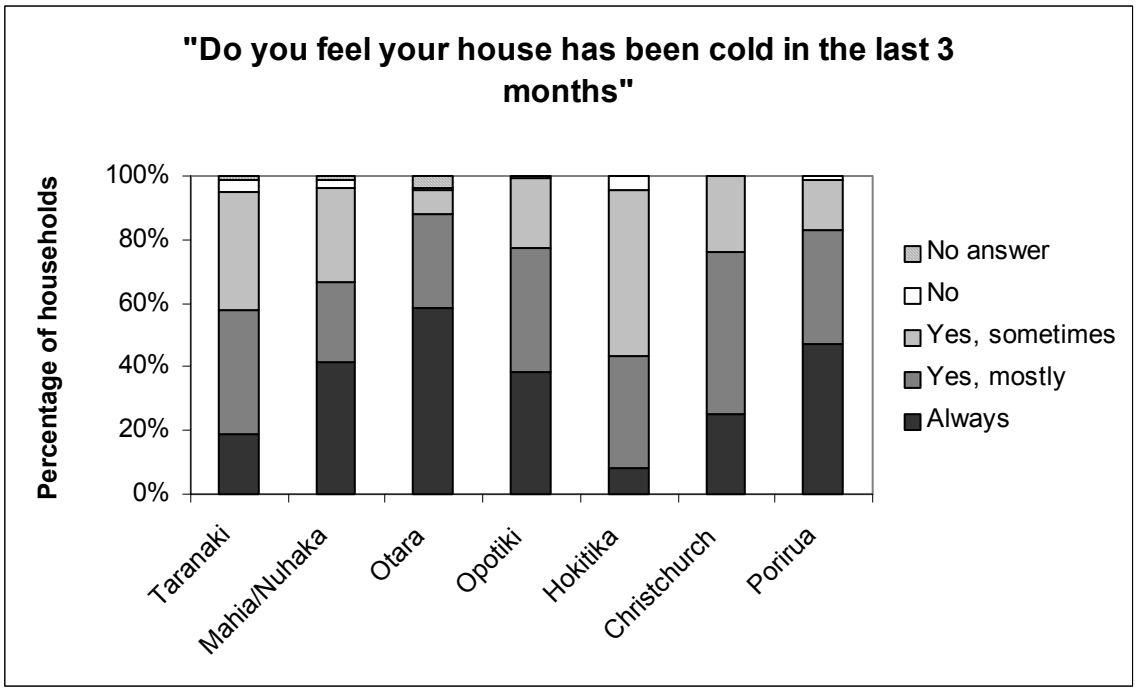


Figure 30 shows that in Otara, the region where the highest proportion of people reported "none" as a fuel source (26.5% see Table 11), the highest proportion of people (61%) reported "always" feeling cold during the winter. Only 8% of those in Hokitika reported that their dwelling had been "always" cold during the winter.

Figure 31

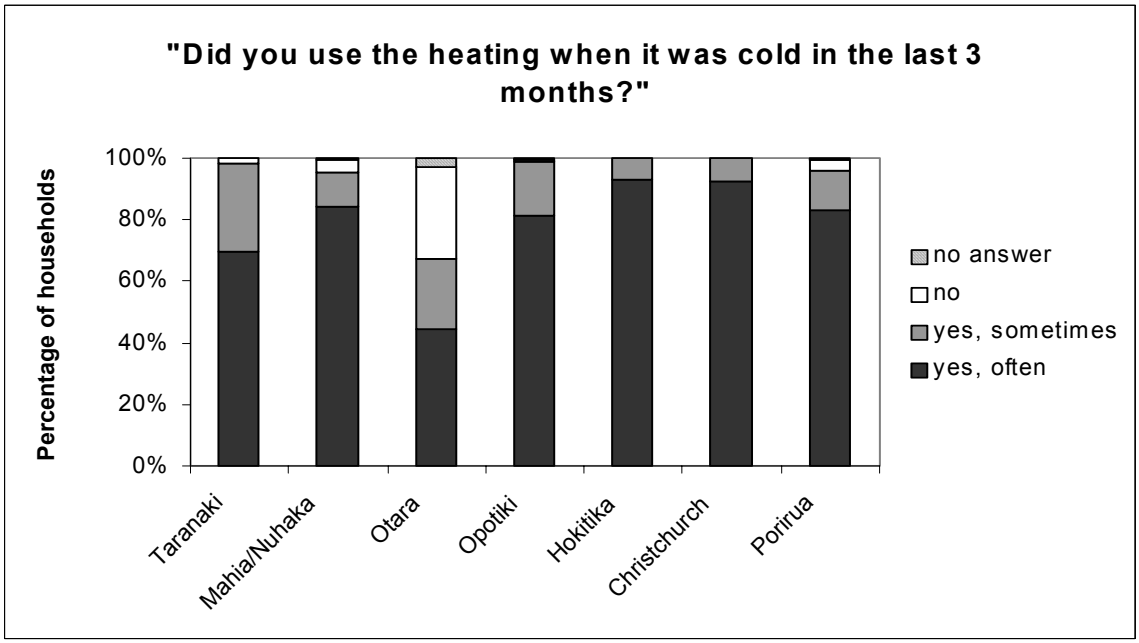
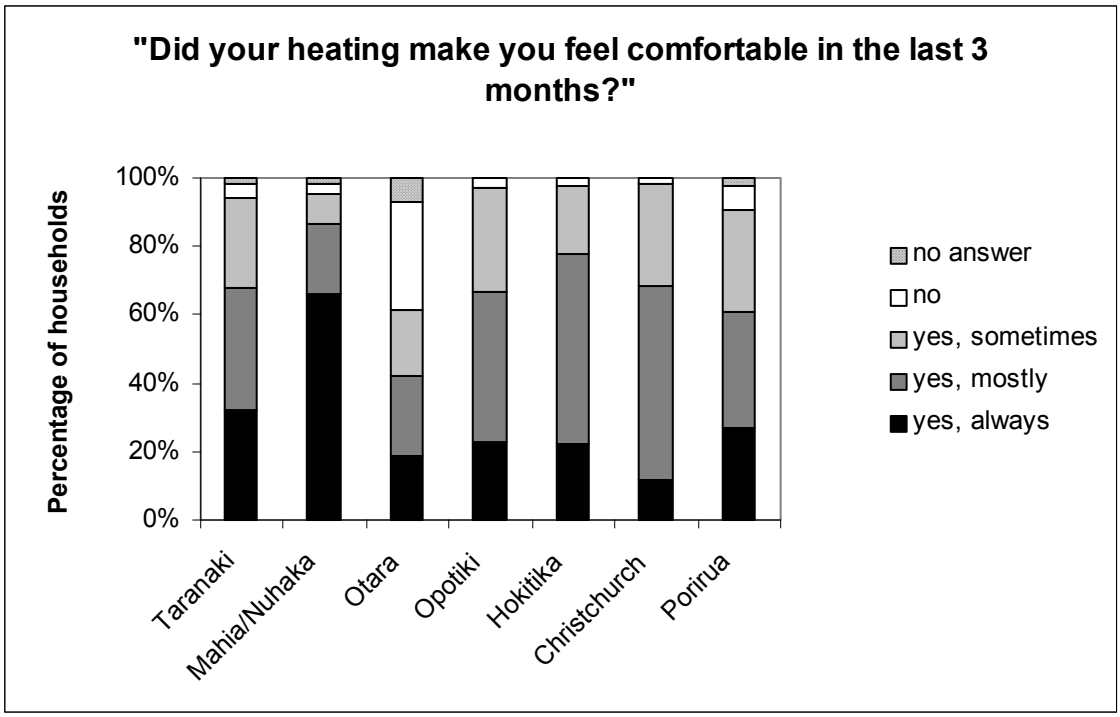


