Enhancing food security and physical activity for Māori, Pacific and low-income families/ whanau – an evidence summary

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Executive Summary

Background

Food security is assured access to food that is of a suitable nutritional value and quality, and that is safe and meets cultural needs. Food insecurity (the opposite to food security) is associated with detrimental health outcomes such as obesity, diabetes, and micronutrient deficiencies. National nutrition surveys have identified food insecurity as an issue for 20 to 22% of New Zealand households, with higher prevalence in Māori and Pacific households.

Physical activity is any bodily movement produced by skeletal muscles that results in energy expenditure. Physical inactivity is associated with detrimental health outcomes such as overweight/obesity and cardiovascular disease. Despite the positive benefits of regular physical activity, approximately 32% of New Zealanders are inactive. Pacific peoples have lower levels of physical activity than both Māori and New Zealand European.

Aim

To determine the environmental influences on food security and physical activity, with particular emphasis on influences for Māori, Pacific, and low-income whanau/families.

Methods

A search for relevant literature was completed in multiple databases. Literature on food security published from 1990 to October 2007 was included. Literature on physical activity was included if it was a review published from 2002 to December 2007, or it was an article relating to New Zealand. Web and bibliography searches were also completed.

The ANGELO framework was used to categorise environmental factors influencing food security and physical activity (identified from the review) into a grid according to environment size (micro or macro) and type (physical, economic, political and socio-cultural).

Results

Food security

One hundred and three studies were included; many were cross-sectional designs (n=41), and conducted in the United States (n=50). Limited research has been conducted in Canada (n=10), Australia (n=12), and the United Kingdom (n=3). Twenty-three studies and reports were identified from New Zealand. Very few interventions aimed at improving food security were identified (n=4).

Food insecurity was consistently associated with low income, unemployment, larger household size or number of children in the family, lack of home ownership or high housing costs, lack of savings, single-parent families (especially if headed by a female), being single, chronic poor health (both physical or mental) in either adults or children, lack of transportation (or cost thereof), or poor access to shops. There were multiple additional environmental influences on food security investigated less frequently.

Physical activity

69 papers were included: 36 reviews and 33 individual papers. Eight reviews and three studies applied to children/adolescents. Sixteen papers or reports were identified in New Zealand. Most of the reviews emanated from the United States, the United Kingdom, Europe, and Australia, with the remaining originating from a variety of countries.

Reviews highlighted that most of the included research was of cross-sectional design, utilised a wide variety of measures of physical activity and the environment (including perceived/self-reported and/or objective measures) often focused on different aspects of PA such as walking or vigorous physical activity, and may be affected by self selection or reverse causality. Methodologies in this area are still being developed, leading to inconsistencies between studies and making comparisons more challenging. Because of the inconsistencies in study design, measurement and methodologies, very few systematic reviews were able to quantitatively synthesise the data. Furthermore, aspects of the environment appeared to have differing effects on recreational and transport-related physical activity, and adults and children. There was a stronger focus in the literature on the physical or built environment, with little exploration of economic or cultural influences on physical activity.

Overall, environmental factors appear likely to have a modest influence on physical activity, and associations were seen with variables such as urban design and aesthetics, social support, some aspects of safety, proximity and accessibility of destinations, presence of facilities and footpaths, and parks and open spaces.

Analysis of current New Zealand research

Four research projects conducted by members of the research team provide additional information relevant to food security and physical activity. Analysis of SoFIE-Health data supported findings in the international literature and showed similar environmental influences on food security in New Zealand. Neighbourhoods and Health analyses found that in New Zealand access to health-related community resources was actually greater in more deprived neighbourhoods, but less so in rural compared with urban areas. The Influences on Children's Activity & Nutrition study found that perceptions of the environment and psychosocial factors were better predictors of physical activity than the built environment. Supermarket Healthy Options Project data will be available in May 2009, and will provide information on effectiveness of price discounts and culturally relevant nutrition education in encouraging healthier food choices.

ANGELO (Analysis Grid of Environments Leading to Obesity)

The ANGELO grid highlighted that there was little evidence available for the influence on food security of schools, workplaces, churches, and health care settings. For physical activity, the majority of research related to the physical environment. Economic approaches to increasing physical activity were virtually unexplored, and only a small number of political influences on physical activity were assessed. It was also evident that many of the micro-level factors for both food security and physical activity are determined by macro-level drivers. For example, income impacts at the micro level, but may be driven by macro level factors such as wage levels, standard of living, labour market, and employment, amongst others. Therefore macro-level, or upstream, intervention and policy are likely to be most effective at improving food security and physical activity.

Focus groups

Nine focus groups have been completed with Māori, Pacific, and low-income New Zealanders. Focus group findings are contained in a separate report.

Conclusion

Consistent associations between some environmental factors and either food security or physical activity have been found, however methodological limitations limit the conclusions that can be drawn. However, there is 'sufficient evidence' to identify key areas likely to influence food security and physical activity.

Background

"If we could give every individual the right amount of nourishment and exercise, not too little and not too much, we would have found the safest way to health." Hippocrates c. 460-377BC

This project aims to investigate the environmental influences on food security and physical activity, with an emphasis on Māori, Pacific, and low-income families/whanau. It arose from a RFP issued by the Health Research Council of New Zealand and the Ministry of Health, as part of the Primary Prevention of Cancer and Other Chronic Diseases Research Strategy. This multi-phase project encompasses identifying the environmental influences, their inter-relationship, and relative contribution to food security and physical activity, along with their inter-relationship and relative contribution, and how these factors can be modified in order to enhance food security and physical activity for Māori, Pacific, and low-income whānau/families.

Food security is the assured access to sufficient food that is nutritious, of good quality, safe, meets cultural needs, and has been acquired in socially acceptable ways[4]. Despite being a land of plenty, food security is an issue for 20-22% of New Zealanders, with higher rates among Pacific peoples and Māori (2002 data)[5]. Food security has been identified in New Zealand's Healthy Eating Healthy Action strategy as a key issue for the health of New Zealanders[6]. Food insecurity (the opposite to food security) has been associated with detrimental health outcomes such as obesity, diabetes, and micronutrient deficiencies.

As well as aiming to improve nutrition, the Healthy Eating Healthy Action strategy aims to improve levels of physical activity. Physical activity has well established health benefits, however despite efforts to increase physical activity levels of the population, approximately 32% of New Zealanders remain inactive[7].

Thus both food security and physical activity are key issues for improving the health and wellbeing of New Zealanders. Māori, Pacific, and low-income families are the focus of this research as they suffer disproportionately from burden of disease. The first stage of this research has been completion of a literature review on environmental

influences on food security and physical activity as well as focus groups with Māori, Pacific, and low-income groups. Results of these have been analysed using the ANGELO Framework to conceptualise the environments influencing food security. Findings of the literature review and ANGELO assessment are presented in this report, and focus group findings are presented in an additional report.

Project objectives

The project aims to answer the following questions:

- What are the environmental factors (including economic, socio-cultural, physical, and political) that enhance (a) food security and (b) physical activity in New Zealand?

  This objective is addressed in this report through the literature review and ANGELO analysis, and in the separate focus group report.

- What are the inter-relationships between these factors and what are their relative contributions to (a) food security and (b) participation in physical activity in New Zealand?

  This objective will be addressed in a subsequent report mapping interactions between factors using Complexity Theory.

- In what ways could these factors be modified to further enhance the food security and physical activity of Māori, Pacific, and low-income whānau/families? What other factors are likely to facilitate change?

  This objective will be addressed in the next phase of solution-oriented research.

ANGELO Framework

Results from the literature review were categorised according to the ANGELO Framework. The Framework was originally devised to develop interventions aimed at obesogenic environments. However, as a Framework, it is suitable for adaptation to other environments. The Framework classifies the environment into four types: physical (what is available), economic (costs), socio-cultural (attitudes and beliefs) and political (the rules)[8]. These may be set in either a macro or micro environment. Macro environments are those that are generally outside of individual control, whereas micro environments are more local, such as the home or neighbourhood. An example of the Framework is provided in Figure 1.

Figure 1: ANGELO Framework[8]

TABLE 1

Examples of Prioritized Projects for Further Investigation in Pacific Island Communities

	Type			
Size	Physical (Food and PA)	Economic (Food and PA)	Political (Food and PA)	Sociocultural (Food and PA)
Micro (settings)				
Festivities				Cultural importance of high-fat foods
Neighborhoods	Recreation and sports facilities Safe walking paths			
Schools	Canteens serving local food		Policies on physical education Promotion of traditional activities, e.g., dancing	
Homes	Home gardens			
Churches				Church leaders as role models
Markets	Availability of local food (especially fish and vegetables)			
Macro (sectors)				
Transport	Availability of buses and bus stops			
Health regulatory system			Policies and standards on imported food quality/ labeling	

Note. PA, physical activity.

Definitions

Environment	All that which is external to the human host. Can be divided into physical, biological, social, cultural, etc., any or all of which can influence health status of populations….[9]
Food insecurity	The inability to acquire or consume an adequate diet quality or sufficient quantity of food in socially acceptable ways, or the uncertainty that one will be able to do so[10].
Food insufficiency	Food insufficiency is analogous to food insecurity with hunger[11] and therefore represents a more severe form of food insecurity.
Food security	Food security is an internationally recognised term that encompasses the ready availability of nutritionally adequate and safe foods, and the assured ability to acquire personally acceptable foods in a socially acceptable way.[4] The RFP from the Health Research Council and Ministry of Health states that "food security goes beyond the issue of resource for 'enough' food and includes the related issues of accessibility to food, the quality of that food (nutritional and biological), whether or not the food available for consumption is culturally acceptable to the recipient and can be accessed in a socially acceptable way".
Physical activity	Physical activity can be defined as "movement required on a daily basis to sustain health". Physical activity opportunities include sport, active recreation, physical education, fitness activities, active transport and play.[12]

- FOOD SECURITY -

Methodology

1 Literature review

1.1 Search strategy

A search was carried out for literature published up to and including 29 October 2007. The following Medline search terms were used, and adapted for other databases where needed:

The search strategy in Medline was:

1. food security.ti.
2. food insecurity.ti.
3. nutrition security.ti.
4. nutrition insecurity.ti.
5. food assistance.ti.
6. food poverty.ti.
7. (food insufficient or food insufficiency).ti.
8. ((food or hunger) adj5 (poverty or low income)).ti.
9. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
10. limit 9 to (humans and english language and yr="1990 - 2007")
11. food security.mp.
12. food insecurity.mp.
13. nutrition security.mp.
14. nutrition insecurity.mp.
15. food assistance.mp.
16. food poverty.mp.
17. 11 or 12 or 13 or 14 or 15 or 16
18. *Socioeconomic factors/
19. *Vulnerable populations/
20. *Poverty/

21. *Food Supply/
22. *Income/ or *Employment/
23. *Economics/
24. *Hunger/
25. *Public health/
26. *Public assistance/
27. *Social welfare/
28. *Nutrition policy/
29. *Public policy/
30. *Health behavior/
31. *Health promotion/
32. *Culture/
33. *Cross-cultural comparison/
34. *Ethnic groups/
35. *Environment/
36. *Social environment/
37. *Social conditions/
38. *Social class/
39. *Social planning/
40. *Social support/
41. *Community networks/
42. *Family/
43. *Family relations/
44. *Environment Design/
45. *Residence characteristics/
46. *Schools/
47. *Educational status/
48. *Health promotion/
49. New Zealand/ or New Zealand.mp.
50. Oceanic Ancestry Group/
51. Maori.mp.
52. (Pacific or Polynesian).mp.
53. 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52

54. 53 and 17

55. limit 54 to (humans and english language and yr="1990 - 2007")

56. 55 or 10

57. limit 56 to (clinical trial or comparative study or controlled clinical trial or evaluation studies or guideline or journal article or meta analysis or multicenter study or practice guideline or randomized controlled trial or "review" or "scientific integrity review" or technical report or validation studies)

The search strategy in SCOPUS (and other databases without MESH headings) was:

((TITLE("food security" OR "food insecurity" OR "nutrition security" OR "nutrition insecurity" OR "food assistance" OR "food insufficien*" OR "food poverty") OR KEY("food security" OR "food insecurity" OR "nutrition security" OR "nutrition insecurity" OR "food assistance" OR "food insufficien*" OR "food poverty")) AND PUBYEAR AFT 1989 AND PUBYEAR BEF 2008) OR ((TITLE(hunger AND poverty) OR TITLE(hunger AND low-income)) AND PUBYEAR AFT 1989 AND PUBYEAR BEF 2008) OR ((KEY(hunger AND poverty) OR KEY(hunger AND low-income)) AND PUBYEAR AFT 1989 AND PUBYEAR BEF 2008)

Databases covered a variety of topic areas. The following databases were searched to identify papers related to food security.

- Medline (biomedical literature)
- SCOPUS (multidisciplinary scientific database)
- Embase (biomedical and pharmaceutical literature)
- PsycINFO (international literature of psychology and behavioural sciences)
- CINAHL (Cumulative Index to Nursing and Allied Health Literature)
- PAIS (public and social policy)
- Index New Zealand (New Zealand database and some South Pacific journals)
- ADT: Australasian Digital Theses Program (Australian and New Zealand theses and dissertations)
- Web of Science (science, social science, arts and humanities literature)
- FSTA: Food Science & Technology (food science, technology and human nutrition literature)

1.2 Inclusion/exclusion criteria

Where possible in each database, limits were set to only include articles that were in English, in humans, and from 1990 onwards. Limits were also placed for articles or reviews where possible. Database searches were completed and articles extracted into Endnote. Exclusion criteria, which are described below, were then applied.

The literature review aimed to identify articles of relevance to countries with a similar political and social environment to New Zealand. Research relating to countries that were dissimilar to New Zealand, or to developing countries were excluded. Exclusions included countries such as Africa, Latin America, South America or Central America, Papua New Guinea, Phillipines, China, Malaysia, Vietnam, Thailand, Pakistan, India, Java, or the Middle East. Articles that related to famine, drought, crisis aid, or that related to crops not grown in New Zealand such as rice, cotton, and quinoa were excluded. Topics unrelated or irrelevant to the New Zealand situation were excluded, such as malaria, land tenure, bushmeat, family poultry, or articles related to tissue banks, blood supply, and fertility clinics. Articles relating to HIV or AIDS, homelessness, or drug use were excluded. Furthermore articles that related to the natural environment such as climate change, soil or water quality, fisheries management, animal health, agroterrorism, or biofuels were excluded, as were articles relating to globalisation and trade. Articles that related to health outcomes or prevalence of food insecurity were also excluded. News items, book reviews, and any non-research based articles were excluded.

Article titles were scanned for obvious exclusions and any duplicates were removed (first step), leaving 627 articles remaining. From these 627 articles, abstracts were scanned (second step) or the full article obtained (third step), which identified 63 articles suitable for inclusion in the review.

A Google search was carried out on 11 October 2007 for “food security” AND “New Zealand”. Searches were also completed of the USDA and FSA (UK) sites, and of various poverty-related organisations websites, such as ANGLICARE in Australia. Further articles were obtained through hand searching bibliographies, journal alerts, and three key informants. A further 40 articles were identified. Thus, a total of 103 food security articles were included in the final review.

1.3 Data extraction

Summary data on study design (study type, design, and population), methodology, findings and limitations were extracted and recorded from all included studies.

1.4 Quality scoring

To aid interpretation of the literature search findings, a simple guide to the quality of included papers was required. Many of the existing quality assessment tools were developed for randomised controlled trials, of which there were very few in the review. No one tool was available which was appropriate for quality scoring all types of included literature. Therefore, three quality scoring tools were used: one to assess non-randomised trials/surveys, another to assess qualitative literature, and the last to assess reviews. Reports and book chapters were not quality scored.

Three potential tools were identified for quality scoring of non-randomised trials[13-15]. The most relevant contained 27 items[13], which was too complex for the sake of this review, and many items were considered irrelevant. Therefore a simplified five-item version was developed based on this tool. In relation to qualitative research, an established or appropriate tool for assessing study quality was not available. Therefore a five-item tool was developed based on advice from experienced qualitative researchers. An established tool developed by Mulrow was used for quality scoring review papers[1]. The tools assessed simple key indicators of study quality, and are shown in Appendix 1.

Quantitative papers and reviews were quality scored by researchers at the CTRU. Qualitative papers were quality scored by researchers at Wellington School of Medicine. Papers were scored independently by a first reviewer, with any areas of doubt resolved through consensus with a second reviewer. The second reviewer also independently scored a sample of papers to ensure consistency of rating. Quality scores are presented in the literature summary table (Appendices 2-4).

Literature was quality scored and evidence was graded as *moderate* if quality scores showed an individual or combined score of 3.5 (out of 5) or more. *Good evidence* was

classified as factors that were reported in more than one study, and had an average quality score of 4 or more. *Well-conducted studies* had an individual quality score of 4.5 or more (Figure 2).

Figure 2: Grading evidence

Grade	Score (out of 5)
Limited evidence (average score)	< 3.5
Moderate evidence (individual or average score)	≥ 3.5
Good evidence (average in >1 study)	≥ 4
Well-conducted study (individual study)	≥ 4.5

Overview of findings

An ecological perspective was taken in examining environmental influences in the literature. This encompasses the physical and social context within which an individual exists, and the interaction and interdependence of an individual with their environment[16 17]. The ANGELO Framework was used as it looks at environments at multiple levels within categories relevant to food security and physical activity. Findings from the literature review have therefore been conceptualised using the ANGELO Framework and categorised into physical, economic, socio-cultural, and political environments. However, it should be noted that some factors may fit within more than one environment.

One hundred and three studies were included in the review; many were cross-sectional surveys (n=41), and conducted in the United States (n=50). Limited research has been conducted in Canada (n=10), Australia (n=12), and the United Kingdom (n=3). Twenty-three studies and reports were identified from New Zealand. Much of this was grey literature (reports, conference proceedings, and other research not commercially published) (n=12) or was qualitative research (n=8). Eight of the papers addressed aspects impacting on food security, but did not report the impact on food security. Very few interventions aimed at improving food security (other than food stamps) were identified (n=4). A summary table of the included studies is attached in Appendix 2.

In the *quantitative* literature, 53 papers were quality scored. Individual scores were variable and ranged from 0.25 to 4.5 out of 5. Eighty-nine percent of papers had a clearly stated aim, 62% used a food security measure that was either used nationally or was validated, and 21% adapted their measure from a national or validated measure. 19% used a measure that was neither validated nor used nationally. Nineteen percent of studies scored maximum points for being representative, illustrating that they had a representative sample with an adequate sample size and response rate. Fifty five percent of studies fully adjusted for confounding. Three reviews were quality scored. Two scored poorly, with a quality score of 2 out of 7. The third had a score of 4.5 out of 7. None reported their method of data identification and selection or attempted any form of data synthesis.

The *qualitative* literature scored more highly, with 12 papers scoring between 3.5 and 4.5 out of 5. None of the papers fully discussed generalisability of results outside of the sample with support from theory or research findings. Seventeen percent of research studies did not clearly state an aim, and one paper did not score full marks for methodology.

2 Physical factors

Among the physical factors that emerged from the literature review, the most prominent were in home and neighbourhood settings. Within the home setting, the research evidence around health, facilities, and home gardens was of moderate quality. For the neighbourhood setting, evidence was of moderate quality and largely related to transport issues and living in a rural versus urban location. Each of these is discussed in detail below.

2.1 Health

There was a range of evidence around aspects of *physical and mental health*, *adult and child health*. Factors that were shown to be associated with food insecurity were poor mental health, poor physical health, or poor child health. People with chronic physical or mental health problems tended to be over-represented as foodbank users[18]. In fact, poor mental health was one of only two factors (along with low income) that was shown to be associated with food insecurity once adjustment was made for unknown confounding[11]. This study used hierarchical modelling of data from five waves of a national survey in the US, providing a very large data sample (n=70,492). In a well-conducted cross-sectional survey in California in 2004 (n=4,037), factors associated with food insecurity were recent depression, feeling overwhelmed and poor mental health[19]. Furthermore, food insecurity has been positively associated with perceived stress, anxiety, depression, and external locus of control; and negatively associated with mastery and self-esteem[20]. A US study of moderate quality showed that whilst having a coping style of taking responsibility reduced the odds of adult-only hunger, it did not have a significant effect once that had extended to include child hunger (a more severe form of food insecurity)[21].

Illicit drug use was also linked to food insecurity and may contribute to foodbank use in New Zealand[18]. It has also been found to predict food insecurity in US hospital and primary care patients[22].

Although a relationship exists between poor physical or mental health and food insecurity, the predominance of cross-sectional study designs means we cannot determine the direction of this effect, that is, which factor is causative. One longitudinal study found unemployed mothers who moved into employment experienced a fall in food insecurity and improved psychological wellbeing, compared with mothers who did not move into employment[23]. However, it was not ascertained whether this was due to improvements in food security. This study (of moderate quality) was conducted in the US with a representative sample of 2,000 low-income urban families.

Ill health or *reduced mobility* may impact on food security by making access to shops to purchase food difficult, as shown in a well-conducted survey in Australia in 2004 (n=1,719)[24]. Furthermore, having a disabled person in the household may reduce food security[25].

A US study of elderly people found that whilst having disease or a serious health problem itself was not associated with food insecurity, *functional health impairments* that led to problems with activities of daily living did increase the odds of food insecurity[26]. An Australian study of older adults did, however, find that the greater the number of long-term health conditions, the greater the probability of food insecurity[27].

2.2 Facilities

Buying food in bulk when it is cheap can lead to cost savings[28]. However, in order to buy in bulk, or buy a large quantity of food, there must be adequate food storage facilities in the home. There also needs to be proper facilities and implements with which to prepare and cook food. There was moderate quality evidence in the literature that *unsuitable housing standards*, especially in relation to storage facilities and kitchen and cooking facilities, is related to food insecurity[28-30].

2.3 Home gardens

Home or community gardens have been proposed as one solution to food insecurity[24 31]. A US study of moderate quality found that having a *vegetable garden* was

associated with having more food in the house, but not with food insecurity[32]. Encouraging people to grow their own food seems plausible. However, barriers to achieving this include environmental conditions being unsuitable for growing food (from research on the West Coast of New Zealand)[33], insufficient space in which a vegetable garden could be grown, fruit and vegetables cheapest to buy when they are most plentiful in the garden, residential transience, and tools for gardening being expensive to purchase[28]. A certain skill level is also required to successfully maintain a vegetable garden[28]. It has been noted that traditional skills in growing and gathering food are becoming lost[31], which may impact on ability to successfully sustain home or community gardens.

2.4 Transport

Lack of transport options can impact on food security[28]. Transport is often needed to shop for food for two reasons: (1) the distance of travel to a shop; and (2) the amount of shopping that needs to be carried. Lack of transport to undertake food shopping has been found to be associated with food insecurity in many studies, with a moderate quality of evidence[24 28 30 31 33-36]. However, people who do not have access to private transport are also likely to be on a low-income, which could account for the association. Much of the research supporting the association between lack of transport and food insecurity was qualitative. Of the two quantitative studies, only one adjusted for confounding factors (eg. household income, health, home ownership, age etc)[24]. Conversely, a well-conducted survey (n=8,881) amongst older Australians found that experiencing transport shopping problems was not predictive of food insecurity[37]. The authors of the study did not provide any rationale for these findings.

Being restricted to use of shops within walking distance[38] or not having any shops within walking distance can cause difficulty for food purchasing[28]. Whilst there is a reliance on transport if shops are not nearby, local shops are often dairies which charge higher prices. To address this, the Braystone Project, a community intervention in Australia, evaluated provision of mobile fruit and vegetable market stalls at public housing estates[39 40]. Evaluation showed that at two high-rise estates access and social connectedness improved, but this was not replicated at two low-rise estates.

2.5 Rural/urban location

With respect to geographical variations in food insecurity, there was a moderate quality of evidence from the US that indicated *living in an urban compared with a rural location* was associated with food insecurity[41]. In Australia, absolute prevalence rates of food insecurity were found to be higher in urban than rural areas, however, living in an urban area showed only a small association with food insufficiency at a household (OR 1.3, CI 1.1 to 1.6) but not at an individual level[42]. Similarly, in a well-conducted survey, older Australians who were food insecure were slightly (but not statistically significantly) more likely to be living in an urban or large rural centre than a small rural centre[37]. Amongst Hispanic youth in the US, living in a non-metropolitan area was associated with a reduced risk of food insufficiency[43].

Food costs may also vary substantially depending on geographical location[28 33 44 45 46], and this is seen in New Zealand as well as internationally. For example, it was estimated that in 1997 foods costs in rural areas on the West Coast of New Zealand were 10-25% higher than in town centres on the West Coast[33]. In addition, fresh produce for sale in rural areas may be limited[33], and transport can be more of an issue due to greater distances to shops[28]. This highlights the importance and dependence on private transport, which also increases the personal cost of getting to shops.

3 Economic factors

There is a large body of evidence supporting an association between economic factors and food insecurity, the most prominent being the association with household income. However, other factors such as wealth (capacity to save or asset income), employment, welfare (benefits or subsidies), debt, costs/bills, and housing costs or home ownership have all been found to be associated with food insecurity. Of the factors identified, there was a good level of evidence for wealth and housing affordability. There was also considerable qualitative research on cost of transport. For all other factors, evidence was of low or moderate quality.

3.1 Income and employment

The majority of research studies have consistently reported an association between *household income* and food insecurity. This relationship has been supported both in

New Zealand and internationally. In Australia, food insecurity was predicted by a household income of less than $40,000/year (2004 data)[24]. In the US, people living on incomes below the poverty line* have been estimated to be 3.5 times more likely to be food *insufficient* than those above the poverty line[47]. However, the relationship between income and food security is not direct. There are many people living in poverty who are food secure. Conversely, various US surveys have estimated that up to half of those who are food insecure have an income above the poverty line[47]. This demonstrates that whilst there is a strong association between income and food security, income alone does not provide a full explanation for food insecurity. Whilst they are related, income poverty and food insufficiency appear to be determined by distinct processes, and food insufficiency depends on more than poverty alone[48].

There is a good level of evidence that different indicators of wealth impact on food security. A well-conducted Australian study showed that food insecurity was predicted by a household not having capacity to save money[24]. Furthermore, when examining pathways into and out of food insecurity, having a low level of income from assets was associated with becoming food insecure[48].

Income volatility, or income changing over time, also impacts on food security. Unexpected income shocks (loss of income or benefits) can cause financial strain, which low-income households do not have the resources to manage[49]. This may be an important factor, which was not taken into account when looking at associations with current income alone.

It should be noted that not all studies reported an association with income. In a sample of refugees in the US, acculturation rather than income was associated with food insecurity (limited quality evidence)[50]. Having an income level above the poverty line was also not significantly related to experiencing hunger (the most severe form of food insecurity), once social capital was adjusted for[51]. Social cohesion and trust in the community were measured as a proxy for social capital.

* The US poverty line is calculated on household income and varies according to size and age of the household. In 2006, the poverty line for a household with five members including a mother, father, great-aunt and two children was US$24,662. (US Census Bureau)

Employment can impact substantially on income, with a greater risk of food insecurity if unemployed[42]. Food insecure households were also more likely to have recently experienced job loss[47]. Conversely, mothers who were able to move into sustained employment reported a decline in food insecurity[23]. On a country level, national case studies indicate that food insecurity was an outcome of prolonged high unemployment rates, along with other aspects of income and wealth distribution[52].

However, employment may not be sufficient to protect against food insecurity. In the US, nearly half of the households who were classified as having very low food security had at least one household member who was employed[53], and food banks have reported increased numbers of low-paid workers needing to use their services[34]. On the other hand, there is limited evidence of a null effect of employment on food security. A small US study found that number of job losses was not associated with food insufficiency[11], although this may not give a true representation of employment. A study in US hospital patients found unemployment was not predictive of food insecurity[22], and another that employment was not associated with food insecurity in mothers with children living at home (a group who are more likely to purposely not be employed)[32].

As well as whether a person is employed or not, there is a moderate quality evidence from New Zealand that *employment related issues* such as unpaid sick leave can impact on food security[34]. Furthermore, there may be geographic variations in wages[25], and seasonal work leads to variations in wages over the year[36].

3.2 Expenses and debt

Household expenses impact on food security by reducing the amount of money available to spend on food. Well-conducted New Zealand qualitative research has identified that prioritising other expenses above food was very common amongst participant Pacific households[54]. Food is seen as the only disposable part of the income[28 38 54], and hence is allocated whatever money is left over after other bills are paid. Having bills to pay is often given as a reason for needing to visit food banks[34], or as one focus group participant has put it "*small money – large bills*"[50].

Poor *budgeting skills* have been suggested by agencies or key informants as one of the possible causes of food security[31 33]. However, the literature also suggests that the

money available to low-income households is inadequate to cover the costs of purchasing sufficient healthy food[28]. If the money available is insufficient to cover costs in the first place, no amount of budgeting can make it do so.

The *cost of food* has been suggested as a contributor to food insecurity[30]. Foods that are less healthy such as higher fat and higher sugar foods are also seen as being cheaper than more nutritious food, making it difficult to select healthy choices[28 54]. One way of trying to reduce the cost of food is food cooperatives. Parnell[55] found that 12% of a low-income sample in New Zealand belonged to a food cooperative, where households pool together to bulk purchase food in order to obtain cost savings.

Both *debt* and inability to *access credit* have been associated with food insecurity[28 34 55], whilst accumulated debt is a factor in food bank use[28]. Amongst a Pacific group living in South Auckland, repaying high-interest debts to loan sharks was also highlighted. Ribar[48] has noted the positive effect that access to credit can have in smoothing income, meaning that income shocks do not have to lead onto food security. However, loan sharks are not a suitable solution to obtaining this credit.

Other *expenses* identified as adding to the financial burden include school fees/donations[56], church donations (Pacific communities)[54 57], medical expenses[56 58], the cost of transport[30 31] (null finding in one US study[11]), heating or cooling costs[18 59 60], a high state tax burden on low incomes[25], and childcare costs[18] (null finding in one US study[11]). Problem gambling may also have serious economic outcomes for some families, and may contribute to the need to use food banks[18].

3.3 Welfare system

Not surprisingly, those who are living off a *welfare benefit* have greater odds of being food insecure (moderate evidence level)[61 62]. Historically, benefits have been designed as a safety net and set at rates that would not encourage welfare dependency. However, the reliance on food banks illustrates that basic living costs are not being met for many. In New Zealand, trends in food bank use show a substantial increase in demand after the benefit cuts of the early 1990s[18 56]. Although benefit levels have increased since the 1990s, food banks have become a necessary means of obtaining food for many low-income households. Whilst fulfilling an obvious immediate need, the definition of food security includes that food should be obtainable in socially acceptable

ways. As people are understandably reluctant to use food banks[28] and they are seen as stigmatising[38], they cannot be seen as a socially-acceptable way of achieving food security. They act as a bandaid rather than a solution to the underlying causes of food insecurity, and some see them as serving to absolve a government's obligation to improve food security[63]. As Raine[64] puts it they create "*the illusion of a solution*". Furthermore, Reid[38] identified that food bank clients do not have an automatic entitlement to receive food. Instead, they are reliant on the good will of the food bank to provide food, and the good will of people to supply food to the food bank.

The most widely examined food assistance program is the *food stamp program* in the United States, which provides funding for food to low-income households. Food stamps are benefits available for use on food items in privately run stores. To be eligible, participants must meet criteria for gross income, net income (which must be at or below the poverty line), and asset tests (assets less than $2,000)[65].

Surprisingly, participation in the food stamp program has not been associated with improved levels of food security[66 48]. One proposed reason for this effect has been self-selection, whereby people with greater levels of food insecurity are more likely to be receiving food stamps. When analyses have accounted for self-selection, food stamps have still not been shown to improve food security[66 67]. However, loss of food stamp entitlements is associated with greater food insecurity[47 49 68]. Furthermore, recent work using hierarchical modelling found food insecurity was less common when food assistance programs were more widely available and utilised[25]. However, this only applied for households who were 'near poverty'; not those who were already in poverty[25]. Another way of looking at the food stamp issue is to see their effect on different measures of poverty. Using this approach, food stamps did not reduce the incidence of child poverty, however they were shown to reduce the depth and severity of it[65]. Therefore, food stamps may be having a positive effect for those who have reached the stage of poverty that is not seen by looking at rates of food insecurity.

Food stamps have been shown to help in other ways. Low-income households often do not have the ability to put money aside in preparation for unexpected events. A well-conducted Australian study found households that were unable to save money were five times more likely to be food insecure[24]. The household is thus vulnerable to any changes or extra demands on income. Unexpected expenses may therefore

contribute to food insecurity[32]. Food stamps have been shown to have a food-smoothing effect, whereby they reduce, but do not eliminate, the effect of a permanent income shock on food consumption in low-income households[69]. Either welfare payments or food stamps *running out* before the end of their payment cycle has been associated with food insecurity (low to moderate evidence level)[31 70]. This especially causes problems obtaining perishable items such as fruit, vegetables, and milk, which need replenishing regularly.

