



SCHOOL OF
ENGINEERING
AND ADVANCED
TECHNOLOGY



House Characteristics and Indoor Dampness in the BRANZ House Condition Survey

PhD study by Phoebe Taptiklis, MPH



Funded from the
Building Research Levy

Background

- Healthy Housing Index created by Otago University.
- 961 houses surveyed in detail to assess house related health hazards

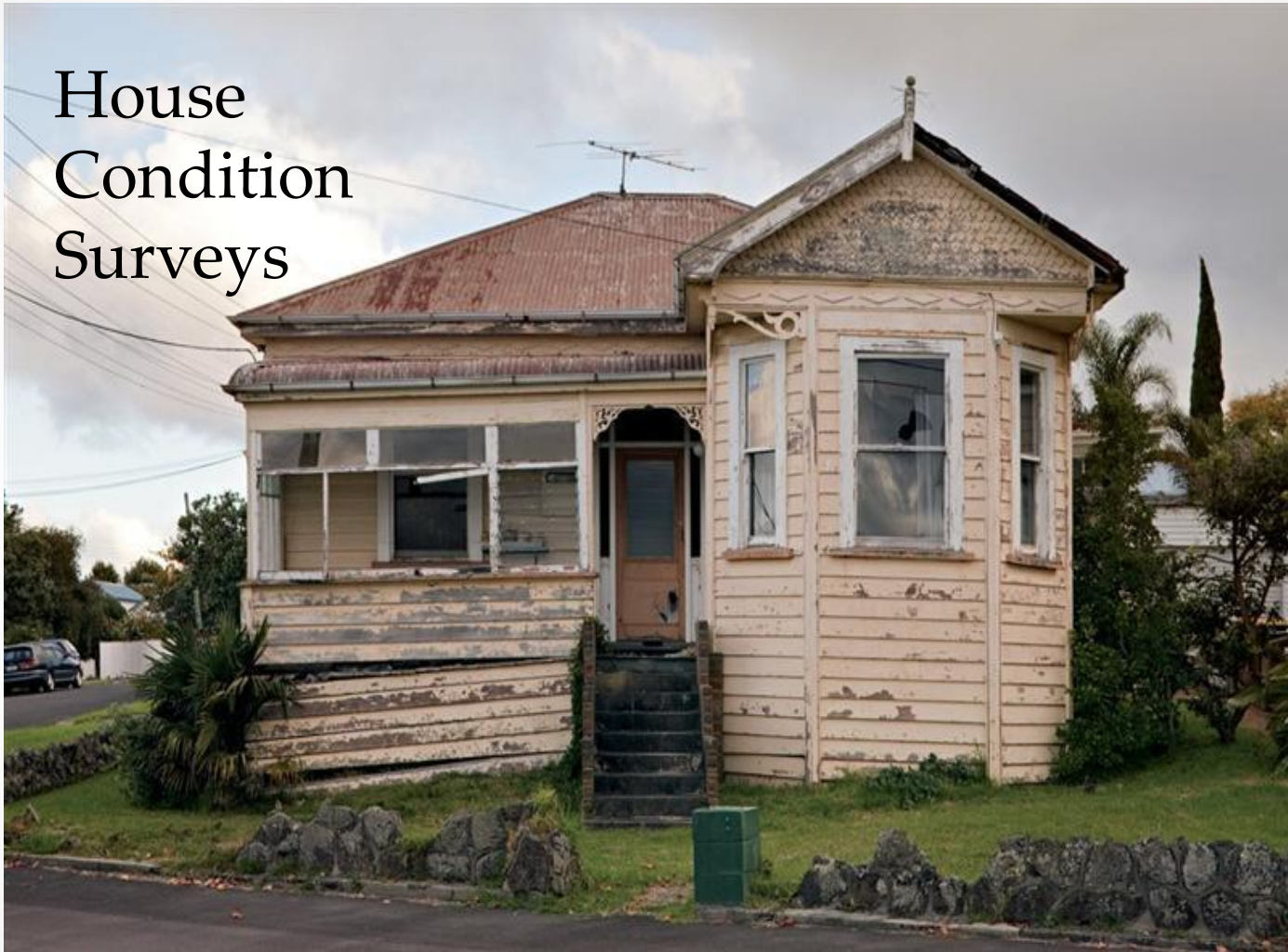
Keall M. (2007). *Healthy Housing Index Pilot study Final Report*. He Kainga Oranga Housing and Health Research Programme.