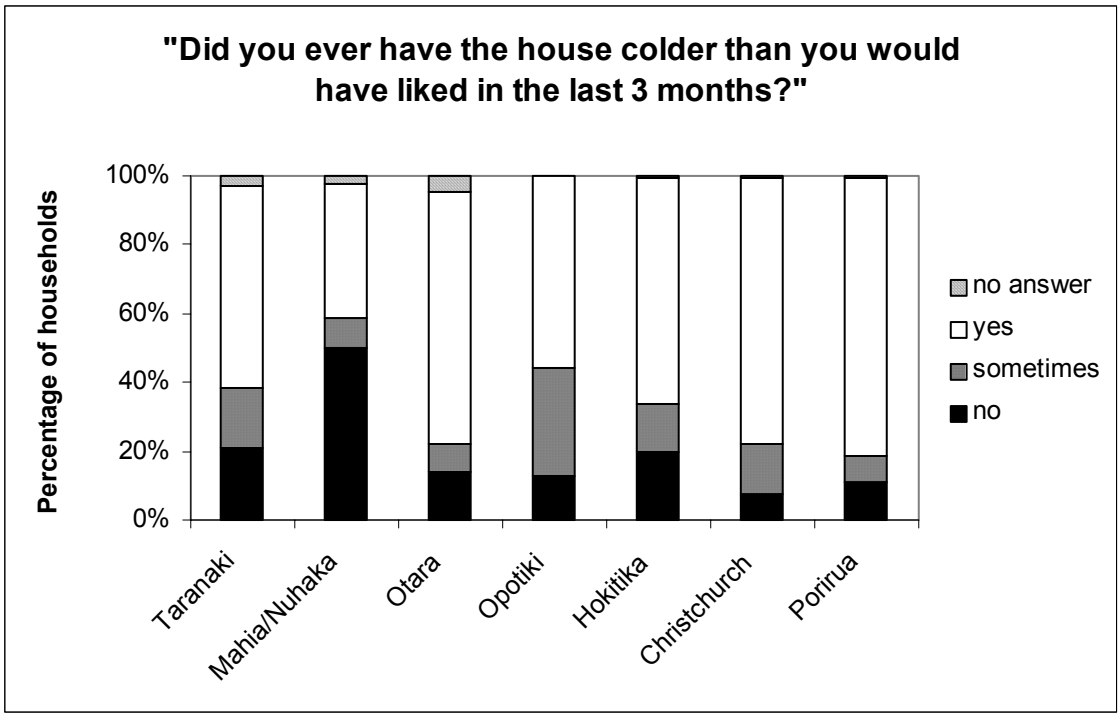
Figure 32



People in Otara were the least likely to report that they had "often" used heating when it was cold (46% compared with 70% in Taranaki and over 80% in all the other regions see Figure 31). However people in Otara were approximately as likely to report that they had "always" been made comfortable by their heating as those in EBP, and Christchurch (between 12% and 23% for each see Figure 32) although less likely than those in Porirua (27%), Taranaki (33%) and Mahia/Nuhaka (67%). Also only 45% of householders in Otara reported being "mostly" or "always" made comfortable by their heating whereas between 63% and 88% of householders in other regions reported being "mostly" or "always" made comfortable by their heating.