In New Zealand, instead of food stamps, a special needs grant or temporary additional support is available, which can be used to purchase food for those experiencing financial hardship. However, not all those who are eligible receive these extra benefits[71] or even know they exist[38], and administration difficulties may at times make them difficult to claim[56].

The definition of food security includes the notion that food meets nutrition needs - thus households must be able to obtain healthy food. When looking at the food expenditure of low-income households in the US, spending on fruit and vegetables was around half of the estimated cost in the Thrifty Food Plan (which represents a healthy but minimal cost meal plan)[72]. Spending on fruit, vegetables and dairy only rose once income was above 130% of the poverty line. Work by the US Department of Agriculture suggests that general food stamp or household income increases may not be successful in increasing fruit and vegetable consumption, and that targeted bonuses are needed if this is the desired outcome[73].

3.4 Housing

There is moderate quality evidence that aspects of housing are associated with food insecurity. *Housing costs* are highlighted as one of the main expenses that take priority over food, and absorb a large amount of the household budget[28 38]. In low-income households, spending on food declines as spending on housing increases[74]. A US study using hierarchical modelling found that for each $100 increase in median rent at a state level, there was a 17.5% increase in odds of food insecurity[25]. However, another study found living in a county with high rents did not in itself increase the probability of food insecurity, but rather it was the interplay between low income and high rent that did so[41].

Food insecurity has been shown to be associated with *renting a home*, versus buying or owning, in two well-conducted Australian surveys[24 37]. Similar findings have come from US and Canadian surveys[25 47 49 58 62]. Contrary to these findings, one US study found that home ownership was not significantly associated with food insufficiency[48]. However, this is looking at the most severe form of food insecurity, and it is possible that there are differences between those who experience food insecurity and food insufficiency which account for the differences in association between these variables. Length of home ownership has also been inversely associated with food insecurity[75], however this may reflect residential mobility, which is in itself inversely associated with food insecurity[21 25].

Welfare policy has also impacted on *housing affordability*. Market rents for state houses were introduced in New Zealand in the 1990s, causing hardship for many low-income families and impacting on food security[18 56]. During this time, over half of all Auckland foodbank users reported spending more than 50% of their income on rent[56]. Income-related rents for state houses have since been reinstated.

4 Socio-cultural factors

Many socio-cultural factors impacting on food security relate to the home setting. Qualitative research highlighted factors such as cooking and financial skills, nutrition knowledge, lack of time and energy to shop and cook, cultural requirements and associated financial costs, familial factors (such as having visitors, relationship break-ups, or giving money to family members), prioritisation of finances, lack of traditional food sources, food preferences, and embarrassment in asking for help. Quantitative research also found associations between increased household size and solo parenthood with food security, along with extra financial demands at certain times of year and parents' education level. At the community and neighbourhood level, quantitative research showed associations with recent immigration, lack of social networks, use of community kitchens, and increased social capital.

Much of the New Zealand literature on socio-cultural factors has emerged from well-conducted qualitative research. Whilst individual studies had high quality scores, the evidence is scored as moderate overall because most factors were examined in one study only. The quantitative literature scores less well, with low to moderate levels of

evidence, except for having English as a second language, which has good quality evidence. However, some individual quantitative studies were well-conducted, and they showed associations with lack of time for food preparation and shopping[24], and household size[19 24].

4.1 Skills and time

In order to acquire and prepare healthy food, *knowledge and skills* are needed. A lack of both nutrition knowledge and food preparation skills has been proposed as a barrier to food security by organisations and key informants assisting people with difficulties obtaining food[31 33]. However, individuals experiencing food insecurity attributed it to lack of money rather than to a lack of knowledge[31]. Other studies have shown that those with poorer self-rated cooking skills had higher odds of food insecurity[29]. Food insecurity has also been predicted by a low level of food and financial skills[58]. However it should be noted that nearly three-quarters of low-income households interviewed achieved the highest level of food and financial skills when assessed[58]. Therefore, only a small number lacked good food and financial skills. A study of food banks in Australia found many users reported that they need to know more about preparing healthy food[30]. However, this may reflect a desire to learn rather than a lack of skills.

Literacy may also impact on food security, and low literacy levels have been associated with food insecurity. Having a low level of literacy made food purchasing and preparation more challenging[35]. For immigrants, unfamiliarity with local foods and cooking methods, and lack of budgeting skills provide extra challenges[44 76].

Improving food and nutrition skills of low-income households has been the focus of two *education programs* in the US. Evaluation of a six-week program showed positive changes in purchasing and preparing food, but no quantitative impact on food security[77]. A community-based nutrition education program with low-income groups showed food insecurity decreased in proportion with the number of lessons received, and that individual lessons were more effective than group education[78].

As well as having the knowledge and skills to acquire and prepare food, having the *time and energy* to do so is also important. This has emerged from well-conducted studies in New Zealand[38] and Australia[24], as well as from international literature[35].

Preparation time is seen as an obstacle to using traditional foods for American Indians, alongside lack of availability[36].

Level of education has been assessed in association with food insecure households, with equivocal results. Some studies show an association with level of education[19 25 26 32 47 48 75 79 80] whilst others do not[11 20 27 81]. However, the weight of evidence would suggest that low education level (often less than a high-school qualification) impacts on food security. It should be noted that there is limited evidence from a US study that once unmeasured characteristics were controlled for, the association of level of education with food insufficiency was lost[11].

4.2 Cultural expectations

In the New Zealand context, the financial impact of *cultural obligations* has been highlighted among Māori and Pacific communities. For Māori, financial contributions for tangi and whānau can cause increased financial strain[57], which impacts on the ability to purchase food. In Pacific cultures, family is often prioritised over personal needs[54]. This includes prioritising sending money to family in the Islands even if personal finances are strained. Payments towards funeral or wedding costs of family, friends or church members are expected, as are church donations. There are also cultural expectations around food. Food for Sunday lunch was given priority over food for the rest of the week, and visitors are provided with the best quality food[38]. For low-income households, these factors create additional demand on finances and/or food that impact on food security.

There are also generic times of *extra demand* due to cultural occasions, for example, at Christmas or Easter. However, the start of the school year and winter also cause extra financial strain due to increased expenditure on school items or heating and may lead to the need to use food banks[18].

Lack of *access to traditional foods* causes issues for some groups. Somali immigrants in Australia have noted difficulty obtaining affordable halal foods[76], and access to traditional foods is also an issue on American Indian reservations in the US[36]. In New Zealand, this also applies to Māori who may have reduced access to traditional foods. The colonisation of New Zealand resulted in loss of Māori land with which to grow or gather both traditional and modern foods, as well as loss of an economic base; whilst

pollution and over-fishing have depleted seafood stocks[82]. There may also be a loss of traditional food gathering skills[31].

4.3 Family

The literature showed consistent trends that *single parent families* (especially with a woman as household head) was associated with higher rates of food insecurity[25 32 42 83]. In New Zealand, solo parents are over-represented amongst foodbank users[34]. When looking at entry and exit to/from food insecurity over time, households that have experienced a change in composition or have a female head are more likely to become food insufficient[48]. In families where the father is absent from the home, regular child visitation by the father (more than once a week) reduced food insecurity[84]. Receiving child support payments may also reduce food insecurity. Inter-partner abuse has also been linked to food security[85 86] as has sexual molestation in childhood[21].

Household size[32], or number of children in the home[25 87], was inversely associated with food security. However, this association was not seen in all studies[20]. In New Zealand, both the adult and children's national nutrition surveys have found that larger households are more likely to be food insecure[4 5]. Household sizes that vary can also impact on food security, either through reduced or increased numbers of people to feed[31]. This can be as simple as grandchildren staying with grandparents for the weekend or having visitors, through to long-term relationship break-ups[34]. A US survey found that food insecurity reduced with increasing numbers of adults in the household[84], whilst other studies found that food insecurity was predicted by having children in the household[24 88]. Larger households are more common among Māori and Pacific peoples. For Pacific, it is common to live with extended family[54]. Absorbing extended family into the household is expected and can create additional financial strain for households. It should be noted that not only large households, but also single people[42 53] or single elderly people[27] are more likely to experience food insecurity.

4.4 Immigration

Immigration has been associated with food insecurity. In Canada, immigration within the last 10 years has been associated with higher odds of experiencing food insecurity[62], whereas in the US people having lived less than half their lives there was associated with greater food insecurity[19]. Refugees who had arrived more recently in

the UK were more likely to be in households where children were experiencing hunger (the most severe form of food insecurity)[89].

Some of the reasons that migration can impact on food security have already been mentioned, such as unfamiliarity with local foods and the high cost of traditional foods. Immigration can also be associated with food insecurity in other ways. Recent arrivals are often on low incomes and are facing the cost of setting up a new home[76]. The literature also identified that having English as a second language is associated with food insecurity in the US and in Australia[19 24], whilst limited acculturation has been shown to be both protective against, as well as predictive of, food insecurity[43 50].

4.5 Social networks

Social isolation has been related to food insecurity in elderly people[26] and in women[90]. In a New Zealand context, it has been perceived as a barrier to food security[31]. For the elderly, eating alone was predictive of food insecurity[91]. Overall, there was a good level of evidence for the relationship of social isolation with food insecurity. However a well-conducted Australian study found no significant association between level of community involvement and food security[24].

Social capital, which encompasses social trust and community reciprocity, has been shown to be inversely associated with food insecurity at a household and community level[51 92], although the evidence was of limited quality. At a household level, once social capital was accounted for, none of the socio-demographic factors assessed continued to be significantly associated with food insecurity. Higher social capital was more likely in households with an elderly member or a member who was part of a social or civic organisation. The relationship with food security was especially strong for reciprocity between neighbours[51]. Furthermore, where there was a perception of high civic structure (organisations are trying to improve food security), there were decreased odds of food insecurity[81].

Community kitchens have been used as a way to both improve food security and provide social support. Community kitchens operate in different ways depending on the needs of the group, but all aim to improve food security in a supportive way. They involve a group of people cooking together to make a large quantity of food in order to save money. A review of the community kitchen literature found that whilst it could not

be certain that community kitchens reduced food insecurity, they did provide social support for participants, and were less stigmatising than using a food bank[93].

4.6 Media

Food marketing was related to food insecurity by creating demand for specific foods, which were often higher priced than budget alternatives. Television *advertising* was mentioned specifically in relation to advertising to children, who then put pressure on their parents for specific types or brands of food[28].

4.7 Personal

There may be a level of *shame* for households that they are experiencing food insecurity[76]. Pride or embarrassment might stop people asking for help[31]. In New Zealand it has been noted from focus groups that food banks are not commonly used by Māori and Pacific due to embarrassment[38]. However, Māori are over-represented in food bank statistics[18], and the National Nutrition Surveys[4 5] report higher rates of food bank usage among Māori compared to the general population. Thus, despite use of food banks being avoided, it would seem that Māori need to use them more frequently than the general population in order to meet their food needs.

5 Political factors

The political factors identified related to government welfare policies, the labour market, policies relating to Māori, or to food pricing. Some of these political factors have been discussed previously so the section below focuses on those not covered previously.

5.1 Government policies

New Zealand government policies that have impacted on food security include taxation reforms, introduction of GST, cuts in welfare payments, restructuring of the public and private sector, labour market reforms (including Employment Contracts Act), housing policy, and New Zealand's standard of living[56]. Food banks have also noted increasing numbers of asylum seekers using their services[18], and the deinstitutionalisation of mental health patients has created a group at high risk of material hardship[56].

6 Associated factors

There are numerous other factors that are likely to impact on food security which did not come through strongly in the literature. In many cases this was because outcomes on food security were not investigated. Examples include the impact of food pricing and food availability on food security. A sample of studies is included in Table 9, Appendix 2 (food security summary tables) to highlight some of these areas.

7 Evidence gaps

There is a dearth of research evidence that has examined effectiveness of interventions to improve food security (other than through welfare payments). Two studies investigated the impact of education on nutrition[77 78], one looked at the cost-effectiveness of a supermarket shuttle but did not directly address food security[94], another looked at the use of vouchers for fruit and vegetables (results published after the date of this review)[95], and another evaluated the Braystone Project in Australia[39 40].

Other gaps in the evidence are discussed in relation to the ANGELO framework, in the section entitled “ANGELO Grid”.

8 Limitations of the review

Due to the extensive volume of literature on food security, this review did not attempt to identify all available literature; therefore some papers are likely to have been omitted. Whilst the search was comprehensive, it was developed to limit papers to only those that were obviously related to environmental influences on food security.

The qualitative and quantitative quality scoring tools used were not published or validated tools, but were based on best practice; therefore their validity may be questioned. However, suitable tools appropriate for use in this review could not be identified, and the tools were intended to give an indication of quality only.

The vast majority of published research was cross-sectional surveys, which cannot determine causality. Statistical adjustments were not always made for confounding factors, although this was taken into account in the quality scoring. Some results were

based on secondary data analysis, and at times the original surveys had been conducted many years prior to publication.

The majority of literature was from the US. In New Zealand, much of the literature was grey literature, and methodologies were not always provided. Food bank data was mentioned in some of these reports; however, it was acknowledged that food bank records were not accurate. Furthermore, they only represent one part of the spectrum of food insecure households.

Research on some factors directly related to food security, such as food pricing and access, did not measure the impact on food security. Some of this research was included in the review to highlight the existence of this area of research rather than providing a comprehensive review.

The measurement of food insecurity is also likely to impact on the nature of the research findings. For example, Ribar et al[48] modelled results using both a food insufficiency and a food security measure. Whilst findings were in the same direction, there were clear differences in which variables reached statistical significance.

There is an urgent need for intervention research in this area. Few interventions addressing food security were identified.

Key findings and recommendations

Food security is a complex issue. There has been wide-ranging research on factors related to food insecurity, which appear to be many and varied, but little on ways to improve it. Despite the plethora of research and the importance of the topic, there is still little guidance on what can be done practically to enhance food security.

Findings from the literature review suggest there is a broad range of factors influencing food security, with income appearing to be a major factor. Some people simply do not have sufficient income to cover all their basic necessities and household expenses. In a New Zealand context, specific cultural obligations for Māori and Pacific further limit their disposable income. However, the literature also shows that low income alone does not guarantee food insecurity. Rather, there is a context in which food insecurity exists. This context includes a range of physical, socio-cultural, economic, and political factors which can all impact on the potential to attain and maintain food security for people on a low-income. Many of these factors, whilst impacting at an individual or micro level, are determined at a macro level. Factors such as health, housing, education, transport, employment, cost of living, welfare, media, and immigration are dependent on government, trade, and international policy. This highlights the importance of addressing macro or 'big picture" solutions to address food security.

Food insecurity is seen most often in households with highly constrained financial resources. Thus, in seeking a solution for food security it must be decided whether the aim is solely to improve food security or whether it is to improve socio-economic status of the household. If it is solely to improve food security, then assistance must be targeted to nutritious food and unable to be diverted to pay other bills, to avoid other expenses being prioritised over food. However, from a public health perspective improving socio-economic status and standard of living is likely to lead to far greater health gains as well as having a positive impact on health inequalities. This requires different solutions that seek to address all the factors impacting on food security.

The number of people in New Zealand experiencing food insecurity demonstrates that our current response is inadequate. With one in five households not always being able to afford to eat properly, it is a sizeable issue[5]. A second adult National Nutrition Survey

is due to be launched this year, and it will be informative to see whether relevant government policies such as Working for Families are associated with changes in the prevalence of food insecurity in New Zealand.

There are many gaps in the evidence base relating to food security, and in particular we know very little about effective interventions. Further research is desperately required on potential interventions or policies to improve food security in New Zealand – we need to know what works, where, how, and with whom. However, it has also been recognised that public health cannot sit back and wait for the "best evidence possible" before taking action, but must instead work with the "best evidence available"[96]. A solution-oriented research paradigm is necessary, which focuses on identifying solutions, rather than continued research to identify determinants of food security[97]. Interventions likely to improve food security should be investigated, and the results translated directly into action through implementation of interventions or policy.

Whilst this review focused on literature that had food security as an outcome, there is a wide field of associated research conducted on factors that directly impact on food security, but in which food security was not assessed. The definition of food security includes that food must be accessible and nutritious. For those on a low-income, what food is available and how much it costs are vital issues in determining which foods are purchased. Issues such as food pricing and food availability are thus integral to food security and are also suitable targets for intervention under a solution-oriented research paradigm.

In deciding where to go next, we cannot lose sight of the importance and urgency of this issue. Food is fundamental to life, and having sufficient food to eat is a basic human right, enshrined in the Universal Declaration of Human Rights[98]:

> *"Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food…" (Article 25, paragraph 1)*

Food security is a moral issue, as well as a scientific one, and whilst it seems a monumental task to ensure food security for all, it is a worthy cause and one that as human beings we are obliged to pursue, and to pursue now. Key recommendations are highlighted below:

- To develop effective interventions to enhance food security based on the available evidence base
- To adopt a solution-oriented research paradigm is needed
- Interventions should target key areas such as income, employment, housing costs and facilities, health, food access and availability (including price)
- Macro-level interventions and policy are required
- Priority groups include Māori, Pacific, low-income households, sole-parent families, immigrants and refugees

- PHYSICAL ACTIVITY -

Methodology

9 Literature review

9.1 Search strategy

The literature search for physical activity was carried out on 9 October 2007, with the following Medline terms used and adapted for other databases:

1. exercise.ti.
2. physical activity.ti.
3. (walk or walking).ti.
4. cycling.ti.
5. physical inactivity.ti.
6. (sedentariness or sedentary).ti.
7. active living.ti.
8. active transport.ti.
9. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
10. *Exercise/
11. *Motor activity/
12. *Recreation/
13. *Sports/
14. *Bicycling/
15. *Walking/
16. 10 or 11 or 12 or 13 or 14 or 15
17. *Public facilities/
18. *Public policy/
19. *Schools/
20. *Residence characteristics/
21. *Transportation/
22. *Esthetics/

23. *Safety/
24. *Socioeconomic factors/
25. *Income/
26. *Economics/
27. *Social support/
28. *Social environment/
29. *Social class/
30. *Social planning/
31. *Culture/
32. *Family/
33. *Family relations/
34. *Environment/
35. *Environment Design/
36. *City planning/
37. *Community networks/
38. *Health behavior/
39. *Health promotion/
40. 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39
41. (policy or political or policies or politics).mp.
42. (culture or cultural).mp.
43. (social or socio$).mp.
44. (economic or financial or cost or resource$).mp.
45. (neighbourhood$ or neighborhood$ or communit$ or school or facility or facilities).mp.
46. environment$.mp.
47. (determinant$ or influence$ or correlate$ or facilitator$ or facilitate$ or barrier$ or enabler$).mp.
48. 41 or 42 or 43 or 44 or 45 or 46 or 47
49. (policy or political or policies or politics).ti.
50. (culture or cultural).ti.
51. (social or socio$).ti.
52. (economic or financial or cost or resource$ or price$ or pricing).ti.
53. (neighbourhood$ or neighborhood$ or communit$ or family or families or school or facility or facilities).ti.

54. environment$.ti.
55. (determinant$ or influence$ or correlate$ or barrier$ or enabler$).ti.
56. 49 or 50 or 51 or 52 or 53 or 54 or 55
57. New Zealand/ or New Zealand.mp.
58. Oceanic Ancestry Group/
59. Maori.mp.
60. (Pacific or Polynesian).mp.
61. 57 or 58 or 59 or 60
62. 61 and 9
63. 61 and 16
64. 62 or 63
65. Hawaiian$.mp.
66. 64 not 65
67. 9 and 40
68. 9 and 56
69. 67 or 68
70. limit 69 to (humans and english language and yr="2000 - 2007")
71. limit 70 to "review articles"
72. limit 66 to (humans and english language and yr="1990 - 2007")
73. 71 or 72

The search strategy in SCOPUS was:

((TITLE(exercise OR "physical activity" OR walking OR walk OR cycling OR "physical inactivity" OR sedentary) OR KEY(exercise OR "physical activity" OR walking OR walk OR cycling OR "physical inactivity" OR sedentary)) AND DOCTYPE(ar OR re) AND PUBYEAR AFT 1989 AND PUBYEAR BEF 2008) AND ((TITLE(policy OR political OR policies OR politics OR culture OR cultural OR social OR socio$ OR economic OR financial OR resource$ OR cost OR environment$ OR neighbourhood$ OR neighborhood$ OR communit$ OR school OR facilities OR facility) OR KEY(policy OR political OR policies OR politics OR culture OR cultural OR social OR socio$ OR economic OR financial OR resource$ OR cost OR environment$ OR neighbourhood$ OR neighborhood$ OR communit$ OR school OR facilities OR facility)) AND DOCTYPE(ar OR re) AND PUBYEAR AFT 1989 AND PUBYEAR BEF 2008)

The following databases were searched:

- Medline (biomedical literature) – 3183 articles
- SCOPUS – 3831 articles
- CDSR (Cochrane Database of Systematic Reviews) – 34 articles
- Central/CCTR (Cochrane Central Register of Controlled Trials) – 95 articles
- PsycINFO (international literature of psychology and behavioural sciences) – 588 articles
- CINAHL (Cumulative Index to Nursing and Allied Health Literature) – 498 articles
- Sport Discus (sport and exercise science) – 280 articles

9.2 Inclusion/Exclusion criteria

Due to the large volume of literature related to physical activity, this evaluation of existing research was limited to reviews published in English over the last five years, since 2002. Reviews had to relate to environmental determinants of physical activity. Reviews that were related to obesity or obesogenic environments but did not clearly differentiate environmental determinants related to physical activity were not included. The evidence base for New Zealand studies was extended to include reviews and individual studies. Some individual research papers published over the previous year were also included as they updated aspects covered in the reviews.

9.3 Data extraction

One reviewer (DG) identified reviews and individual studies based on the inclusion and exclusion criteria. Summary data (study type, design, population, methodology, findings and limitations) from the included studies were then extracted and summarised in Appendix 4.

9.4 Quality scoring

A quality scoring protocol was used to rate the respective quality of the reviews of literature as well as individual studies. For the reviews of literature a seven-point system was used, which rated the presence or absence of the following points; a clearly stated purpose, a statement of data identification, outline of data selection, a

some form of validity assessment, explanation of data synthesis, a summary, and presentation of future research direction. Individual studies were scored on a five-point system that assessed; the study aim, design, use of an accepted measure, a representative sample and whether the analysis adjusted for confounding factors (Appendix 1). Figure 1 shows how quality scores were graded.

Figure 1: Grading evidence

Grade (reviews)	**Score (out of 7)**
Poor quality review	< 2.5
Average quality review	≥ 2.5 and < 4
Good quality review	≥ 4
Grade (individual studies)	**Score (out of 5)**
Limited evidence (average score)	< 3.5
Moderate evidence (individual or average score)	≥ 3.5
Good evidence (average in >1 study)	≥ 4
Well-conducted study (individual study)	≥ 4.5

Overview of Findings

A total of 66 papers were included: 36 reviews and 30 individual papers. Eight reviews and three studies focused on children/adolescents. A total of sixteen individual research studies, reports or reviews were identified from New Zealand. Most of the remaining reviews emanated mainly from the United States, Europe, and Australia.

Much of the research focused on identifying the environmental determinants of physical activity and as such, largely relied on survey methodology with cross-sectional research design. Because of the heterogeneity in research design, and the varied methodologies used in the assessment of physical activity and the environment, few of the systematic reviews were able to synthesis the available data. Four systematic reviews reported on the effectiveness of interventions to increase physical activity among adults (two) and youth (two). Two reviews were of high quality and included synthesised data in the form of meta-analysis or utilised Community Guide Rules of Evidence to quantify the availability of research evidence.

With respect to the reviews, 34 of the 36 could be quality scored whilst two were reports and were not scored. The quality of the reviews varied enormously (scores ranged from 1 to 6.5), with the mean score (3.2) indicating average quality. Approximately 50% of the reviews clearly stated a purpose and had an appropriate search strategy. Although most of the reviews were considered systematic, they were essentially narrative in content and did not include any statistical synthesis of the data. There was one meta-analysis of environmental factors and one good quality systematic review of walking. A summary (85%) and some form discussion of future research direction (94%) were provided in most of the reviews.

Of the 30 individual papers, 28 were able to be given a quality score, which ranged from 0.9 - 4.8 (mean = 3.3). Twenty-six studies included a clear aim, with almost all studies incorporating a cross-sectional or survey research design. Only five randomised controlled trials were conducted and three were longitudinal in design. Approximately 60% included an accepted measurement tool, whilst most performed adjusted statistical analysis.

10 Physical factors

Amongst the physical factors that emerged from the literature review, the most prominent were in the home, school, and neighbourhood settings.

10.1 Home setting

With respect to the home setting, a systematic review of environmental determinants of physical activity in adults identified three studies; two of which reported a positive association between *availability of physical activity equipment* and activity in adults and one study reported no assocation.[99] A second review[100] found a positive association between physical activity and ownership of home exercise equipment. Others have shown that *increasing opportunities* for physical activity within the home environment can make a difference to physical activity participation in both children and adults.[99] A review[101] of environmental correlates of physical activity identified 17 independent samples investigating the association between variables of the home and physical activity. Of these, the *number of cars* in the family and the availability of and access to exercise equipment (e.g., physical activity promoting toys) were not related to children's

physical activity. Similarly, family infrastructure variables such as single-parent family, household size or number of children in the family, and dog ownership was not related to physical activity. Positive associations were found for *time spent outdoors* and *father's physical activity level*.

Although increased *media use* (TV watching, computer use etc) has been found to be negatively associated with physical activity behaviour,[102 103] the relationship is small. A handful of studies have been conducted with adults, of which all demonstrated a significant negative association between media use and physical activity. A meta-analysis of 54 studies of children's media use and physical activity demonstrated a significant displacement of physical activity by television and video game use. The effect sizes found were -.13 for television use and -.14 for video and computer use.[102]

Within the home setting, *family-based interventions* attempt to change heath behaviour through the use of techniques that increase the support of family members for behaviour change. As part of a systematic review, a total of nine family-based interventions were reviewed which mainly targeted children (eight studies). In general these interventions appeared to have a positive effect on physical activity participation. Unfortunately, the heterogeneity of study design, short term follow-up, and in some cases, no control group, made it difficult to draw definitive conclusions.[104]

10.2 Workplace setting

There is some evidence that interventions focused on *increasing opportunities* to be active among adults within the workplace have resulted in increased physical activity.[105] There is also sufficient evidence that *point of decision prompts* to walk the stairs instead of taking escalators was associated with increased stair use in a number of worksites (including hospitals) and shopping malls.[106-109] This type of intervention is likely to be effective across diverse population groups, provided that appropriate care is taken to adapt the messages.[109]

10.3 School setting

The school setting provides important opportunities for children to be active informally through play during school breaks and active commuting, and formally through physical education (PE) classes and school sport. A good quality systematic review[110] identified 27 studies which evaluated *school-based interventions*. Thirteen of these were

restricted to the school setting only, of which three resulted in a significant positive effect, resulting in the classification of inconclusive. For adolescents, 14 studies were identified that evaluated school-only interventions, including two high quality randomised controlled trials, one of which reported a significant intervention effect. The authors of the review stated these findings represented an inconclusive effect.[110]

Within schools, *increasing opportunities to be active* has been associated with increased physical activity,[104 105 110-113] as have interventions to *increase walking to school*.[114] A recent review[104] suggested that *environment only interventions* such as painting a school playground with activity markings, providing games equipment and activity cards were associated with small increases in physical activity.[104] However a separate review[113] concluded that increased access and availability of sporting equipment was not associated with increased physical activity participation in school children, but a positive association existed between physical activity and *school sport* physical participation among adolescents. Within the preschool setting there is evidence that *structured periods of play* and *time spent outdoors* were associated with increased physical activity involvement, whereas appropriate physical activity training of staff was related to time spent in sedentary pursuits and average activity levels.[115]

A good quality systematic review of interventions[109] to increase physical activity reported there was insufficient evidence regarding the effectiveness of classroom-based health education focused on information provision to increase physical activity because of inconsistent results among studies. However, there is strong evidence that *school-based PE* is effective in increasing levels of physical activity and improving physical fitness. Findings for college-based health education and PE interventions suggest there is insufficient evidence available for this approach to increase physical activity and physical fitness.

Another good quality systematic review of interventions to increase physical activity among youth[104] found that in school settings, there was limited evidence supporting the effectiveness of curriculum-based strategies, with only one of the five studies reviewed resulting in increased physical activity. The intervention in this study targeted multiple risks in the Know Your Body programme among low-socio-economic status children 9-11 years of age consisted of two 45-minutes/week modules over 18 weeks, of which one focused on fitness and exercise. It is noteworthy that a replication of this program

using a similar self-report measure was not effective. Although the other four interventions did not increase physical activity they were associated with decreased TV watching and increased fruit and vegetable consumption.

Combined curriculum and physical education interventions have also resulted in limited impact with only two studies conducted among children showing some positive effect of levels of physical activity, and only two of the eight studies reviewed[104] resulting in increased physical activity among adolescents. Other reviewed studies have evaluated changes in *PE strategies* (increased aerobic activities and spending more lesson time being active) which resulted in modest increases in physical activity in classrooms but had no effect on overall physical activity. Combined PE and environment change (nutrition education, modification of school lunches etc) resulted in increased physical activity during school but had no effect on physical activity outside the school environment.[104]

Two reviewed studies investigated the effectiveness of *activity breaks* on children's physical activity. One intervention (Promoting Lifetime Activity in Youth; PLAY) included 15 minute play breaks during class time (four week duration), in which the teachers taught children games and activities. At the 12-week evaluation, children in the intervention group had higher self-reported physical activity compared to the control group (no activity breaks). A second study assessed the PLAY programme in schools that did and did not have PE classes. The PLAY intervention was associated with increased physical activity (self-reported and objective) for children with both PE and no PE classes compared to control groups (no PLAY programme).[104]

The after school setting has been targeted for intervention to increase physical activity participation. Two reviewed studies[104] examined the effectiveness of *after-school programmes* among adolescents. One study randomised participants to one of three intervention conditions to promote fruit and vegetable consumption and physical activity. No change in physical activity was found. The second study involved three two-hour after-school sessions per week over four weeks and comprised 60 minutes of student-selected activities and behavioural skills training. The intervention group increased their physical activity levels (objectively measured) by approximately 22 minutes a day compared to the control group, whose physical activity levels declined.

In NZ, the Apple project[116] evaluated the effectiveness of a *combined school- and community-based intervention* to prevent obesity in children. The physical activity component of the intervention focused on increasing the opportunity and variety of activities as well as an emphasis on lifestyle-based pursuits. Results showed a significant increase in accelerometer counts at the one-year follow up, but not at two-years. A systematic review identified 14 combined school and family or community-based interventions to increase physical activity in children. Only two studies found a positive effect, therefore the authors of the review concluded that no evidence of an effect exists for these types of intervention among children. However positive effects for increased physical activity have been found with adolescents following a combined school, community or family intervention.[110]

11 Neighbourhood and environmental factors

11.1 Perceptions of the environment

The *neighbourhood environment*, *urban design* and *transport infrastructure* has received a great deal of research attention, with much of the research focused on identifying environmental determinants of physical activity. Overall, the evidence suggests the environment has a modest influence on physical activity but the mechanism is not clear. Generally positive associations have been found between perceptions of the environment and physical activity. Of these, factors such as perceived convenience of local environments (e.g., footpaths and trails) and closer distance to facilities as well as better access have been shown to be related to physical activity (including walking) in adults[99 100 107 117-120] and children and adolescents.[101 121-124] There seems to be consistent evidence supporting a positive association between perceived safety and physical activity in adults,[100 107 125-127], however the evidence for an association between crime/personal safety and physical activity is mixed among youth.[111 128] Two reviews found no association between physical activity and safety[128 101] (but did report a negative association between crime rates), whereas there was a positive association between crime and physical activity among NZ youth.[124] Concerns, however, about traffic safety may be more salient among children, but the research findings are mixed, with associations between traffic safety and physical activity varying by age and type of activity.[111] Traffic-related infrastructure, such as improved footpaths,

crossings, traffic calming and speed limit initiatives, were associated with active transport and walking in children.[111 123] The aesthetics of the environment also seem important among adults with a number of reviews consistently reporting an association with physical activity[100 107 117-120 129 130], but the findings are equivocal for children and adolescents.[101] The presence of trees, interesting features to look at and litter were not associated with active travel to school, but were positively associated with physical activity in adolescent girls.[123] The presence of exhaust fumes and other bad smells were negatively related to walking and cycling but unrelated to physical activity levels. Moreover, in children perceived aesthetics has not been shown to be related to activity.[128]

A high quality systematic review[106] reported a modest but statistically significant association between *perceived environment* variables and physical activity. Using meta-analytic techniques no significant associations were found between environmental characteristics and physical activities using crude odds ratios (OR). However, using adjusted odds ratios, perceived presence of physical activity facilities (OR 1.20, 95% 1.06-1.34), footpaths (OR 1.23, 95% 1.13 -1.23), shops and services (OR 1.30, 95% 1.14-1.46), and perceiving traffic not to be a problem (OR 1.22, 95% 1.08-1.37) were positively associated with physical activity.