Taptiklis P, Douwes J, Phipps R & Keall M. (2016). *Quantifying the relationship between house maintenance and indoor dampness*. Proceedings of the Conference of Indoor Air, 2016

Healthy Housing Index

- General maintenance “poor” = 12x more dampness than maintenance “good”
- Spouting defects and roof defects both associated with increased dampness
- Not many envelope characteristics

House Condition Surveys



House Condition Surveys

- Buckett NR, Jones MS, & Marston N. 2012 *BRANZ 2010 House Condition Survey- Condition comparison by tenure*. Study Report 264. BRANZ, Porirua, New Zealand.
- Clark SJ, Jones MS, Page IC. 2005 *New Zealand House Condition Survey*. Study Report 142. BRANZ, Porirua, New Zealand.
- White V, Jones M, Cowan V, Chun S. 2017 *BRANZ House Condition Survey: Comparison of house condition by tenure*. Study Report 370. BRANZ, Porirua, New Zealand.

Survey methods

- Trained inspectors
- From 2010, recruitment focus on generating a representative sample so that results can be generalised to the whole of New Zealand

Supervisors

- Prof. Robyn Phipps – Massey School of Engineering and Advanced Technology
- Dr. Mark Jones – BRANZ
- Prof. Jeroen Douwes – Massey Centre for Public Health Research

Hypothesis and aims

- Kiwis are not great at house maintenance!
- The House Condition Survey measures the condition of individual house components and several measures of dampness
- Let's look for links in the data between characteristics (including condition) and dampness using statistical methods

HCS dampness outcomes

Moisture Measurements

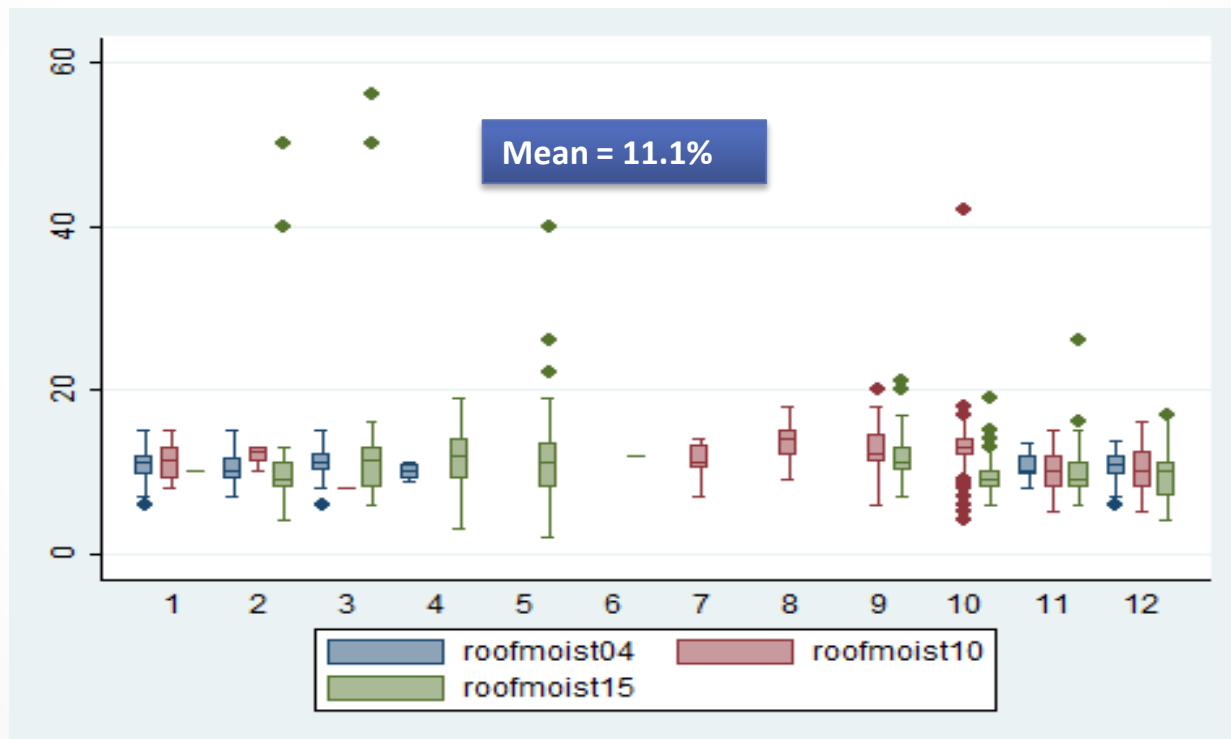
- Roof joist moisture content
- Floor joist moisture content