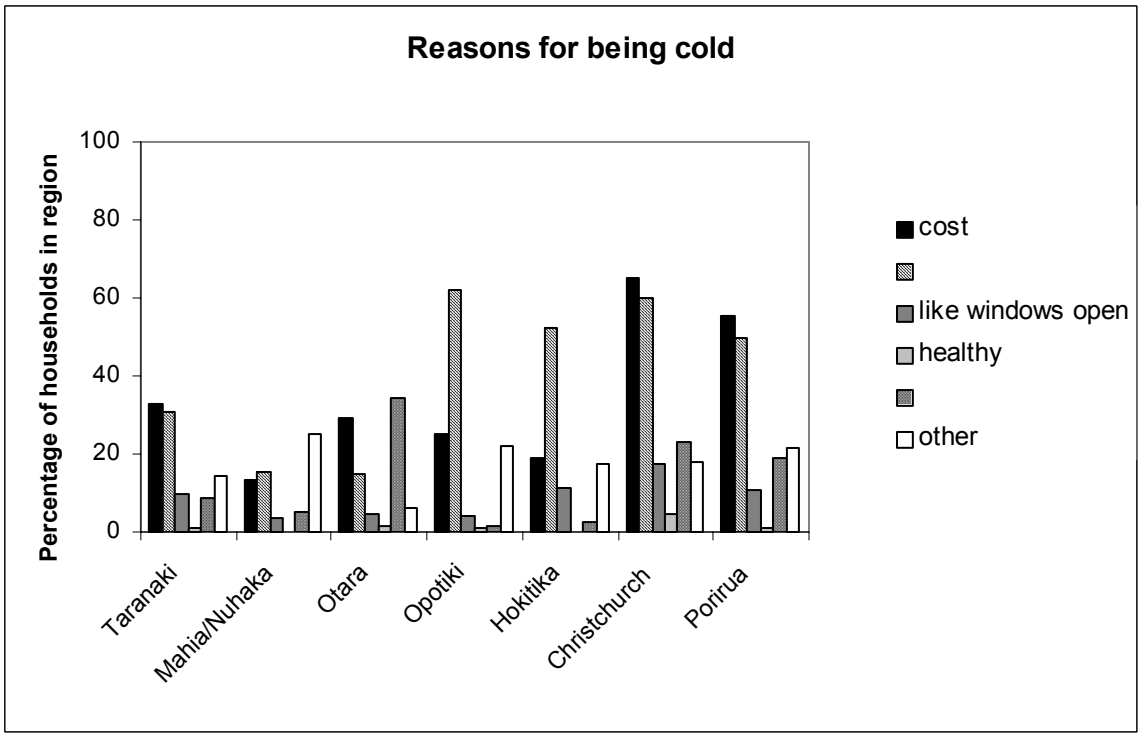
People in Otara were the most likely to report that their dwelling had been "always" cold, and those in Hokitika the least likely. Participants in Otara were the least likely to use heating during the winter and to feel warmed by it, and those in Christchurch and Hokitika were most likely to use it.

Figure 33



People living in urban environments (Otara, Christchurch, Porirua) were more likely to report that the dwelling had been colder than they would have liked. Overall, the participants least likely to report that their house had been colder than they would have liked, lived in Mahia/Nuhaka.

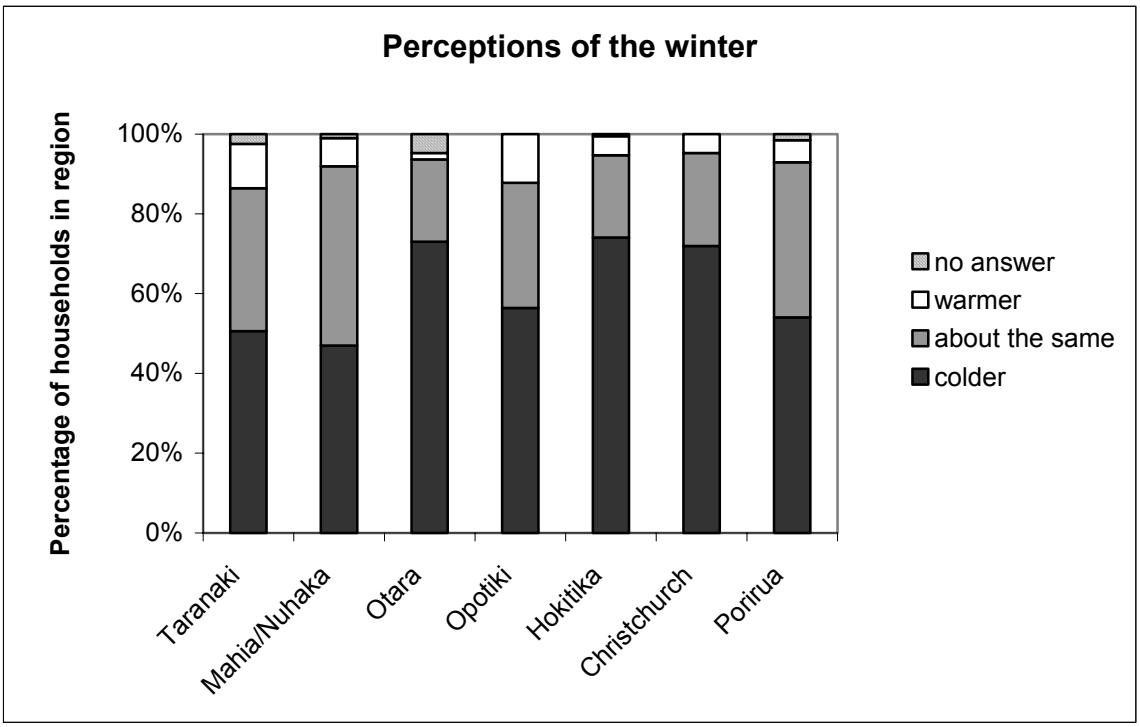
Figure 34



People were asked for the reasons that they had been cold. The answer to this question varied greatly between regions. The most frequently cited reasons were cost

and "heat just disappears", these reasons were in the top three in every region. About 60% of residents in EBP and Christchurch, and 50% of those in Porirua and Hokitika cited heat "just disappears"; large proportions also mentioned the cost of heating especially in Christchurch (65%) and Porirua (56%). However in Otara the most frequently cited reason (34%) was the energy crisis. Very few people (no more than 5% in any region) chose to be cold because they believed it to be healthy.

