Improving Health through the Built Environment

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He Kainga Oranga/Housing and Health Research Programme awarded NZ Prime Minister’s Science Prize, 2014
Background

He Kainga Oranga / Housing & Health Research Programme

• Department of Public Health, University of Otago Wellington

• Multidisciplinary team of social scientists, medical specialists, epidemiologists, statisticians, physicists, engineers, architects, mycologists

• Aims to produce innovative, robust, relevant research to improve housing and health in NZ

• Working in partnership with local communities, government and private organisations
Outline

• Background on scope of housing & the built environment

• Why housing is important to health:
  1. Vulnerable people spend a lot of time at home
  2. Poor housing causes illnesses & injuries
  3. Poor housing mediates health inequalities
  4. Better housing improves health & safety
  5. Better housing improves sustainability

• Implementing better quality housing - WoF
Unable to pay steep rent, family huddle in freezing tent

ASHLEIGH STEWART

BLANKETS and body heat.
That is how one Christchurch family, huddling together in a
freezing tent as rain butters their makeshift home, have spent two
months trying to keep warm.
The family of five have just weathered their third storm in a
tent pitched at the Spencer Beach Holiday Park.
Taurua Houia, his wife and
their three children are one of 270
priority A applicants on the
Housing New Zealand waiting list.
They have been priority A for
three weeks, despite being assessed in February.
“We had a private rental in
Hills Rd, but it was too expensive,” Houia said.
“I’ve just been sitting up in the
tent every night. I don’t get much
sleep.”
Houia works fulltime as a
roofer, but wife Sonia is unem-
ployed and receives a benefit.
But they say this income still
do not provide enough money
for Christchurch’s rents as well as
being able to survive.
A large tarpaulin is draped
across the outside of the tent for
extra insulation as members of
the family curl together under
duvets during this week’s rain.
The mattresses account for about
half of the floor in the small tent,
the remainder is bare.

Tent trap: Taurua Houia and his family live in tents at a holiday park because of a housing shortage. Photo: FAIRFAX NZ

There are no separate rooms,
and no privacy.
“It’s blankets and body heat to
keep warm,” Houia said.
They had returned to the spot
on Monday after a brief, but un-
pleasant, stint outside the camp-
ing ground.

Forced to leave as it was booked out for Easter, the family
moved their tent to Waikuku on
Friday – where it was blown
down. In an effort to save money,
they then gave freedom camping
a try.
After their tent flooded, they
moved to a camping ground in
Linwood, where they paid $24 a
night for a campsite.
But even after their ordeal and
as the weather closed in, Houia
was hesitant to complain. “We
just take it. I’m all right, it’s just
the kids.”
Family friend and Taurua’s
boss, Allan Rolfe, has been help-
ing the family and advocating for
them to the agencies.
He had offered to let the family
stay with him at his home, but
they were “fiercely independent”
and had refused, Rolfe said.
“It’s a horrendous situation.
It’s a desperate situation, they’ve
got three children as well.”

Ministry of Social Develop-
ment general manager Marama
Edwards said Sonia Houia –
whose name the application was
under – was first assessed in
February, and has been on the
waiting list since April 4.

“Housing New Zealand and
registered community housing
providers will continue to work
with Ms Houia to find a suitable
property,” Edwards said.
Definition of ‘built environment’

• All human-made aspects of our world, from houses, buildings, schools & factories to roads, footpaths, parks and shops.
• Focus here on ‘Healthy Housing’
• Principles can be applied to many indoor environments, incl. workplaces & schools
• Concerns for health & safety overlap with environmental sustainability and economic development
## Levels of the built environment