Dampness indicators

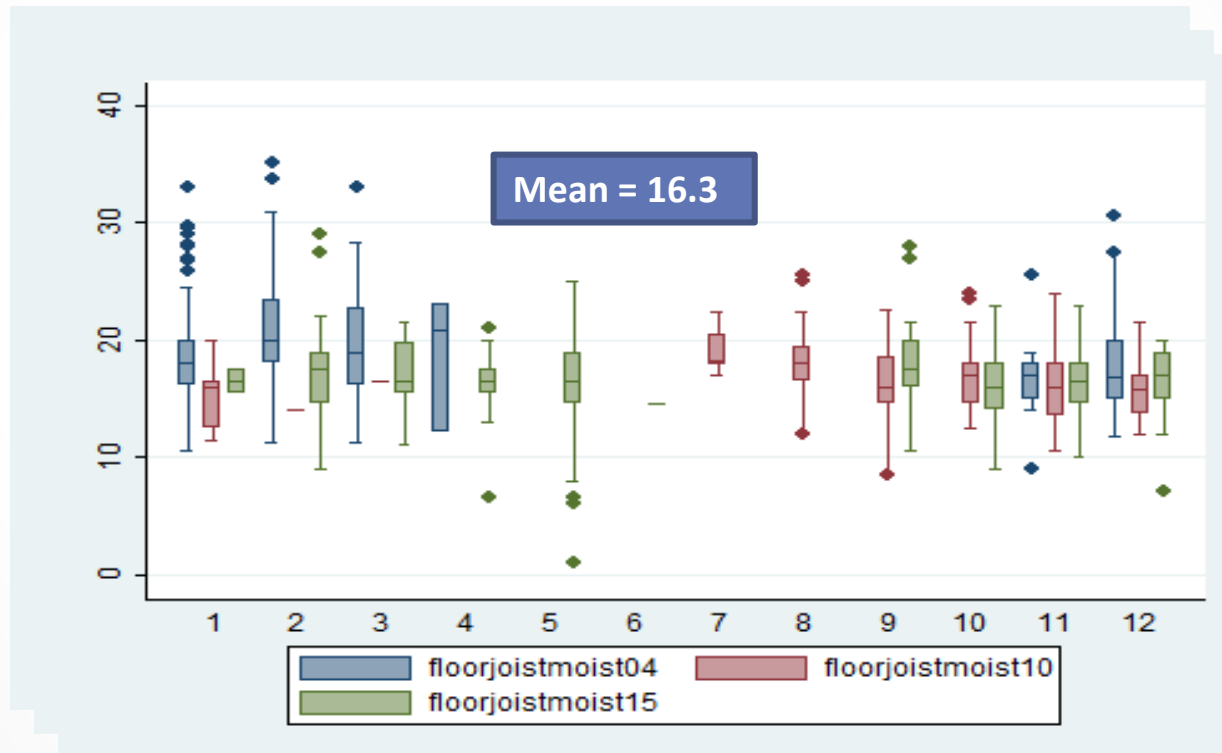
- Feels Damp
- Smells Musty
- Visible Mould

**BEING ABLE TO MAKE COMPARISONS BETWEEN OUTCOMES,
AS WELL AS ACROSS THE THREE SURVEYS, ADDS VALIDITY.**

Roof joist moisture content



Floor joist moisture content



HCS dampness and moisture predictors

Tenure*	Kitchen ventilation type	Subfloor ventilation condition
Number of occupants*	Other mechanical kitchen ventilation	Wall cladding condition
Capital value	Ventilation of indoor clothes dryer	Wall cladding holes cracks
General maintenance assessment	How long since bathrooms refurbished	Wall cladding paint deterioration
Age of house	Floors living room/bedrooms (carpet etc)	Wall cladding materials
Month of assessment		Roof material
Surveyor	Wall Insulation	Roof leaks
No. of storeys	Basement	Roof condition rating
No. bedrooms	Basement signs of leaks	Spouting condition rating
Town	Roof space insulation %	No. of spouting defects
House in shade	Roof space insulation thickness	Internal gutters leaking
House sheltered/exposed	Roof slope	Window flashing deterioration
Type of heaters	Cladding deterioration near ground	Windows joint cracks
Air conditioner	Water ponding under house	Windows leaking
Dehumidifier	Ground cover under house	Windows condition rating
Heat recovery air treatment	Underfloor insulation %	Double glazing
Stove elec/gas	Plumbing waste leaking under house	
Bathroom fan	Subfloor ventilation above/below requirements	