Figure 35

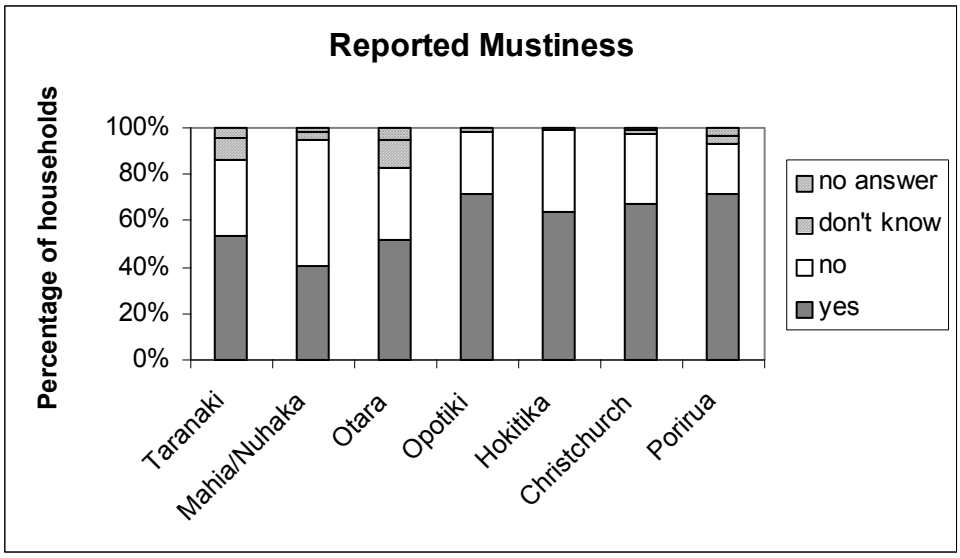


In every region except Mahia/Nuhaka over half the households regarded the winter of 2001 as colder than usual with the vast majority of those who did not report it as "colder than most winters" calling it "about the same" rather than "warmer than most winter". Mahia/Nuhaka was the only region where under half (46.9%) of the respondents reported that the winter was colder than usual. Mahia/Nuhaka was also the region that stood out in figures 32 and 33 for the respondents being more likely to find their houses comfortable when heated.

3.14 Mould and Mustiness

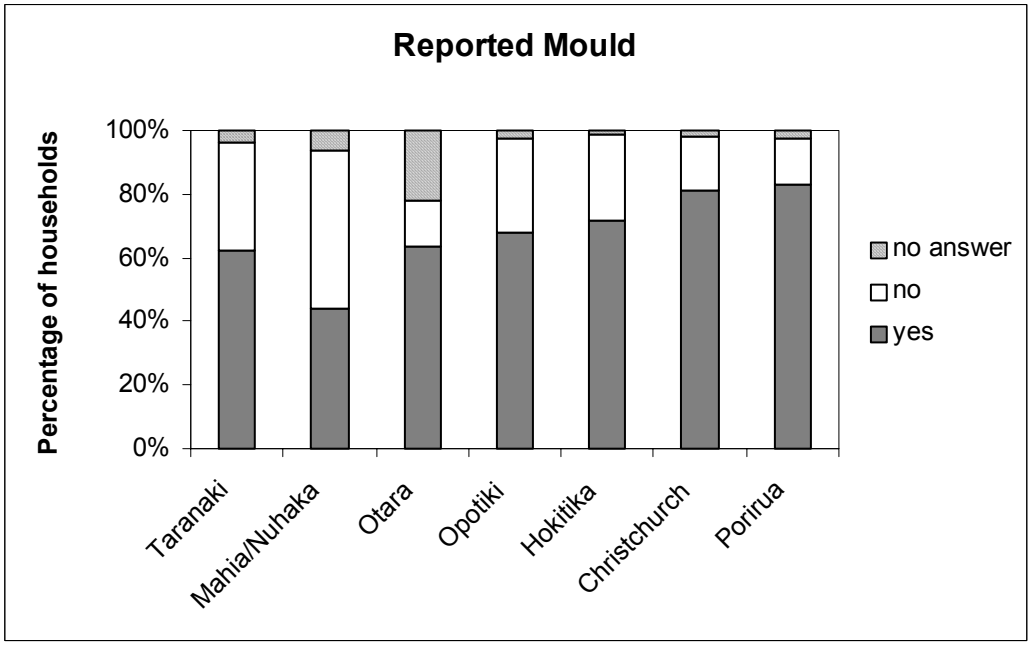
Householders were asked if there had been any mould in their house over the winter or if their house had smelt musty. A relatively high proportion of those in Otara "did not know" if their dwelling had been musty. There was a wide variation in reported mustiness between the regions. Of those who did know, and did answer the question a low of 43% of householders in Mahia/Nuhaka reported mustiness up to a high of 77% of households in Porirua.

Figure 36



There was also a substantial variation between reported mould in the regions. A low of 47% of householders in Mahia/Nuhaka reported mould and a high of 85% in Porirua of those that answered. However a substantial number of householders did not answer this question – especially in Otara.