A New Zealand review[131] of national and international research was conducted to identify key factors associated with walking and cycling. A number of *barriers to cycling* for adults were identified including fear of one's bicycle being stolen, lack of on-road safety, adverse weather, lack of storage and shower facilities at work, time and distance, hilly terrain, convenience of motor vehicles, being physically unfit, and the need of a car to pick up children. For children, parental safety concerns, distance of the school, traffic danger (lack of cycle lanes), and adverse weather were highlighted as barriers to walking and cycling to school.

11.2 The built environment

With respect to the built environment, walking has been consistently associated with *dense, mixed-use neighbourhoods* with greater *street connectivity* among adults.[118 120 132-135] Young people who live in dense, walkable neighbourhoods are also more likely to walk and cycle to school.[123] Other urban design issues such as proximity of facilities (e.g., schools, shops, etc.), quality of footpaths, and reduced traffic flow are associated

with increased walking and active commuting behaviours among adults[107 120 127 130 132 133 136] and children.[123]

Urban design features such as *high land use mix* and *good access to services* have been found to be related to walking in studies in the U.S.,[118 133] and other factors such as subdivision age, housing density, [133] proximity to coastal regions and beach access[118 119 137] have been associated with increased walking or sufficient levels of physical activity. Finally community design has been shown to be associated more with transport-related walking than with recreational walking.[120] Good urban design can facilitate overall physical activity by encouraging neighbourhood safety, developing interconnected streets, mixed use areas, high density housing, and improved aesthetics.[138]

A review of obesogenic environments[118] reported that in eight European countries (excluding the United Kingdom: UK) the level of *greenery and vegetation* around the home and surrounding environment was associated with the frequency of physical activity. In the UK a cross-sectional examination of the relationship between access to quality urban green space and level of physical activity in 4,950 middle-aged people was conducted and found no evidence of a clear relationship between recreational activity and access to green space.

It is noteworthy that many of the reviews highlighted the high number of cross-sectional studies, which utilised a wide variety of measures of physical activity and the environment, reported either perceived (self-reported) and/or objective measures, often focused on different aspects of physical activity such as walking or vigorous physical activity, and may be affected by self selection or reverse causality. Methodologies in this area are still being developed, leading to inconsistencies between studies and making comparisons more challenging. Furthermore, aspects of the environment appeared to have differing effects on recreational and transport-related physical activity, and adults and children. There was a stronger focus in the literature on the physical or built environment, with little exploration of economic or cultural influences on physical activity.

12 Economic factors

12.1 Socioeconomic status

Relatively few research studies have examined the impact of the economic environment on physical activity participation. Of these, most have looked at the role of *socio-economic status* (SES) as a determinant of activity. Overall the findings suggest a gradient exists, in that there was a higher prevalence or higher levels of leisure-time or moderate-vigorous intensity physical activity in those at the top of the socio-economic strata compared to those at the bottom.[118 139 140] Although lower recreational physical activity has been found in low SES neighbourhoods,[120] racial and ethnic minorities are more likely to live in walkable neighbourhoods and walk for transportation.[120]

12.2 Deprivation and access

It has been suggested that individual or household deprivation is amplified by *area level deprivation* (e.g., lack of affordable facilities for physical activity in the neighbourhood). However, a discussion paper[141] suggested that the distribution of facilities and resources does not always disadvantage poorer neighbourhoods. Evidence from reviewed studies showed that in total, there were more official recreation facilities for physical activity in a more socially deprived area. In addition the frequency of street sweeping and de-littering was higher in poorer areas and there was a greater incidence of crimes against the person in the poorer areas, but there was a greater incidence of crimes against commercial premises and cars in richer localities.[141] It was also observed in Glasgow that the proportion of the population living within 300 meters of a green space greater than two hectares in size was greater among those in more deprived areas. There was also on average less public outdoor playgrounds per thousand children in more affluent than in more deprived areas.[141] In a longitudinal study of Australian women[136] the availability of gyms and parks was also greater in low SES areas.[136] Women in high SES areas reported less moderate-intensity activity as the density of gyms and parks increased, whereas women in low SES areas reported more moderate-intensity activity as density increased.

In New Zealand, the *cost* associated with leisure time physical activities has been cited as a barrier to physical activity participation,[142] yet data from the Sport and Recreation

Survey[112] found there was little difference in levels of activity between adults who lived in households with different levels of available income. In a Canadian study higher area affluence and living in area located in small urban area was associated with greater use of local facilities among women only.[143]

12.3 Socioeconomic status and children

For children, *parental SES* indicators (e.g., family income) are associated with less physical activity among those who are more deprived.[105] [143] However, a review of environmental determinants of physical activity in youth found that different estimates of family/parental SES were generally unrelated to children's physical activity.[101] The Dunedin Multidisciplinary Health and Development Longitudinal Study found that non-participation in vigorous physical activity during adulthood was shown to be associated with low family SES in childhood.[144]

12.4 Economic factors and intervention

Economic factors have also been considered for intervention. In a systematic review of interventions to increase walking[114] a non-randomised study found that a directive that employers should *subsidise employees who chose not to commute by car* was associated with a significant increase in the proportion walking to work.

13 Political factors

13.1 National or policy initiatives

For this review political factors included local (e.g., schools, worksites), regional (council) or national policy/initiatives that involved various forms of media.

Environmental and policy approaches are designed to provide environmental opportunities, support, and cues to help people develop healthier behaviours.[109] A good quality systematic review[109] identified a total of 12 studies that evaluated the effectiveness of, creation of, or enhanced access to places for physical activity combined with informational outreach activities. These interventions involve worksites, coalitions, agencies, and communities to create or provide access to places and facilities where people can be physically active. In addition to promoting access, many of these studies incorporated components such as training on equipment, health

behaviour education and techniques, seminars, counselling, risk screening, health forums and workshops, referral to physicians or additional services, health and fitness programs, and support and buddy systems. Of the 12 studies, only 10 had fair execution. Eight studies were conducted at *worksites* and two in low-income communities. Eight arms from five studies measured change in aerobic capacity and showed a median increase of 5.1%. Three arms from two studies measured energy expenditure and showed a median increase of 8.2%. Four arms from two studies measured change in the percentage reporting some leisure time activity: the median increase was 2.9%. Six arms from one study measured the exercise score: the median increase was 13.7%. Four arms from three studies measured the percentage reporting three or more exercise sessions per week: the median increase was 48.4%. The overall conclusion was that this type of intervention was effective in increasing physical activity.

The impact of *political factors* on physical activity levels has been investigated at a number of different levels. For example, city-level initiatives have been trialled to determine the impact on physical activity with mixed results. A systematic review of interventions to increase walking[114] reported that a three year multi-faceted initiative to promote cycling in a city in Denmark was associated with a net increase in walking (+0.1 km/day) after adjustment for trends in control areas and other confounding factors. In a second study a sustainable transport campaign in the UK had no effect on walking.

There is an absence of research that has evaluated environmental and policy variables and their associations with active transport, recreational physical activity and total physical activity. Sallis et al.[135] however suggested that both transportation investments and land use decisions affect public health through a variety of mechanisms and need to be considered. For example, extreme levels of social inequality may also be related to a disproportionate burden of exposure to pollution, as well as poorer access to transport which could impact on employment etc.

From a neighbourhood perspective, there is some evidence that dog owners are more active than non-dog owners.[145] Unfortunately, there is a paucity of evidence on the importance of different policy environments to *dog walking*, which potentially has a large impact on the ability to exercise dogs. It has been shown that women are more

likely to walk dogs if the neighbourhood is safe.[145] A weak relationship between the presence of unattended dogs and physical activity exists,[117] therefore dog control policy may indirectly influence physical activity.

Political factors have also been shown to have some influence on physical activity through wider *community level urban design and land-use regulations*.[146] A systematic review identified twelve studies, which provided sufficient evidence for a relationship between community urban design/land use, transport policies/practices, and physical activity. These community factors were proposed to increase levels of walking and cycling by providing destinations people want to walk to, employment close by, and safe and attractive paths to get there. Sufficient evidence from six studies suggested that street-level urban design as well as land use and transport policies and practices could increase physical activity. Interventions involved improved access, redesigned streets, enhanced aesthetics, improved safety (lighting, traffic calming, bicycle lanes) and the building of playgrounds.[146]

Within the NZ health system, a Ministry of Health Initiative to provide *primary care activity prescriptions* for those considered insufficiently active (Green Prescription programme GRx) reported a net increase of 10% of the proportion of participants achieving the recommended levels of physical activity.[147] The per patient GRx programme cost was $NZ170, with the incremental cost of $NZ1,756 to convert one sedentary person to an active state.[148]

13.2 School policy and physical activity

A review of environmental correlates of physical activity in youth[101] reported that *school policies* to promote physical activity (i.e., time allowed for free play, time spent outdoors, and number of fields) has been investigated in three or more independent samples, with 60% of the cases showing a positive association with children's activity levels. A report on modifiable environmental and behavioural determinants of overweight among children and adolescents[103] stated that school policies to modify or change the physical education environment increased physical activity during physical education time, particularly for boys. In NZ, school or council policies to ban skateboards from schools and public areas with no alternative facilities was considered a barrier to children's physical activity involvement.[149]

In a review of interventions to increase physical activity among youth, two studies evaluated the effectiveness of *whole-of-school strategies*, which including policy changes to the curriculum, PE, and the physical, social, and organisational school environments (including teacher training, modified school meals, development of school action plans which targeted curriculum, physical activity, school canteens, and playground activities). One of the interventions resulted in no difference in physical activity, whereas the other resulted in an increase in moderate-intensity physical activity levels.[104]

Two studies evaluated changes in *PE strategies* (increased aerobic activities and spending more lesson time being active) resulted in modest increases in physical activity in classrooms but had no effect on overall physical activity. Combined PE and environment change (nutrition education, modification of school lunches, etc) resulted in increased physical activity during school but had no effect on physical activity outside the school environment. [104]

Two reviewed studies investigated the effectiveness of *activity breaks* on children's physical activity. One intervention (Promoting Lifetime Activity in Youth; PLAY) included 15 minute play breaks during class time (four week duration), in which the teachers taught children games and activities. At the 12-week evaluation children in the intervention group reported higher self-reported physical activity compared to the control group (no activity breaks). A second study assessed the PLAY programme in school that did and did not have PE classes. The PLAY intervention was associated with increased physical activity (self-reported and objective) for children with PE and no PE classes compared to control groups (no PLAY programme).[104]

Two reviewed studies examined the effectiveness of *after-school programmes* among adolescents. One study recruited African-American students, and were randomised to one of three intervention conditions (an education programme with behavioural skills training, the same programme with motivational interviewing, and an educational programme promoting fruit and vegetable consumption and physical activity. No change in physical activity was found for any of the three conditions. The second study focused on economically disadvantaged schools and involved three two-hour after-school sessions per week over four weeks and comprised 60 minutes of student-

selected activities and 30 minutes of behavioural skills training. Time spent in moderate- and vigorous-intensity activity (accelerometer counts) increased by 22.4 minutes per day in the intervention compared to the control group.

13.3 Media

From a broader perspective there is sufficient evidence that *mass media campaigns* and *community events* impact positively on walking[114] and physical activity.[109] Specifically, a systematic review of interventions to increase physical activity[109] identified ten reports on the effectiveness of community-wide campaigns. Although many of the interventions were designed to decrease levels of cardiovascular disease morbidity and mortality throughout a community over a period of several years, activities were directed both at increasing levels of physical activity and improving dietary behaviours. Five studies measured change in the percentage of people being active, with a median net increase of 4.2% (range, 2.9% to 9.4%). Two studies measured change in energy expenditure with a median net increase of 16.3% (range, 7.6% to 21.4%). Four studies reported other measures of physical activity, and all but one showed increases in physical activity.

In NZ, a national *social marketing campaign* (Push Play) resulted in increased awareness of any physical activity messages, with a significant increase in the number of people intending to be active. However no sustained change in physical activity levels was reported.[150] A national physical activity survey conducted by Sport and Recreation New Zealand (SPARC) over a similar time period as the Push Play campaign reported a 3% increase in people meeting physical activity recommendations.[112]

14 Sociocultural factors

The influence of socio cultural factors on physical activity has been studied extensively focusing on variables such as *social support*, *psychological factors* and *role modeling* primarily within the home and school settings. Social interactions and interpersonal relationships are an important aspect of the environment, with social support and social networks being two common indicators of interpersonal relations.

14.1 Social support in the home setting

Within the home setting, *social support* as a variable has been consistently shown to have a positive association with physical activity in adults,[99 100 105 140 151 152] and children,[101 124] however there is less evidence for social contacts influencing adult physical activity particiation.[151] Some aspects of social support such as the number of social contacts and frequency of contact have been found to be related to increased physical activity related energy expenditure and improved adherence to physical activity.[151] The Task Force on Community Preventive Service's review of physical activity interventions suggested there is strong research evidence that social support interventions in a community setting (including the home) can increase physical activity levels. This type of intervention focuses on changing physical activity through building, strengthening, and maintaining social networks that provide supportive relationships for behaviour change. This change can be achieved either by creating social networks or working within pre-existing networks; for example the creation of "buddy systems," walking groups, and exercise contracts with another person have been found to be effective.[109]

Conversely, *social isolation* has been shown to be negatively associated with physical activity.[100 151] An increasing body of evidence exists that suggests dog ownership provides a sense of social support and is associated with regular walking.[145]

14.2 Social support and youth

Social support has also been shown to be an important factor among children and is positively associated with physical activity levels.[104 105 115] Studies have also shown that having a *spouse and/or supportive family and friends* are positively associated with increased physical activity[99 140 151] however for children, *parental role modelling* is positively associated with physical activity. Younger children are more likely to participate in sufficient levels of activity if their parents (particularly the father) [3] are active.[101 105 142] In NZ, older children reported that their *peers* were a positive source of motivation to be active.[124] In addition, *sport participation* is positively associated with physical activity,[144] however time is consistently cited as a barrier to being active.[101 105 142]

Positive social interactions may also be conducive to children's physical activity. Various aspects of social connectedness (e.g., child visits with peer, neighbourhood relationships, other children live in neighbourhood close by) have been shown to be associated with Italian children's independent mobility and Australian youth walking and cycling in their neighbourhood.[111] Further, an Australian study found that children were less likely to actively commute to school if their parents perceived that there were few children nearby.[111] In childcare environments, interactions between staff and young children may promote physical activity by not only promoting and encouraging physical activity involvement, but by joining in with children and providing positive statements and support to be active.[115]

14.3 Family-based social support

Family-based interventions attempt to change health behaviour through the use of techniques that increase the *support of family members for behaviour change*. These interventions target factors in the social environment and interpersonal and behavioural patterns that are likely to influence physical activity behaviours including strategies such as goal-setting, problem solving, or family behavioural management.[109] One systematic review[109] identified 11 valid studies, all of which indicated no change on physical activity behaviours. A second review of youth physical activity interventions[104] identified nine family-based interventions; eight targeted children and one targeted adolescents. Two of the interventions ran for one year or longer with the remainder being of short duration (on average 12-weeks). Two of the short-term interventions were successful and three showed positive trends. Of the two longer-term studies only one, a three-year Finnish study targeting children four years of age, was successful. Strategies included annual meetings with parents, delivery of print materials, an annual physical activity demonstration with children and a one off radio program for parents. The intervention group spent more time in very active outdoor play than did the control group.

A number of research studies have *integrated family based strategies with the school curriculum* to promote children's physical activity. The intervention strategies generally incorporated classroom lessons, PE classes and homework sessions with parents. Of the nine reviewed studies, seven reported a positive effect on at least some elements of children's physical activity. There were no reviewed studies that included school and family components in promoting adolescents' physical activity.[104]

14.4 Social support interventions in community settings

A systematic review of social support interventions in community settings found that there was sufficient evidence to support this approach to increase physical activity levels.[109] The typical intervention involved recruiting participants into *voluntary groups* in which members provided companionship and support for attaining self-selected goals. Phone support, encouragement from staff, monitoring of progress were also included. Five arms from four studies measured change in time in physical activity with a median net increase of 44.2%. Six arms from three studies measured change in frequency of physical activity with a median net increase of approximately 20%. Other measures of physical activity also improved including frequency of activity, and physical fitness.[109]

14.5 Other psychosocial factors

Other psychosocial factors related to physical activity include variables from the Theory of Planned Behaviour including, *intentions, attitude, and perceived behavioural control[153] as well as motivation*.[142] Physician influence or encouragement has also been found to be positively associated with physical activity among adults.[100]

14.6 Individually-adapted health behaviour change programs

A good quality systematic review[109] found there was strong research evidence that *individually–adapted health behaviour change programmes* are effective in increasing levels of physical activity.[109] These programmes teach participants specific behavioural skills that enable them to incorporate moderate-intensity activity into daily routines. Many of the interventions incorporated constructs from one or more of the established health behaviour change models such as Social Cognitive Theory,[154] The Health Belief Model,[155] or the Transtheoretical Model of Change.[156] All programmes incorporated the following components: (1) goal setting and self-monitoring; (2) building social support; (3) behavioural reinforcement through reward and self-talk; (4) structured problem solving; and (5) prevention of relapse into sedentary behaviour. A total of eighteen studies were reviewed. Twenty arms from 10 studies measured change in time spent in physical activity with a median net increase of 35.4%. Thirteen arms from four studies measured change in maximal oxygen uptake with a median increase of 6.3%. Fifteen arms from four studies measured change in energy expenditure with a median net increase of 65%. Other measures such as adherence to exercise and frequency of activity increased as well.

In New Zealand, there is a dearth of research evidence that has examined the environmental influences on Maori and Pacific people. Although some studies in the U.S. have included African-American and Hispanic groups (which are based on race and not ethnicity data), these do not necessarily translate to NZ-specific populations.

15 Limitations of the review

Given the enormous volume of literature on physical activity, this evaluation of existing research did not attempt to identify all available literature, but focused in on reviews of evidence and some individual papers (especially in the NZ setting). Because of this approach it is possible that some studies were omitted. Again, because reviews of evidence were used there is likely some overlap, with some papers included in various reviews. We extracted data primarily from literature reviews rather than accessing the source research papers therefore interpretation of findings may be biased. The quality scoring approaches were based on published tools, but did require some adaptation, which may impact on their validity.

The vast majority of published research incorporated cross-sectional research design, which does not permit causal associations to be drawn. The majority of literature originated from the U.S., however sufficient evidence was identified from Europe (including the UK) and Australia. In general, the level of evidence from NZ was not of a high standard. Although a few randomised controlled trials have been conducted, other evidence is based on cross-sectional surveys. In addition, methodologies were not always provided.

Key findings and recommendations

Regular physical activity is associated with many positive health outcomes. Given that approximately 30% of New Zealanders are inactive, it is imperative from a public health perspective to both identify factors related to physical activity as well as develop interventions that will positively affect this behaviour. The purpose of this review of research evidence was to identify the environmental influences on physical activity. As part of this purpose we have identified environmental determinants of physical activity in NZ and internationally as well as present the evidence for the effect of environmental-based interventions on physical activity.

There is an enormous body of evidence that has examined environmental determinants of physical activity among adults and youth, however much of this research was limited by cross-sectional research design, utilised a wide variety of measures of physical activity and the environment, reported either perceived (self-reported) and or objective measures, often focused on different aspects of physical activity (such as walking versus overall activity), and may be affected by self-selection or reverse causality. Given these methodological consideration, the reviews of observational studies generally suggest the environment has a modest association with physical activity.

Key determinants of physical activity were

- Social support in adulthood and childhood
- Other psychosocial factors such as intention, attitude etc
- Personal SES factors
- Availability and accessibility of physical activity opportunities
- Convenience of facilities
- Urban design features such as walkability, mixed land use, density
- Perceived environmental factors such as aesethetics, safety, and traffic not being a problem
- Increased media use (TV, computer and video games)

Several reviews evaluated the effectiveness of interventions to increase physical activity. Methodological issues also existed for intervention studies, with many studies not reporting a control group. Only a few studies used multilevel analysis to account for

the fact that potential environmental correlates are often studies in non-independent samples such as individuals clustered within a neighbourhood, schools or worksites. Given these methodological considerations there is evidence that interventions can increase physical activity across a number of domains. Increasing physical activity behaviour is a complex issue and requires a multi-level approach in which interventions target different environmental settings at both a micro and macro level.

Interventions that are likely to positively impact physical activity include

- Environmental and policy changes to increase physical activity opportunities at school and worksites
- Increasing the number of hours of physical education/physical activity in schools (affects activity levels during school time)
- Combined school and family- or community-based interventions
- Increasing social support
- Individually-adapted health behaviour change programs
- Point of decision prompts (stair walking)
- Community wide campaigns (including media campaigns)
- Creation of, or enhanced access to, places for physical activity combined with informational outreach activities

At present there is also insufficient research evidence to support the effectiveness of some interventions; however continued work is required to further develop and enhance these interventions as well as develop new interventions based on the determinant literature. These include:

- Environmental and policy changes to urban design to facilitate active environments
- Infrastructure and policy changes to transportation systems to facilitate active transport and reduce reliance on motorised transport
- Where possible retro-fitting existing built environments to facilitate activity (improve lighting, safety, footpaths etc)
- Enhanced informational approaches
- Continued development of worksite interventions which could also include policies to promote activity in these settings, provide incentives to actively commute etc.

- Continued development of primary care sites to promote activity, such as primary health organisations to deliver or encourage PA programmes
- Improved family and or community based approaches

- FOCUS GROUPS -

A separate report has been prepared on focus group methodology and findings. Details of the focus groups are presented in that report.

- ANALYSIS OF CURRENT NEW ZEALAND RESEARCH -

Four projects are currently being conducted by the research team which have direct relevant to food security and physical activity. Those projects are the Neighbourhoods and Health project, SoFIE-Health, Supermarket Healthy Options Project (SHOP), and Influences on Children's Activity & Nutrition (ICAN). A summary of these studies and their relevant findings is provided below.

Neighbourhoods and Health

The ongoing Neighbourhoods and Health project (HRC 04/250R) seeks to examine whether a range of neighbourhood characteristics exert influence on the health of individuals residing in those neighbourhoods, independently of their individual socio-demographic characteristics. As part of this research we used Geographical Information Systems to calculate an index of geographical accessibility to a range of health-related community resources for all neighbourhoods (38,254 meshblocks) across New Zealand.[157] We then sought to determine the association of neighbourhood community resource access and various biologically-plausible health outcomes and health-related behaviours. Of most relevance to this project, our index includes accessibility measures for supermarkets, convenience stores (dairies, fruit and vegetables shops etc), fast food outlets, public parks, beaches and recreational centres. Our neighbourhood index of accessibility was appended to the 2002-03 New Zealand Health Survey, a survey of 12,529 adults aged over 15. Multilevel modelling has been used to evaluate whether our neighbourhood measures are important determinants of individual health outcomes and behaviours such as BMI, fruit and vegetable consumption, and physical activity, after controlling for potential individual- and neighbourhood-level confounders.

In our analyses we have found that, contrary to popular belief, access to health-related community resources (including food and alcohol retail provision and opportunities for physical activity) tends to be better (i.e. closer)[158] in more socially disadvantaged neighbourhoods[5], although in rural areas and some regions this pattern is reversed.[159] Similarly, there were a better range of these resources in more deprived

neighbourhoods.[160] In a separate analysis, we also found that fast-food outlets tend to preferentially locate in deprived areas.[161]

With regards to the health outcomes associations, we found little evidence to suggest that neighbourhood access to supermarkets and convenience stores influences fruit and vegetable consumption (although individuals in the quartile of neighbourhoods with the best access to convenience stores had 25% lower odds of eating the recommended vegetable intake compared to individuals in the base category),[162] or that access to fast food access influences consumption or BMI.[163] With regards to our measures of neighbourhood accessibility access to parks and beaches, we found no association with BMI, sedentary behaviour or physical activity.[164] There was some evidence of a relationship between beach access and BMI and physical activity.

SoFIE-Health

The Survey of Family, Income and Employment (SoFIE) is an eight-year longitudinal study collecting annual information on family and household structure and standard of living indicators, with detailed information on individual and household income, labour market status and assets and liabilities. It commenced in October 2002 and is being run by Statistics New Zealand. University of Otago, Wellington researchers secured 20 minutes of interview time in years 3, 5 and 7 for a health-related add-on to SoFIE. This extended survey, complete with the original part, is called SoFIE-Health and includes measures of health related quality of life (SF36), mental health (Kessler), and stress (4-item Perceived Stress Scale).

Within SoFIE-Health, there are three questions related to food security embedded within the NZiDep (NZ individual deprivation score). These questions were included in assessments between October 2004-2005 (wave 3), and again from October 2006-2007 (wave 5):

- In the last 12 months have you made use of any special food grants or food banks because you have not had enough money for food?
- In the last 12 months have you been forced to buy cheaper food so you can pay for other things you needed?
- In the last 12 months have you gone without fresh fruit and vegetables so that you can afford to pay for other things? -> If so, often or occasionally?

A respondent was classified as food insecure if they answered yes to any of these. Aspects of food security were examined cross-sectionally (at Wave 3) by ethnicity, household income, socio-economic status and family circumstance, asset wealth (Wave 2) and perceived health status.

Food insecurity was associated more with being female, younger age groups (25-45 years), being never legally married or separated, divorced or widowed, as well as Māori and Pacific ethnicity. Respondents who lived in a sole parent family or did not live in a family nucleus or lived in a single person household were more likely to be food insecure.

Food insecurity was associated with being unemployed (either actively looking for work or not looking for work – students/retired) and receiving some form of means tested government benefit. Respondents who lived in non-major cities in the North Island as well as lived in highly deprived areas (NZDep deciles 7-10), were more likely to be food insecure. Respondents in low household and personal income quintiles, as well as low wealth quintiles, were more likely to be food insecure. The findings were equivocal for education.

Respondents who rated their health as good, fair or poor were more likely to be food insecure. Food insecurity was also found to be associated with higher levels of mental distress and perceived stress in the ability to handle everyday issues. Food insecurity was associated with much higher levels of current smoking and binge drinking. However, respondents who were food insecure were more likely to abstain from drinking regularly. Respondents who were food insecure were more likely to have higher proportions of chronic comorbid conditions, such as asthma, diabetes, migraine and depression or schizophrenia.

It is expected that the Wave 5 data will be available in April 2009. The longitudinal nature of SoFIE-Health will allow us to determine how changes in socio-demographic variables, such as income, labour market status, family and household structure, and standard of living are associated with changing food security from Wave 3 to Wave 5. It will also be possible to examine how changes in aspects of food security influence changing health status, mental health and perceived stress (and vice versa).

Supermarket Health Options Project (SHOP)

The Supermarket Healthy Options Project (SHOP) is a large, randomised, controlled trial to evaluate the effect of tailored nutrition education price and discounts on supermarket food purchases. The trial is currently being conducted in eight supermarkets in the Lower North Island (Wellington, Wanganui and New Plymouth).

The supermarkets included in the trial offer use of a system of handheld barcode scanning terminals that allows registered customers to scan each item they select from the supermarket shelf before putting it in their trolley (Shop 'N Go). Use of the barcode scanner, in conjunction with a personalised scannable card, allows collection of individualised electronic data on all food items purchased by a cardholder, and thus provides an objective measure of shopping habits and the effect of the trial interventions on supermarket food and nutrient purchases.

Participant recruitment took place over nine months beginning in February 2007 and a total of 1104 shoppers have now been randomised: 248 (22%) Maori, 101 (9%) Pacific, and 755 (68%) non-Maori, non-Pacific. The study interventions are delivered for a period of six months and follow-up will continue for an additional six months after to determine the sustained impact of the study interventions. Final results are expected in May 2009.

Data from the SHOP trial that will be useful for the ENHANCE project include:

- Effectiveness/cost-effectiveness of price discounts for purchase of healthier foods
- Effectiveness/cost-effectiveness of culturally appropriate (and cost-sensitive) nutrition education
- Effect of ethnicity and income on food choices and dietary quality

Influences on Children's Activity & Nutrition (ICAN)

The Influences on Children's Activity and Nutrition (ICAN) project (HRC 06/540; NHF funded) investigated the feasibility of conducting intervention research targeting major environmental influences on nutrition and physical activity in New Zealand children. This project examined the relative influences of the built environment and other

(psychological, physical and individual) factors on children's nutrition and physical activity. Methods included:

(a) mapping the neighbourhood environment using Geographic Information Systems (GIS);
(b) questionnaire assessment of perceptions of the environment and psychosocial factors; and
(c) objective assessment of behaviour using accelerometers and global positioning systems (GPS). Data from the various sources were incorporated into a GIS database to determine the feasibility of examining relations between these different variables.

Complete data were available for 164 children aged 12-17 years (M=14.29 ± 1.49). Participants were from two large Auckland metropolitan schools; Mt Albert Grammar (n=87) and Mt Roskill Grammar (n=77), were predominantly female (75%) and New Zealand European or Other (57%) (NZ Maori 11%; Pacific 11%, Asian 12%) and overweight (mean BMI = 24.24 ± 6.5). Results revealed that perceptions of the environment (e.g., home ownership of sport and recreation equipment) and psychosocial factors (i.e., intention, self-efficacy and perceived behavioural control) were better predictors of physical activity variables compared with the built environment. Being Maori or Pacific was inversely related to home ownership of sport and recreation equipment, as was socio-economic status. Psychological factors (social norms, attitude, and self-efficacy) were related to home ownership and use of sport and recreation equipment. Differences were found between objectively (accelerometer) and subjectively (self-report) measured physical activity. GPS derived-time spent in proximity to unhealthy and healthy food outlets was positively related to time spent outside of school, neighbourhood walkability and whether the child was driven to school. As part of this feasibility study, several indices relevant to this RFP will be developed including:

- Walkability index
- Physical activity resource accessibility index

- ANGELO Framework -

The ANGELO framework divides environments into two levels: micro and macro; and four environment types: physical, economic, political and socio-cultural. Environmental influences identified in the literature have been categorised into levels and environment types in a grid format (Table 1 and 2).

It was evident when categorising factors into either the micro or macro level, that many of the micro-level factors are in fact driven by macro-level factors. For example, some of the economic factors experienced in the home relate to income, employment, and household bills. Whilst these impact in a home setting, they are largely determined by macro-level factors such as standard of living, employment levels, wage rates, labour market policy, and inflation, amongst others.

Table 1: Food security

Settings	**Type**			
	Physical	**Economic**	**Political**	**Socio-cultural**
Micro				
Home	Home gardens Physical and mental health Housing facilities Access to shops Drug use	Poor budgeting skills Financial difficulty Unemployment Use of loan sharks Periods of extra demand on income Prioritising bills over food Household bills Debt Income Wealth Income volatility Rent		Cooking skills Nutrition knowledge Cultural expenses and obligations Family dynamics Household size Lack of time Access to traditional food sources Food preferences Gambling Parents' education Locus of control
Workplaces		Unpaid sick leave		
Schools		School fees		
Churches		Donations		
Community groups	Community kitchens			English as a second language Migration Difficulty obtaining cultural foods Acculturation (+ve and –ve)
Institutions				Embarrassment using food banks

Settings	Type			
	Physical	**Economic**	**Political**	**Socio-cultural**
Food retailers	Supermarket access null effect	Cost of healthy food		
Neighbourhood	Food access Rural vs urban areas Transience	Price differentials		Social capital Social networks
Transport service centres	Lack of transport			
Local health care	Access to primary health	Medical expenses		
Macro				
Technology	[Not assessed in the literature review]			
Media				Food advertising to children
Food production and manufacture	Healthy food availability	Food pricing healthy vs unhealthy food, rural vs urban, and deprived vs non-deprived areas Cost of food	Legislation, loss of land, and abuse of fisheries limits Māori ability to grow food or use as an economic base	Lack of access to traditional food sources
Sports industry				
Urban/rural development				
Health system				
Housing system	State housing facilities	Housing affordability Home ownership		
Transport systems	Lack of transport			
Government policy, employment, and welfare	Knowledge of special grant availability	Money running out before end of benefit period Geographic inequalities in wages Cost of transport Heating/cooling costs Childcare costs Employment Government subsidies and benefits Inability to obtain credit	Contract based funding for voluntary agencies Benefit cuts State housing policy Eligibility requirements for benefits Stand down periods Paper work Labour market reforms	

The ANGELO grid highlights settings where evidence exists, and where it is lacking. Some environmental settings that appear quite relevant to food security had either limited or no evidence. These include schools, workplaces, churches, community groups, and the health system. There is a disturbing lack of research evaluating the effectiveness of interventions to address food security, other than research into food stamps in the US.

