Healthy Homes Guarantee Standard Cost Benefit Input

Warm Up New Zealand evaluation rental sector sub-analysis: differences in health events and costs by existing insulation status

Lucy Telfar Barnard, Nicholas Preval

He Kainga Oranga/Housing and Health Research Programme,
University of Otago, Wellington

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Background

In 2011 the University of Otago, in conjunction with Motu, evaluated changes in numbers and costs of hospitalisations, pharmaceutical prescriptions, and deaths (health events), associated with participation in the government's Warm Up New Zealand (WUNZ) subsidy programme. The results of that evaluation are published in Telfar Barnard et al., 2011.[1]

The 2011 evaluation found that after installing insulation people had no fewer health events, but the cost of those events was reduced. Some of the health cost reduction was from hospitalisation costs, a total of $64.44 per household per year, but the majority of the health cost savings accrued from mortality prevented, which was estimated at 0.852 deaths per 1000 households each containing 3.61 individuals; valued at $439.95 per year per treated household, based on the transport value of a statistical life. There was no significant change in pharmaceutical costs. Subsequent work refined the hospitalisation and mortality benefits to ongoing annual benefits of $38.23 and $749.11 respectively per household treated.[2] [3]

Purpose

The Ministry of Business, Innovation and Employment (MBIE) is considering options for the Healthy Homes Standards, which will set rental property standards for heating, insulation, ventilation, moisture ingress, draught-stopping and drainage.

In regard to insulation, MBIE has identified three options for the standards:

- to leave the insulation standard as set by the Residential Tenancies (Smoke Alarms and Insulation) Regulations 2016, which require rental properties with less insulation than the 1978 insulation requirement benchmarks to upgrade to the 2008 Building Code benchmarks, but do not require upgrade for those properties already meeting the 1978 Building Code benchmarks;
- to require rental properties with less insulation than the 2001 Building Code standard to upgrade to the 2008 Building Code benchmarks, but require no upgrade for those properties already meeting the 2001 Building Code benchmarks; or
- to require all rental properties to meet the 2008 Building Code benchmarks.

The primary purpose of this 2018 analysis report was to provide input on changes in health costs for a cost:benefit analysis comparing these three options. The cost savings referred to in this report refer only to savings from reduced costs of hospitalisations and prescriptions, and in the value of life years gained; they do not include any offset of costs of installing insulation, nor do they include broader health benefits including wellbeing, doctors' visits, days of work or school, nor broader social and economic benefits such as days of work or school, reduced energy use, or employment for insulation installers. For a more complete description of what might be included in a full cost:benefit analysis, see Preval 2014.

The authors were also asked to look at whether any available data on other WUNZ interventions might provide results useful for decisions on other healthy homes standards, including on-ground vapour barriers and extractor fans; and to also see whether cost savings were different for population sub-groups known to be particularly vulnerable to cold, i.e. the elderly, pre-schoolers, and households on low incomes.

Method

Data collection

Data collection for this Healthy Homes Standards CBA input was described in the 2011 report. The 2018 analysis differed from the 2011 version in that it took a subset of the original data, as follows:

- Treatment households were limited to households reported in the original EECA data to be rental households with ceiling insulation installed.
- These rental households were disaggregated according to whether EECA data showed the property to have 'some' or 'none' existing insulation.
- The disaggregated rental households were further disaggregated in three other ways to measure differences for potentially vulnerable sub-groups:
  - whether or not someone in the household held a Community Services Card (CSC);
  - whether or not someone in the household was under 5 years of age;
  - whether or not someone in the household was over 65 years of age.

Next, we removed any control household that no longer had an associated treatment household in the dataset.

For mortality, limiting the data to rental properties only reduced the treatment cohort size to a level where it was too small for analysis. We therefore included the full original cohort, including owner-occupiers, in our mortality analysis. However, we measured only the mortality cost savings for elderly who were aged 65 and over when hospitalised for a circulatory condition, as this was the only statistically significant saving in Preval 2014.

We also measured uptake of other WUNZ interventions in rental properties, both to check for a mediating effect on the insulation results, and also to see whether the results of these interventions might be measured independently of insulation.

"Some" vs "none" existing insulation

Information provided by EECA described the difference between "some" and "none" existing insulation as follows in Table 1:

Table 1: Comparison of "CeilingNone" and "CeilingSomeExisting" insulation installations.