Figure37



Mould cannot grow without moisture. An analysis was done comparing reported mould in the households with reported dampness, and relative risks calculated for the households participating in each region. (A relative risk is a statement of conditional probably, comparing the likelihood of something occurring depending on whether or not a co-condition has occurred, thus a relative risk of 2 means that the outcome occurs twice as often if the "cause" under consideration is present than if it is absent). The crude relative risk of a dwelling being described as having had mould in the last 3 months, if it previously had been described as having dampness other than condensation, is 1.81 (95% CI 1.63 – 2.00)

Tables 20 to 25 show the relative risks and confidence intervals for dwellings, kitchens, bathrooms, bedrooms, laundries and living rooms to be mouldy if they were also reported to be damp. The shaded rows show those where the 95% confidence limits do not include the null value. In every case there is an elevated risk, and in every case but one (living rooms in Hokitika) the difference is statistically significant at the 95% level.

The questions on dampness and mould in the dwellings were asked in different parts of the questionnaire (questions 10 and 11 were about dampness, and questions 31 and 32 were about mould) so these relative risks are unlikely to be just an artifact of the layout of the questions. However it is possible that people who are aware of mould in their dwelling are more likely to be aware of dampness if there is any present. Householders in mould-free dwellings underreporting dampness would lead to an increased observed relative risk. It is also possible that in regions where there has been a history of retrofit programmes or housing improvements the participants are more likely to be aware of mould, and to look for it.

Table 20

Relative risk of a dwelling being mouldy if the dwelling was damp	RR	95% CI	
Taranaki	1.79	1.31	2.45
Mahia/Nuhaka	2.20	1.59	3.03
Otara	1.51	1.06	2.15
EBP	1.70	1.32	2.18
Hokitika	1.63	1.35	1.98
Christchurch	1.51	1.21	1.88
Porirua	1.75	1.26	2.44
Weighted RR	1.71	1.54	1.89

Table 21

Relative Risk of mouldy living room if the living room was damp	RR	95 % CI	
Taranaki	4.62	2.30	9.26
Mahia/Nuhaka	4.11	2.20	7.69
Otara	3.32	2.43	4.55
EBP	3.42	2.10	5.57
Hokitika	2.03	0.95	4.34
Christchurch	4.38	2.61	7.33
Porirua	3.40	2.27	5.09
Weighted RR	3.49	2.91	4.18

Table 22

Relative Risk of mouldy bedroom if a bedroom was damp	RR	95 % CI	
Taranaki	4.64	2.75	7.83
Mahia/Nuhaka	2.70	1.82	4.01
Otara	2.59	1.79	3.76
EBP	2.32	1.75	3.08
Hokitika	2.17	1.69	2.77
Christchurch	2.08	1.57	2.75
Porirua	2.09	1.55	2.82
Weighted RR	2.42	2.14	2.73

Table 23

Relative Risk of a mouldy kitchen if the kitchen was damp	RR	95 % CI	
Taranaki	7.00	2.56	19.17
Mahia/Nuhaka	5.81	2.85	11.81
Otara	3.38	2.46	4.65
EBP	2.89	1.45	5.78
Hokitika	5.77	2.59	12.84
Christchurch	3.20	1.89	5.43
Porirua	3.33	2.19	5.05
Weighted RR	3.68	3.02	4.49

Table 24

Relative Risk of a mouldy bathroom if the bathroom was damp	RR	95 % CI	
Taranaki	2.00	1.48	2.70
Mahia/Nuhaka	4.83	3.15	7.40
Otara	2.12	1.64	2.74
EBP	2.10	1.59	2.77
Hokitika	1.84	1.44	2.36
Christchurch	2.32	1.74	3.09
Porirua	1.77	1.4	2.24
Weighted RR	2.15	1.94	2.39

Table 25

Relative Risk of a mouldy laundry if the laundry was damp	RR	95 % CI	
Taranaki	4.41	2.53	7.71
Mahia/Nuhaka	10.65	5.44	20.84
Otara	3.25	2.45	4.33
EBP	2.55	1.34	4.83
Hokitika	4.79	2.71	8.48
Christchurch	4.14	2.22	7.72
Porirua	3.10	2.04	4.71
Weighted RR	3.67	3.07	4.4

4.0 MYCOLOGY OF HOUSEHOLD DUST PARTICLES, *N.W. Waipara, HortResearch, Canterbury Research Centre LINCOLN*

This project was initiated to examine the biodiversity and biomass of culturable fungi colonising individual dust particles from selected New Zealand households. The identification of fungal species present in household dust will allow the presence and levels of potentially allergenic or mycotoxin producing species to be determined. The presence of such species may have implications for future research into indoor environmental factors affecting occupants' health. This following summarises the baseline results from the Year 1 fungal isolations and identifications.

4.1 Methods

1- Dust Sampling

Dust samples from houses across three geographical-climatic regions; Hawke's Bay, Wellington, Christchurch (149 homes in total) were collected by vacuuming 1m^2 of bedroom floor area for1minute into 20µm mesh bag.

2- Fungal Isolations

0.1g dust was removed from each sample and added to 10 ml of sterile phosphate buffer (6.75 g KH_2PO_4 + 8.75 g K_2HPO_4 + 0.5 ml Tween 80, 1 L H_2O) and shaken in a stomacher blender for 1 minute. Dust suspensions were then serially diluted and plated onto two non-selective mycological media; Malt Extract Agar (MEA), Potato Dextrose Agar (PDA), amended with antibiotic (1% chlortetracycline). Xerophilic fungi were obtained by plating the dust suspensions onto antibiotic Dichloran Glycerol 18 (DG18).