A lack of evidence relating to the school setting in the literature was apparent. The only research identified was in relation to the National School Lunch Program (NSLP) in the United States, which provides free or low-cost lunches for eligible children. Dunifon[75] has shown that on the face of it, participation in the NSLP is actually associated with detrimental outcomes for children (relating to behaviour, health, and test scores; nutrition was not an outcome). However, comparison of siblings who are using and not using the NSLP indicates that this association is due to confounding from unmeasured familial factors. However, analyses showed that participation in the NSLP still does not lead to improvements in child wellbeing.

There was some evidence around employment and employment-related factors such as sick leave and seasonal work. However, the workplace did not feature as an intervention setting in any other way.

Churches are a setting that has potential to improve food security, however, they were only mentioned in the literature in relation to Pacific peoples. They either reduced food security through financial and social obligations, or made people feel less threatened by food insecurity due to the support of other churchgoers.

The health system is likely to have frequent contact with people who are food insecure. In the literature, the health system have really only been mentioned as a barrier to food security in relation to medical expenses or health care fees. No research relating to detection of food security or interventions were identified.

Table 2: Physical Activity

Settings	Type			
	Physical	**Economic**	**Political**	**Socio-cultural**
Micro				
Home	Increasing opportunities Availability of PA equipment	Socio economic status		Social support Parental behaviour Role modelling Dog ownership Having companion Social isolation Media use (adults) Sport participation Time
Workplaces	Increasing opportunities Intervention to increase active commuting Point of decision prompts	Subsidy for not commuting by car	Program to increase active commuting	
Schools	Increasing opportunities Walking to school activities Sports equipment and facilities Playground markings		School PA policy	Social support
Churches				
Community groups	PA opportunities and staff training at pre-schools			Social support
Institutions	Point of decision prompts			
Food retailers				
Recreation facilities	Perceived access and distance			
Neighbourhood	Perceived convenience Safety Aesthetics Accessibility Unattended dogs Cycle lanes Destination proximity Footpaths Reduced traffic Urban location Green space Neighbourhood functionality Inverse association SES-PA environment Closer proximity to	Cheaper or subsidised parking	Unattended dogs	Intentions, attitudes and perceived behavioural control Motivation

Settings	Type			
	Physical	**Economic**	**Political**	**Socio-cultural**
	school Pedestrian crossings Density Subdivision age			
Transport service centres	Availability of bike racks			
Local health care				Physician's influence
Macro				
Technology				
Media			Mass media and community events Push Play media Media campaign to promote cycling	
Food production and manufacture				
Sports industry				
Transport systems	Availability of public transport Parking facilities at public transport sites (bicycle storage etc)			
Urban/rural development	Coastal proximity Beach access Land use mix Environmental improvements Street connectivity Community design		Urban design and land use practices	
Health system			Green Prescription	
Government policy			Dog ownership policy	

Much of the literature on environmental influences on physical activity relates to the physical environment. Social aspects have also been investigated and tend to have influence in the home setting. However, cultural factors that can be used to influence physical activity have not been examined. There has also been limited investigation of ways to use the media to influence physical activity levels. Political influences on physical activity in the literature are limited in scope, however political initiatives such as Push Play and the Green Prescription have shown promise in influencing physical activity.

An obvious gap in the evidence relates to economic influences on physical activity – either as barriers or enhancers to physical activity. Economic incentives for physical activity or disincentives for non-activity remain virtually unexplored, although use of economic disincentives is a fairly common political tool (eg. fuel tax, cigarette tax).

The ANGELO framework helped to identify gaps in the evidence base, with many settings or environment types having limited evidence. These findings are pertinent given that the Neighbourhoods and Health project identified that when examining the influence of the environment on food security and physical activity, all four environment types must be explored.

- OVERALL FINDINGS AND RECOMMENDATIONS -

Food security and physical activity are influenced by multiple environmental factors and the interaction between these factors is complex. When identifying ways to enhance food security and physical activity, multi-component, multi-level solutions are required. The ANGELO analysis has highlighted that many environmental factors have macro level drivers, and these will most likely require upstream intervention. However, even micro level factors are often determined by macro level factors. A comprehensive approach, implemented and supported at these macro and micro levels is required.

In relation to food security, the environmental influences in New Zealand are similar to those experienced internationally. However, Māori and Pacific have additional cultural obligations which may exacerbate food insecurity, but in some instances may also afford protection. There was little exploration in the literature of environmental factors pertinent to physical activity amongst Māori and Pacific peoples, and no exploration of cultural factors impacting on physical activity levels.

By definition, food security includes food must be accessible (economically and physically), acceptable, and appropriate. The most consistent evidence relates to economic accessibility. Low income and household expenses limit disposable income available for spending on food, therefore limiting its accessibility. However, improving income alone is not the only solution. There are a wide range of other factors influencing food security, which we must also act to improve. This research has identified a wide range of determinants that can inform the development of future interventions.

Within the physical activity domain a number of intervention settings have been shown to be effective; however the evidence also highlighted that there are many opportunities to improve physical activity at both the micro and macro level. Whilst individual and community level factors are a target for intervention, changes to the built and perceived environment are likely to enhance and support physical activity.

The next phase of this research project will adopt a solution-oriented approach. It aims to identify a range of solutions that will enhance food security and physical activity in

New Zealand, especially for Māori, Pacific, and low-income whanau/families. Complexity theory will be used to map interactions between the various environmental factors and identify key areas that are likely to bring about the most positive change. Stakeholder and community consultation will be undertaken to identify appropriate solutions to target these key areas, and solutions will be developed into a portfolio of actions. Community feedback will be sought on the final portfolio. Thus, while the literature is lacking in evidence on effective interventions, a solution-oriented approach will provide a way forward and allow us to address these very important issues. It is now time to take action, and look to find solutions to improve food security and physical activity levels in New Zealand, especially for Māori, Pacific and low-income whanau/families.

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Appendix 1: Quality Scoring Tools

Box 1: Quality scoring tool for surveys/non-randomised trials

1. Clear aim – *Is the aim or objective of the study clearly stated?* Yes=1, No=0
2. Study design – *what was the study design?* Case series/interview = 0.25; survey = 0.5; longitudinal = 0.75; RCT = 1.0
3. Accepted measure – *nationally accepted/validated measure used?* Yes = 1; Adapted from validated measure= 0.5; No = 0
4. Representative sample – *is the sample representative, adequate sample size, response/attrition rate reported?* Yes= 1; Partially= 0.5; No= 0
5. Adjusted for confounding – *adequate adjustment for confounding?* Yes= 1; Partially= 0; No=0

Box 2: Quality scoring tool for quantitative studies

1. Clear aim – *Is the aim or objective of the study clearly stated?* Yes=1, No=0
2. Methods appropriate – *are the methods appropriate to achieve the research aims? Have the methods been justified? Are the methods consistent with identified methodology?* Yes=1, No=0
3. Setting described – *is the sample and research setting clearly described? What/where/when is the sample frame?* Yes=1, No=0
4. Conclusion justified – *does the discussion/conclusions appear justified by the results presented?* Yes=1, No=0
5. Generalising results – *is there a consideration to how widely the results can be generalised outside of the sample/setting, and is this supported by reference to theory and/or other research findings?* Yes=1, No=0

Box 3: Quality scoring tool for reviews[1]

1. Purpose – *purpose of the review stated?* Yes=1, Unclear=0.5, No=0
2. Data identification – *source of the information reviewed described?* Yes=1, Unclear=0.5, No=0
3. Data selection – *criteria for selection provided?* Yes=1, Unclear=0.5, No=0
4. Validity assessment – *standardised, methodological assessment of data used?* Yes=1, Unclear=0.5, No=0
5. Data synthesis – *integration of results and consideration of limitations?* Yes=1, Unclear=0.5, No=0
6. Summary – *summary of pertinent findings supported by valid review process?* Yes=1, Unclear=0.5, No=0
7. Future directives – *specific research recommendations made?* Yes=1, Unclear=0.5, No=0

Appendix 2: Summary tables – food security

The food security summary tables are organised as follows:

- Table 1: New Zealand literature
- Table 2: General international literature
- Table 3: Economic literature
- Table 4: Socio-cultural literature
- Table 5: Physical literature
- Table 6: Political literature
- Table 7: Specific population groups
- Table 8: Interventions
- Table 9: Associated factors
- Table 10: Models

Abbreviations:

QS = Quality Score

QL = Qualitative research

NNS = National Nutrition Survey

Author/study name	Design	Methods	Results	Limitations
Table 1: New Zealand				
Barry 1997[33] Food security on the West Coast: food costs and barriers to obtaining food QS: QL 4.5/5	*Type*: Dietetic student practicum - food cost survey and one-to-one interviews *Aim*: Determine food costs and perceived barriers and level of neediness for food *Population*: People dealing with food security issues on the	Survey of cost of 135 basic food items at 35 stores throughout the West Coast. One to one interviews with 20 key informants.	Family food costs 10-25% higher in rural areas in Northern Buller and South Westland compared with Greymouth, Hokitika and other areas of NZ. Average food costs for entire West Coast 8% higher than other centres in NZ. Common barriers suggested to obtaining food were lack of food preparation skills, nutrition knowledge, poor budgeting skills and	Food costs are ten years old and may no longer be accurate. Interviews were only with key informants, and did not include households experiencing food insecurity.

Author/study name	Design	Methods	Results	Limitations
	West Coast of New Zealand		financial difficulty. For rural locations also lack of transport, limited fresh produce, and environmental conditions unsuitable for growing food.	
Brodie 2007[165] Is a centralised food bank supply system appropriate for the Wellington region?	*Type:* Dietetic student practicum *Aim:* Opinions of food banks on a centralised food bank system for Wellington *Population:* Food banks in Wellington	Purposive sample of a staff member from 21 food banks. Twelve were interviewed and 14 completed a semi-qualitative questionnaire.	Food banks in Wellington function independently, and food often needs to be purchased to meet needs. A centralised food bank supply system is not appropriate as it does not address the underlying causes of food insecurity or relieve hunger for all.	Small sample size.
Cheer 2002[54] Housing policy, poverty, and culture: 'discounting' decisions among Pacific peoples in Auckland, New Zealand QS: QL 4.5/5	*Type*: Semi-structured interviews *Aim*: Examine links between housing, welfare policies, income, and culture *Population*: 17 Samoan or Cook Island low-income households with high housing costs in Otara, South Auckland	Snowball sampling Interviews of 1 - 2 hours conducted with female respondents. Mean of 6.5 household members. Mean household weekly disposable income of $360.	Expenses in all households needed to be prioritised. Most households paid bills first and used what was left for food. Mean household income spent on housing was 52%, limiting disposable income. Households overspent their income on regular bills by a mean of $31 each week (before food or irregular expenses were paid). Most stated there was sometimes or never enough food because of lack of money. Over ¾ spent less than half the amount per capita needed to adequately feed a family in Auckland. Cultural expenses added to the financial burden eg. funerals, sending money home, church donations. A small number of households paying loans to loan sharks at up to 40% interest.	Income-related rents have since been introduced and the requirement for Housing New Zealand to make a profit has been removed. Results cannot be generalised to other ethnic groups. Non-representative sampling. Small sample size.
Crack 2007[166]	*Type*: Key	Key informant	Economic reform leading	Assessed Dunedin-based

Author/study name	Design	Methods	Results	Limitations
The changing face of voluntary welfare provision in New Zealand QS: QL 3.5/5	informant interviews, survey, and participatory observation *Aim*: Not stated *Population*: Dunedin-based voluntary welfare providers and clients	interviews conducted with 10 voluntary welfare providers (seven voluntary service organisations and three drop in centres). Questionnaires distributed in six of the centres, and completed by 115 clients. Participatory observation undertaken in the 10 welfare provider centres.	to benefit cuts in the 1990s and deinstitutionalisation of mental health patients led to increased demand for community services. Contract-based funding means funding often centred in larger Voluntary Service Organisations (VSO), leaving a very fragile funding base for drop in centres and small VSOs. This limits their ability to advocate for and empower clients. However often preferred by clients as also fulfil social needs. Funding for VSOs is capped at a certain number of clients, and does not meet the growing need for their services.	VSOs only.
Jamieson 2007[167] Associations between ethnicity and child health factors in New Zealand QS: 3.5/5	*Type*: Population survey *Aim*: Prevalence of factors (including food security) amongst Maori and Pacific children that are damaging to health *Population*: School children in New Zealand	Schools randomly selected and invited to participate. Individual students randomly sampled. 91% response rate of schools. 69% response rate for children. 3,275 children participated: 1,224 Maori, 1,058 Pacific, 993 NZEO. Computer-based home interview (used NNS 97 food security questions).	More Maori and Pacific children lived in large households, lived in households that did not own their home, and had low incomes. Food insecurity was highest in Pacific, followed by Maori, then NZEO households. Proportionally more Pacific children either never ate breakfast, ate it on the way to school, or bought their lunch.	Cross-sectional design. Descriptive data only.
McPherson 2006[34] Food insecurity	*Type*: Interviews and GIS mapping *Aim*: Explore links between	Secondary data analysis of socio-demographic data from 1,695	Poverty and food insecurity is dispersed in Christchurch, and not confined to most deprived neighbourhoods.	Food bank electronic data contained inaccuracies and missing data. Foodbank users not

Author/study name	Design	Methods	Results	Limitations
and the food bank industry: a geographical analysis of food bank use in Christchurch (thesis) QS: QL 4.2/5	poverty, food insecurity, and food banks from a socio-spatial perspective *Population*: Food bank users from a Christchurch social service agency	users of the Methodist Mission in 2005, which was geocoded and linked to NZDep data. Interviews and questionnaires with staff and volunteers in local food banks and with 22 food bank users (12 males, 10 females). Participants recruited by food bank staff.	Users presenting with multiple problems, of which lack of food is only one. Groups over-represented as food bank users were Maori, solo parents, and beneficiaries. Other groups included single males and low-income workers. Under-represented groups were the elderly, Pacific, refugees, and under 25-year olds. Reasons given for food bank use: ▪ Household bills (mainly utility bills) ▪ Unaffordable housing ▪ Family – mainly having visitors, but also relationship breakups or giving money to other family members ▪ WINZ issues – non-eligibility for special needs grant or on a benefit stand-down ▪ Debt ▪ Health reasons ▪ Employment issues such as unpaid sick leave or seasonal work ▪ Being involved in the justice system As neighbourhood deprivation increased, access to food outlets increased (both supermarkets and fast food outlets). Overall, ¾ had to walk further than 800m to a supermarket. Half used a car to do supermarket shopping, and did not necessarily shop at closest supermarket. Without a car, food had to be carried home, and often had to	representative of all food insecure people. Data from just one foodbank. Convenience sampling.

Author/study name	Design	Methods	Results	Limitations
			shop locally at higher priced outlets.	
Ministry of Health 1997[4 168] National Nutrition Survey QS: 3/5	*Type*: National survey *Aim*: Nutritional status of New Zealand adults *Population*: Nationally representative sample of adult New Zealanders	Sub-sample of the New Zealand Health Survey using an area based sampling frame and three stage stratified design. In-home interviews conducted with 4,636 adults. Completed NNS food security questionnaire. Response rate 50.1%.	Food insecurity more common in women, younger age groups, and Pacific peoples. Half of Pacific people, one third of Maori, and one-tenth of NZ European/Other report food running out due to lack of money. 2 to 6% had to access food banks/grants when they did not have enough money for food. Households with seven or more members were less likely to always be able to afford to eat properly compared with households of four or less members.	Cross sectional data. Did not address aspects pertinent to the elderly or incorporate cultural aspects. Food security questions related to financial causes only. Low response rate. Descriptive data.
Ministry of Health 2003[5] National Children's Nutrition Survey QS: 3.5/5	*Type*: National survey *Aim*: Assess nutritional status of New Zealand's children *Population*: Representative sample of New Zealand school children aged 5 to 14 years	Random sample of schools in New Zealand, followed by a random sample of 3,275 children in those schools. Interviews included a 24-hour diet recall, FFQ, and anthropometric measures. NNS97 food security measures used. School response rate 91%, child response rate 69%.	Households with NZEO children most likely to be food secure, followed by those with Maori then Pacific children. Largest households with the most children more likely to be food insecure.	Cross sectional data. Descriptive data only.
Network Against Food Poverty 1999[28] Hidden Hunger – Food and Low Income in New Zealand	*Type*: Evidence based report *Aim*: Report on food and low income in New Zealand	No methodology reported.	Insufficient income major reason for food insecurity. Cost of a basic healthy diet more than low-income households have to spend on food. Food costs and wages vary depending on location in New Zealand.	Cannot assess methodology.

Author/study name	Design	Methods	Results	Limitations
	Population: N/A		Food one of the few areas where low-income households can cut back. Rent takes up largest share of low incomes. Difficulties faced in getting food at lowest prices due to: ▪ Lack of transport ▪ Lack of storage ▪ Lack of money to buy in bulk when food is cheap Price the main determinant of where low-income people shop, followed by location. People on low incomes less likely to have cars than other New Zealanders (Statistics NZ 1995), limiting access to food outlets within walking distance. Lack of transport a problem in rural areas. Lack of storage facilities may mean having to shop for small amounts frequently. When money runs out, the local dairy may be the only place that extends credit, however food costs more. Kitchens in low rent houses often not of good quality or adequately resourced (pots, pans, basic ingredients) to cook from scratch. Home gardens often not feasible as low-income households move more often; land for a garden may not be available or of good quality; tools, materials, skills, and time are needed. Crops often ready when they are cheap in supermarkets. Freezing and preserving	

Author/study name	Design	Methods	Results	Limitations
			equipment needed to cope with surplus. Higher fat and sugar foods tend to be cheaper than low-fat foods. Television advertising of foods to children often high in fat and/or sugar or salt, and create demand for specific brands of foods. The number of foodbanks and the number of people using them increased dramatically after the 1991 benefit cuts and the move to market rents. People are reluctant to use food banks, and usually only use them in crises. Main reason for using them was that high rents didn't leave enough money for food (1994, 1995). A 1994 survey showed most food bank users had accumulated bills or debts or unexpected costs which meant they didn't have money for food.	
Parnell 2005[55] Food Security in New Zealand QS: 1.25/5	*Type*: Thesis - case study of 40 households *Aim*: Perceptions and experiences of the food insecure *Population*: Economically disadvantaged households in Auckland and Dunedin	A convenience sample of forty food insecure households identified through church-based charities in Auckland and Dunedin in 1994. Administered a questionnaire. Six non-consecutive 24-hour food recalls carried out over a two-week period with adult women in the households. Two recalls	Food costs estimated as 27% of weekly expenditure. Supermarkets the first choice for food shopping. Half often or sometimes did not have sufficient food in their household. The main reasons given were lack of money (22/40) and outstanding debts (9/40). One-third given food from family or friends, and 70% had visited a food bank at least once. 5/40 households belonged to a food cooperative (bulk	No Pacific participants. Sample not representative of economically disadvantaged households in NZ. Only assessed households that accessed church-based food assistance programs.

Author/study name	Design	Methods	Results	Limitations
		carried out for male partners and children. Included 38 females aged 20 to 48 years (mean age 34 years). 34 were NZ European and four Maori.	purchasing of foods between households).	
Reid 1997[38] Developing food insecurity indicators for New Zealand New Zealand QS: QL 4.5/5	*Type*: Thesis - focus groups *Aim*: Identify key themes related to food insecurity *Population*: People on a low-income responsible for household food	Purposive, snowball, and opportunistic sampling, through a key community contact, focus group participants, and pre-existing groups. Five focus groups were run: two Pacific, one Maori, one Pakeha, and one mixed, varying in size from 8 to 16 people.	Factors related to food security: ▪ Purchase and planning of meals took a lot of time and energy ▪ Unexpected expenses ▪ Transport problems or being restricted to shops within walking distance ▪ Food only discretionary part of the budget ▪ Lack of money ▪ Cultural aspects such as Pacific households prioritising traditional foods for Sunday lunch over food for the rest of the week, or providing best food for visitors ▪ Food banks not commonly used amongst Pacific and Maori due to embarrassment ▪ Availability of special food grants not well known ▪ Burden of high accommodation and living costs Conceptual model developed based on international literature and focus groups shown in Figure 6.	No differentiation between chronic and acute food security.

Author/study name	Design	Methods	Results	Limitations
Te Hotu Manawa Maori, 2007[82] Food security among Māori in Aotearoa	*Type*: Toolkit *Aim*: Inform regional and local action on food security *Population*: N/A	Methodology not provided. Compiles articles, research, and statistics relevant to food security among Māori.	Inequalities in levels of food security between Maori and NZEO. Maori are more likely to live in socially deprived areas, and more likely to struggle to afford and access healthy food. Loss of land, legislation, abuse of fisheries, and water pollution has limited access to traditional food sources and their use as an economic base.	Unable to assess methodologies.
Uttley 1997[56] New Zealand: a question of rights? In First World Hunger	*Type*: Book chapter *Aim*: Review of New Zealand's historical situation in relation to food security *Population*: N/A	No methodologies provided.	Various government policies that have impacted on food security: ▪ Taxation reforms and introduction of GST ▪ Cuts in welfare benefits and difficulties with administration of special payments ▪ Public and private sector restructuring and rising unemployment rates ▪ Labour market reforms eg. reducing power of trade unions ▪ State housing policy and income related rents ▪ School fees/donations ▪ Access to primary health care ▪ Reductions in New Zealand's standard of living	Unable to appraise methodologies.
Woodhouse 1999[31] Food Security in Wairarapa: the realities of food poverty QS: QL 4.5/5	*Type*: Interviews *Aim*: Develop a profile of the perceived needs, barriers and possible local action in relation to the issue of food security in the Wairarapa *Population*: Community	Twenty-five representatives of community organisations interviewed using a qualitative questionnaire. 23 individuals interviewed	**Individuals** ▪ Varying household size put households under additional food stress ▪ Not eating properly related to finances, due to lack of income and jobs, rather than lack of knowledge ▪ Food ran out more towards end of income period, causing problems	Small study size. Convenience sample.

Author/study name	Design	Methods	Results	Limitations
	organisations and individuals dealing with food insecurity		obtaining perishable staple foods ▪ Extra bills or unexpected events impacted on how well families ate, as not able to have an emergency fund ▪ Embarrassment often stopped people from asking for help ▪ Families often prevented from using food banks/grants more frequently by organisational rules, such as only allowing two food parcels/year ▪ Many households felt tension between lack of food and social requirements (eg. visitors or social events) and so avoided social occasions **Organisations** Perceived causes of food insecurity: ▪ Financial difficulty ▪ Lack of education and life skills. This included traditional skills such as fishing and gathering puha; growing vegetables; low educational attainment; lack of cooking skills; poor food choices ▪ Money management and the poverty cycle ▪ High costs eg. food, power, school uniforms ▪ Priorities eg. junk food, gambling, alcohol, power, rent ▪ Government and government agencies eg. benefit cuts, poor wages ▪ New Zealand food culture eg. pre-packaged food, boil ups, extended families	

Author/study name	Design	Methods	Results	Limitations
			▪ Other reasons – rural-urban migration, nomadic behaviour, very young mothers Perceived barriers to food security: ▪ Finances (27% responses) ▪ Lack of education and life skills (18%) (eg. learning to cook, growing vegetables, advocacy skills, not knowing where to go for help) ▪ High costs (16%) ▪ Government and government agencies (12%) ▪ Transport (6%) (eg. can't get to supermarket or to WINZ) ▪ Pride (8%) ▪ Isolation **Food Security Services** Churches often asked for food on Friday night or weekends when food banks closed. Limited availability of food banks in some areas.	
Wynd 2005[18] Hard to Swallow: Foodbank use in New Zealand New Zealand	*Type*: Working paper / report *Aim*: To document foodbank usage, to reduce confusion around interpretation of foodbank figures, and to explore why foodbanks are needed at all *Population*: Data fron foodbanks in NZ. Much of the data is from the Auckland City Mission as this appears to be the most robust, it is	Appears to have been a combination of a literature review, interviews, and case studies.	Rapid increase in foodbanks between 1989 and 1994 attributed to benefit cuts, Employment Contracts Act resulting in lower wages for low-paid and casual jobs, market rents, and high unemployment. Increased supplementary assistance and reduced threshold for special benefits reduced foodbank demand by about 30% in Auckland and 13% elsewhere. However in some localities demand increased. Factors contributing to need to use foodbanks:	Methodology not defined. Foodbank use is an indirect measure of food security, and is not a specific marker as not all food secure people use them. Foodbank use underestimates the number of hungry families and foodbank visitors may be distinct from other hungry families. Foodbank statistics are not overly robust and do not take account of underlying factors.

Author/study name	Design	Methods	Results	Limitations
	comprehensive, and they have consistent eligibility criteria over the years		▪ Lack of income ▪ Fall in real wages and benefits ▪ High cost of rent and rising house prices ▪ Extra food/money demands at Christmas, end of January (due to Christmas bills), beginning of school year, and Easter; as well as over winter in the South Island due to increased power costs ▪ Multiple complex issues, such as drug use, problem gambling, and mental health problems ▪ Debt ▪ Injury or sickness ▪ Childcare costs ▪ Cultural pressure to give money to the church ▪ Increasing number of asylum seekers (not entitled to a benefit while they appeal decision) Majority of foodbank users have children (dominant family type sole parents with children or single person households), many are in debt and have chronic health (including mental health) problems. At the Auckland City Mission in 2005, 56% Maori or Pacific. Foodbanks operate differently. Some give out a maximum number of parcels a day; they may give out varying sizes of parcels; they may divide the amount of food up between the number of applicants; they may give out whatever is hand; or if no volunteers are available, no food may be given out at all.	

Author/study name	Design	Methods	Results	Limitations
Table 2: General - Australia				
Babbington 2006[30] When there isn't enough to eat: study of clients at ANGLICARE's emergency relief service in Wollongong. Summary of pilot survey findings Australia QS: 2.5/5	*Type*: Pilot survey *Aim*: Clients' experience of food insecurity *Population*: People visiting an Anglicare food bank in Wollongong, Sydney	121 respondents interviewed. Completed a food security measure adapted from the USDA Food Security Module and a questionnaire. Sample was generally representative of usual clients at that centre.	Main reasons given for struggling with food were lack of money (due to cost of meeting basic necessities), cost of transport, and cost of food. Other reasons related to distance and transport, knowledge, poor health, and lack of resources for cooking and storing food.	Sample was of clients accessing one emergency food relief centre so cannot be generalised. USDA food security module designed to produce population estimates, not to be accurate on an individual level.
Booth 2001[44] Food security and poverty in Australia – challenges for Dietitians Australia QS: 2/7	*Type*: Review *Aim*: Strategies for Dietitians to improve food security *Population*: N/A	Not provided.	Food in remote areas costs up to 200% more than capital city prices. Rural households generally on low incomes. Indigenous Australians at risk of food insecurity due to remoteness, poverty, and cultural transition, amongst other things. Factors related to food insecurity amongst refugees include poor understanding of English, unfamiliarity with foods and cooking methods, lack of social support and budgeting skills.	Does not appear to be a comprehensive review. Unable to assess methodology.
Nolan 2006[24] Food insecurity in three socially disadvantaged localities in Sydney, Australia Australia QS: 4.5/5	*Type*: Telephone survey *Aim*: Measure prevalence, determine local residents understanding of food security, and areas for intervention *Population*: Residents of three most	Random sample taken from the three lowest-ranking postcode areas in the three most disadvantaged localities in south-western Sydney. 1,719 people recruited and participated in CATI survey.	Multiple logistic regression showed food insecurity predicted by: ▪ Age 18-49 years versus 50+ years ▪ Being Aboriginal ▪ No capacity to save money ▪ Children in the family ▪ Household home <$40,000 ▪ Poor health ▪ Language other than English spoken at home	Cross sectional data Telephone survey will not capture low-income families who do not have a phone (but nearly all of State has a phone).

Author/study name	Design	Methods	Results	Limitations
	disadvantaged localities in south-western Sydney	Response rate 74%. Both the 16-item US Household Food Security Survey Module and the single-item Australian food security indicator administered. Further survey questions around transport, community involvement, and possible interventions.	▪ Renting versus buying or owning a home ▪ Difficulty accessing shops ▪ Price of food being a problem ▪ Lack of time for shopping and cooking being a problem	
Radimer 1997[42] Food insufficiency in Queensland Australia QS: 4/5	*Type*: Regional health surveys *Aim*: Prevalence of food insecurity and factors associated with it *Population*: Adults who spoke English, and had a private telephone number in 13 regions of Queensland	CATI interviews using random selection from commercial lists of phone numbers or random digit dialling. 10,451 interviews conducted in 1993. Response rates of 75-80% in the 13 regions. Sample broadly similar to Census demographic characteristics.	Logistic regression showed risk of food insufficiency associated with: ▪ Younger age ▪ Lower income ▪ Unemployment ▪ Shared accommodation ▪ One-adult households ▪ Being single	Unemployed and people from non-English speaking backgrounds underrepresented. Excluded people without telephones. Food security status identified using two questions only. Cross-sectional data.
General – United States				
Bartfeld 2006[25] State-level predictors of food insecurity among households with children United States	*Type*: Hierarchical modelling *Aim*: Relationship between state characteristics and household food security *Population*:	Hierarchical modelling of data from 70,942 households who participated in the1998-2001 Food Security Supplements to the Current Population Survey (five	Socio-demographic factors impacting on household food insecurity: ▪ Lower income ▪ Renting vs owning a home ▪ Being a single mother ▪ More children in the household	

Author/study name	Design	Methods	Results	Limitations
QS: 4/5	Households with children	panels of data). Supplemented with state-level data. Analysis with random intercept and random slopes models, at the household and State level. Used an 18-item scale to assess food security.	▪ Lower education ▪ Having a disabled person or non-citizen in the household ▪ Being of African-American, Hispanic, or American-Indian ethnicity State factors impacting on household food insecurity: ▪ Lower average wage ▪ Less residential stability ▪ Tax burden for low-income households ▪ Higher unemployment rate ▪ Increasing percent with bachelor's degrees ▪ Higher median rent State/infrastructure factors that *modify* socio-demographic/household impacts on food insecurity at the *near* poverty (1 to 1.3x poverty line) and/or low income (1.3 to 1.85x/poverty line) level: ▪ Receiving food stamps ▪ High poverty rates ▪ Residential stability ▪ Low tax burden ▪ Unemployment rate None of the State characteristics modify impacts on food security at a *poverty* income level. Therefore, State factors may be particularly important for financially vulnerable households not yet in poverty. State factors impacting on food security for households *without* children were unemployment rate, average wage, median rent, and residential stability.	

Author/study name	Design	Methods	Results	Limitations
Bernell 2006[41] Restricted opportunities, personal choices, ineffective policies: what explains food insecurity in Oregon? United States QS: 3.5/5	*Type:* Surveys *Aim:* Role of local (County) and State factors in likelihood of experiencing food insecurity *Population:* Adults living in the State of Oregon	Data from the 2000 Oregon Population Survey, Census data, and other sources. 4,725 households included. Food security assessed using the short form (6-item) USDA Food Security Core Module.	Urban versus rural location and high county-level housing costs when on a low-income significantly associated with food insecurity.	Telephone surveys may under-represent low-income households. Small sample size in rural locations. Cross-sectional data so cannot determine causality.
Campbell 1991[169] Food insecurity: a nutritional outcome or predictor variable? United States	*Type*: Symposium *Aim*: Conceptualise food insecurity and its risk factors *Population*: N/A	Paper discussing definitions, measurement, risk factors and consequences of food in/security.	Risk factors for food insecurity are anything that either limits household resources or limits the amount of resource able to be utilised for food. Conceptualisation of food insecurity and its risk factors are shown in Figure 5.	Discussion paper.
Casey 2004[170] Maternal depression, changing public assistance, food security, and child health status United States QS: 3.5/5	*Type:* Survey *Aim:* Relationship of maternal depression to food security, welfare payments, and child health *Population:* Mothers of children ≤3 years attending hospitals in six areas	Convenience sample of 5,306 participants who completed a questionnaire and had medical records audited. 92% response rate. Questionnaire administered the USDA 18-item foos security scale.	Mothers with depression significantly more likely to report food insecurity, decreased welfare payments, food stamps stopped, fair/poor child health, and child having past hospitalisations.	Cross-sectional data cannot determine causation. Self-reported data. Not a representative sample.
Dunifon 2003[75] The influences of participation in the national school lunch program and food insecurity on child wellbeing United States	*Type*: Panel study *Aim*: Family factors that predict food insecurity *Population*: Primary caregiver of 6-12 year old	1,854 primary caregivers in the 1997 annual Child Development Supplement of the Panel Study of Income Dynamics. Food security	Significant negative associations between food insecurity and: ▪ Family income ▪ Length of home ownership ▪ Paternal education ▪ Child insurance Positive associations with:	Cross-sectional data as only reported results for one survey, although some of the control measures/characteristics were longitudinal.