Label	"CeilingNone"	"CeilingSomeExisting"
Description	No pre-existing ceiling insulation, or where pre-existing ceiling insulation was either less than 75mm thick, or damaged (e.g. lots of gaps).	Pre-existing ceiling insulation in acceptable condition, but only 75 - 120mm thick
Insulation product used	"Total fill" (Has higher R-value than "top-up")	"Top up" (Has lower R-value than "total fill")
Final result	Meets 2008 Building Code benchmarks	Meets or exceeds 2008 Building Code benchmarks
CBA proxy for:	Upgrading from below 1978 benchmarks	Upgrading from 1978 benchmarks

For each resulting data subset we then measured whether, after insulation, there was any difference in the costs of health service utilisation between the subset households and their control households compared to the period before insulation dates. We also measured whether there was any significant difference in health service utilisation costs between 'some' and 'none' insulation groups.

In addition, we provided breakdowns of numbers of people and households in each analysis group, and compared uptake of underfloor insulation and heating interventions between insulation categories.

Analysis

Statistical methods repeated those used in Telfar Barnard et al 2011. For hospitalisations and prescription numbers we used a 'negative binomial' regression model. The model output is a relative rate ratio, or difference in difference, controlling for sex, age group (except for <5 and 65+ years sub-analyses), prioritised NHI ethnicity, and NZDep quintile; representing:

$$\frac{(\text{treatment event rate after/treatment event rate before})}{(\text{control event rate after/control event rate before})}$$

For cost data, we used a fixed effects OLS estimator with standard errors clustered by house. For full details we recommend readers refer to Telfar Barnard et al 2011. For mortality, we used a Cox Proportional Hazards model, as described in Preval 2014.

Costs were calculated across households, and changes in hospitalisation and pharmaceutical prescription rates were also counted at an individual level. Analyses controlled for age group (except <5 and 65+ age group analyses), sex, ethnicity (prioritised), and NZDep quintile.

Results

Cohort

Table 2 shows the number of individuals in the study cohort.

Table 2: Rental cohort numbers by treatment/control, CSC household, and existing insulation status.

		Treatment/control					
		Total		**Some existing insulation**		**No existing insulation**	
		T	C	T	C	T	C
All individuals	All	12,432	75,972	2,012	11,886	10,420	64,086
	Under 5s	1,735	7,539	267	1,149	1,468	6,390
	65+	1,140	9,692	168	1,538	972	8,154
CSC households	Total	9,277	55,937	1,370	7,994	7,907	47,943
	Under 5s	1,388	5,681	193	779	1,195	4,902
	65+	880	7,145	122	1,013	758	6,132
Non-CSC households	Total	3,155	20,035	642	3,892	2,513	16,143
	Under 5s	347	1,858	74	370	273	1,488
	65+	260	2,547	46	525	214	2,022

Table 3 shows the number of households in the study cohort.

Table 3: Household numbers by treatment/control, CSC household, and existing insulation status.

		Treatment=T| Control=C					
		Total		Some existing insulation		No existing insulation	
		T	C	T	C	T	C
Total	Total	2,762	19,691	454	3,177	2,308	16,514
	Under 5s	1,094	5,018	175	775	920	4,243
	65+	821	6,959	129	1,108	692	1,108
CSC households	Total	2,020	14,371	305	2,110	1,715	12,261
	Under 5s	861	3,749	126	516	735	3,233
	65+	622	5,104	96	724	526	4,380
Non-CSC households	Total	742	5,320	149	1,067	593	4,253
	Under 5s	233	1,269	48	259	185	1,010
	65+	199	1,855	33	384	166	1,471

Other interventions

Uptake of underfloor insulation and ground vapour barriers was similar across the "some and "none" existing insulation groups. There was greater uptake of heating among those who had some existing insulation than those who had none; but greater uptake of draught-stopping amongst those who had no existing insulation.

Table 4: Percentage of treatment group taking up other WUNZ options by previous insulation status (rental properties only).

	Existing insulation status	
	Some	**None**
Underfloor insulaton	39.3%	38.9%
Ground vapour barrier	22.2%	22.4%
Draught-stopping	20.2%	24.4%
Heating	11.3%	8.3%

Effects of ground vapour barrier and draught-stopping

We looked at whether it would be possible to measure the effect of ground vapour barriers or draught-stopping separately from other interventions. Unfortunately, there were too few rental households who only installed either intervention to measure their effects independent of other interventions.