A further sub sample of 0.05g of the dry dust was sieved and sprinkled directly over the same media as well as an additional an additional media (V8 agar). Isolation plates were incubated at 20^oC for and colony forming units (CFUs) were enumerated after 7-20 days.

3- Fungal Identification

Standard light microscopy and phenotypic/morphological classification techniques were used to identify a number of CFUs directly from the isolation plates after 20 days. The remaining CFUs were sub-cultured onto an array of synthetic nutrient-poor media for further identification procedures.

4.2 Results

1- Fungal biomass

Total counts significantly different between many homes and ranged between <100,000 - >1,000,000 CFUs/g dust, however the overall mean counts were similar between the three regions surveyed (Figure 1). These results were consistent with previous international surveys reported e.g. Germany.

Regional variation between mean fungal counts

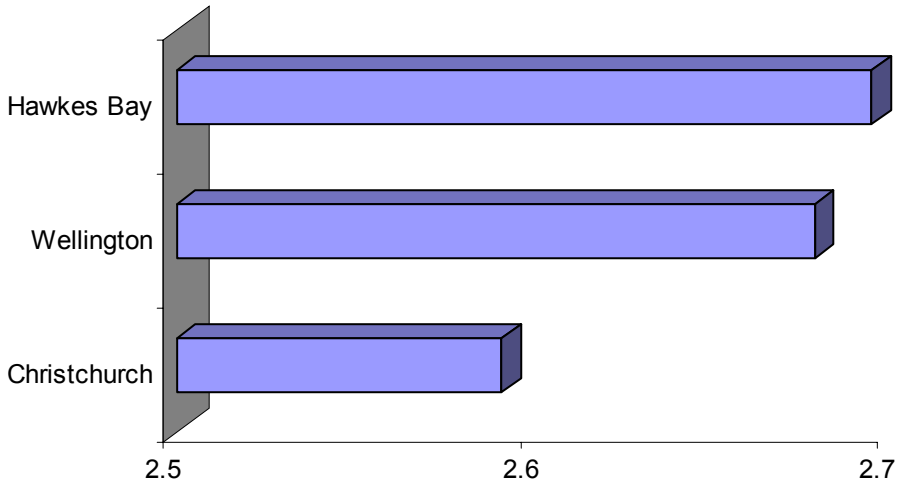


Figure 38 Mean total fungal counts CFUs/g dust (log)

2- Fungal biodiversity

A wide taxonomic range of fungi was isolated from plated dust particles. Dust fungi populations were comprised from over 73 genera and 191 species indicating household dust contains a diversity of fungal organisms similar to that reported in other environmental substrates such as arid and temperate soils or plant roots. Ubiquitous airborne fungi were frequently isolated in household dust with *Cladosporium cladosporioides* being the most frequently identified species across all samples (Figure 2).

A significant variation in the fungal species diversity between most households was observed, but the overall regional biodiversity was not significant ($P>0.05$). A few significant exceptions to this were observed, for example a dematiaceous hyphomycete fungus, *Acremoniella atra,* was more frequently isolated from Christchurch dust samples (Figure 3). Additionally *Aspergillus* spp and *Wallemia sebi* more commonly isolated from the Hawke's Bay samples (Figure 4).

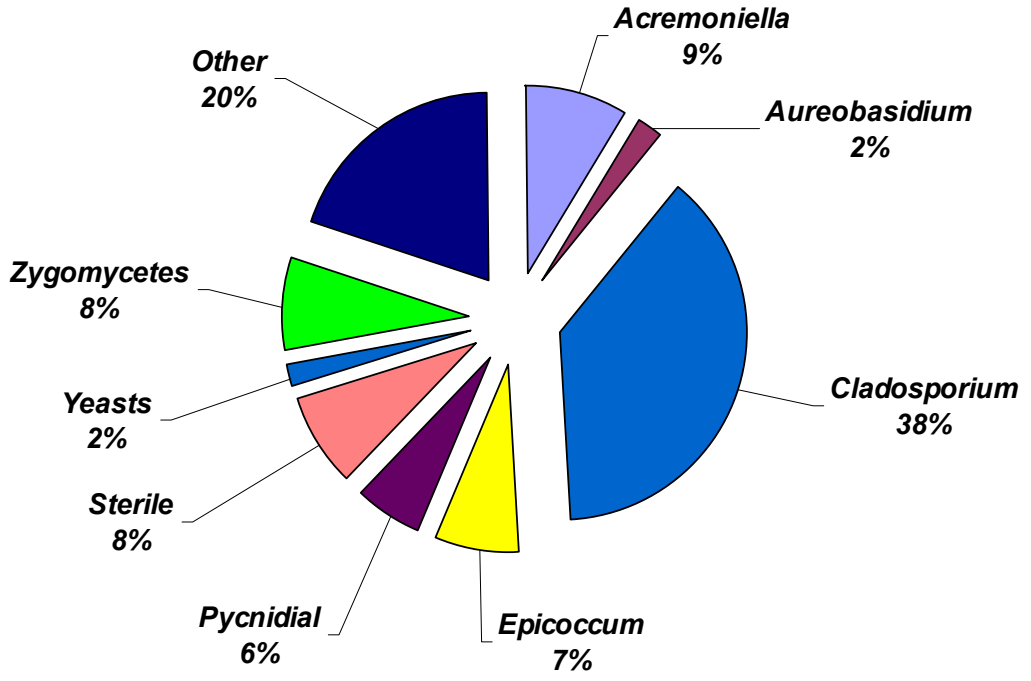


Figure 39 Total fungi identified from dust particles (% of mean total CFUs counted)