Author/study name	Design	Methods	Results	Limitations
QS: 3.75/5	children from nationally representative sample of families	measured using the 18-item USDA scale.	▪ Number of years child received food stamps ▪ Maternal depression	
Furness 2004[88] Prevalence and predictors of food insecurity among low income households in Los Angeles County United States QS: 3.5/5	*Type*: Telephone survey *Aim*: Assess prevalence and predictors of food insecurity *Population*: Households in Los Angeles County	Follow up calls made to 630 participants of a population-wide survey in LA County, with income below 300% of the Federal poverty line. 55.4% response rate. Used the Six-Item Short Form of the Household Food Security Scale (USDA).	Predictors of food insecurity: ▪ inversely associated with household income ▪ having children in the household ▪ being homeless within the past five years Race and public assistance not associated with food insecurity.	Short-form food security questionnaire used, and scale may therefore not be as sensitive. Low response rate. Participants more likely to be White, without children, and receiving public assistance than non-participants (data weighted based on Census, but not for income). Low-income groups without telephones likely to be most at risk, and not included in this survey.
Garasky 2007[84] Evidence of the effectiveness of child support and visitation: examining food insecurity among children with non-resident fathers United States QS: 3.5/5	*Type*: National survey *Aim*: How non-resident fathers affect food insecurity for their children *Population*: Nationally representative sample of people aged under-65 years. Over-sample of low-income families	Sub-sample from the 1997 National Survey of America's Families. Sample is the guardians of 7,861 children whose father is absent from the home. Three questions assess food security over the past 12 months.	Only 59% of families with child support awards received payments. Receipt of child support statistically significant in reducing one of the three indicators of food insecurity. Visitation by father more than once a week reduces all three indicators of food insecurity. Indicators of food insecurity reduced by: ▪ Increasing family income (excluding child support ▪ Increasing number of adults in the household Food security indicators increased by: ▪ Guardian being female ▪ Guardian with less than a high school qualification or with some college education	Cross-sectional data. Only three indicators of food security used.

Author/study name	Design	Methods	Results	Limitations
			▪ Guardian in poor health Not related to age or employment.	
Heflin 2007[11] Work trajectories, income changes, and food insufficiency in a Michigan welfare population United States QS: 3.25/5	*Type:* Panel survey *Aim:* Determinants of changes in food insufficiency over time *Population:* Representative sample of African-American or White single mothers receiving welfare assistance in Michigan	Data from five waves of Women's Employment Study. Structured interviews conducted with 484 women. Stratified random sampling from a list of eligible single mothers. Response rate at each wave between 86% and 92%. One question asked about household food sufficiency.	After adjusting for unobserved associations, only having mental health problems and low total net monthly income were significantly associated with food insufficiency.	Reverse causality cannot be eliminated with mental health. Using only one measure of food insufficiency limits sensitivity. Food insufficiency (roughly equivalent to hunger) is a slightly different measure to food security.
Hunt 2000[87] Self reported concern about food security – eight states 1996-1998 United States QS: 2/5	*Type*: Cross-sectional State-wide survey *Aim*: Assess food security status of households *Population*: Residents in a selection of States in the United States	An additional food security question asked as part of the Behavioural Risk Factor Surveillance System - an ongoing, state-based, random digit dialling telephone survey of the adult US population. Asked one question about whether people had experienced food insecurity in the past 30 days. Survey included four States in 1996 n=11,485; five States in 1997 n=11,487;	Concern about food security higher amongst: ▪ Women than men ▪ People aged 18-34 years ▪ People who were divorced, separated or never married ▪ Households with more children ▪ Those who reported poor physical or mental health ▪ Unemployed people Concern about food security decreased as education level, annual household income, and length of time at present residence increased. Lowest among retired people, and non-Hispanic whites.	Cross-sectional and descriptive data. Does not control for confounding. Addressed one aspect of food security only. Did not include households without telephones. Demographics of participants not provided and did not discuss representativeness of sample, but few older participants. Response rates not provided.

Author/study name	Design	Methods	Results	Limitations
		two states in 1998 n=7,100.		
Kaiser 2007[19] Who is food-insecure in California? Findings from the California Women's Health Survey, 2004 United States QS: 4.5/5	*Type*: State-wide survey *Aim*: Factors associated with food insecurity in Californian women *Population*: Adult women in California	4,037 participants in the California Women's Health Survey annual telephone survey. A screened random digit dial sample used. Used a 6-item subset of the USDA Food Security Module, assessing individual food security status over past 12 months.	Multivariate analyses found factors associated with greater food insecurity: ▪ Black or Hispanic ▪ Being Spanish speaking ▪ < 12th grade education ▪ Not married ▪ < 55 years of age ▪ Lived less than ½ their life in the US ▪ Depression for two or more days the previous month ▪ Feeling overwhelmed ▪ Poor physical/mental health	Cross-sectional data. Telephone survey will exclude participation of low-income families without a telephone.
Laraia 2006[20] Psychosocial factors and socioeconomic indicators are associated with household food insecurity among pregnant women United States QS: 3.75/5	*Type*: Cohort study *Aim*: Prevalence and predictors of food insecurity in low and middle-income pregnant women *Population*: Pregnant women before 20 weeks gestation attending obstetric clinic at Univerity of North Carolina	606 participants from the Pregnancy, Infection, and Nutrition cohort who had complete food security and delivery information, and household income ≤400% of poverty line. Women recruited between 2000 and 2004 through a state-funded obstetrics clinic. USDA food security module used to assess food security.	Strongest indicator of food insecurity was income ≤100% poverty line, followed by income 101-200% poverty line. Education, marital status, and number of children not significant indicators. Food insecurity positively associated with psychosocial indicators of perceived stress, anxiety, depression, chance locus of control (belief in chance), and powerful others locus of control (other people control events in their life). Negative associations seen with mastery and self-esteem.	75% of sample food secure. Therefore small sample size in the marginally food secure and food insecure groups. Cross-sectional data reported. Sample not representative.
Nelson 1998[22] Hunger in an adult patient population United States QS: 3/5	*Type:* Survey *Aim:* Prevalence of hunger and food insecurity *Population:* Adult patients at an urban county	Interviews carried out with 567 inpatients and 170 patients with diabetes on insulin. Participation rate of 80% for the	Predictors of individual food insecurity and of hunger were: ▪ Annual income of less than $10,000 ▪ Illicit drug use ▪ Reduction in food stamps	Cross-sectional data so cannot determine causality. 17% patients could not be tracked post-discharge from hospital and were more likely to be homeless or not have a telephone, which may have introduced

Author/study name	Design	Methods	Results	Limitations
	hospital admitted to certain wards over a one to two-week period; and primary care patients purchasing insulin from the hospital pharmacy over a one-month period	survey and 75% for the telephone interview. A 10-item food security questionnaire assessed individual food security. Eight of the questions taken from two validated measures.		respondent bias. Food security questions not validated in the way they were used.
Nichols-Casebolt 2002[79] Making ends meet: private food assistance and the working poor United States QS: 1/5	*Type*: Survey *Aim*: Characteristics of working households dependent on private food assistance programs *Population*: Households receiving food assistance from food pantries and soup kitchens in Virginia who were aged 18 to 65 years and not disabled	976 participants from nine randomly selected food banks and one soup kitchen in each of seven regions in Virginia, using multistage cluster sampling. For analysis, participants grouped into currently employed (n=329), recently unemployed (n=242), and unemployed over the past six months (n=356).	Significant difference between groups in education level and % receiving food stamps. Long-term unemployed more likely to be African-American or non-Hispanic White than recently unemployed. Barriers to employment were health, transportation, and childcare. When employed, earnings for many were extremely low (¼ at or below the minimum wage and ⅔ not working 40 hour weeks) and hence still reliant on food assistance. Having a greater number of hardships over past six months associated with having only one worker in the household, being recently unemployed, or in a single-parent household.	Cross-sectional data. Participants using food banks may not be representative of all food insecure households. People were classed as employable if they were not receiving a disability benefit.
Nord 2005[83] Household food security in the United States, 2005 United States	*Type*: Report on the US Food Security Survey 2005 *Aim*: Prevalence and severity of food insecurity in the United States	47,500 households surveyed. Appears to be a self-completed survey sent to households (although not described).	Prevalence rates of food insecurity were substantially higher for the following groups: ▪ Households with an income near or below the Federal poverty line ▪ Households headed by single women	Descriptive data only so does not account for confounding. Cross-sectional data so cannot determine cause and effect.

Author/study name	Design	Methods	Results	Limitations
QS: 3/5	*Population*: Representative sample of the US civilian population		with children ▪ Black and Hispanic households ▪ More common in large cities and rural areas than in the suburbs *Note: results of the 2006 survey have now been reported, and these findings are the same as above*[171]	
Nord 2007[53] Characteristics of low-income households with very low food security United States QS: 3/5	*Type*: National survey *Aim*: Characteristics of households with very low food security *Population*: Nationally representative US sample	Data from the Current Population Survey Food Security Supplement 2005 (n=50,000). *Note: 'very low food security' is the new term in the US for 'food insecure with hunger'*	Nearly half of households with very low food security had at least one household member employed. Just over half were on a food assistance program. Low-income households with very low food security had disproportionately large numbers of: ▪ Adult men living alone ▪ Non-Hispanic Black households ▪ Adult members unemployed or disabled	Descriptive data only so does not account for confounding. Income not reported by 19% of sample.
Olson 1997[32] Factors contributing to household food insecurity in a rural upstate New York county United States QS: 3.5/5	*Type*: Survey *Aim*: Factors contributing to household food insecurity *Population*: Women aged 20 to 40 years with children living at home and <16 years of education, living in a rural county of New York, who had participated in an earlier health census	193 women interviewed twice in their homes in 1993. Radimer/Cornell hunger and food insecurity index administered and household food inventory collected (repeated twice).	Household factors contributing to food insecurity: ▪ Lack of savings ▪ Single parent households ▪ Larger households ▪ Having unexpected expenses ▪ Adding $50 or more to food stamps Higher levels of household food supplies associated with: ▪ More education ▪ Spending more on food ▪ Having a vegetable garden ▪ Receiving free milk, eggs, or meat	Predominantly White population. Cross sectional data. Method of selecting women from the sampling frame not given.

Author/study name	Design	Methods	Results	Limitations
Olson 2004[58] Factors protecting against and contributing to food insecurity among rural families United States QS: 3.25/5	*Type*: Interviews *Aim*: Identify characteristics of food insecure rural households *Population*: Rural low-income families from 14 states of the US, participating in a program for low-income groups. Annual household income at/below 200% of Federal poverty line, and at least one child >12 years of age. Represented diversity of families with children affected by welfare reform.	Purposive sampling used. Interviews carried out with the mother in 316 households. Food security status assessed using the US Household Food Security Survey Module. Participants also completed a chronic health conditions index, a food and financial skills index (neither validated), a knowledge of community resources tool, and the CES-D measure of depression.	Food insecurity predicted by: ▪ Low level of food and financial skills (but note that 72% had the highest level of skill) ▪ Difficulty paying medical expenses ▪ Symptoms of depression in mother ▪ Being non-White with less than a high school education ▪ Renting instead of owning a home	Used some non-validated measures. Cross-sectional data.
Ribar 2003[48] Dynamics of poverty and food insufficiency United States QS: 4.25/5	*Type:* Longitudinal surveys *Aim:* Change in food insufficiency over time in households *Population:* United States	Data from the 1993 Panel Survey of Income and Program Participation and the follow on 1998 Survey of Program Dynamics. Sampling methods for these surveys not described.	Whilst poverty and food insufficiency are both indicators of economic hardship, they are distinct processes. Transitions into and out of food insufficiency show that: ▪ Female-headed households more likely to enter and less likely to leave food insufficiency ▪ Changes in household composition associated with entry into food insufficiency overall and for working age adults and low-income households ▪ High school completion increased the chances of leaving food insufficiency. When broken down	May not be nationally representative due to data difficulties and attrition. One dataset unedited causing difficulty linking data and missing data. High attrition rate between the two surveys (used weighting to adjust for this). Food insufficiency question asked slightly differently between the two surveys. Analyses showed that some of the study's findings were sensitive to the way that food problems were measured.

Author/study name	Design	Methods	Results	Limitations
			into groups, this was significant for working age adults and low-income households, but not households with children. ▪ Low asset income associated with entering food insufficiency	

Author/study name	Design	Methods	Results	Limitations
Wehler 2004[21] Risk and protective factors for adult and child hunger among low-income housed and homeless female-headed families United States QS:3.75/5	*Type*: In-depth structured interviews *Aim*: To identify factors associated with adult or child hunger *Population*: Low-income housed and homeless mothers	The Worcester Family Research Project: a sample of 220 homeless women recruited from shelters and a comparison group of 216 housed women recruited from the Dept of Public Welfare Office.	Predictors of adult hunger (where hunger hadn't extended to include children) included: ▪ Mothers' childhood sexual molestation (further analysis showed this appeared to be mediated by having experienced partner violence as an adult and having a lifetime diagnosis of posttraumatic stress disorder) ▪ Current parenting difficulties Risk factors for both child and adult hunger in a family included: ▪ Mothers' childhood sexual molestation ▪ Receiving housing subsidies ▪ Living in the area for less than a year ▪ Having more or older children ▪ Substandard housing Homelessness status was not significantly related to hunger. Factors that were protective against adult-only hunger were: ▪ Older age ▪ Receiving child support ▪ Having a coping style of taking responsibility ▪ Siblings helping with money Factors that were protective against adult and child hunger combined were: ▪ Mother's positive health perception	Sample design was to compare homeless and housed poor, with hunger as a secondary outcome. Relied on self-report, which may have been affected by the level of distress currently felt. Some homeless participants were living in shelters, so their usual level of hunger may be underestimated. Looked at hunger over the last 12-months only (possibly leading to overestimation).

General – Canada				
Broughton 2006[29] Predictors and outcomes of household food insecurity among inner city families with preschool children in Vancouver Canada QS: 3/5	*Type*: Survey *Aim*: Association of food insecurity with potential predictor variables *Population*: Several low-income neighbourhoods in Vancouver	142 households with a child aged between 2 to 5 years participated. 18-item USDA Food Security Survey Module administered, along with blood haematology and anthropometric measurements for each child.	Low income was the primary risk factor for food insecurity. Households with less well equipped kitchens, poorer self-rated cooking skills, and less access to food of reasonable quality had higher odds of food insecurity.	Cross-sectional data. Small sample size. Methods of assessing environmental predictors not given. Non-representative convenience sample. Sampling methods not described. Statistical analyses not described.
Che 2001[62] Food insecurity in Canadian households Canada QS: 4/5	*Type*: National survey *Aim*: Prevalence and characteristics of households who are food-insecure *Population*: Nationally representative sample in Canada	Data from the 1998/99 National Population Health Survey. Socio-demographic and some health data from 48,952 respondents; food security data from 17,226 respondents; and additional food security data from 1,265 food-insecure respondents. Three questions asked about food security over the past 12 months.	Higher odds of experiencing food insecurity for: ▪ Low- and middle-income households versus upper-middle/high income households ▪ Households receiving welfare payments versus wages ▪ Single-parent families with a female head versus a couple with children ▪ Divorced/separated versus married ▪ Tenants versus home owners ▪ Aboriginal people ▪ Immigrated in the last ten years versus Canadian-born ▪ Age groups younger than 65+ years Being single had *lower* odds versus married. Food insecure people had higher odds of: ▪ Poor health ▪ Having at least three chronic health conditions ▪ Obesity ▪ Distress and emotional upset ▪ Depression.	Cross-sectional data cannot determine causality. Only three measures of food insecurity used, all of which focused on financial causes. One person provided information for everyone in the household, whereas not all members of households experience food security the same.

Hargrove 1994[35] Food security: what the community wants. Learning through focus groups Canada QS: QL 4.2/5	*Type*: Focus groups *Aim*: Identify the range of issues threatening food security in low-income groups *Population*: Pre-existing low-income groups in Ontario Canada	Recruited from related established groups. Sample size of 35, with four men.	Five themes emerged: ▪ Low literacy had a major impact on ability to shop for and prepare food. ▪ Insufficient finances to feed family as wished. Many were single parents and/or receiving welfare payments. Lack of transport meant had to shop at closest grocery store. ▪ Limited time to plan and prepare meals. ▪ Those living alone or with a mental illness not eating well. Fatigue a problem for some single mothers. ▪ Many had low self esteem and wanted to receive help in a way that is not demeaning.	Small sample size. Ran focus groups with pre-existing groups, which may bias the responses. Not generalisable.
McIntyre 2000[61] Child hunger in Canada: results of the 1994 national longitudinal survey of children and youth Canada QS: 3.5/5	*Type*: National nutrition survey *Aim*: Prevalence and characteristics of families with children experiencing hunger *Population*: Canadian households with children under 11 years	16,639 children under 11 years from randomly selected households surveyed. 206 families had experienced hunger (1.2%).	Odds of ever experiencing hunger increased by: ▪ Main income source social assistance ▪ Primary caregiver's health poor ▪ Child's health fair or poor ▪ Of Aboriginal ethnic origin ▪ Main activity looking for work Odds were reduced by: ▪ Increasing household income ▪ Increasing number of parents (children living with a single mother with very low income are most likely to be at risk of hunger)	Not a representative sample. Small sample size who had experienced hunger (n=206). First wave cross-sectional data reported.
Tarasuk 2001[90] Household food insecurity with hunger is associated with women's food intakes, health	*Type*: Questionnaire and 24-hour recall *Aim*: Relationship between food insecurity and	Stratified random sample of users of 21 food banks in Toronto. Three interviews conducted with 153 participants over a three-week	Women experiencing more severe forms of food insecurity more likely to report feelings of social isolation, chronic poor health and limitations in activity levels.	Cross-sectional data. Small sample size.

and household circumstances Canada QS: QL 4.5/5	health and social circumstances *Population*: Non-pregnant female food bank users, aged 19-49 years and with at least one child, in Toronto, Canada	period. Food security assessed using the USDA Core Food Security Module. Participation rate 68%.	Precipitating factors were chronic low income, unexpected expenditures, and debt.	

Author	Design	Methods	Results	Limitations
Table 3: Economic				
Coley 2007[23] Maternal functioning, time, and money: the world of work and welfare United States QS: 4.25/5	*Type*: Longitudinal multi-method study *Aim*: Follow women's work and welfare experiences over a two-year period *Population*: Representative sample of low-income families with children living in low-income neighbourhoods in Boston, Chicago, and San Antonio	Data from waves one and two of Welfare, Children and Families: a three-city study. 1,974 in-home interviews conducted with primary female caregiver. Response rate of 74%. 8 items used from the USDA food security measure.	Mothers moving into sustained employment of more than 30 hours/week reported declines in financial strain and food insecurity and improved psychological functioning, compared to mothers remaining on or entering welfare. Stable employment over the two years related to increases in total household income but not to improvements in financial strain or food security.	Models used cannot determine causation. Data was collected at a time of very favourable economic climate, and the average income of families in the sample increased 50% over the two years.
Bhattacharya 2003[59] Heat or eat? Cold-weather shocks and nutrition in poor American families United States QS: 3.25/5	*Type*: Surveys *Aim*: Effects of cold weather on budgets in low-income families *Population*: Participants in two large, nationally representative surveys	Data from 104,747 households in the 1980 to 1998 Consumer Expenditure Surveys and 33,994 people in the NHANES III collected between 1988 and 1994. Weather conditions from the National Oceanic and Atmospheric Administration for each state and month between 1980 and 1998. Poor families classed as those with a poverty-income ratio less than 1.5. Rich families have a ratio greater than 3.	A 10°F temperature drop associated with a $9/month increase in fuel expenditure in poor families, and $11/month in rich families (1982-1984 dollars). Poor families reduced expenditure on food during cold months, whereas rich families did not. Calorie intake reduced by 10% during winter in poor families.	

Author	Design	Methods	Results	Limitations
Gundersen 2001[49] The dynamic determinants of food insufficiency United States QS: 3.75/5	*Type*: Multi-panel longitudinal survey *Aim*: The impact of unexpected changes in income on food insufficiency *Population*: Non-institutionalised population of the US with an income below 200% of the poverty line	Comparison of food sufficient and food-insufficient households using data from the 1991 and 1992 panels of the Survey of Income and Program Participation. Households are examined in the eight months prior to reporting being food insufficient and their first month of food insufficiency.	Compared with food sufficient households, food-insufficient households are more likely to: ▪ Have lower average monthly income ▪ Suffer from income shocks due to loss of earnings or food stamps ▪ Have proportionally greater variance in income ▪ Not have any savings ▪ Have lower rates of home ownership and health insurance	Descriptive statistics only. Effects of the income shock on food security may not be felt immediately. Only one question used to assess food insufficiency.
Kirkpatrick 2007[74] Adequacy of food spending is related to housing expenditures among lower-income Canadian households Canada QS: 3/5	*Type:* National survey *Aim:* Relationship between income spent on housing and adequacy of food expenditure and impact of a housing subsidy *Population:* Representative sample of Canadians	Data from 15,535 households in the 2001 Survey of Household Spending. Food expenditure (including eating out) compared to the cost of the Nutritious Food Basket. The Basket is based on a reference four-person family, and adjusted using an equivalence scale for different household sizes.	Food spending declines significantly as proportionally more income spent on housing, amongst lowest three income quintiles. Housing subsidies improved adequacy of food spending in the lowest income quintile, but still did not meet amount needed for a basic nutritious diet.	Cross-sectional data. Food spending is not a measure of food security nor dietary adequacy. The cost of a Nutritious Food Basket was a couple of years out of date. Its estimates may not be accurate for rural areas and the territories.
Cook 2002[68] Welfare reform and the health of young children United States QS: 4.25/5	*Type*: Retrospective cohort study with cross-sectional surveys *Aim*: Association of loss or reduction in welfare and food security and health *Population*: Children aged ≥36 months attending six urban hospitals	Sub-sample of 2,718 adult caregivers interviewed. Survey included questions on demographics, food security (USDA), assistance program participation, changes in benefits, and child hospitalisation history. Response rate to	Households whose welfare payments had been reduced or stopped had 1.5x greater odds of being food insecure and children had 1.3x odds of being hospitalised since birth than households whose benefit was unchanged.	Cross sectional data. Convenience sample.

Author	Design	Methods	Results	Limitations
	and clinics in six States whose family either received or had lost welfare entitlements	main sample 93%, with an additional 15% ineligible.		
Power 2006[86] Economic abuse and intra-household inequities in food security Canada QS: 0.25/5	*Type*: Case report *Aim*: Demonstrate the potential of economic abuse to impact on food security *Population*: Single mothers living in poverty	Reports on a qualitative interview conducted as part of a larger study with single mothers living in poverty	A form of abuse in this case was withholding sufficient funds to feed the family, whilst having to provide quality meals for the father.	Findings based on one case report.
Rose 1999[47] Economic determinants and dietary consequences of food insecurity in the United States United States	*Type*: Symposium *Aim*: Determinants of food insecurity in the US and its consequences *Population*: United States	Summarises relevant research. No methodology given.	Strong inverse relationship between hunger and income. Those in poverty 3.5x more likely to be food insufficient. However, there is not a direct relationship between income and hunger (some households in poverty are not food insecure, and vice versa). Food insufficient households more likely to have had recent financially stressful events such as job loss, gaining additional household member/s, or losing food stamps. Lower rates of food insufficiency associated with home ownership, head of the house completed high school or aged >60 years. Higher rates associated with being Hispanic, larger households, or a household with one adult plus children.	Many of the studies reported cross-sectional. Not a comprehensive review of all studies related to economic determinants.

Author	Design	Methods	Results	Limitations
Table 4: Policy				
Blundell 2003[69] Income volatility and household consumption: the impact of food assistance programs United States QS: 3.25/5	*Type*: Panel study *Aim*: The extent that Food Stamps protect against income shocks *Population*: Households with a continuously married couple aged between 25 and 65 years of age, who received Food Stamps	Sub-sample of 2,469 households in the 1978 to 1992 Panel Study of Income Dynamics. Divided into low-income (<200% poverty line) and medium/high income.	Food consumption in low-income households sensitive to permanent income shocks, whereas it is not in medium/high-income households. Food Stamps have a consumption-smoothing effect in low-income households, whereby the response of food to an income shock is one-third lower in those receiving Food Stamps.	Analysis based on a household with two parents/couple, which excludes the many Food Stamp participants who are single or solo parents.
Breunig 2005[172] Do intra-household effects generate the food stamp cash-out puzzle? United States QS: 1.5/5	*Type*: "Cash out" experiment *Aim*: Previous studies have shown higher marginal propensity to purchase food with food stamps than cash income (the "cash out" puzzle). Does this differ for multiple or single-headed households? *Population*: Households in San Diego who receive food stamps	Secondary analysis of data from an experiment in the late 1980s. 1,200 families from San Diego receiving food stamps randomly selected to continue receiving food stamps or to receive a cheque for same value. Sample for regression analysis was 494 unconstrained households (use both money and food stamps to buy food) from this dataset.	The cash-out puzzle appears to be driven by multiple-headed households, whereby more is allocated for food if receiving food stamps than if receiving cash. Single-headed households' marginal propensity to purchase food with food stamps not significantly different to when receiving cash income.	Only 40 single-person food stamp recipients in the dataset.
Gundersen 2001[66] The Food Stamp program and food insufficiency United States QS: 3/5	*Type*: Theoretical modelling *Aim*: Food insufficiency rates in Food Stamp program recipients and non-recipients	Effect of Food Stamps on food insufficiency analysed using a simultaneous equation model, with a sub-sample from the 1991 and 1992 panels of the Survey of Income and Program	Participation in the food stamp program has no effect on food insufficiency. Recipients have the same probability of food insufficiency as non-recipients.	Possible sources of bias could be existence of unobserved variables effecting decision to receive food stamps, over-reporting of food insufficiency, or under-reporting of food stamp participation. Small number of food-

Author	Design	Methods	Results	Limitations
	Population: Sub-sample of households eligible to receive food stamps from a nationally representative sample of non-institutionalised US population	Participation (n=3,452).		insecure households.
Guthrie 2007[45 73] Can Food Stamps do more to improve food choices? United States	*Type*: Summary of USDA research *Aim*: Effect of Food Stamps on the quality of diets of recipients *Population*: N/A	Methodologies not reported.	▪ Regional differences in food prices may cause difficulty as Food Stamp allowance based on national data. ▪ General increases in food stamps may not improve food choices ▪ Money is diverted first to other priorities before increasing spending on fruit and vegetables ▪ Targeted bonuses to purchase fruit and vegetables may be more successful ▪ Estimated that a 20% reduction in price of fruit and vegetables would increase intake to 2.2 cups/day. Increased spending on fruit and vegetables occurs only when annual household income (four-person household) reaches US$70,000. ▪ Restricting purchases of unhealthy choices with Food Stamps does not appear effective ▪ Nutrition education can improve food choices but doing so consistently is difficult ▪ Behavioural economics suggest ways of improving diet quality for those who wish to eg. delivering pre-ordered groceries to avoid temptation, increasing frequency of food stamps to weekly	Unable to assess methodologies.

Author	Design	Methods	Results	Limitations
			to avoid over-consumption at the start of the monthly food stamp cycle, ability to allocate proportion of Food Stamps to specific food categories.	
Jolliffe 2005[65] Food stamp benefits and child poverty United States QS: 2.25/5	*Type*: Data analysis *Aim*: Extent to which food stamps can reduce child poverty *Population*: Nationally representative sample	Assessed the impact of food stamps on three different measures of poverty – headcount, poverty gap, and squared poverty gap – using data from the Current Population Survey 1989 to 2001 (monthly survey of 50,000 households).	Incidence of child poverty is not reduced by food stamps, but the severity and depth of child poverty is reduced. Modelling shows that the greatest decrease in severity of child poverty is achieved by targeting increased benefit payments at extremely poor households in the food stamp program.	The Current Population Survey underestimates participation in food stamp program by 13%.
Riches 1997[52] Hunger, food security and welfare policies: issues and debates in First World Societies	*Type*: Comparative research *Aim*: Relationship between hunger, food security, and welfare policies in Australia, Canada, New Zealand, UK and the USA *Population*: Developed countries	National case studies	Hunger an outcome of country characteristics of: ▪ Prolonged high rates of unemployment ▪ Inequality in wealth distribution ▪ Declining real value of wages and benefits ▪ Inadequate welfare benefits; all due to economic restructuring.	Methodology not provided.
Nestle 1999[173] Hunger in America: a matter of policy United States QS: 2/7	*Type*: Review paper *Aim*: History and current situation with food insecurity in the US and related policy *Population*: N/A	None given.	Prevention of hunger in the US is a matter of policy and political will. Government policies have not raised incomes above the poverty line. Hunger cannot be addressed in isolation from other correlates of poverty. Need to solve problems due to unemployment, other income sources, housing,	Discussion paper rather than a systematic review. Methodology not provided.

Author	Design	Methods	Results	Limitations
			education, health, transportation, child care, family support systems, mental health, and substance abuse.	

Author	Design	Methods	Results	Limitations
Table 5: Physical				
Cassady 2007[174] Is price a barrier to eating more fruits and vegetables for low-income families United States	*Type:* Market basket survey *Aim:* Determine if price is a barrier to fruit and vegetable purchase for low-income families *Population:* Supermarkets in two urban areas in California	Fruit and vegetable market baskets developed to meet criteria for the old US Thrifty Food Plan and the new 2005 Dietary Guidelines. Cost differences compared between baskets and between different store types and in different neighbourhoods. Price survey carried out at 25 supermarkets within five miles of very low-income areas and repeated three times over a year.	The average price of a fruit and vegetable basket lower in low-income areas than higher-income neighbourhoods (eg. 20% lower in very low-income vs middle income areas). Prices varied by up to 76% between stores. 43% of the Food Stamp budget would be required to purchase recommended amount of fruit and vegetables.	Results may not be generalisable outside of the assessed areas. Quality of produce not considered.
Engler-Stringer 2005[93] Collective kitchens in Canada: a review of the literature Canada QS: 4.5/7	*Type*: Literature review *Aim*: To synthesis research on collective kitchens (community based programs where a group of people cook together to make a large quantity of food, in order to save money) *Population*: N/A	Literature search identified four research articles and two master's theses.	It is questionable whether people have increased food resources from the use of collective kitchens. However they are less stigmatising than food banks and provide social support networks and health promotion benefits.	Research identified was small scale and limited in scope. None included prolonged observation of collective kitchen groups, and there was no direct measurement of impacts. Mostly qualitative research. Some studies interviewed more leaders and facilitators than participants.

Author	Design	Methods	Results	Limitations
Table 5: Socio-cultural				
Martin 2004[51] Social capital is associated with decreased risk of hunger United States QS: 3.5/5	*Type*: Interviews *Aim*: Is food security associated with social capital? *Population*: Low-income households (<185% poverty line) in Hartford, Connecticut	Systematic sampling with a random start from a list of all residential addresses in the city. 330 door-to-door interviews conducted. US Household Food Security Module used. Measure of social cohesion and trust used as a proxy for social capital. Response rate among eligible households that could be contacted was 55%.	Household and community social capital associated with decreased odds of being hungry. Households with an elderly member less likely to experience hunger. When social capital included in the regression model no demographic variables predictive of experiencing hunger. Factors associated with greater odds of having high social capital were households having an elderly member, or a member of a social or civic organisation.	Cross-sectional data. Results may not be representative of other cities. A large number of people in the sampling frame were not contactable and not included in the survey, which may have introduced respondent bias. Proxy measure of social capital used and measures were self-reported.
Morton 2005[81] Solving the problems of Iowa food deserts: food insecurity and civic structure United States QS: 2/5	*Type*: Survey *Aim*: Investigate whether social organisation in rural areas decreases odds of food insecurity *Population*: Residents of two rural, high-poverty counties in Iowa	Mail survey of a random sample of households taken from each county. 720 surveys completed. Response rate of 60.1%. 12% of sample food insecure, using the 6-item USDA scale.	People on lower incomes and who are younger have higher probability of being food insecure. Education and living in town are not associated. Perceptions of high civic structure (the efforts of groups and organisations to address food problems) decrease odds of being food insecure. Personal connections (food sharing with friends and family) do not decrease odds of food insecurity.	Representativeness of the sample not discussed. Small number of participants in the food insecure group. Results cannot be generalised to other rural locations. Food security index used measures adult food insecurity only.
Walker 2007[92] Household food insecurity is inversely associated with social capital and health in females from special	*Type*: Cross-sectional survey *Aim*: Relationship between food insecurity, social capital and health	Mailed survey with three validated measures: US Household Food Security Survey Module; perceived health status question; and a measure of social capital.	Household food insecurity inversely associated with social capital (sense of social trust and community reciprocity).	Low response rate may introduce respondent bias. Non-probability sampling.