Linear and Logistic regression modelling

A very quick stats lesson:

- Linear regression for continuous/scale (i.e. measurements)
- Logistic regression for categorical/categories (i.e dampness and mould ratings)
- Outcomes and predictors
- Univariate regression
- Confounding
- Multivariate regression

Areas for discussion

- How important is maintenance of the house exterior, as a contributor to dampness and mould in New Zealand homes?
- How effective are common, cost –efficient interventions to remediate dampness and mould in New Zealand homes?
- Examining the influence of heating and ventilation on dampness and mould in New Zealand homes
- Intrinsic characteristics of houses related to dampness in 1616 New Zealand homes 2004-2015
- The relationship between structural moisture and indoor dampness and mould in New Zealand homes

How important is maintenance of the house exterior, as a contributor to dampness and mould in New Zealand homes?

General maintenance Assessment		Roof Moisture Content		Floor joist moisture content		Subjective damp		visible mould		Musty Odour
	<i>n</i>	Coefficient (p)	<i>n</i>	Coefficient (p)	<i>n</i>	Odds Ratio (p)	<i>n</i>	Odds Ratio (p)	<i>n</i>	Odds Ratio (p)
2004		R ² =0.01 model p=0.053		R ² =0.003		PseudoR ² = 0.17 model p= 0.000		PseudoR ² = 0.17 model p= 0.000		--
Well	240	Ref	134	Ref	280	Ref	280	Ref		
reasonably	165	-0.04 (0.826)	128	-0.07 (0.879)	195	7.03 (0.000)	195	6.05 (0.006)		
Poorly	77	0.49 (0.026)	64	0.54 (0.337)	90	24.91 (0.000)	90	36.33 (0.000)		
2010		R ² = 0.03 model p=0.013		R ² =0.012		PseudoR ² =0.23 model p=0.000		PseudoR ² =0.23 model p=0.000		PseudoR ² =0.21 model p=0.000
Well	99	Ref	69	Ref	119	Ref	125	Ref	125	Ref
reasonably	94	-0.08 (0.850)	71	-0.31 (0.522)	122	12.06 (0.000)	127	15.07 (0.000)	127	2.73 (0.144)
Poorly	87	1.11 (0.013)	77	0.44 (0.351)	105	49.59 (0.000)	112	61.50 (0.000)	112	22.59 (0.000)
2015		R ² =0.003		R ² =0.03 model p=0.018		Pseudo R ² =0.12 model p=0.000		Pseudo R ² =0.11 model p=0.000		Pseudo R ² =0.21 model p=0.000
Good	193	Ref	115	Ref	237	Ref	243	Ref	243	Ref
reasonably	161	0.62 (0.258)	140	0.69 (0.097)	212	5.46 (0.000)	220	3.42 (0.000)	220	13.96 (0.012)
Poorly	68	0.10 (0.888)	67	1.45 (0.005)	89	16.35 (0.000)	96	9.91 (0.000)	96	76.25 (0.000)

How important is maintenance of the house exterior, as a contributor to dampness and mould in New Zealand homes?

Poorer condition = more dampness and mould problems

- Roof cladding condition – more mould
- Wall cladding condition (paint condition)- more damp & mould
- Window condition – more dampness & mould
- Spouting condition – visible mould
- Subfloor ventilation condition – floor joist MC
- Ponding/leaks under house ---

(adjusted for house age, season, surveyor, tenure, heating number/type, HRV/DVS, kitchen/bathroom /dryer ventilation, roof, wall and window materials, groundcover/foundation type)

How effective are common, cost –efficient interventions to remediate dampness and mould in New Zealand homes?

- Roof space insulation – Yes!
- Wall insulation - meh
- Underfloor insulation - meh
- DVS - meh (but)
- HRV – meh (but)
- Dehumidifier – No! (but?)
- Groundcover under the house – Yes!

(adjusted for Age of house, season, surveyor, locality, tenure, number and type of heaters, kitchen/bathroom/dryer ventilation, roof/wall/window materials and condition, subfloor ventilation and spouting condition)

What's next?

- This is observational data and all results from this analysis must be tested in a controlled experiment before we can say, for sure, that **this** causes **that**
- However, this study gives us a good set of priorities in terms of conducting those experiments which can demonstrate causation