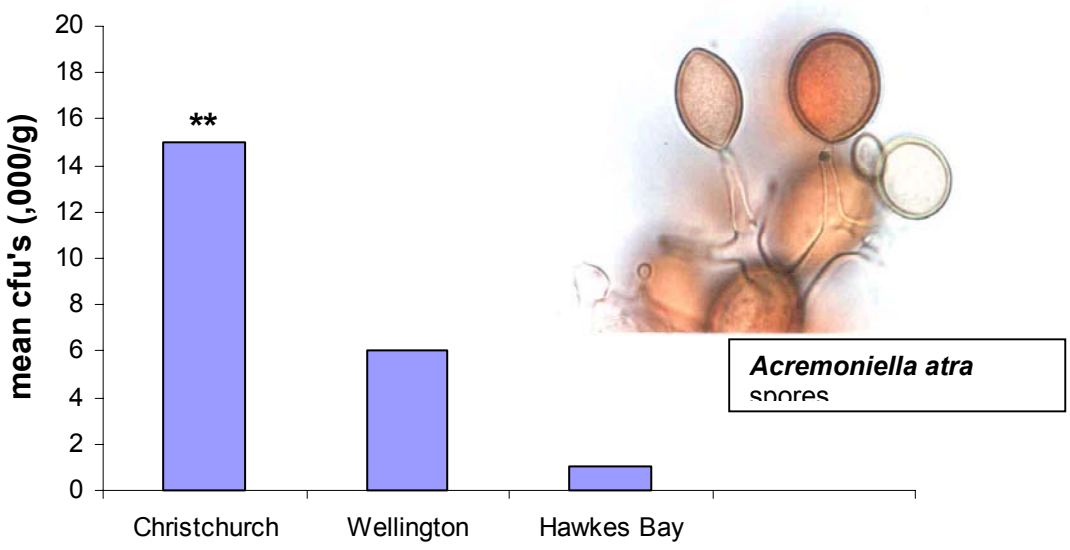


Figure 40 Isolation of *Acremoniella atra* (pictured) from household dust samples** **= numbers significantly higher *P*<0.05**

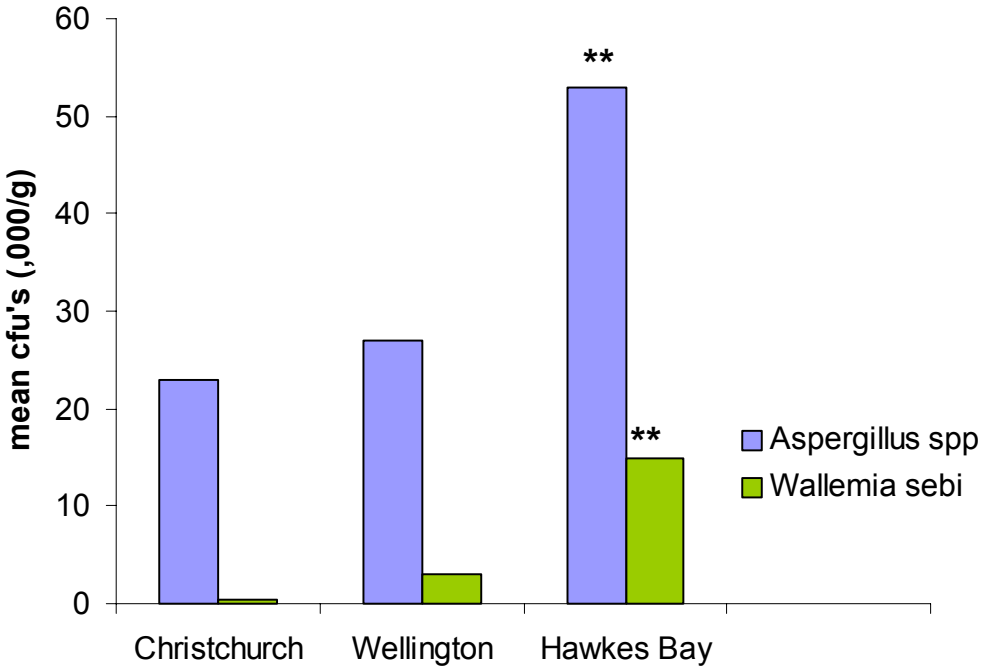


Figure 41 Isolation of *Aspergillus* spp. *& Wallemia sebi* from household dust samples. ** = **numbers significantly higher *P*<0.05**

2- Fungal biodiversity continued

The genus *Penicillium* was the most diverse identified from this survey with over 28 species identified to date. Potentially new species were also obtained from dust particles as almost 20% of *Penicillium* isolates do not fit the current published species descriptions for this genus. Utilisation of molecular techniques (PCR) is currently underway to help elucidate the identity of these unknown species.

High numbers of *Aspergillus* species were also obtained from all samples (Figure 5), this group of fungi has been investigated worldwide as several species can infect lung tissues causing a respiratory condition known as Aspergillosis. The isolation and toxicity of these species should be investigated further.
Almost 25% of fungal cultures obtained in this study (including both *Aspergillus* and *Penicillium* spp), have previously been reported as mycotoxin/voc producing fungi (Figure 6), and therefore further research is required to ascertain the toxicity or otherwise of these New Zealand household isolates.