Author	Design	Methods	Results	Limitations
supplemental nutrition program for women, infants, and children households in Appalachian Ohio QS: 2.5/5	*Population*: Women in the Ohio WIC program	235 participants, with a response rate of 22%. 52% food insecure.		

Author	Design	Methods	Results	Limitations
Table 7: Specific population groups				
Minority groups				
Burns 2000[175] Easing the transition: food and nutrition issues of new arrivals Australia QS: QL 3.5/5	*Type:* Focus groups *Aim:* Identify refugees' food patterns and issues *Population:* Adult Somali asylum seekers in Melbourne who had immigrated within the past five years	33 Somalis, recruited through snowball sampling, participated in four focus groups. Seven Somali women interviewed re food purchasing and eating pattersn.	▪ Recent arrivals are on low incomes ▪ Facing costs of setting up new home ▪ Often supporting relatives in refugee camps ▪ Shame and cultural sensitivity around being food insecure ▪ Difficulty obtaining traditional foods at affordable prices ▪ Halal foods hard to find and expensive ▪ Unfamiliarity with local foods, fruit and vegetables ▪ Concerns about food safety (freshness and use of chemicals)	Non-representative sampling. Small sample size. Food security not measured.
Chilton 2007[85] Hunger of the body and hunger of the mind: African American women's perceptions of food insecurity, health and violence United States QS: QL 4.5/5	*Type*: Focus groups or semi-structured interviews *Aim*: Understand the experience and context of food insecurity for African-American women *Population*: Women using food banks in Philadelphia	Four focus groups and 12 individual interviews conducted with 34 women. Recruited using a snowball technique. Average age of participants was 45 years, and most received food stamps. About half had children at home.	Physical hunger exacerbated by emotional stressors. Physical hunger experienced because could not afford food. Often associated with extreme circumstances such as homelessness or drug addiction. Inability to eat, or purposely not eating, due to amount of stress in their lives or depression. Individual and community violence, abusive partners manipulating through food, abuse in childhood also contributed to stress which led to not eating.	Small convenience sample. Not generalisable.
Himmelgreen 2000[70] Food insecurity among low-income Hispanics in Hartford,	*Type*: Retrospective exploratory study *Aim*: Variables associated with	248 people recruited from Hispanic organisations, health facilities, the WIC program, and community	Variables associated with food insecurity: ▪ Female caregiver also the household head ▪ Child not enrolled in preschool or kindergarten	Convenience sample. Cross sectional data.

Author	Design	Methods	Results	Limitations
Connecticut: implications for public health policy United States QS: 3.25/5	food insecurity among low-income inner-city Hispanics *Population*: Low-income Hispanic caregivers of children aged 1-6 years old living in Hartford, Connecticut	based agencies. Interviews assessed socio-demographics, participation in food assistance programs, feeding practices, dietary intake and health status. Radimer/Cornell scale used to assess food security. 73% participants born outside the US, 58% had a high school education, 48% single, average age of 36 years.	▪ Food stamps not lasting the month	
Mazur 2003[43] Diet and food insufficiency among Hispanic youths: acculturation and socioeconomic factors in the third National Health and Nutrition Examination Survey United States QS: 4/5	*Type*: National survey *Aim*: Associations between acculturation and income with food insufficiency *Population*: Representative sample of Hispanic youths aged 4-16 years living in the US	Data on sub-sample of 2,985 Hispanic youths from the third National Health and Nutrition Examination Survey (1988-1994). Food insufficiency assessed using three questions (first phase) or five questions (second phase of the survey).	Household food insufficiency tended to be less with lower levels of acculturation. However, not significant for all food security indicators.	Cross-sectional data cannot determine direction of cause and effect. Only three food security questions asked in both Phase I and Phase II. Acculturation measured by level of English spoken only.
Weigel 2007[80] The household food insecurity and health outcomes of US-Mexico border migrant and seasonal farmworkers United States QS: 3.5/5	*Type*: Quantitative interviews *Aim*: Examine food insecurity in migrant and seasonal farmworkers *Population*: Migrant and seasonal farmworker households in two border	Convenience sample recruited through several different organisations dealing with this group. An adult respondent from 100 households took part in an interview. Administered the 18 item USDA Food Security	Household food insecurity predicted by: ▪ Presence of minor children ▪ Maternal education of 0-6 years vs greater levels of education Food insecurity with hunger predicted by: ▪ Having spent less than 10 years in the US	Very wide confidence intervals. Cross-sectional data. Non-random sampling (note there are no official records kept of this group). Small sample size.

Author	Design	Methods	Results	Limitations
	counties in Texas and New Mexico and who had performed paid farm work in the past 12 months	Module and a shortened version of the California Agricultural Worker Health Survey.		
White 2006[36] Healthy families on American Indian reservations: a summary of six years of research by tribal college faculty, staff and students United States	*Type*: Research summary *Aim*: Review and summary of six years research on food assistance and nutrition on American Indian reservations *Population*: American Indian people living in reservations across the US	Brief summary of a variety of research carried out on different reservations.	▪ Food insecurity prevalent on reservations ▪ Paperwork and eligibility requirements an obstacle to receiving food assistance ▪ In isolated areas transportation is an issue ▪ Few stores on reservations, less access to fresh fruit and vegetable, high prices, and few healthy options ▪ Traditional foods rarely used, and availability and preparation time an obstacle to use ▪ Lack of money to buy food ▪ Food security declined with age ▪ Seasonal workers receive an unsteady income	Study methodologies not provided so cannot be assessed. Results not generalisable outside of these communities.
Hadley 2007[50] Acculturation, economics and food insecurity among refugees resettled in the USA: a case study of West African refugees United States QS: 2.5/5	*Type:* Exploratory research and a survey *Aim:* Examine food insecurity amongst a West African refugee community *Population:* Adult West African refugees in a mid-sized US city with children under the age of five years, who had lived in the US for less than four years	Formative research followed by interviews with 101 participants. Six months later food security status over previous six months measured. Measure adapted from the USDA Food Security Survey Module. Participants recruited through resettlement agencies, WIC meeting places, church groups, and snowball sampling. Survey participants	Formative research showed insufficient economic resources to be main cause of food insecurity “small money – large bills”. Multivariate analysis showed level of acculturation and household size, but not income, predicted food insecurity.	Cross sectional data. Cannot ascertain how representative sample is of newly arrived refugees. Acculturation difficult to measure, and focused on dietary acculturation.

Author	Design	Methods	Results	Limitations
		average age 30 years, five individuals per household, just over half with a high school education or higher, and over half employed		
Sellen 2002[89] Food insecurity among refugee families in East London: results of a pilot assessment United Kingdom QS: 2.5/5	*Type*: Pilot questionnaire *Aim*: Associations with child hunger in recently arrived refugees *Population*: Somalian, Kosovan, and South American refugees arriving in London within the last 24 months, with a pre-school child	Formative research and pre-testing guided development of a questionnaire. Food security assessed using Radimer/Cornell scale. Ten mothers interviewed from each ethnic group (total n=30) from a list provided by The Children's Society. Further participants identified using snowball technique.	Refugee households with child hunger, compared to those without child hunger, more likely to have recently arrived in the UK, filed application for asylum, or moved to London more recently.	Does not account for confounding. Designed to pilot survey methodology. Likely to be selection bias as only sampled refugees in contact with an aid agency. Small sample size.
Elderly				
Lee 2001[26] Factors associated with food insecurity among US elderly persons: importance of functional impairments United States QS: 4/5	*Type*: Surveys *Aim*: To examine how functional impairment is associated with food insecurity in the elderly *Population*: Nationally and state representative sample of elderly persons aged 60+ years	Data from the NHANES III survey (n=6,596) (one-item question) and the Nutrition Survey of the Elderly in New York State (n=553) (three-item question).	Functional impairments (especially in activities of daily living) and sociodemographic variables made substantial contributions to predicting food insecurity. Low income, low education, minority status, participation in a food assistance program, and social isolation significantly related to food insecurity.	Cross-sectional data.
Temple 2006[27] Food insecurity among older Australians: prevalence, correlates and	*Type*: National survey *Aim*: Examine characteristics of the food insecure	Face to face interviews carried out in the 2001 National Health Survey. A sub-sample of 4,650 participants, of	Highest prevalence of food insecurity amongst: ▪ Single people ▪ Low-income earners ▪ Multiple chronic health conditions	Food security status assessed with only one question. Cross-sectional data. Small sample size of food

Author	Design	Methods	Results	Limitations
wellbeing Australia QS: 4/5	*Population*: Australians aged over 55 years	whom 2.8% food insecure. Food security assessed with one question.	Food insecurity decreased with age in this age bracket. Geographical location, education, country of birth, and employment status not significantly related.	insecure participants (n=121).
Nord 2006[60] Seasonal variation in food insecurity is associated with heating and cooling costs among low-income elderly Americans United States QS: 2.75/5	*Type*: National survey *Aim*: Association between high heating or cooling costs and food insecurity *Population*: Households with income below the poverty line and with no school-aged children from a nationally representative sample	Data from the 1995-2001 Current Population Survey Food Security Supplements and state-level data on heating and cooling degree days. A 30-day measure of adult food security used. Data for 20,058 households (5,768 with an elderly member, and 12,775 without) used.	In States that have high winter heating demands, households experience more food insecurity in winter than in summer. In States that instead have high summer cooling demands, food insecurity levels are higher in summer. This finding was significant in elderly households, but not in households without elderly members.	Cross-sectional data.
Quandt 1999[91] Hunger and food security among older adults in a rural community United States QS: 3.5/5	*Type*: Structured interviews *Aim*: Level and predictors of food insecurity among older adults *Population*: Representative sample of residents of rural Appalachia 65 years of age and older	192 participants from a random sample of 22 sites which could provide a listing of elders (eg. churches, senior centres, clubs, clinics etc). 91% response rate. Survey items on food security developed for this study, and content validity established. 24% had at least one indicator of food insecurity.	Strongest predictors of food insecurity in elderly were taking three or more prescription drugs, income <150% of poverty line, and eating alone.	May not be generalisable to other areas.
Quine 2006[37] Food insecurity in community-dwelling older	*Type*: Population based survey *Aim*: Extent and characteristics of older people	CATI interviews with 9,000 people in The Older Person's Health Survey in 1999/2000.	Significant positive risk factors for older males were struggling financially and lower self-rated health. Private health insurance was negatively associated.	One question only used to assess food security, and that question focused on finances as a cause.

Author	Design	Methods	Results	Limitations
Australians Australia QS: 4.5/5	who experience food insecurity *Population*: Representative sample of people aged 65 years and over in New South Wales who were living independently	A random selection of at least 500 older people taken from each of the 17 area health services in NSW. One question asked on food security. Response rate 71%.	For females, positive predictors were renting, living alone, struggling financially, and a self-reported less healthy lifestyle. Negative predictors were older age and private health insurance.	Cross-sectional data.
Wolfe 1996[176] Understanding food insecurity in the elderly: a conceptual framework QS: QL 4.5/5	*Type*: Interviews *Aim*: Develop a conceptual framework to understand factors influencing food insecurity in the elderly *Population*: Elderly low-income rural white and urban black people living in upstate New York	Open-ended in-depth semi-structured interviews conducted with a purposive sample of 41 individuals in 35 households. Recruited through subsidised housing programs, food pantries, and meal deliver programs. Majority of participants were female, aged 70-79 years, had health problems, and used one or more food programs.	A conceptual framework of the factors related to food insecurity was developed based on the experiences of participants. See Figure 7 for the conceptual framework.	Some participants had difficult hearing and understanding questions. Limited generalisability.
Wolfe 2003[177] Understanding the experience of food insecurity by elders suggests ways to improve measurement United States QS: QL 4.5/5	*Type*: Semi-structured interviews *Aim*: Conceptualise food insecurity in elders *Population*: Latino and non-Latino elderly households in upstate New York	Two in-depth interviews carried out six months apart with 25 Latino and 28 Caucasian elders.	Themes emerged that food security impacted by: ▪ Lack of money ▪ Transportation limitations ▪ Health or mobility limitations ▪ Not the right foods for health ▪ Financial priorities ▪ Compromises on food quantity and quality ▪ Lack of motivation to cook or eat	Not generalisable.

Author	Design	Methods	Results	Limitations
Table 8: Interventions				
DeWolfe 2003[77] The basic shelf experience: a comprehensive evaluation Canada QS: 2.75/5	*Type:* Pre- and post-test evaluation *Aim:* Evaluate the Basic Shelf Experience program to assist people on a low-income manage their food resources *Population:* Participants in the program	Evaluation of the Basic Shelf Experience, which consists of six weekly meetings where participants plan, prepare, and eat meals. Facilitators discuss suggested topics. Assessment via questionnaire pre- (42 participants) and post-course (20 participants), and focus groups (17 participants) at three months post-intervention. Radimer/Cornell food insecurity instrument and Rosenberg self-esteem scale administered.	Quantitative results showed no significant change in food security up to three months post-intervention. Qualitative results showed positive changes in shopping, planning and meal preparation and increased confidence. Still faced barriers of living in a rural area, limited transport, and insufficient money which impacted on food security.	Small sample size. Possible sampling bias. Under half the sample completed the post-questionnaire, and only 40% returned for the three-month follow up assessment.
Dollahite 2003[78] The impact of nutrition education on food insecurity among low-income participants in EFNEP United States QS: 3.5/5	*Type*: Pre- and post-test comparison group design *Aim*: Impact of nutrition education on food security status *Population*: Participants in the Expanded Food and Nutrition Education Program in New York State	16,146 participants in the EFNEP, a community-based nutrition education program aimed at low-income families with children. Comparison between 15,846 graduates of the program and 300 participants who completed at least six lessons, but did not fully complete the program (terminators). Food security status assessed by one question.	Food insecurity decreased more in graduates of the program compared to terminators. Dose-response relationship between number of lessons received and decrease in food insecurity. Being taught in a group reduced food insecurity less than those taught individually.	Small comparison group, and comparison group had still received a reasonable number of lessons. Food security assessed with one question only, and it has not been formally validated. Mean food security score low to start with – between 'seldom' and 'sometimes' experienced over the previous month.

Author	Design	Methods	Results	Limitations
Herman 2006[95] Choices made by low income women provided with an economic supplement for fresh fruit and vegetable purchase United States QS: 2.5/5	*Type*: Non-randomised control group trial *Aim*: Investigate uptake and use of a welfare supplement specifically for fresh fruit and vegetables *Population*: Postpartum women enrolled in the Special Supplemental Program for Women, Infants, and Children in Los Angeles, aged >18 years	602 women enrolled from three WIC centres in Los Angeles in 2001. Participants recruited sequentially. Two-month baseline assessment of fruit and vegetable consumption via 24-hour recalls. Participants given $10/week vouchers for fruit and vegetables at either a farmers market or supermarket over a six-month period. Control group issued with vouchers for diapers. Participants had similar socio-demographic characteristics to those in other WIC centres.	Redemption rates for vouchers 90.7% at farmers market and 87.5% at supermarket. Five fruit and five vegetables accounted for 70% of the items purchased.	Control group data not reported. Change in fresh fruit and vegetable consumption not reported (reported elsewhere but cannot locate). Purchases self-reported. Did not assess impact on food security in this low-income group.
VicHealth 2006[39] and Elsworth 2005[40] Food for All: lessons from two community demonstration projects Sustainability in health promotion: case studies of two food insecurity demonstration projects Australia	*Type*: Report and summary document *Aim*: Improve access to healthy food for food insecure people through community projects *Population*: Melbourne	Braystone Project offered both a shop, delivery service, and mobile market stall for affordable fresh fruit and vegetables. The other project is not reported here as it was targeted at homeless people.	Most successful component was weekly mobile market stalls at two high-rise public housing estates. They improved access and provided social interaction among residents. This was not as successful at two low-rise housing estates.	Unable to access the evaluation reports.

Author	Design	Methods	Results	Limitations
Table 9: Associated factors (but did not directly assess food security)				
Howell 2000[71] Still missing out: how welfare entitlement is denied New Zealand	*Type*: Report *Aim*: Highlight that low income earners are not receiving entitlements to a Special Benefit from WINZ *Population*: New Zealanders receiving a benefit and accommodation supplement	Through the Official Information Act, Department of Work and Income figures were obtained and entitlements calculated.	In early 2000, nearly 131,000 households not receiving entitlement to Special Benefit. Conditions of entitlement eased in July 2000, increasing the number to 175,000 not receiving Special Benefit (note this report was written in July 2000). On average, households missing out on $22/week.	Report is now seven years out of date. Did not assess impact on food security.
Ling 2005[178] A comparison of prices for 'healthy' and 'less healthy' food baskets in contrasting neighbourhoods	*Type*: Dietetic student practicum - food basket survey *Aim*: Does the cost of a healthy vs less healthy food basket differ in supermarkets in a more and less deprived area *Population*: Christchurch supermarkets	Three focus groups run with people from more deprived area to determine foods commonly bought. 16 foods included in a food basket (less healthy) with a healthy alternative food basket made up. Prices of 157 food items recorded and compared between a discount and full service supermarket in a less and more deprived area. Comparison of costs for a healthy vs less healthy food baskets between a most and least deprived area.	More foods expensive in most deprived area at both full service and discount supermarket. Healthier food basket more expensive than the less healthy food basket in both areas by $13-$15. Less healthy food basket slightly cheaper in the more deprived area by -$0 to -$5. Healthy food basket slightly more expensive in the more deprived area by $1-$2 compared with less deprived area.	The healthy basket included some unnecessarily expensive alternatives, and was not a complete food basket. Included price of foods on 'special', which widened the gap between baskets in the more deprived area, and reduced the gap in the less deprived area. Assessed prices in a one-week period only. Does not address impact on food security.
Ministry of Health 2007	*Type:* Longitudinal evaluation	Yearly interviews and surveys of schools and a sample of 591	Fruit in Schools project considered successful by principals, teachers, and students. Increased focus	Full evaluation report not available. Information available does

Author	Design	Methods	Results	Limitations
	Aim: Evaluate the Fruit in Schools initiative *Population:* Around 280 New Zealand schools (mostly decile 1)	students in the Fruit in Schools project.	on health in schools, and most were changing policies and school activities. Students developed more positive attitudes to health, and some had started to change behaviours. Number of students eating fruit and vegetables, and amount eaten, had increased.	not specifically address food security aspects.
Pearce 2007[179] Are socially disadvantaged neighbourhoods deprived of health-related community resources?	*Type*: GIS mapping *Aim*: Whether access to community resources varies by area deprivation *Population*: New Zealand	GIS mapping of community resources by Census meshblock area. Access was by street network and travel time. Each meshblock categorises into a quintile of deprivation, based on 2001 NZDep data.	Access to all community resources was better in more deprived areas (recreational, shopping, educational, health, and marae facilities), except for beaches. This included access to fruit and vegetables.	Access was defined by location only, and travel times were for access by car only. Quality of facilities was not assessed. Perceived safety of neighbourhood may impact on use of facility.
Pearce 2007[180] Neighbourhood deprivation and access to fast food retailing: a national study	*Type*: GIS mapping *Aim*: Whether access to fast food varied by area deprivation *Population*: New Zealand	Food outlets throughout New Zealand geocoded. Distance by road to each food outlet from the centre of each meshblock measured by GIS, and linked to area level NZDep. Distance also measured from schools.	Greater numbers of all food outlets found in more deprived areas, including fast food outlets.	Does not assess actual consumption patterns.
Waldegrave 2003[57] Assessing the progress on poverty reduction	*Type*: Paper *Aim*: Summarise results of the New Zealand Poverty Measurement Project's poverty and policy analysis *Population*: Low-	Data from comprehensive focus group with low-income households throughout New Zealand, the Household Economic Survey, and other surveys and qualitative	Established poverty threshold as 60% of median, equivalent, disposable household income after adjusting for housing costs, although this may vary year after year. For Maori a minimum adequate budget must allow for contributions to	Some cross-sectional data

Author	Design	Methods	Results	Limitations
	income households in New Zealand	studies.	tangihanga and whānau, and for Samoan must include expenditure of church and family here and in the Pacific[181]. Superannuation, income-related rents, and active labour market policies introduced this decade have reduced poverty rates.	
Williams 2006[46] Te Wai O Rona Diabetes Prevention Strategy: directory of kai outlets	*Type:* Food cost and availability survey *Aim:* Prevent type 2 diabetes amongst Maori *Population:* Maori within the Waikato and Lakes District Health Board areas	Assessed variations in food availability and cost in the Waikato. Methodology not available	In Hamilton CBD, Thames-Coromandel, Hauraki, Matamata-Piako, Waipa, Otorohanga, and South Waikato wide variety of healthy food options available at reasonable price. Further away from Thames, more expensive to purchase healthy options, except for meat. Healthy food less available in small rural areas in Waikato, Kawhia, smaller coastal townships near PioPio and Te Kuiti, and rural areas around Taupo and Turangi. Small price difference in healthy food options in PioPio and Te Kuiti, and lean meat expensive. Healthy options more expensive, except for meat, in rural regions around Taupo.	Methodology for this part of project not currently available. May not be generalisable to other localities. Did not assess impact on food security.
Ni Mhurchu 2007[182] The price of healthy eating: cost and nutrient value of selected regular and healthier supermarket foods in New Zealand	*Type*: Shopping basket comparison *Aim*: Estimate cost and nutrient differences between healthy and regular foods *Population*: Supermarket shoppers in Wellington	882 participants contributed electronic supermarket shopping data over a one-year period. A healthy and regular shopping basket was modelled from top-1000 selling food items, derived from sales data.	No major difference in overall cost of a healthy and regular food basket. Healthy food basket for a household cost ~$6/week more than regular basket. Healthier options more expensive for meat/poultry, butter and margarine, and cheese, and cheaper for tinned fish.	Sales data was from a single supermarket. Sales data only for the top-1000 selling items. Comparison across a limited number of food categories.

Author	Design	Methods	Results	Limitations
Dubowitz 2007[183] Lifecourse, immigrant status and acculturation in food purchasing and preparation among low-income mothers United States	*Type:* Focus groups *Aim:* How lifecourse, immigrant status, acculturation, and neighbourhood influence food purchasing in low-income groups *Population:* US and foreign-born low-income mothers with young children living in two metropolitan areas in Massachusetts	Purposive sample of 44 women who had completed a 12-month RCT of a nutrition and physical activity program.	Limited food and limited access to food outlets did not influence food purchasing and preparation as much as time limitations (especially in US born women) and transportation. US born women would shop at one or two nearby places and were more likely to use convenience food. Immigrant women would shop in a variety of shops. Price a key determinant of where they food shopped.	Likely to be sampling bias. Unable to disentangle whether differences between groups were due to neighbourhood or immigrant status. Not a representative sample and attitudes may possibly have been biased by their participation in earlier nutrition RCT. Did not specifically assess food security.
Blisard 2006[72] How low-income households allocate their food budget relative to the cost of the Thrifty Food Plan United States	*Type*: Modelling *Aim*: Budgeting of food expenditure by low-income households in comparison to the Thrifty Food Plan (TFP) benchmark *Population*: Low-income households that are female-headed with children, married with children, single females, and elderly couples across the US	Comparison of food expenditure from the 2002 Consumer Expenditure Survey (n=3,235) to the cost of the Thrifty Food Plan benchmark, modelled for various household types.	Expenditure on food at home and away from home averaged 125% of the TFP. The comparatively lowest spend was on fruit and vegetables, on which low-income households spent only 53% of the recommended TFP amount. Spending on food at home in comparison to the TFP was 96% for elderly couples, 93% for single women, 73% married with children, and 82% for female head with children. Low-income households first allocated food to meat/eggs/cereals/bakery products. Expenditure on fruit and vegetables and dairy only rose when income was above 130% of the poverty line.	Nuts and dry beans included in the TFP fruit and vegetable category to allow comparability with Survey data.
Burns 2004[184] Food cost and availability in a rural setting in	*Type:* Healthy food basket access survey *Aim:* Costs and	Cross-sectional survey of costs and availability of the healthy food basket in 53	56% of stores stocked the complete healthy food basket. More likely to be available from chain-stores than	Measures availability but not impact on consumption.

Author	Design	Methods	Results	Limitations
Australia Australia	availability of a healthy food basket *Population:* towns with over 100 people in rural Victoria	shops in 42 rural towns. 72% shop response rate. Food basket consisted of 44 items for a family of six for two weeks	independent stores in towns with only one grocery store. Poor access to a healthy food basket in 15/42 towns. Basket was cheaper in chain stores. High variability in cost of fruit and vegetables.	
Coveney 2006[185] Conference presentation: community food security issues in Australia Australia	*Type*: Semi-structured interviews *Aim*: To explore the experiences of people who live in a food desert *Population*: Adelaide, South Australia	Interviews with 16 households, six of which were in a food desert. Comparison of people living more than 2.5km from nearest supermarket or without a car compared with those living closer than 2.5km.	Food desert status is determined by mobility (including reliable and appropriate transport) not geography (distance to supermarket). Public transport unrealistic for most households.	Small sample size Taken from a conference presentation, paper not available. Unpublished data. Not a representative sample.
Giskes 2007[186] Socioeconomic inequalities in food purchasing: the contribution of respondent-perceived and actual (objectively measured) price and availability of foods Australia	*Type*: Face to face survey and supermarket audit *Aim*: Whether perceived and objective price and availability of recommended foods contributes to differences in food purchasing by household income *Population*: n=812 households in areas representing each deprivation index level.	Part of the 2000 Brisbane Food Study. (1) Face to face interviews to assess food purchasing behaviour and perceptions of availability and price of a range of foods (recommended vs regular choices). (2) Supermarket audits to objectively assess price and availability of 'regular' and 'recommended' food choices. The supermarkets audited were where participants usually shopped.	Neither objectively measured nor perceived price differences made a difference to explaining inequalities in food purchased (<5%). Perceived availability explained 5-10% of the inequality in less healthy food purchasing by the lowest-income households.	Did not assess actual food purchases. Did not assess impact on food security.
Jones 2007[118] Obesogenic environments evidence review	*Type*: Evidence review *Aim*: Consider evidence	Database search of Medline, CINAHL, EMBASE, AMED, PsychLit,	US and Canadian research suggests differences in price and availability of healthy food by neighbourhood,	Many of the studies included were cross-sectional.

Author	Design	Methods	Results	Limitations
United Kingdom	regarding existence of obesogenic environments *Population*: N/A	SciSearch, GEOBASE, SIGLE and Sports Discus. Did not include grey literature.	based on deprivation or race. This finding has not been supported by recent large observational studies in the UK. Introducing large-scale supermarkets into deprived areas does not increase fruit and vegetable consumption.	
Macintyre 2007[141] Deprivation amplification revisited; or, is it always that poorer places have poorer access to resources for healthy diets and physical activity?	*Type*: Debate *Aim*: Does deprivation amplification exist? *Population*: N/A	Not provided.	Evidence on deprivation amplification is inconsistent - appears to be location and resource specific. Research shows some poorer areas are in fact better served in their nutrition environment. Differences in US, UK, and Australian research likely to be due to urban sprawl and racial segregation.	Presents a wide range of relevant literature to support argument but was not intended to be a systematic review of all literature.
Robinson 2000[187] Access to shops: the views of low-income shoppers United Kingdom	*Type*: Survey *Aim*: Opinions of low-income people on shopping facilities and barriers to use *Population*: Adults from two lowest social classes (D and E) living in urban areas	Face to face interviews with 503 adults, with quota sampling from 88 deprived areas across England. ¼ of participants were over 65 years of age, 20% were in full time employment, and 41% had dependent children. Descriptive statistics presented.	Local supermarkets most frequently visited shop because more convenient. Local shops used because convenient and easy to use. Big supermarkets used because seen as cheaper with a wider range of goods. Biggest barrier to using better shopping facilities was distance. 4/5 top barriers to use related to transport.	Cross-sectional data. Food retail structure in the UK different to NZ. Did not assess their impact on food security.
Tang 2007[188] Adelaide healthy food basket Australia	*Type*: Healthy food basket survey *Aim*: Assess food accessibility and affordability in Adelaide *Population*:	Healthy food basket had been previously developed, and contained 44 core foods and 13 extra foods. Developed for a reference family of five (three adults, two children) for	Cost of a healthy food basket was lower in lower SES areas and tended to be higher in high SES areas. Items in the healthy food basket were largely available in all supermarkets. The healthy food basket cost 35% of the average weekly wage and 31% of	Only assessed price and availability at supermarket, green grocer and butchers. Study was conducted over a five-month period and there may have been seasonal price fluctuations over that time. Did not assess impact on

Author	Design	Methods	Results	Limitations
	Suburbs from five council areas with varying SES in Adelaide	one week's food. Brands stipulated for some foods, but allowed substitution with cheaper alternatives for others. Supermarkets within each council area selected based on presence of a supermarket, green grocer and butcher close by.	welfare payment for a family of five (three adults).	food security.
Travers 1996[189] The social organization of nutritional inequities Canada	*Type*: Qualitative research – participant observation and in-depth interviews *Aim*: To explain the social organisation of nutritional inequities among socially/ economically disadvantaged women and their families *Population*: Low-income residents in an urban neighbourhood in Nova Scotia	Interviews and observation of five economically disadvantaged households; group interviews at a community drop-in centre	Approximately 5% price differential between inner city stores (more expensive) and suburban stores. However, did not have the time or money to travel further to cheaper stores. Children influenced by advertising campaigns, and influenced parents to buy (more expensive) advertised products. Benefits insufficient to cover cost of a nutritious food basket and insufficient to cover all necessities. Nutrition recommendations often completely impractical.	Not representative and small sample size.
Cassady 2004[94] Doing well by doing good? A supermarket shuttle feasibility study. United States	*Type*: Breakeven analysis *Aim*: Can a supermarket shuttle be self-supporting? *Population*: Low-income urban areas in California	Literature search and interviews with five supermarket managers who operated a supermarket shuttle service. Market analysis to identify areas which could support a shuttle service. Breakeven	Assumptions made in the analyses were that: ▪ The annual cost of a van and driver is US$63,444 ▪ Weekly food expenditure per household of US$25 ▪ Gross margin for supermarkets was 26.4% ▪ The 67 target areas had a population of over 3 million If 5% (n=181) of transit-	Used a single zip-code as the boundary for the supermarket catchment area. Potential cost-savings from reduced loss of shopping trolleys not included in analysis. Weekly estimate of food expenditure at the supermarket was low. Petrol prices have since risen.

Author	Design	Methods	Results	Limitations
		analysis to determine financial feasibility of a shuttle service in the 67 target areas identified.	dependent households in the area used the shuttle, it would take 16 months to break even. If 10% (n=361) used the shuttle, it would take eight months.	Different population density to New Zealand. Did not estimate effect on food security.
Awaiting results				
Project Energize	*Type:* Evaluation *Aim:* Improve health and wellness of children *Population:* School children in the Waikato region	Project Energize incorporates a range of nutrition and PA initiatives. 62 programme schools and 62 control schools involving approximately 62,000 children.	Project in progress, formal evaluation not completed. Free milk and fruit in decile 1 schools. Anecdotal evidence from a principal that lunchbox theft has stopped now that free fruit and milk provided in school [personal communication: Elaine Rush].	Evaluation results not yet available.