<table>
<thead>
<tr>
<th>Level</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global, national, regional levels</td>
<td>Includes policy, socioeconomic, cultural and environmental influences beyond neighbourhood level</td>
</tr>
<tr>
<td>Neighbourhood</td>
<td>Physical features such as air pollution, road safety, urban design, transportation, amenities</td>
</tr>
<tr>
<td>Community</td>
<td>Social, cultural and economic aspects such as social capital, safety from crime, civic capacity</td>
</tr>
<tr>
<td>House or other dwelling</td>
<td>Physical and environmental quality of building and its services such as insulation and safety</td>
</tr>
<tr>
<td>Household</td>
<td>Social, cultural and economic aspects such as affordability, suitability, security of tenure</td>
</tr>
<tr>
<td>Individuals</td>
<td>Demographic, psychological and biological features, including knowledge, attitudes, behaviour</td>
</tr>
</tbody>
</table>
1. Increase in vulnerable at home

NZ Time Use Survey, Statistics NZ 1998-99 (8,500 people)
NZ Travel Survey, 1997-98 (14,250 people)

<table>
<thead>
<tr>
<th>Environment</th>
<th>NZTUS</th>
<th>NZTrS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home</td>
<td>72%</td>
<td>73%</td>
</tr>
<tr>
<td>Work &amp; study</td>
<td>13%</td>
<td>12%</td>
</tr>
<tr>
<td>Transport</td>
<td>6 %</td>
<td>5%</td>
</tr>
<tr>
<td>Recreation</td>
<td>5%</td>
<td>8%</td>
</tr>
<tr>
<td>Other*</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>Unknown</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

*Included almost 4% of time spent at ‘other peoples houses’

NB. 94% of time is spent indoors (including 70% indoors at home)

1. Increase in vulnerable at home

Source: NZ Travel Survey, 1997-98
1. Increase in vulnerable at home

- Steadily ageing population means increasing need for home support and residential care
- Larger population living with disabilities at home & participating actively in society
- Deinstitutionalisation of chronic illness e.g. mental illness, intellectual disability
- Early hospital discharges
- Ambulatory services e.g. Continuous ambulatory peritoneal dialysis (CAPD)
1. Increase in vulnerable at home

NZ population 65+ will reach ~25% in ~ 30 Years
1. Increase in vulnerable at home

Increasing proportion of population living with disabilities
2. Illness & injury in the home

Injuries in the home:

Half of injuries requiring hospitalisation occur at home
• Average 8,394 per year (2000-2003)
• Other settings: Work 17%, Transport 18%, Sport 14%

A significant proportion (19%) of deaths from injury occur at home
• Average 104 per year (2000-2001)
• Other settings: Work 7%, Transport 72%, Sport 1%
2. Illness & injury in the home

Meningococcal disease

![Chart showing the number of Meningococcal disease cases from 1990 to 2006. The chart distinguishes between probable cases and lab-confirmed cases.](chart.png)
2. Illness & injury in the home

Meningococcal disease cases in Auckland, 1998-2002, and CAU crowding level at 2001 Census

2. Illness & injury in the home

- Case-control study of meningococcal disease in Auckland children < 8 years during 1997-99
- 202 cases and 313 controls
- Overcrowding, measured by the number of adults aged ≥10 years, was the most important risk factor for disease
- OR=10.7 (95%CI 3.9-29.4)

2. Illness & injury in the home

Average family living in 6 room house
Median of 2.6 adults in household

Additional adults  Risk of meningococcal disease

- 2x
- 5x
- 10.7x
2. Illness & injury in the home
META-analysis of Meningococcal Disease risk and Household Crowding