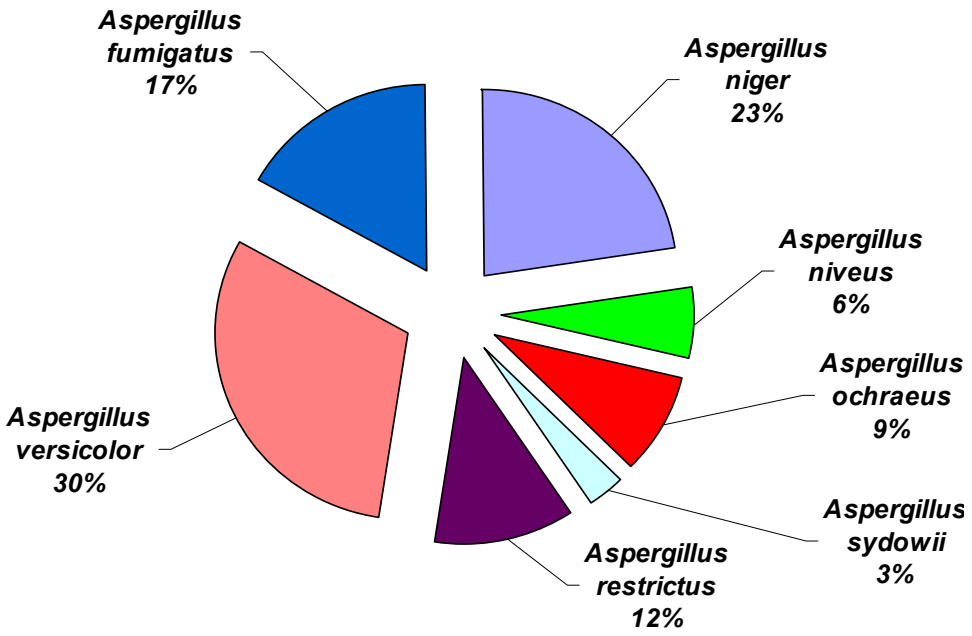


Figure 42 *Aspergillus* spp identified from household dust (~ 11%of isolates are unknown or undescribed species)

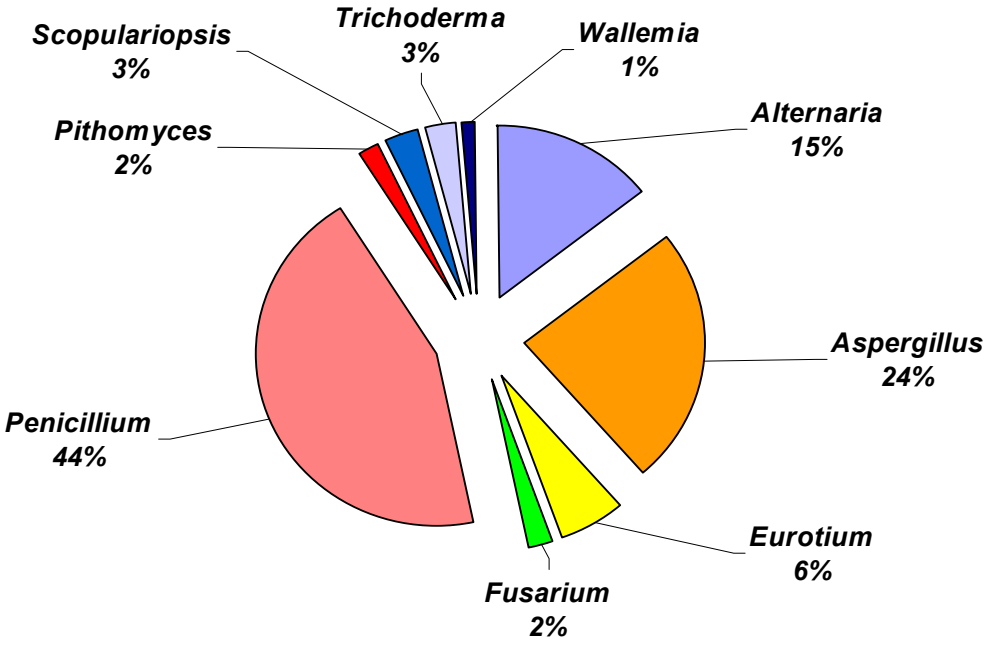


Figure 43 Potential mycotoxin/volatile organic compound producing fungi isolated from household dust. (previously reported from international mycotoxin analyses)

Appendix A

List of key community organisations

Otara

Otara Health Incorporated

Eastern Bay of Plenty

Opotiki Trade Training Limited

Nuhaka/Mahia

Te Iwi o Rakaipaaka Incorporated

Te Hauora o Te Wheke-a-nuku

South Taranaki

Te Puni Kokiri
New Plymouth District Council

Porirua

Housing Action Porirua

Hokitika

Rata Branch of the Maori Women's Welfare Group

Christchurch

Crown Public Health Limited

Appendix B

List of local community interviewers, 2002

Christchurch interviewers

Will Davey
Annabel Driscoll
Julie Whitla
Marina Wylaars

Hokitika interviewers

Monique McLaren
June Robinson
Linda Wall

Porirua interviewers

Gayle Chalmers
Parerimu Cummings
Marie Munro
Te Rongo Tekii

South Taranaki interviewers

Ngawai Akapita
Maria Hemara Wahanui
Donna Leatherby
Sonya Morehu
Kawarau Ngaia

Nuhaka/Mahia interviewers

Elyria Fau
Alberta Hunga
Linda Kawana

Eastern Bay of Plenty interviewers

Lisa Church
Karlene Koopu
Maree Koopu
Wakata Mira

Otara interviewers

Mate Tipene
Bill Wiki

Appendix C

List of retrofit teams contracted to study

Community Energy Action
CHRISTCHURCH

Energy Smart Limited
PORIRUA
HOKITIKA

Opotiki Trade Training
EASTERN BAY OF PLENTY

New Plymouth District Council
SOUTH TARANAKI

Manukau Work Trust
OTARA