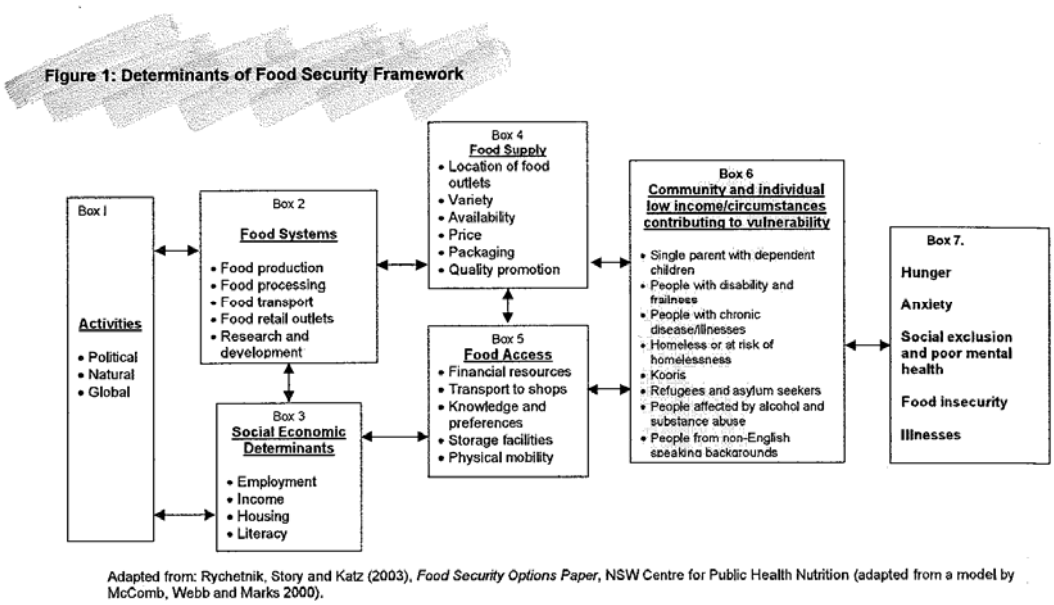
Author/study name	Design	Methods	Results	Limitations
Table 10: Models				
NSW Health 2003[3] Food Security Options Paper: a planning framework and menu of options for policy and practice interventions Australia	*Type*: Options paper *Aim*: A guide to intervention options for food security in New South Wales *Population*: N/A	Materials and literature review. Identification of conceptual frameworks. Consultation with experts. Search of other sources.	Who is food insecure? ▪ Socio-economically disadvantaged or low disposable income ▪ Not confined to only the poorest people. Can also affect those with higher than average living costs (eg. chronic illness, high rent area, unexpected events) ▪ People who are disadvantaged due to disability, ill health or other physical or social factors. Determinants of food security framework, see Figure 2 below. Food supply: ▪ Location of food outlets – accessibility of outlets that provide a diverse range of affordable foods ▪ Small convenience stores tend to be expensive with an inadequate range of foods ▪ Availability in stores - regular availability of healthy and appropriate foods ▪ Price – a key feature in determining what low-income households eat. Food security is improved when fresh produce such as fruit and vegetables are affordable and when low-fat or high fibre products are competitively priced. ▪ Quality – good standards of quality and freshness ▪ Variety – wide variety of foods available ▪ Promotion – the way food is promoted in the local area impacts on ability to identify, locate and choose foods – eg.	Evidence base of model it is based on unclear.

Author/study name	Design	Methods	Results	Limitations
			specials, instore promotions, positioning of food and outlets, and advertising Access to food: ▪ Financial resources to buy good quality food ▪ Distance and transport to shops (especially supermarkets) ▪ Knowledge, skills and preference – knowing how to choose and prepare healthy foods on a limited budget ▪ Storage facilities for food ▪ Preparation and cooking facilities ▪ Time to prepare foods (rather than rely on convenience foods) and mobility (ability to shop and prepare meals) ▪ Social support – support networks to assist with transport, purchase, or preparation of food	

Figures

The following figures are examples of the various models that have been developed in relation to food security.

Figure 3: Determinants of food insecurity framework, VicHealth[2]



Adapted from: Rychetnik, Story and Katz (2003), *Food Security Options Paper*, NSW Centre for Public Health Nutrition (adapted from a model by McComb, Webb and Marks 2000).

Figure 4: Determinants of Food Security, NSW Health[3]

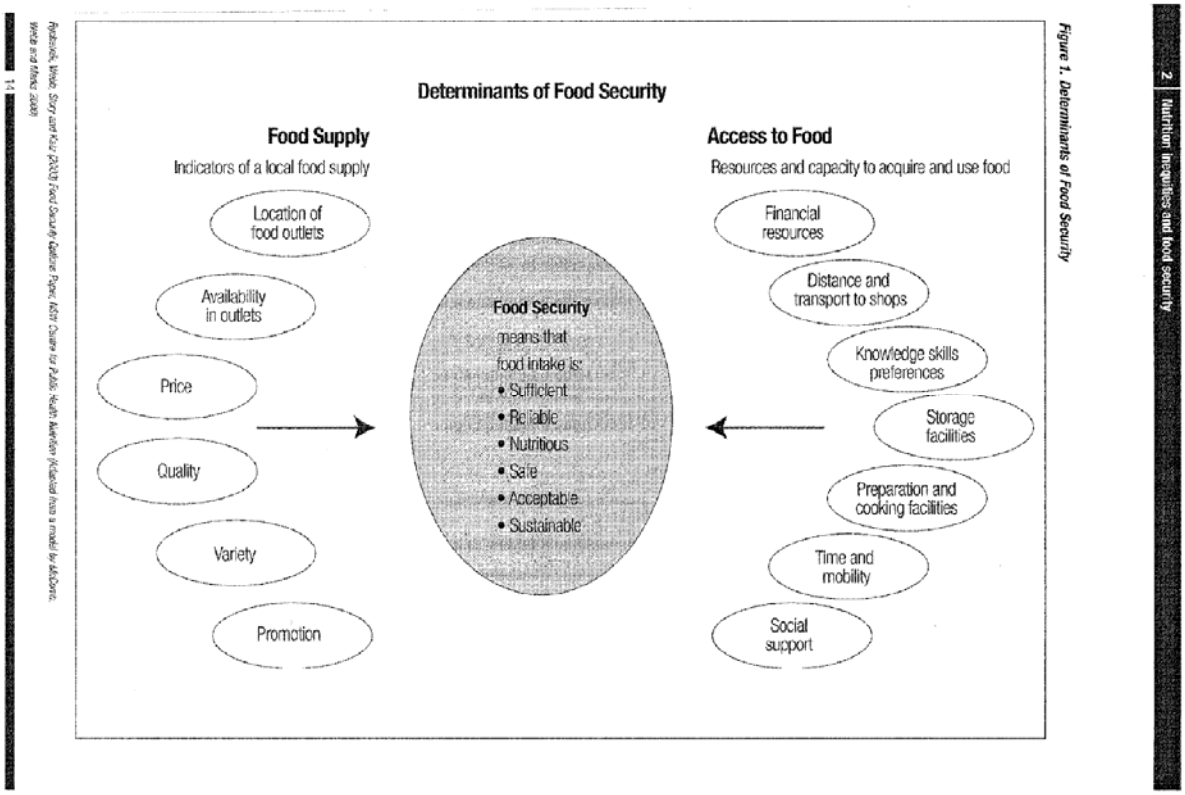


Figure 5: A conceptual overview of factors influencing the supply and access to food, McComb, Webb and Marks 2000[190]

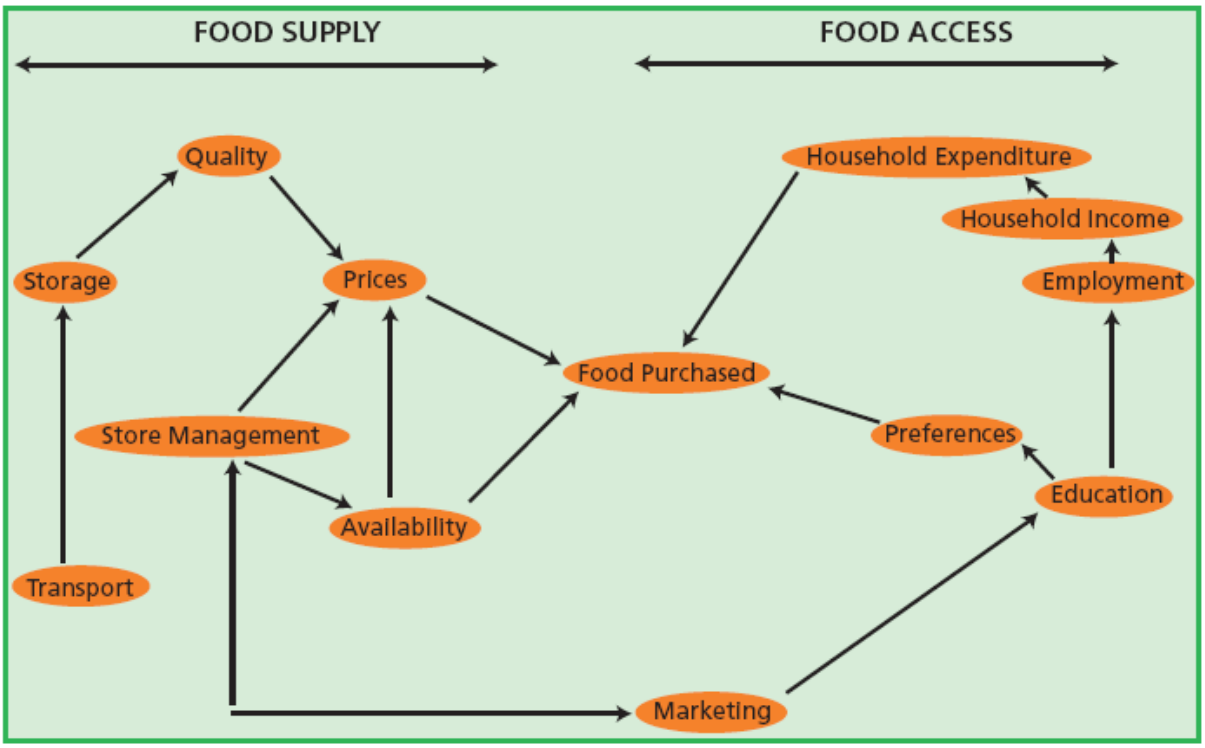


Figure 1: A conceptual overview of factors influencing the supply and access to food, and their relationship to price, quality and consumer buying patterns.

Figure 6: Conceptualisation of food insecurity and its risk factors, Campbell 1991[169]

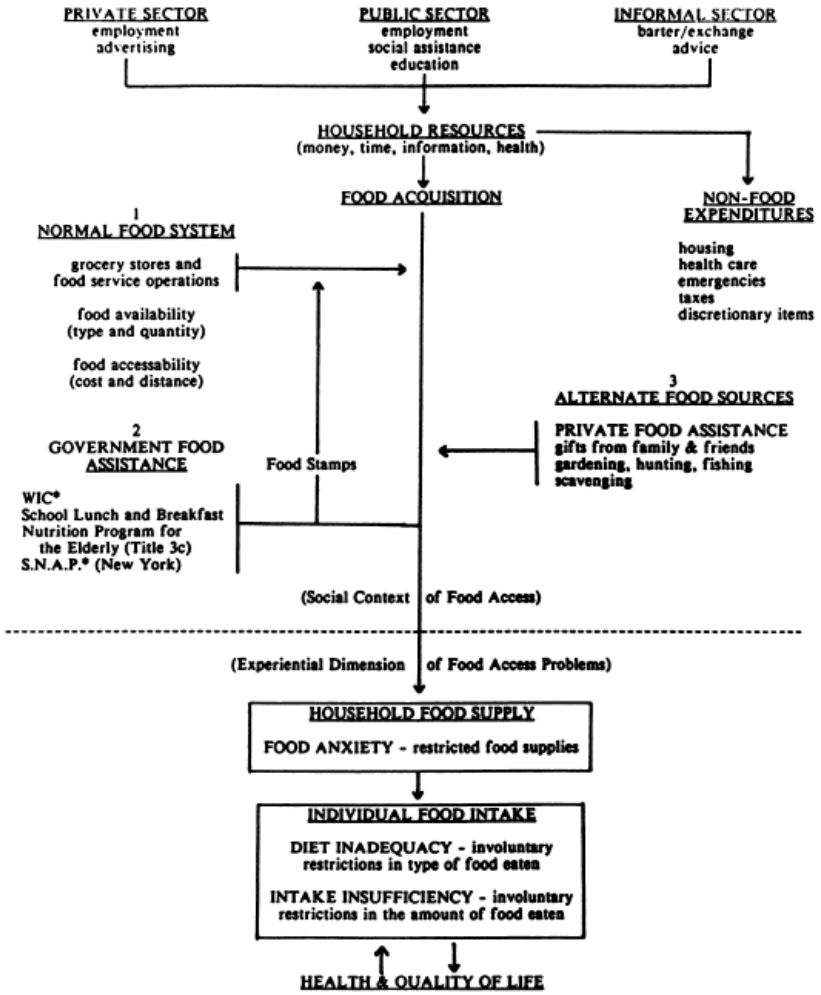


FIGURE 1 Conceptualization of food insecurity and its risk factors. *W.I.C. = Women, Infants and Children Supplemental Food Program, S.N.A.P. = Supplemental Nutrition Assistance Program.

Figure 7: Interactions of food insecurity and hunger, Reid 1997[38]

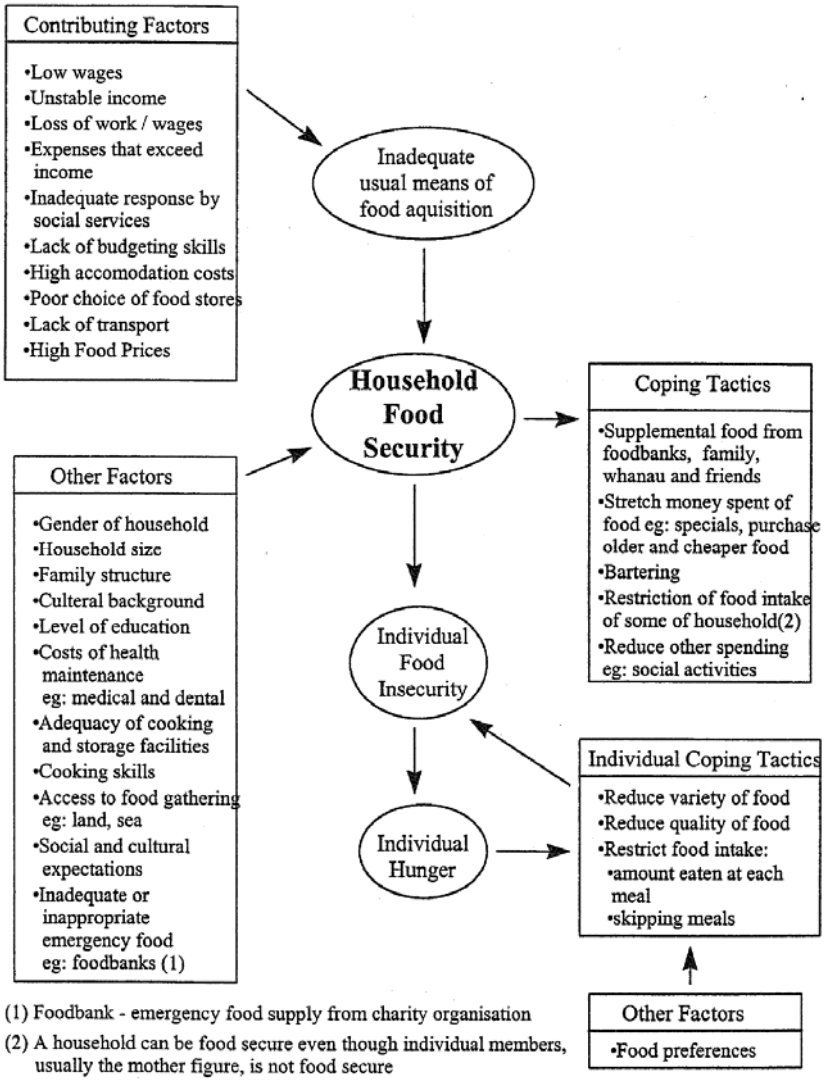


Figure 8: Food insecurity in the elderly - a conceptual framework (double boxes indicate key factors) Wolfe 1996[176]

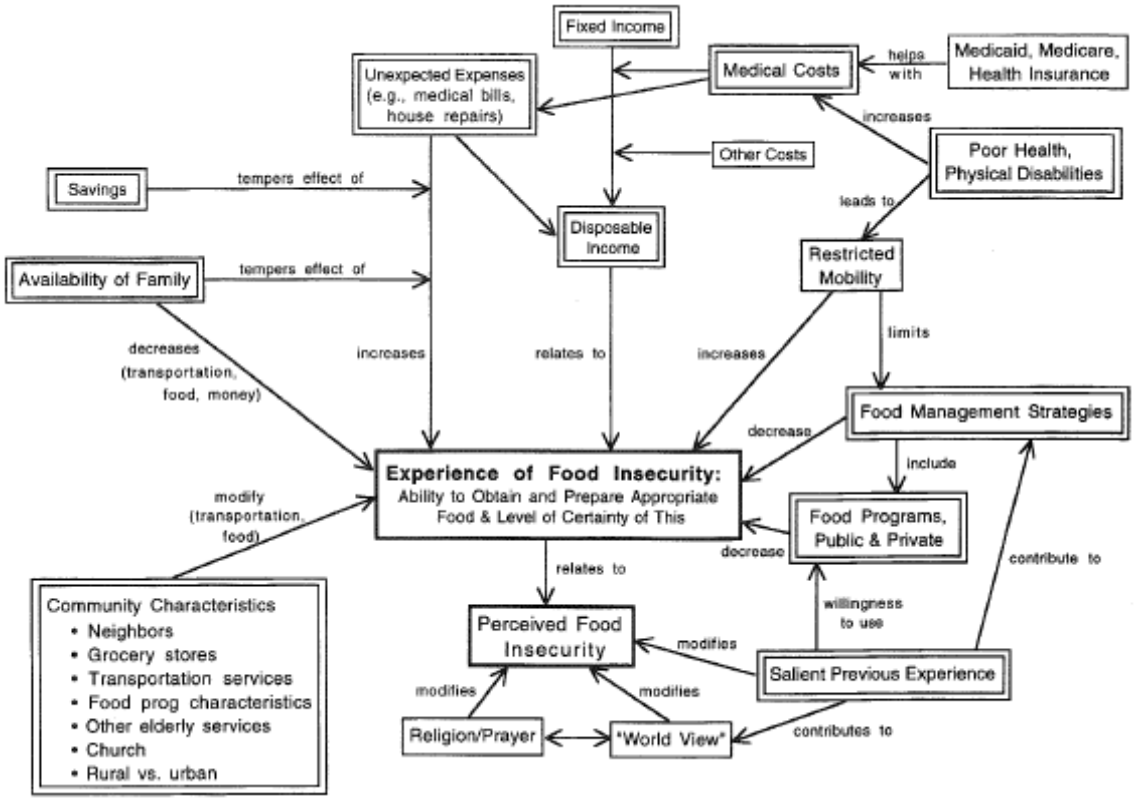


Figure 9: Influences on food choices, WHO 2007[191]

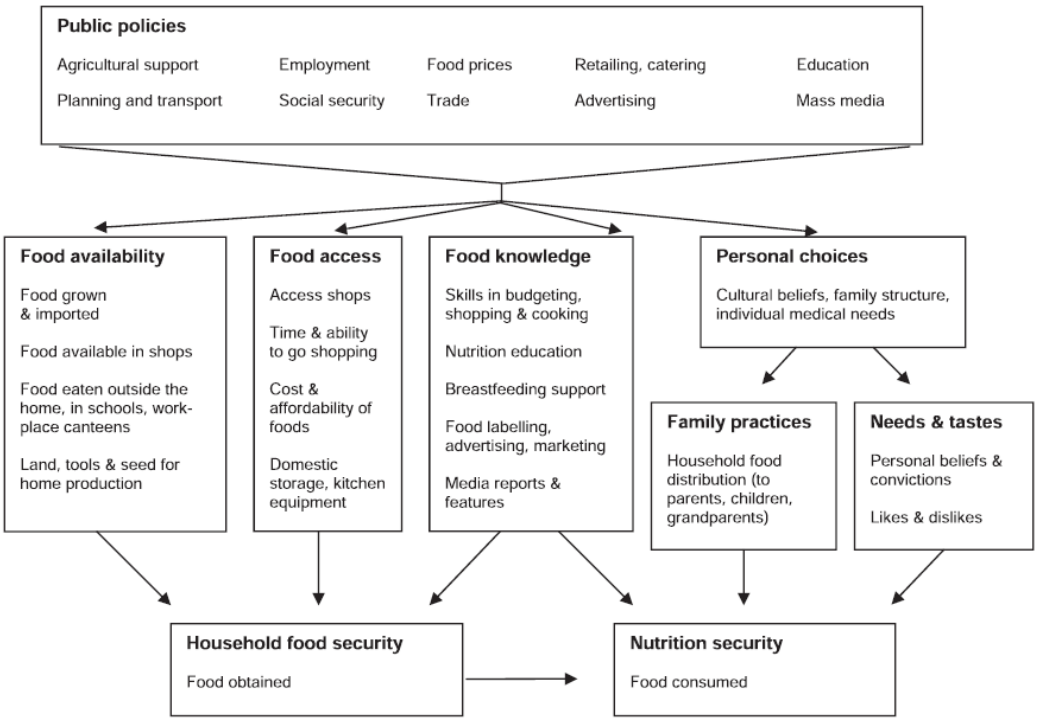


Figure 1 Influences on food choices (Source: WHO 2003).

Appendix 3: Ecological influences on food security (not reviewed)

	Physical	Economic	Political	Socio-cultural
Micro (local) settings	▪ Soil erosion ▪ Maintenance of soil quality and use of fertilisers ▪ Food safety ▪ Water management and supply, building of dams ▪ Small scale fisheries ▪ Sustainable agriculture ▪ Use of pesticides ▪ Organics ▪ Recycling	▪ Access to affordable biotechnology (eg. drought resistant crops)		▪ Growth of traditional food crops ▪ Maintaining a seed bank of traditional crops (ie. heritage seeds)
Macro settings	▪ Climate change ▪ Carbon sequestration in soil ▪ Use of food crops to produce biofuel ▪ Floods, droughts, environmental crises ▪ Mad cow's disease and animal health ▪ Land usage	▪ Globalisation and trade	▪ Fisheries management ▪ Pollution control ▪ Food safety policies ▪ Agroterrorism ▪ Water management	

Appendix 4: Summary tables – physical activity

The physical activity summary tables are organised as follows:

- Table 1: Reviews – general
- Table 2: Reviews – physical
- Table 3: Reviews – socio-cultural
- Table 4: Reviews – political
- Table 5: Economic
- Table 6: Reviews – children/adolescents
- Table 7: Studies
- Table 8: New Zealand

Abbreviations:

CBD Central business district
GIS Geographic Information System
PA Physical Activity
PE Physical education
QS Quality score
RCT Randomised Controlled Trial
SES Socioeconomic status
UK United Kingdom
US United States of America

Author	Design	Methods	Results	Limitations
Table 1: Reviews - General				
Brug 2006[105] Revisiting Kurt Lewin: how to gain insight into environmental correlates of obesogenic behaviors QS: 2/7	*Type:* Six systematic reviews *Aim:* Summarise evidence on environmental factors and obesity-related behaviours *Population:*	297 observational studies and 112 intervention studies published before 2005 reviewed. Methodology fully described elsewhere, unable to obtain.	Observational studies do not support effect of environment on PA. Intervention studies, however, show positive influence of physical environment on PA in adults. Also appear to support socio-cultural and economic environmental interventions.	Unable to assess review methodology. Lack of high quality studies and study replications in included papers. Weak study designs and measurement instruments. Most observational

Author	Design	Methods	Results	Limitations
	Children, adolescents, and adults		• Social support appears important for PA • Increasing PA opportunities makes a difference, and schools and worksites good settings to do so. Increasing hours spent in PA at school and improving walking opportunities for adults make a difference • Parental SES indicators show less PA in children from more deprived families • Parents crucial as role models and for using parenting techniques that encourage PA in children	studies cross-sectional. Many potentially relevant environmental determinants not studied. Research focused on micro and not macro level factors. Most studies reported simple associations. Few used multivariate or multilevel analyses. Many intervention studies did not have a control group. Mostly self-reported data with little information about validity of measures.
Cutt 2007[145] Dog ownership, health and physical activity: a critical review of the literature QS: 4/7	*Type:* Review *Aim:* Environmental factors influencing PA level of dog owners *Population:* Adults in general community	Database search of Medline, Pubmed, Biological abstracts, PsycINFO, FAMILY, CAB abstracts, ProQuest, ScienceDirect, and Web of Science. Grey literature examined in areas with limited research. 65 articles included; 51 related to environment.	Increasing evidence that dog owners are more active than non-dog owners. Dogs provide supportive social environment for PA – motivation, social support and increase social interaction with other people. Paucity of evidence on importance of physical and policy environment to dog walking, but has a potentially large impact on ability to exercise dogs. Women more likely to walk dogs if neighbourhood safe, but no relationship in men.	Lack of evidence in some areas, and some studies poor quality.
Jones 2007[118] Obesogenic environments evidence review QS: 3/7	*Type:* Review *Aim:* Evidence on environmental determinants of PA and obesogenic environments *Population:* Particular emphasis on UK findings	Literature from database search (Medline, CINAHL, Embase, Amed, PsychLit, SciSearch, Geobase SIGLE, and Sports Discus), author's library, and recommendations from colleagues. Number of studies	Evidence suggests environment has modest influence on PA, but mechanism not clear. No consistent pattern between perceived environment and overall PA or walking. Safety and convenience had most consistent positive associations with overall PA. Perceived	Reliance on cross-sectional data so cannot show direction of effect. Reverse causality a possibility. Inadequate controlling for confounding. PA usually self-reported. Many studies measure specific forms of PA

Author	Design	Methods	Results	Limitations
		identified not reported.	convenience of local neighbourhoods, but not safety, positively associated with walking. Different associations between men and women but no clear pattern. Patterns of association between objectively measured environmental variables and PA also inconsistent. Coastal proximity and beach access may be positively associated with PA. Modest positive association with urban design and walking (high land-use mix, good access to services) in US studies. See Figure 1 for model of determinants of PA.	and not overall PA. Poor reliability and validity of environmental measures. Frequent lack of a control group or pre-intervention outcome measure in intervention studies. Lack of evidence on cost-effectiveness. Secondary effects of interventions not assessed. No evidence on whether environment has different effects on sedentary and active people.
Ogilvie 2007[114] Interventions to promote walking: systematic review QS: 6.5/7	*Type:* Systematic review *Aim:* Characteristics of interventions effective in promoting walking *Population:* Not stated	Search of 25 databases for interventions or changes related to walking from 1990 onwards, 12 websites, reference lists, and key informant checks. Studies needed control group and to report specific measure of walking. 48 studies included after screening 53,260 studies. Where possible outcomes converted to net change in time spent walking/week.	Five non-randomised trials identified at community level (eg. mass media campaign, community events, modest environmental improvements, walking groups). Three found a significant net increase in self-reported walking (one brief report and one with significant methodological limitations). Most robust evidence for intervention with substantial mass media component. Three studies evaluated walking to school interventions. One small non-randomised study found a significant increase in walking to school. Four miscellaneous non-randomised studies. Significant increases in walking with subsidising employees not commuting by car; and with a 3-year campaign to promote cycling.	Small number of environmental interventions, and often not robust methodologies.

Author	Design	Methods	Results	Limitations
Owen 2004[119] Understanding environmental influences on walking: review and research agenda QS: 3.5/7	*Type*: Review *Aim*: Relationship of environment to walking *Population*: Adults	18 quantitative studies identified examining environmental attributes related to walking. Database searches of PsycInfo, Cinahl, and Medline. 16 cross-sectional studies and 2 prospective. 12 included at least one objective measure of environment.	Modest but consistently positive association of environment with various types of walking. However, in many studies some of these relationships not statistically significant. Environmental attributes associated with transport-related walking differ to those for walking for exercise or recreation. Environmental factors associated with walking: aesthetics, convenience of facilities (footpaths, trails), accessibility of places to walk to (specific destinations, beaches, open spaces, walkability), level of traffic, and composite scores of environmental attributes.	Studies mostly cross-sectional. Small number of studies specific to walking. Assessing relationships with walking only. Many use self-reports and perceived ratings of environment only Some studies did not adjust for confounding.
Wendel-Vos 2007[99] Potential environmental determinants of physical activity in adults: a systematic review QS: 3.5/7	*Type*: Systematic review *Aim*: Potential determinants of PA *Population*: Adult men and women	Database searches of Medline, PsycINFO, Embase and Social Scisearch for observational studies on environmental determinants of PA, published between 1980 and end 2004. 47 papers included. Evidence graded.	Social support and having a companion for PA convincingly associated with PA. Availability of PA equipment convincingly associated with some forms of PA. Possible but less consistent correlations with availability, accessibility and convenience of recreational facilities.	Most studies cross sectional and used non-validated measures of environments and/or behaviour.

Author	Design	Methods	Results	Limitations
Table 2: Reviews - Physical				
Badland 2005[133] Transport, urban design, and physical activity: an evidence-based update QS: 2.5/7	*Type*: Review *Aim*: Evidence on urban design/transport factors and PA *Population*: Not stated	Methodology not given.	Urban design features associated with transport-related PA are density, subdivision age (proxy for urban form), street connectivity, and mixed land use.	Unable to assess methodology. Majority of research country-specific, self-reported measures, and cross-sectional. Sampling and measurement inconsistencies between studies. Three errors made when reporting studies[192].
Duncan 2005[106] Perceived environment and physical activity: a meta-analysis of selected environmental characteristics QS: 6/7	*Type*: Meta analysis *Aim*: Identify the strength and direction of associations between perceived environmental variables and PA *Population*: Adults	50 studies identified from database searches of Medline, Proquest, and Infotrac; manual journal searches; and reference list searches, for studies from 1989 to February 2005. Studies included if measured perceived environment, assessed at least five environmental variables, and used logistic regression for analysis.	Perceived environment has a modest but significant association with PA. Increased PA had significant positive associations with: • PA facilities close by vs not proximal • Presence of footpaths vs no footpaths • Presence of shops and services within walking distance vs none nearby • Heavy traffic not a problem vs a problem Crime, street lighting, and unattended dogs no significant association. Amount of variance in PA accounted for by heavy traffic not a problem (4%), facilities (5%), sidewalks (6%), and shops/services (7%).	PA facilities and presence of services/shops both displayed significant heterogeneity which could not be resolved. Studies used self-reported measures and a variety of different measures. Few studies conducted outside US. Studies all cross-sectional. PA facilities and presence of shops/services displayed significant heterogeneity which could not be resolved.
Foster 2004 [108] Changing the environment to promote health enhancing physical activity	*Type*: Systematic review *Aim*: Potential ability of the natural or built environment to increase physical	Database search of Medline, CINAHL, EMBASE, AMED, PsychLit, SciSearch, GEOBASE, SIGLE, Sports Discus and handsearching	The studies show consistent, small, short-term effects of changing physical environment to increase PA. Three environmental interventions showed:	Only two studies had control groups. Many stair interventions short term. Two of the three

Author	Design	Methods	Results	Limitations
QS: 3/7	activity *Population*: Adults	reference lists. Intervention studies published up to Dec 2001 examining effect of changing environment or using an element of the environment to increase PA, compared against control or pre- and post-test. 14,000 papers identified, and 17 studies included.	• changes to make PA more convenient led to small improvement in fitness compared to control • 7% of employees changed to active commuting post-intervention • and no statistically significant difference in PA levels. Stair interventions (16 studies) led to small increases in stair use, but inconclusive on whether maintained after prompts removed. A review of six studies suggested prompts increased stair use by 54%. Most saw short-term effects up to three months, with one seeing an effect at six months.	environmental interventions were in military settings (and given time during work to exercise).
Gebel 2007[192] The physical environment and physical activity: a critical appraisal of review articles QS: N/A	*Type*: Systematic appraisal of methodological aspects of literature reviews *Aim*: Methodological overview of reviews on PA and physical environment *Population*: N/A	Database search of Medline, CINAHL, DARE/EBM, Psychlit, Pub Med, Avery, and Transportation, and handsearching to identify peer-reviewed papers published between 2000 and 2005. 11 review papers on association between physical environment and PA assessed.	Most reviews omitted between 1/3 and 2/3 of eligible studies. Methodologies not always provided. Some studies reported incorrectly, or physical environment confused with social environment or cognitive factors. Incorrect reporting nearly always made physical environment variables significant when actually either non-significant or not assessed.	
Humpel 2002[117] Environmental factors associated with adults' participation in physical activity QS: 2.5/7	*Type*: Review *Aim*: Determinants of PA in the physical environment *Population*: Adults	Journal scans and database search of PsychInfo, Medline, and Cinahl. 19 quantitative studies identified assessing relationship between physical environment and PA. 16 measured perceived physical environment, and four objectively measured environment.	Consistent associations between PA and perceptions of: • Accessibility • Opportunities for activity • Aesthetics of the environment Weaker relationships between: • Weather (in two studies only) • Safety (of safety aspects, only perceived safe	Studies measured varying outcomes. Differences in methods assessing PA. Mostly cross-sectional studies, with only one prospective study.