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Weight</th>
<th>IV, Random, 95% CI</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baker 2000</td>
<td>11.0%</td>
<td>10.70 [3.89, 29.41]</td>
<td></td>
</tr>
<tr>
<td>Deuch 2004, 1-6yo</td>
<td>23.8%</td>
<td>1.50 [1.11, 2.02]</td>
<td></td>
</tr>
<tr>
<td>Deuch 2004, less 1yo</td>
<td>24.3%</td>
<td>1.50 [1.14, 1.97]</td>
<td></td>
</tr>
<tr>
<td>Kriz 2000</td>
<td>11.9%</td>
<td>1.13 [0.44, 2.89]</td>
<td></td>
</tr>
<tr>
<td>Moodley 1999</td>
<td>13.5%</td>
<td>2.30 [1.00, 5.29]</td>
<td></td>
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<tr>
<td>Robinson 2001, 16+yo</td>
<td>6.3%</td>
<td>1.37 [0.30, 6.23]</td>
<td></td>
</tr>
<tr>
<td>Robinson 2001, less 16yo</td>
<td>9.2%</td>
<td>5.40 [1.68, 17.33]</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>100.0%</td>
<td>2.13 [1.38, 3.29]</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity:
- Tau² = 0.18; Chi² = 19.24, df = 6 (P = 0.004); I² = 69%
- Test for overall effect: Z = 3.40 (P = 0.0007)

Source: Baker, McDonald et al. 2013.
2. Illness & injury in the home  
Meta-analysis of IDs and Household Crowding

<table>
<thead>
<tr>
<th>Disease/category</th>
<th>N</th>
<th>Case-control (cross-sectional studies*)</th>
<th>Cohort studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respiratory infections:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Pneumonia</td>
<td>7</td>
<td>OR 1.58, CI 1.19-2.10</td>
<td>RR 1.61, CI 1.12-2.31</td>
</tr>
<tr>
<td>• Other respiratory infection</td>
<td>8</td>
<td>OR 1.38, CI 0.71-2.67</td>
<td>RR 1.35, CI 1.02-1.79</td>
</tr>
<tr>
<td>• Haemophilus influenza</td>
<td>6</td>
<td>OR 1.74, CI 1.27-2.37</td>
<td></td>
</tr>
<tr>
<td>• Meningococcal disease</td>
<td>7</td>
<td>OR 2.13, CI 1.38-3.29</td>
<td></td>
</tr>
<tr>
<td>• RSV / bronchiolitis</td>
<td>4</td>
<td>2.24, CI 1.14-4.38</td>
<td></td>
</tr>
<tr>
<td>• TB</td>
<td>7</td>
<td>OR 3.78, CI 1.78-8.13</td>
<td></td>
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<tr>
<td><strong>Enteric infections:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Gastroenteritis</td>
<td>4</td>
<td>OR 1.13, CI 1.01-1.26</td>
<td></td>
</tr>
<tr>
<td>• Hepatitis A</td>
<td>6</td>
<td>OR 1.42, CI 1.15-1.75</td>
<td></td>
</tr>
<tr>
<td>• H. pylori</td>
<td>28</td>
<td>OR 1.82, CI 1.55-2.13</td>
<td></td>
</tr>
<tr>
<td><strong>Skin/eye infections:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Trachoma</td>
<td>2</td>
<td>OR 2.07, CI 1.06-4.06</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>79</td>
<td></td>
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</tr>
</tbody>
</table>

*Source: Baker, McDonald et al. 2013.*
2. Illness & injury in the home

Rheumatic fever

- Acute Rheumatic Fever (ARF) → Rheumatic Heart Disease (RHD)
- 140 RHD deaths pa
- ARF rates rising in Māori and Pacific children (1993-2014)

Source: Baker et al. BMC Infect Dis 2017; Under Review
2. Illness & injury in the home

- Excess Winter Mortality (EWM) measures the increase in deaths in 4 coldest months (June-Sept)
- EWM in NZ = 19 % → **1,600 excess winter deaths**
- No decline in EWM from 1980-2000
- Young, old, females particularly vulnerable


- Poor housing may contribute to EWM
- Nationwide surveys indicate few NZ homes maintain temperatures in the 18-21°C comfort zone

  *Source: Isaacs & Donn, 1993; BRANZ, 2003*
3. Housing mediates health inequalities