Hospitalisation

There were 28,699 hospitalisation events in the total cohort over the study period. 3,176 of these were among children aged under 5 years, and 7,408 among people aged 65 years and over. 22,195 were among people living in a CSC card holder household. 4,750 were among people living in households with some existing insulation.

Events

Changes in hospitalisation events are shown in Table 5. There was no statistically significant change in hospital events for the total rental population, whether or not the property had some existing insulation. However, there were statistically fewer hospitalisations among children aged under 5 years. There was no statistically significant difference in hospital events between properties with some existing insulation and properties with none, nor between properties with CSCs and those without.

Table 5: Differences in hospitalisation rate following insulation for people living in rental households.

		Relative rate ratio			
		Total	Some existing insulation	No existing insulation	p-value some vs no existing[a]
Total	Total	1.01	1.02	1.01	0.865
	Under 5s	**0.67**	0.65	**0.67**	0.990
	65+	0.94	0.72	0.97	0.632
CSC households	Total	1.03	1.00	1.04	0.767
	Under 5s	**0.70**	0.70	**0.69**	0.767
	65+	1.03	0.72	1.06	0.653
Non-CSC households	Total	0.93	1.11	0.88	0.254
	Under 5s	**0.57**	0.37	0.62	0.372
	65+	**0.61**	0.59	**0.61**	0.710

Figures in bold are statistically significant to $p<0.05$.
[a]The two identical consecutive p-values in this column are correct.

Costs

Changes in hospitalisation costs per household for treated households compared to control households are shown in Table 6 below.

Table 6: Monthly rental household hospital utilisation cost differences following insulation

		All insulation	Some existing insulation	No existing insulation	Prob>chi2 some = no existing[2]
All households	All ages	**-$4.81**	**-$12.04**	-$3.59	0.1598
	Under 5s	**-$73.21**	$24.62	**-$91.66**	**0.0249**
	65+	$0.47	-$14.98	$3.11	0.3927
CSC households	All ages	-$4.41	**-$13.51**	-$3.01	0.1401
	Under 5s	-$63.48	-$2.10	-$73.08	0.1642
	65+	$1.15	-$3.76	$1.90	0.8236
Non-CSC households	All ages	-$5.96	-$9.72	-$5.18	0.6813
	Under 5s	-[1]	-[1]	-$103.62	-[1]
	65+	-$5.04	-$47.43	$5.12	0.1231

Figures in bold are statistically significant to $p<0.05$.
1. Model could not resolve
2. Wald test for whether “some” and “no” existing insulation coefficients are equal. A value of 0.05 or less means the two values are significantly different.

There was a statistically significant total cost saving of $4.81 per rental household insulated. The cost saving was greater for properties with some existing insulation, at $12.04. For children aged under 5, the cost saving was $73.21 per household treated, but was greater for properties with no existing insulation, at $91.66.

There was also a significant hospitalisation cost saving for CSC households with some existing insulation, but no statistically significant changes for other categories. Differences between CSC and non-CSC households, and between previously and non-previously insulated properties, were not statistically significant except for all households with under-5 year olds, among whom there was a significantly greater health cost saving associated with installing insulation in properties with no existing insulation than in properties with some existing insulation.

Pharmaceutical prescriptions

Prescriptions issued

Changes in pharmaceutical prescription rates are shown in Table 7.

Table 7: Differences in numbers of pharmaceutical scripts issued following insulation for people living in rental households.

		All insulation	Some existing insulation	No existing insulation	p-value some vs no existing
All households	All ages	0.98	0.99	1.00	0.960
	Under 5s	**1.16**	1.36	1.13	0.350
	65+	0.97	1.22	0.94	0.144
CSC households	All ages	0.99	0.99	0.99	0.877
	Under 5s	1.12	1.17	1.10	0.620
	65+	1.06	1.31	1.02	0.113
Non-CSC households	All ages	0.93	0.89	0.94	0.869
	Under 5s	1.35	2.20	1.24	0.397
	65+	**0.72**	0.65	**0.72**	0.947

Figures in bold are statistically significant to p<0.05.

There was no significant difference in the number of prescriptions people received after their properties were insulated, except for children aged under 5, whose prescriptions increased significantly, and elderly aged 65 and over in households without a community service card, whose prescriptions decreased significantly. There was no significant difference between previously or non-previously insulated households for any analysis category, nor between CSC or non-CSC households.

Costs

Changes in the costs of pharmaceutical scripts issued are shown in Table 8.

There were small but significant pharmaceutical cost savings for rental households treated under the WUNZ scheme. There was a much higher significant cost saving in pharmaceutical prescriptions to under-5s in properties with some existing insulation, however this result is unusually high compared to other results so should be treated with caution.

Differences between households by CSC or existing insulation status were both small and non-significant, except for non-CSC households with under-5 year olds living in them, where prescription cost savings were significantly higher in properties with some existing insulation.

Table 8: Monthly rental household pharmaceutical script cost differences following insulation

		All insulation	Some existing insulation	No existing insulation	Prob>chi2 some = no existing[a]
All households	All ages	**-$1.88**	**-$1.84**	**-$1.89**	0.9314
	Under 5s	-$1.78	-$6.63	-$0.88	0.4794
	65+	-$0.54	-$0.95	-$0.43	0.7048
CSC households	All ages	**-$2.01**	**-$2.02**	**-$2.01**	0.9917
	Under 5s	-$2.21	-$4.25	-$1.77	0.7364
	65+	-$0.08	-$0.19	-$0.05	0.9356
Non-CSC households	All ages	**-$1.68**	**-$1.58**	**-$1.70**	0.8828
	Under 5s	-$2.41	**-$34.48**	$0.96	**0.0000**
	65+	-$1.75	-$2.98	-$1.44	0.4894

Figures in bold are statistically significant to p<0.05.
[a]Wald test for whether "some" and "no" existing insulation coefficients are equal. A value of 0.05 or less means the two values are significantly different.

Mortality

The mortality cohort was already a smaller subset of the original study, as it included only people aged 65 and over who had previously been hospitalised with a respiratory or circulatory illness.

With the analysis reduced to include only rental properties, the mortality cohort sample size reduced to 157 for the treatment group, among whom there were 11 deaths. The sample size was thus too small to produce meaningful results. All 11 deaths were among the 130 people with no existing insulation, and all 11 were among the 123 who were CSC-holders.

We note that while 11 deaths out of 157 people might seem high, the cohort was a particularly vulnerable population: they had already had at least one hospitalisation in the few years previous to having insulation installed, and they were living in a rental property, which even more a marker of deprivation in the elderly than it is among younger age groups.

Table 9: Association between insulation treatment and mortality rates in people aged 65+ with previous circulatory illness

		Cohort size	Deaths after treatment month	Mortality rate per 1000 people per year	Fully adjusted hazard ratio (95%CI) p-value	Total health cost savings per household[a]
All insulation	**Treatment**	819	102	114.8 (92.2 – 137.5)	**0.71 (0.57 – 0.87) p=0.001**	$749.11[b]
	Control	1840	312	159.4(141.7 – 177.2)		
Some existing	**Treatment**	158	14	71.6 (31.1 – 112.1)	**0.50 (0.29 – 0.86) p=0.011**	$934.72
	Control	371	63	152.5 (113.9 – 191.1)		
None existing	**Treatment**	722	117	129.1 (105.1 – 153.0)	**0.75 (0.60 – 0.94) p=0.011**	$733.90
	Control	1919	317	154.6 (137.5 – 171.7		

As numbers were too small to produce meaningful results for the rental cohort, we looked at the full cohort. The methodology has been refined somewhat since the 2011 report, as described in Preval 2014. As both the 2011 study and Preval 2014 found no significant result for total mortality or

[a] Health cost benefit per household treated, across all households
[b] This figure comes directly from Preval 2014, p123.

mortality among those with a prior respiratory hospitalisation, we have limited this report to mortality among those with a prior circulatory hospitalisation only. We have also limited the cohort to those who received ceiling insulation.

Results for the full cohort with previous circulatory illness are presented in Table 9. The difference between some and no existing insulation (Wald test prob>chi2=0.1602) was not significant.

Discussion

Insulating rental properties brought hospitalisation cost savings, and reductions in total events for children aged under 5 years.

There was no significant difference in reductions in health cost or use between properties with existing insulation and those without. Where there was a significant total cost or event reduction, as with total hospitalisation costs and events, pharmaceutical costs, and hospitalisation events for under-5s, we can therefore conclude that it was just as beneficial to insulate properties with some existing insulation as it was to insulate properties with no existing insulation.

For the full cohort, including owner-occupied properties, there was a significant cost saving from reduced mortality among elderly aged 65 years and over previously hospitalised with circulatory illness. When this saving was measured across the total cohort, it was valued at $749.11 per household treated; $934.72 for households with some existing insulation, and $733.90 per household with no existing insulation; the health cost savings difference between households with some and no existing insulation was not statistically significant.