- Where you live is a powerful predictor of health outcomes
  - Area based deprivation measures (e.g. NZDep) linked to mortality, life expectancy & many health outcomes
- Potential mediating pathways
  - Material deprivation
  - Relative disadvantage (psychosocial mechanism)
- Declining home ownership likely to increase socio-economic and health inequalities
3. Housing mediates health inequalities

Life expectancy by NZDep, Males

Life expectancy by NZDep, Females
3. Housing mediates health inequalities

Cumulative material deprivation
3. Housing mediates health inequalities

Relative disadvantage (psychosocial mechanism)
3. Housing mediates inequalities

- Declining levels of home ownership
- BRANZ House Conditions Survey included rental housing for first time in 2010 (~33% of 491 houses across NZ)
- Rental houses were in worse condition than owner-occupied houses: 44% poor condition vs. 25% of owner-occupied housing
3. Housing mediates health inequalities

- **Severe housing deprivation** considered more accurate, valid and useful measure than ‘homeless’
- 2013 prevalence = 1.0% (40,658 people)
- 67.1% sharing severely crowded private houses, usually with family
- 51% < 25 years of age
- Associated with non-European ethnicity, new migrant, high residential mobility, unemployed, unskilled job, low level of education.

*Source: Kate Amory. Report to Stats NZ, 2016.*
3. Housing mediates health inequalities

Increasing fuel poverty in NZ (≥10% of income on fuel)

3. Housing mediates health inequalities

Housing affordability = proportion of households spending > 30% of income on housing costs
From 1988 to 1997 prop increased 11% to 25%

3. Housing mediates health inequalities

Incidence of ID hospitalisations compared with Non-ID & All-cause, 1989-2008 (age stand. to 2006 Census)

3. Housing mediates health inequalities

- **Structural crowding** = Insufficient living space (bedrooms / floor area) for the occupants of a dwelling to maintain health & wellbeing based on established norms for the size & composition of that household

- **Functional crowding** = Crowding caused or increased by how the house is used:
  - *Bedroom sharing* eg >2 people per bedroom
  - *Sharing sleeping areas just to keep warm* eg family sleeping on mattresses in living room
  - *Bed sharing* eg children sharing same bed with others
3. Housing mediates health inequalities
Household crowding exposure, 1+ bedroom deficit

![Graph showing household crowding exposure, 1+ bedroom deficit over time.](image-url)
3. Housing mediates health inequalities

3. Housing mediates health inequalities

Dose-response (relative risk)  
Eg 2.0

Exposure (proportion crowded)  
Eg 10%

Disease incidence (hospitalisations)  
Eg 100 cases

Population Attributable Fraction (PAF)  
Eg 9.1%

Burden of disease  
Eg 9 cases
3. Housing mediates health inequalities

![Bar chart showing cases and percentage distribution by ethnicity.](chart)

Source: Baker, McDonald et al. 2013.
3. Housing mediates health inequalities

Ratio of Māori & Pacific ID hospitalisation rates to European/Other, 1989-2008

4. Better housing improves health

- Insulation eg Insulation Trial*, Warm up NZ
- Heating eg Heating Trial*, WHEZ Study*
- Injury reduction eg HIPI Study*
- Benefits of social housing eg SHOW Study
- Crowding reduction eg HHP
- Safe Housing Enabling Long-term Effective Recovery (SHELTER)

*Community randomised trials
4. Better housing improves health

Community randomised trials

- Use rigorous controlled trial method with random assignment to intervention and control arms to reduce selection bias
- More likely to be taken seriously by policy-makers with results translated into policy
- Assess health and sustainability outcomes using subjective and objective measures
- Relatively expensive so usually need public/private partnership to fund interventions
4. Better housing improves health

Community randomised trial (continued)

• Provide benefits to participants if intervention is effective (intervention also provided to controls at end of trial)

• Provide benefits to local community partners eg through employment

• Examples
  • Housing, Insulation and Health Study
  • Housing, Heating and Health Study
4. Better housing improves health