For many readers, the idea that a thinner layer of insulation in a dwelling receiving a top-up might provide as much health benefit as a thicker layer of insulation in a dwelling receiving a full install, is counter-intuitive, particularly since building physics models suggest that adding additional insulation provides diminishing returns. However, possible explanations for the similar benefit would be post-hoc speculation, and beyond the scope of this report.

Limitations

The most important limitation of this study is the possibility of information bias. In the original study, the main information gap was the insulation status of the control properties: we therefore described that study as a comparison of properties that were “definitely insulated” with properties that were “mostly probably not insulated” rather than “insulated” and “not insulated”. That information gap is unlikely to be any stronger in this study, as existing insulation status is primarily a factor of dwelling construction decade, and matching variables for control houses included construction decade. However, this study has the additional information gap that the rental status and CSC-holder status is known for the treatment properties but not for the control properties. It is unclear whether this bias would be towards or away from the null.

There is also a potential selection bias for results for children aged under-5. If a child is regularly unwell, its caregivers are likely to do what they can to improve their child’s health. At the same time, children’s health does tend to improve as they get older. As the study method compares health after intervention to health before intervention, for the treatment group compared to the control group, a higher likelihood of ill health in children in the treatment group before intervention increases the likelihood of an association being found.

On the other hand, the study may underestimate health cost savings for the elderly, among whom the opposite applies: elderly people who have been regularly unwell may be more likely to have insulation installed, and are also more likely to have further health deterioration than those who are in good health.

Readers should also note that the analysis included 153 different output measures. With outputs measured as statistically significant at $p<0.05$, we would expect about 8 of the 30 statistically significant outcomes to be statistically significant only through chance. Therefore, any single statistically significant result should be considered in relation to other results for similar analyses, and individual significant results should not be treated as meaningful, particularly where they are inconsistent with general trends in significant results.

Finally, this CBA input is limited in that the health costs measured include only hospitalisation, pharmaceutical and mortality benefits, and not broader health benefits including wellbeing, doctors' visits, days of work or school, or other health benefits associated with income savings on heating.

Conclusion

Insulating rental households brings some reductions in health costs, particularly for under-five year olds. As in previous 2011 and 2014 analyses, the primary cost savings from insulation lay in reduced mortality. Hospitalisation and pharmaceutical costs on their own provide no firm direction on whether it would be worthwhile to top up existing insulation, compared to only requiring top-ups for properties with no existing insulation, as insulation makes little meaningful difference to the number of hospitalisations or prescriptions, so any savings lie in the costs of those events. The monthly cost savings per household of $4.81 in hospitalisations ($57.72 per year for rental tenure, compared with $38.23 across all tenures) and $1.88 in prescriptions ($22.56 per year for rental tenure, compared with $24.10 across all households) are small compared to the cost outlay of installing insulation. However, the all tenure mortality cost savings from insulating properties is high, and results indicate that there is at least as much value in topping up properties with existing insulation as there is in full insulation installs.

While mortality cost savings could only be measured for the full cohort, we note that properties do move in and out of rental tenure, so even if savings were weighted towards owner-occupiers, those savings would later be seen in those insulated rental properties which moved into owner-occupier tenure.

This particular analysis provides no statistically significant evidence to support targeting insulation interventions at particular age or income groups. However, there is a large body of other evidence indicating that insulation or other interventions that improve indoor thermal comfort may provide greater benefits for children, particularly children in low income and renting households[4], and people on low incomes[3]. For the elderly, while this report does not find significant differences in hospitalisation or pharmaceutical cost savings, it is worth noting that the mortality benefits are likely to be particularly concentrated in older age groups as they have a higher base mortality risk. The elderly are also recognised to be at particular risk from cold indoor temperatures.[5]

To conclude: given extensive other evidence for the benefits of insulation[6], in particular for reducing mortality, insulation top-ups are as worthwhile as total fills.

Implications for policy makers:

- WUNZ insulation top-ups saved at least as much per household in health costs as total fill insulation.
- Most of these savings came from reduced mortality.
- This particular analysis provides no statistically significant evidence to support targeting insulation interventions at particular age or income groups, however;
- Policy makers should assess this evidence in conjunction with other evidence that insulation or other interventions that improve indoor thermal comfort may provide greater benefits for children, particularly children in low income and renting households[4], and people on low incomes[3]; while the elderly are recognised to be at particular risk from cold indoor temperatures, and most likely to benefit from mortality risk reductions.[5]

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