Housing, Insulation and Health Study Design

• 1400 households where one member had chronic respiratory symptoms
• Winter 2001 baseline measures taken
• Houses randomly assigned to intervention group insulated over summer
• Winter 2002 follow-up measures taken
• Houses assigned to control group insulated

4. Better housing improves health

Intervention included:
- Ceiling insulation
- Under-floor sealing
- Draft stopping
4. Better housing improves health

Housing Insulation & Health Study Results

• Occupants in insulated houses used 23% less energy
• Exposed to cold temperatures (< 10°C) for 0.75 hours less /day
• Exposed to high humidity (> 75%) for almost 1.5 hours less /day
4. Better housing improves health

Housing Insulation & Health Study Results

• Significant improvement in self-reported housing conditions (less cold and dampness)
• Significantly fewer days off school and work
• Significantly fewer symptoms of wheeze and colds
• Fewer hospital admissions
• Positive benefit to cost ratio of 2:1

Source: Howden-Chapman, et al., BMJ 2007; 334: 460-4
4. Better housing improves health

Housing, Heating and Health Study

- Experimental intervention study
- Replacing old heaters in the homes of 450 children 7-12 years old with asthma
- New heaters more efficient & use sustainable energy
4. Better housing improves health

Housing, Heating and Health Study

Previous:
- X electric heaters (2kW)
- X unflued gas heaters (4kW)

Replaced with:
- √ 320 heat pumps (4-7kW)
- √ 55 wood pellet burners (10kW)
- √ 11 flued gas heaters
4. Better housing improves health

Housing, Heating and Health Study Results

• Less poor health (aOR 0.44)*
• Children less coughing at night & on waking (aOR 0.50)*
• Less wheezing (aOR 0.52)*
• Less asthma reliever in morning (aOR 0.53) *
• Children had fewer episodes of cold & flu (aOR 0.76)*
• Children had 1.8 days less off school *
• Children had fewer visits to the GP (0.13visits) *

*Significant

4. Better housing improves health

**Housing NZ Healthy Housing Programme**
Ventilation, Insulation, Crowding Reduction, Health services.
Before & after comparison showed reduction in acute hospitalisations for participants:
- <4 year olds = ↓ 11% (95% CI 1% to 11%)
- 5-34 year olds = ↓ 23% (95% CI 70% to 85%)

*Source: Jackson et al. JECH 2011, 10.1136/jech.2009.107441*

Children <20 years participating in HHP: 27% (95%CI -43% to −6%) decline in acute and arranged hospitalisations

*Source: Baker et al. Health Impacts of HHP on HNZC Tenants: 2004-2008*
4. Better housing improves health

Home Injury Prevention Intervention (HIPI)

• Single-blinded cluster randomised controlled trial of home injury prevention measures to reduce medically-treated home falls.
• Taranaki Region in owner-occupied dwellings
• 842 households: 436 (950 people) randomised to treatment group, 406 (898 people) to control group
• Significant reduction in home fall injuries - 26% (95% CI 6%-42%)
• Social benefits of injuries prevented >> costs of intervention (average $560 per house)

4. Better housing improves health
Safe Housing Enabling Long-term Effective Recovery (SHELTER)

- Observational study
- 800 families in Wellington
- Intervention: coordinated housing intervention (Well Homes)
- Data collected using administrative systems
- Collaborators include:
  - Wellington Regional Public Health,
  - District Health Boards,
  - Energy Efficiency Conservation Authority,
  - Housing NZ, Ministry of Social Development,
  - Tu Kotahi Māori Asthma Trust,
  - Sustainability Trust
4. Better housing improves health

Well Homes Referral Sources

HVDHB Secondary services
Community providers
GPs Primary care
CCDHB Secondary services

WELL HOMES
HOUSING COORDINATION SERVICE
Assessment and allocation of referrals to providers;
Coordination of housing interventions and charitable funds

Well Homes RPH Nursing
Well Homes Tu Kotahi
Māori Asthma Trust
Well Homes Sustainability Trust
Eco Design advisors
Warm Fuzzies

MoH/DHB FUNDED HOUSING PROVIDERS
COMMUNITY FUNDED HOUSING PROVIDERS
Well Homes is a **free** service that may be able to help your whānau with:

<table>
<thead>
<tr>
<th>Beds &amp; Bedding</th>
<th>Mould Cleaning Kits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpet</td>
<td>MSD/Work &amp; Income Assistance</td>
</tr>
<tr>
<td>Curtains</td>
<td>Other - i.e. Health or Social Referrals</td>
</tr>
<tr>
<td>Heating</td>
<td>Social Housing Relocation</td>
</tr>
<tr>
<td>Insulation</td>
<td>Ventilation</td>
</tr>
<tr>
<td>Minor Repairs</td>
<td></td>
</tr>
</tbody>
</table>

Please phone us on 0800 675 675
5. Better housing improves sustainability

Climate change & CO$_2$ emissions

- Kyoto CO$_2$ reductions average 5% by 2012 for industrialised countries
- Buildings account for 40% of total energy & 30% of CO$_2$ emissions
- Renovation dominant construction activity
- If energy efficiency measures can serve two purposes better chance of implementation
The cost of cutting carbon in different ways

Marginal cost of abatement, examples €/t CO₂

- Water heating
- Cellulosic ethanol
- Nuclear
- Sugar-cane biofuel
- Fuel-efficient vehicles
- Lighting systems
- Fuel-efficient commercial vehicles
- Insulation improvements
- Forestation
- Wind
- Solar
- Carbon capture and storage in retrofitted coal-fired power stations
- Switch from coal to gas for power generation
- Carbon capture and storage with enhanced oil recovery and new coal-fired power stations

Abatement potential, gigatonnes CO₂/year in 2030

Source: Vattenfall

http://www.economist.com/surveys/displaystory.cfm?story_id=9217972
Implementing better housing
Housing Warrant of Fitness

Rating tool linking housing conditions to health & sustainability/efficiency outcomes

Could measure:
- Health, eg respiratory
- Safety, eg injury hazards
- Energy efficiency

Source: Bennett et al NZ Med J 2013, 126: 74-85
Implementing better housing
How WoF could be used with rentals & sales
Implementing better housing

- 29-point evidence based checklist covering basic insulation, ventilation/dryness, fixed heating, amenities, state of repair and safety hazards
- Developed with Green Building Council
- Field testing by councils in Jan-Feb 2014

Source: Bennett J, et al. ANZJPH 2016 Mar
Implementing better housing
HRC-funded Rental WoF study

• Does introducing a Rental WoF improve health without reducing rental affordability or availability?
• Intervention cities: Wellington and Dunedin
  • Control cities: Porirua and Invercargill
• Health outcomes: ACC claims, hospitalisations, mortality
• Economic outcomes: Trademe rental listing prices and numbers (by bedroom size)
• App available from Google Play or the App Store
  www.rwof.org.nz
Implementing better housing

- Need to consider affordability & security of tenure
- Tradition of good-quality, low-cost social housing, with a vegetable garden
- Recognised secure rental housing for life
Conclusion

- Energy independence
- Preserve rainforests
- Sustainability
- Green jobs
- Livable cities
- Renewables
- Clean water, air
- Healthy children
- Etc., etc.

What if it's a big hoax and we create a better world for nothing?
Conclusions

1. Built environment, particularly housing, is an important health determinant:
   - We spend a lot of time there, particularly vulnerable groups
   - Poor housing causes considerable illness and injury
   - Housing mediates health inequalities
   - Built environment uses energy, generates greenhouse gases
Conclusions

2. Built environment also provides opportunities to improve health and reduce inequalities

- Evidence shows better housing improves health, safety and sustainability
- Need to improve housing quality eg well-validated rental housing WoF
- Need adequate quantity of affordable, suitable housing
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