Author	Design	Methods	Results	Limitations
			footpaths and unattended dogs related to being active) More significant findings related to vigorous activity.	
Kaczynski 2007[129] Environmental correlates of physical activity: a review of evidence about parks and recreation QS: 3/7	*Type:* Review *Aim:* Relationship of parks and recreation to PA *Population:* Not stated	Included 50 studies published between 1998 and 2005. Sourced from database searches (PsychInfo, PubMed, LeisureTourism Abstracts, and Web of Science) in December 2005, and handsearching. Qualitative studies excluded.	Some evidence that parks and recreational settings associated with PA, but must be interpreted with caution due to methodologies. Natural settings such as trails, parks, and open spaces more likely to be associated with PA than indoor facilities. Increased proximity to parks and recreational spaces appears to be associated with increased PA.	Wide variety of measures or lack of definition for access and proximity. Almost all of the studies cross-sectional.
Lee 2004[130] Physical activity and environment research in the health field: implications for urban and transportation planning practice and research QS: 3.5/7	*Type:* Review *Aim:* Environmental characteristics that are barriers or promoters to PA, especially walking and cycling *Population:* Not stated	20 studies chosen for review. Databases searched include Medline, PsychInfo, and Web of Science. Publications from local public health agencies searched. Literature up to June 2003 included.	Walking preferred form of PA. Biking also popular but to a lesser degree. Close, attractive destinations support walking and biking. Outdoor and free PA facilities most frequently used eg. neighbourhood streets. Built environment not conducive enough to encourage PA eg. distance, safety, facilities. Perceived neighbourhood aesthetics promote PA.	Details not provided on how papers selected.
McCormack 2004[107] An update of recent evidence of the relationship between objective and self-report measures of the physical environment and physical activity behaviors QS: 2/7	*Type*: Review *Aim*: Update evidence on relationship between built environment and PA *Population*: Not stated	30 quantitative studies included from literature published since 2000. Sourced from database search in Medline, ISI Current Contents, SportDiscus, and TRIS Online, and handsearching bibliographies.	Positive associations between both objective and perceived environment and PA. The presence, access to, and convenience of/ shorter distance to PA facilities and destinations positively associated with PA. Neighbourhood functionality (perceived presence of footpaths, perceived personal safety, etc) and perceived visual	Mostly self-reported environmental attributes. Most studies cross-sectional. Differences between studies in how attributes are measured.

Author	Design	Methods	Results	Limitations
			characteristics positively associated with PA. Two intervention studies identified: a recently constructed cycleway did not lead to an increase in total time walking or cycling, but did increase cycle traffic on it over the 5-month period; and stair prompts increased stair usage.	
McIntyre 2007[141] Deprivation amplification revisited; or, is it always that poorer places have poorer access to resources for healthy diets and physical activity? QS: 1/7	*Type*: Debate *Aim*: Does deprivation amplification exist? *Population*: Not stated	No methodology given.	Evidence on deprivation amplification inconsistent, and location and resource specific. Poorer areas may have better PA environment than less deprived areas. The same resource not necessarily health promoting for all, may actually be health damaging for some. Results may not be generalisable between countries eg. US more marked racial segregation and more sprawling. Disadvantage may be in terms of quality rather than quantity. People's behaviour may be more influenced by resources outside of their residential location. Resources in a location may not actually meet the needs of residents and may be used by people from outside the neighbourhood. May be a difference between the influence of actual and perceived presence of facilities on behaviour.	Not a comprehensive coverage of all literature. Cannot assess methodology for inclusions.
Saelens 2003[134] Environmental	*Type*: Review *Aim*: Brief review	Database search of TRANSPORT. 14 studies included.	Positive correlations between physical activity and:	Small number of studies, all US based.

Author	Design	Methods	Results	Limitations
correlates of walking and cycling: findings from the transportation, urban design, and planning literatures QS: 3.5/7	of transportation literature on relationship between neighbourhood and active transport *Population*: Not stated		• Mixed land use • Higher density • Greater street connectivity	Outcomes walking and cycling only. Included studies were inconsistent in evaluating confounding variables.
Sallis 2004[135] Active transportation and physical activity: opportunities for collaboration on transportation and public health research QS: 2.5/7	*Type*: Review *Aim*: Draw together literature from planning, transportation, and health fields on environment and transport- or recreation-related PA *Population*: Not stated	Methodology not provided.	Consistent associations of neighbourhood environment with walking and cycling for transport: • Proximity and connectivity impact on active transport • Residents of high walkability neighbourhoods report two times more walking trips than those in low-walkability neighbourhoods. Difference likely due to utilitarian trips such as shopping, as no difference in levels of walking for exercise • Population density consistently positively correlated with walking • Land use mix related to more walking/cycling • Limited evidence suggesting positive effect of better walking/cycling infrastructure Availability and proximity of recreational facilities associated with PA. Programs aimed at increasing active commuting have increased prevalence and frequency of active commuting.	Unable to assess review methodology.
Transportation Research Board and Institute of Medicine 2005[132] Does the built environment	*Type*: Report *Aim*: Role of land use and travel patterns to PA *Population*: US population	Literature review, workshops, Committee briefings, and expert review.	Characteristics of built environment can be a barrier or promoter to PA, and may differ depending on type of activity eg. footpaths and mixed use areas may promote transport-related walking,	Current literature weakened by lack of sound theoretical framework, mostly cross-sectional research designs and incomplete data.

Author	Design	Methods	Results	Limitations
influence physical activity? Examining the evidence QS: N/A			whereas parks and trails may promote recreational walking. Relationship of built environment to PA mediated by many factors such as socio-demographics, culture, personal factors, safety, and time. Evidence shows associations between built environment and PA, but cannot show causality. Today's built environment has been shaped by long-standing policies and practices, and opportunities exist for changing these.	
Trost 2002[100] Correlates of adults' participation in physical activity: review and update QS: 5/7	*Type*: Systematic review *Aim*: Personal, social and environmental factors related to PA *Population*: Adults	38 quantitative studies published between 1998 and 2000 identified from database searches of Medline, Psychlit, Social Science Index, and Sports Discus and from handsearching. Studies included if dependent variable was exercise, PA, or exercise adherence.	Factors positively associated with overall PA in adults: • Physician influence • Social support • Actual and perceived access to facilities • Aesthetics – enjoyable scenery • Frequently observe others exercising • Home exercise equipment • Hilly terrain • Neighbourhood safety • Satisfaction with facilities Factors negatively associated with overall PA in adults: • Social isolation • Climate/season • Urban location	31 of the studies cross-sectional (but findings of prospective studies generally consistent with cross-sectional data).
Williams 2007[120] The built environment and physical activity: what is the relationship? QS: 4/7	*Type*: Review *Aim*: Association between built environment and PA *Population*: Adults	Research derived from both public health and transportation fields (methodology not provided in this report). Studies published since 2000 judged against quality	• Parks and open spaces associated with transport-related walking but not recreational walking • Living close to destinations such as shops associated with transport-related walking • Overall walkability of neighbourhood	Majority of evidence cross-sectional. Clustering of community characteristics makes determining relative contributions difficult.

Author	Design	Methods	Results	Limitations
		criteria. Only those in the middle and top quality tier included, with greater weight given to top tier.	associated with walking (land use mix, connectivity, density) • Footpaths associated with walking • Neighbourhood aesthetics associated with overall PA and recreational walking • Social and community support predict PA • Heavy traffic and crime either positively or not associated with PA • Racial and ethnic minorities more likely to live in walkable neighbourhoods and to walk for transportation • Differences in aesthetics and social support may explain lower levels of recreational PA in low SES neighbourhoods • Community design more strongly associated with transport-related walking than recreational walking • Associations may differ between men and women and children and adults	Inconsistent measures of activity used between studies, and usually self-reported. Many studies do not report both objective and subjective measures of community characteristics such as proximity, safety and aesthetics. Few intervention studies and most small and local and most do not meet evidence threshold for inclusion in this review. Cannot rule out self-selection of active people choosing to live in walkable neighbourhoods.
Zimring 2005[127] Influences of building design and site design on physical activity: research and intervention opportunities QS: 1.5/7	*Type:* Review *Aim:* Evidence linking building and site design features and PA *Population:* None specified	None provided.	Site selection and site design features that encourage PA: • Destinations within 0.4 to 0.8km of workplace • Locating carparking away from the building • Price of parking cheaper at more distant locations • Availability of pubic transport, as it is often paired with walking • Specific stimuli can motivate movement such as presence of people or activities • Pedestrians often choose route based on interest rather than distance • Providing safe and comfortable environments (footpaths, street lights, traffic calming, pedestrian	Unable to assess review methodology. For some topics, case studies or development design recommendations only available.

Author	Design	Methods	Results	Limitations
			amenities such as water fountains and bike racks) • Provide a visible walking surface, and a variety of path choices Buiding architecture and design: • Provide desirable venues for PA and amenities to serve them, with views in/out • Place attractors (such as coffee kiosk) outside immediate work environment Building elements: • Make stairs, exercise and shower rooms, and plazas available, convenient, desirable, safe and comfortable • Encourage stair use	

Author	Design	Methods	Results	Limitations
Table 3: Reviews - Socio-cultural				
Gidlow 2006[139] A systematic review of the relationship between socio-economic position and physical activity QS: 4.5/7	*Type*: Systematic review *Aim*: Evidence of a positive gradient of increasing PA across the socio-economic strata *Population*: Adults in Western countries	Search of major databases in October 2004: PubMed, PsychInfo, Sports Discus, Web of Knowledge for papers in peer-reviewed journals reporting socio-economic and PA outcomes. 5292 papers identified, from which 28 cross-sectional and 5 longitudinal studies included. Half from the US.	Higher levels of leisure time or moderate-vigorous activity consistently found at highest vs lowest SES. Studies that objectively measure PA reported relationships, but less consistent. Relationships between PA and education tended to be strongest, and those between PA and income least strong.	Majority of studies were secondary analyses of existing health survey data up to 40 years old. Many studies used non-validated self-reported measures of PA (n=17). SES data not reported at follow up in 3/5 of the longitudinal studies. Many studies did not adjust income for household size.
McNeill 2006[151] Social environment and physical activity: a review of concepts and evidence QS: 1/7	*Type:* Review *Aim:* Develop a taxonomy of the social environment and its influence on health *Population:* Not stated	Identified aspects of the social environment related to PA, and amenable to change. Three broad categories identified, representing five social dimensions. No methodology provided.	*Interpersonal relationships* - social support can increase PA. Less evidence for social networks, but some aspects such as number of social contacts and frequency of contact related to increased energy expenditure and exercise adherence. *Social inequalities* – most research found positive association between SES and PA. *Neighbourhood and community characteristics* – negative association between social participation and low recreational PA. Those living in more deprived areas less likely to exercise.	Does not describe review methodology or included studies.
Maibach 2007[102] The influence of the media environment on physical activity: looking for the big picture	*Type:* Review *Aim:* Examine influence of the media on PA *Population:* Children and	No methodology provided.	Media consumption in US increased by >2 hours/day between 1977 and 2002. American children consume ~6 hours 20 minutes/day of overall media.	Studies have cross-sectional designs and variable validity of measures. Methodology not provided.

Author	Design	Methods	Results	Limitations
QS: 1/7	adults		In adults, significant negative correlation between media use and PA. Media use appears to displace PA. Effect of media content on PA almost completely untested. Media environment largely untapped as a means of positively influencing PA.	Paper has a US focus.

Author	Design	Methods	Results	Limitations
Table 4: Reviews - Political				
Heath 2006[146] The effectiveness of urban design and land use and transport policies and practices to increase physical activity: a systematic review QS: 4.5/7	*Type*: Systematic review *Aim*: Most effective population-wide interventions to increase PA *Population*: Not stated	Methods of the Task Force on Community Preventive Services used. Review conducted by a diverse team who assessed literature on environmental and policy interventions related to PA that included the effect size. Net intervention effects calculated for all reported measures. Evidence graded.	Sufficient evidence that *community*-level urban design and land use regulations and practices can increase levels of walking and cycling, by providing destinations people want to walk to, employment close by, and safe and attractive paths to get there (12 cross-sectional papers between 1993 and 2003). Research suggests differences in walking between neighbourhoods determined by built environment rather than self-selection. Barriers to implementing community-level urban design and land use policies and practices: • Slow rate of change • Zoning regulations preventing mixed land-use • Cost of remodelling/retro-fitting • Lack of effective communication between professional groups • Changing behavioural norms Sufficient evidence that *street*-level urban design and land use policies and practices can increase PA (six studies between 1987 and 2003 – pre-post or cross-sectional designs). Interventions involve access, redesigned streets, enhanced aesthetics, and improved safety eg. street lighting, traffic calming, one-way streets, bicycle lanes, forming squares, and creating playgrounds.	Urban design and land use literature cross-sectional, PA outcome measures often incomplete, outcomes limited to behavioural differences rather than behavioural change, and exposures grouped making it difficult to determine which environmental characteristics were important. Unclear whether research would apply to rural environments. Very limited economic data available.

Author	Design	Methods	Results	Limitations
			Barriers to change are cost and the requirement for planning and coordination between a wide range of professional groups. Only one good quality study identified related to transportation and travel policies and practices. Insufficient evidence to determine effectiveness of transportation and travel policy to increase PA.	

Author	Design	Methods	Results	Limitations
Table 5: Economic				
Pratt 2004[193] Economic interventions to promote PA: application of the SLOTH model QS: 1.5/7	*Type:* Discussion paper *Aim:* Combined economic and public health perspective to understand PA and provide a framework for economic interventions *Population:* N/A	None provided.	The SLOTH model is an economic and time-budget model categorising the day into five domains: • Sleep • Leisure • Occupation • Transportation • Home. Proposes a variety of economic channels and interventions within the non-sleep domains for discussion, however these are not evidence-based recommendations. The SLOTH model can be used as a basis to identify potential economic incentives.	Almost no evidence relating to economic interventions to increase PA.

Author	Design	Methods	Results	Limitations
Table 7: Reviews - Children/Adolescents				
Ferreira 2006[101] Environmental correlates of physical activity in youth – a review and update QS: 5/7	*Type*: Systematic review *Aim*: Understand environmental factors associated with PA in youth *Population*: Healthy 3-18 year olds not involved in competitive sport	Database searches of Medline, PsycInfo, Web of Science, EMBASE, Sport Discus, and handsearching for observational studies from developed countries and published 1980 to December 2004. 150 studies included. Strength of evidence graded	Home and school environments especially associated with children's PA. Most consistent positive correlates were: • Father's PA • Time spent outdoors • School PA policies • Support from significant others • Mother's education level • Family income • Attending high school vs vocational school • Low crime incidence in neighbourhood	Most studies cross-sectional. Most studies used subjective measures of environment and PA. In 10 studies, both self-reported PA and objectively-measured PA examined, and only moderate association between the two. Most studies not analysed to take account of clustering (eg. classes within schools).
Johnson-Taylor 2006[103] Modifiable environmental and behavioural determinants of overweight among children and adolescents: report of a workshop QS: 1.5/7	*Type:* Symposium *Aim:* Modifiable determinants of overweight in children and adolescents *Population:* Children and adolescents	Meeting of experts to present and discuss evidence in 2004.	Weak correlation at best between decreased time spent television viewing and increased PA in children. A review for the Institute of Medicine found no consistent relationship between built environment and PA in children, but inconsistent measurements and limited data. Built environment may affect children differently to adults. Offering and changing PE environment increase PA during PE time, especially in boys.	Methodologies of studies not presented.
Davison 2006[128] Do attributes in the physical environment influence children's physical activity? A	*Type:* Review *Aim:* Associations between physical environment and PA in children *Population:* Children and	Database search of PubMed, PsychInfo, EBSCO, CINAHL, and TRANSPORT, general internet search, and searching of bibliographies.	Children's PA positively associated with availability of recreational areas. Children with shorter distances to travel to school more likely to actively commute. Presence of sporting facilities and equipment at	Little consistency in methodology. All but two studies cross-sectional. Little consideration of moderating or confounding

Author	Design	Methods	Results	Limitations
review of the literature QS: 4/7	adolescents	33 articles included in review. Qualitative studies and those that used composite environment scores excluded. Bivariate analyses used to allow for comparison between all studies.	school encourages PA. Positive association between PA and presence and condition of sidewalks, controlled crossings, access to destinations such as shops, and public transport available. Negative association with presence of road hazards. No association with perceived safety but negative association with crime, area deprivation, and roaming dogs.	variables. Children often assessed across a broad age range, and role of parents in controlling children's use of physical environment not considered. Most studies from the US.
Nelson 2007[123] Engineering children's physical activity: making active choices easy QS: 2.5/7	*Type:* Review *Aim:* Proposes that PA has been engineered out of children's lives *Population:* Children and adolescents	24 peer-reviewed quantitative and qualitative studies identified from database searches of Web of Science, Cinahl, PubMed, Science Direct, Cab Direct, Avery Index, Geobase, and Compendex, as well as handsearching bibliographies.	Physical environment features that support physical activity in children from cross-sectional studies: • Access to footpaths and walking trails • Cycle lanes • Low connectivity • Traffic safety • Dense, walkable neighbourhoods • Destinations, public transport, and schools within walking distance • Density, quality, safety, and convenience of PA facilities • Safe adults at PA facilities • Perceptions of aesthetics • Presence of trees, interesting features and lack of litter Physical environment features that are barriers to physical activity in children from cross-sectional studies: • Heavy or dangerous traffic • Unsafe roads and lack of a safe route to school • Limited pedestrian crossings • Parental concerns about traffic • Steep roads • Low density residential	Majority of studies cross-sectional. No description of included studies.

Author	Design	Methods	Results	Limitations
			areas • Parental concerns about child's personal safety • Actual and perceived crime • Exhaust fumes or bad smells Interventions that have supported PA: • New or improved paths and crossings with lights • Traffic calming and speed limits • Playgrounds within 500m • Home zones • Walking and cycle friendly infrastructure and policy	
Salmon 2007[111] Prevalence, trends and environmental influences on child and youth physical activity QS: 2/7	*Type*: Journal chapter *Aim*: Evidence relating neighbourhood social and physical environment with children's PA *Population*: Children and adolescents	No methodology given.	Evidence relating environment to children's PA: • Associations with traffic safety mixed, and vary by age and type of activity. Traffic-related infrastructure associated with walking, cycling, and active transport to school. • Associations of PA with crime/personal safety mixed. • Positive social interactions and social connectedness may be conducive to children's PA. • Urban design features have been infrequently studied in children. Data on street connectivity mixed. Possible that has differential effects on different types of PA. • Studies in Australia and UK have shown shorter distances to school, open spaces, or sports areas associated with increased PA, but not in US.	Cannot assess methodology. No details provided of included studies.
Salmon 2007[104] Promoting physical activity	*Type:* Review *Aim:* Evidence of effectiveness of	Database search of Medline, preMedline, Sports Discus, PsycINFO,	Three environment only interventions produced small increases in PA, using simple interventions	Difficulty with study comparisons. Many studies had

Author	Design	Methods	Results	Limitations
participation among children and adolescents QS: 5/7	interventions to increase PA in children *Population:* Children and adolescents	PsycARTICLES, Cochrane, CINAHL, Science Direct, Web of Knowledge, Social SciSearch, and all OVID databases for articles published 1985 to June 2006. Included RCTS, cluster randomised, or quasi-experimental studies. 90 studies included, reporting 76 interventions.	(painting a school playground eg. hopscotch; and providing games equipment and activity cards). Most effective school interventions for children were including a focus on PE, activity breaks, and family strategies. .	major limitations (small sample sizes, contamination, poor measures, no baseline data).
Van der Horst 2007[113] A brief review on correlates of physical activity and sedentariness in youth QS: 4/7	*Type:* Systematic review *Aim:* Correlates of PA and sedentary behaviour in young people *Population:* Healthy children and adolescents	Database search of Pubmed and PsycINFO for studies from 1999 to January 2005. 57 papers included (51 cross-sectional and 6 prospective).	In children, no significant associations found between perceived access to facilities, play areas, or home sporting/exercise equipment. In adolescents, evidence for positive association between school sports and PA. No evidence for availability of facilities.	Majority of studies cross-sectional. Few studies had examined environmental correlates.
van Sluijs 2008[110] Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials QS: 5.5/7	*Type:* Systematic review *Aim:* Evidence on promotion of PA in children *Population:* Children and adolescents without disease or health problems	Database search of Pubmed, Psychlit, Scopus, Ovid Medline, SportDiscus, and Embase up to December 2006 for papers promoting PA through behaviour change and with a non-PA control. 57 papers included. In children, four environmental interventions. In adolescents, only one environmental intervention. Evidence graded.	Limited evidence of effect of environmental interventions in children (four school based interventions: two controlled trials and two low-quality RCTs) and inconclusive evidence in adolescents (one low quality study). Strong evidence of effect of multicomponent interventions in adolescents and inconclusive evidence in children. In multicomponent interventions, the policy or environmental part usually involved changes to the PE programme eg. adding classes or providing more equipment. PA improved during classes, but did not improve overall PA.	Level of exposure to intervention and lack of adherence may have limited effectiveness in some studies, but many papers did not describe these. Most studies completed in US. Information lacking on randomisation procedures and blinding. Short follow up period, inadequate adjustment for confounding, lack of adjustment for clustering. Frequently only used self-reported

Author	Design	Methods	Results	Limitations
				data and non-validated measures.

Author	Design	Methods	Results	Limitations
Table 8: Studies				
Bower 2007[115] The childcare environment and children's physical activity QS: 2.9/5	*Type*: Survey *Aim*: Relationship between social and PA environment in childcare centres and PA of children *Population*: Children in childcare centres in North Carolina	20 childcare centres randomly selected from 96 centres participating in an environmental nutrition and PA intervention. PA environment assessed using the Environment and Policy Assessment and Observation instrument (validated in this study). PA assessed with modified version of the Observation System for Recording Activity in Preschools, using momentary time-sampling.	Childcare centres with total PA environment scores above median had more active children than those scoring below median. Active opportunities (structured PA, outdoor play, and time spent in active opportunities) most important predictor for PA. Portable play environment positively related, and fixed play environment negatively related, to time spent in moderate to vigorous PA. Sedentary activity opportunities and PA training of staff helped explain variability in amount of time spent in sedentary activities and mean activity level.	Cross-sectional data cannot prove causality. Small sample size. Measurement of intensity of moderate to vigorous PA did not precisely estimate time.
Bowles 2006[194] Mass community cycling events: who participates and is their behaviour influenced by participation? QS: 2.9/5	*Type:* Online pre- and post-even survey *Aim:* Effect of a mass cycling even on subsequent cycling behaviour *Population:* Adults registering online to participate in a mass cycling event in Sydney	Participants registering online for a cycling event completed pre-event questionnaire, and were asked for consent to be followed up post-event. Questionnaire assessed cycling ability and PA level. Post-event survey sent by email to those with low cycling ability, low PA level, females (as under-represented in total sample), and to random sample of men and experienced cyclists. 1,135 respondents, with a 55% response rate to post-event survey.	51% of respondents moved from low to high self-rated cycling ability pre- to post-event. 62% with low PA pre-event improved to high self-rated PA post-event, and 2% regressed from high to low PA post-event. Respondents with low pre-event cycling ability or PA level, and first time participants increased average number of bicycle rides significantly post-event. 85% of respondents to post-event survey met PA guidelines.	Did not examine if behaviour maintained long term. Self-reported PA. Small number of participants with low self-rated PA. Low response rate may introduce respondent bias.

Author	Design	Methods	Results	Limitations
Chin 2007[195] Accessibility and connectivity in physical activity studies: the impact of missing pedestrian data QS: 1.4/5	*Type*: Pilot study *Aim*: Impact of missing footpath data from measures of street connectivity *Population*: Perth metropolitan neighbourhoods	Four neighbourhoods aerial mapped and pedestrian routes added to street network maps. Walking distances of 5, 10, 15 and 20 minutes to schools tested in each neighbourhood. Network connectivity compared.	Connectivity higher when consider pedestrian networks rather than street networks (street networks have been used in much previous research). Greater increase in connectivity seen in neighbourhoods with curvilinear street networks as opposed to grid networks.	
Colabianchi 2007[121] Towards an understanding of salient neighbourhood boundaries: adolescent reports of an easy walking distance and convenient driving distance QS: 1.8/5	*Type:* Survey *Aim:* Perceptions of an easy walking distance *Population:* 12th grade adolescent girls in South Carolina	Sub-sample of 909 participants in a physical activity intervention trial. Completed a PA recall survey, a question on easy walking distance in minutes, and home address geocoded.	Mean easy walking distance was 14.8 minutes (translating to approx 1.2km). White girls reported two minutes longer mean easy walking time than African American girls. Those not overweight reported 2 minutes less easy walking distance than those who were overweight.	Walking distance may not be generalisable to other localities, age groups, or to boys. Only 55% of original sample included, and methods of recruitment/ inclusion for sub-study and main study not provided.
Cutt 2007[196] Encouraging physical activity through dog walking: why don't some owners walk with their dog? QS: 1.9/5	*Type:* Questionnaire *Aim:* Factors associated with dog owners not walking their dog *Population:* Dog owners in Perth, Western Australia	629 dog owners taking part in the RESIDE study self-completed a questionnaire. PA assessed using NPAQ.	23% dog owners never walk their dog, and did significantly less PA per week than dog owners who did walk their dog. Walking their dog made up 74% of dog walkers total walking time. Likelihood of not walking the dog significantly higher if dogs not perceived as motivation to walk or perceived that dog provided poor social support.	Cross-sectional data. Other dog-related factors not measured may be associated with dog walking, such as dog training and socialisation. Data self-reported.
Dawson 2007[122] Perceived barriers to walking in the neighbourhood environment and change in physical activity	*Type:* Prospective survey *Aim:* To what extent perceived barriers are related with PA *Population:*	551 participants surveyed at baseline and 12 months. Completed a Daily Activities Questionnaire which asks about	Recreational walking did not change over the 12 months, but total PA reduced significantly. At baseline, 55% reported barriers, the most common being no one to walk with and concerns about safety.	Relatively affluent and older aged sample. Self-reported PA only.

Author	Design	Methods	Results	Limitations
levels over 12 months QS: 3.6/5	Members of two walking schemes in England and Scotland (mostly retired)	PA over previous 7 days and barriers to walking. Response rate 75% at 12 months.	Number of perceived barriers to walking increased significantly (from average 1.2 to 1.4), apart from concerns about personal safety which decreased. Barriers that increased significantly related to aesthetics, lack of/unsafe footpaths, lack of destinations, concern about cyclists on footpaths, and traffic. Increased awareness of a health condition at baseline associated with increased number of perceived barriers.	
Garrard 2007[197] Promoting transportation cycling for women: the role of bicycle infrastructure QS: 2.9/5	*Type*: Observational count *Aim*: Whether women are more likely to use bicycle lanes separated from traffic *Population*: Female commuter cyclists in Melbourne	Observational counts conducted at 15 strategically selected locations around CBD at peak commuting times over 11 days in February 2004. Cyclists coded as to type of bicycle lane using. 6,589 cyclists counted, of which 21% female.	The majority of cyclists used on-road cycle lanes and roads with no cycle lanes compared with off-road cycle lanes. Proportionally more men than women used off-road cycle lanes. After adjusting for distance to CBD from where cyclist counted (surrogate for distance commuted), proportions of men and women cycling on-road almost identical. Odds ratios, however, showed women preferred routes with off-road cycle lanes.	Trip distance was taken as a straight line distance from location where observed to central post office and is unlikely to reflect actual trip distance. Study was an opportunistic analysis of data collected for other purposes. Cannot determine over what distance cyclists used the particular form of cycle lane and whether it had impacted on their route choice.
Giles-Corti 2007[125] Evaluation of the implementation of a state government community design policy aimed at increasing local walking: design issues and baseline results	*Type*: Evaluation *Aim*: Describe design and baseline evaluation of a pedestrian-friendly subdivision urban design code *Population*: Adults moving into new housing subdivisions in	RESIDE is a five-year longitudinal study of 1,813 participants moving into 74 new housing developments, some of which meet a new urban design code. Participation rate of 33%. New housing developments matched, with one	Little difference in baseline walking level of those moving into conventional or new design code developments. Those choosing hybrid developments less active. Majority of baseline walking recreational and within the neighbourhood. Baseline neighbourhoods (pre-move) had low walkability.	Follow up data not yet reported. Hybrid developments further inland from the coast than other types of development. Cannot rule out self-selection. Low response rate.

Author	Design	Methods	Results	Limitations
from RESIDE, Perth Western Australia QS: 3.6/5	Perth, Western Australia	meeting new design code and the other a conventional design. Baseline results reported here, with follow up at 12 months and 2 years.	Most commonly cited reasons for choice of new subdivision were affordability, safety from crime, closeness to parks, safe for children, and streets designed to minimise traffic. More people moving into new design code developments claimed aspects of walkability affected choice of subdivision.	
Kirby 2007[198] Perceived community environment and physical activity involvement in a northern-rural Aboriginal community QS: 3.4/5	*Type:* Survey *Aim:* Relationship between perceptions of environment and PA and walking *Population:* Adult Canadian rural Aboriginal peoples living in Moose Factory	263 participants recruited through a stand at a shopping centre and advertisements. Completed a 15-item survey on environmental perceptions, walking and PA. PA questions drawn from the Godin Leisure Time Exercise Questionnaire.	Safety and aesthetics significantly related to walking. Perceived environment accounted for 5.3% of variance in walking behaviour. Environment did not contribute significantly to all intensity PA, strenuous, moderate or light PA.	Cross-sectional data. Self-reports of perceived environment and PA only (no objective measures). Factors such as traditional beliefs not investigated.
Lee 2007[136] Contribution of neighbourhood socioeconomic status and physical activity resources to physical activity among women QS: 3.9/5	*Type:* Survey *Aim:* Investigate whether relationship of less PA with women in poor areas is mediated by access to PA resources *Population:* Women participating in the Stanford Heart Disease Prevention Program (1979-1990)	Multilevel regression analysis using data from Stanford Heart Disease Prevention Program, census data, and archival data (telephone books for 1979-90). Measured presence of and access to gyms and parks.	Availability of gyms and parks greater in low SES areas, but distance to a gym 160m less in higher SES areas. No measures of presence or access to gyms and parks significant. However, two significant interactions. Women in higher SES areas reported less moderate PA as density of gyms or parks increased, whereas women in lower SES areas reported more moderate PA as density increased. No significant interactions for vigorous activity.	Response rates 56% to 69%. Cross-sectional data. PA self-reported. Access measured by distance only (does not state if straight line or street network distance).
McCormack 2007[199] The relationship between destination	*Type:* Survey and GIS *Aim:* Over what distance will people consider	Secondary analysis of survey data from the Study of Environmental and Individual Determinants of PA	Many people will walk (regularly or irregularly) 1,500m (15 minutes) to reach a destination. More destinations within an area increase time spent	Cross-sectional survey data. PA self-reported over previous two weeks.

Author	Design	Methods	Results	Limitations
proximity, destination mix and physical activity behaviors QS: 3.9/5	walking as a means of transportation? *Population:* Western Australian adults	collected in 1995. GIS data on location and mix of destinations within 400 and 1500m from home, using shortest road trip.	walking for transport (each additional destination increased walking by ~10 minutes/fortnight). Transport-related walking more influenced by presence and mix of destinations than recreational walking or vigorous PA. Living within 15 minute walk (1500m) of a beach related to regular vigorous PA and irregular recreational walking.	Limited range of destinations included (eg. cafes, banks, pool, gyms, not included). Respondents with missing data excluded. Did not control for neighbourhood self-selection and no adjustment for multiple comparisons.
Moudon 2006 Operational definitions of walkable neighbourhood: theoretical and empirical insights QS:	*Type:* Survey *Aim:* Define measurable attributes of walkable neighbourhoods *Population:* Adults in King County, Washington (medium density urban development)	Telephone survey of 608 randomly selected adults. Response rate 32%. GIS data of physical environment. PA appears to be self-reported over previous week.	Environments associated with meeting PA recommendations through walking had greater residential density, had activities closer together and shorter distances to food and retail facilities, more footpaths, and smaller blocks. Large office land areas and schools were deterrents to walking.	Cross-sectional data. Low response rate. Distances reported were straight line. Unpublished data reports street distances. Self-reported PA measures.
Nelson 2008[200] Active commuting to school: how far is too far? QS: 2.4/5	*Type:* Cross-sectional survey *Aim:* Distance that is a barrier to active commuting to school for adolescents *Population:* 15-17 year olds at school in Ireland	4013 students at 61 secondary schools completed a questionnaire, as part of the Take PART Study. Data collect in 2003 to 2005 using cluster sampling by school. Participants self-reported distance travelled to school (objectively checked in sub-sample, with no significant difference between them).	1/3 of students walked or cycled to school. Greater odds of actively commuting if lived in a more densely populated area. For each 1.6km increase in distance, odds of active commuting decreased by 71%. Most walkers lived within 2.4km of school, and most cyclists within 4km. Barriers to active commuting were distance, time, laziness, convenience of car.	Cross-sectional data. Data analysis did not account for cluster sampling
Rhodes 2007[153] Prediction of leisure-time walking an integration of	*Type:* Survey *Aim:* Integrate personality, perceived environment and	358 randomly selected participants responded to a mail questionnaire. Response rate	Close proximity to retail shops, quality of walking infrastructure, and neighbourhood aesthetics correlated to walking.	Cross-sectional data. Low response rate may introduce respondent bias.

Author	Design	Methods	Results	Limitations
social cognitive, perceived environmental and personality factors QS: 3.9/5	planning into a framework to predict leisure-time walking *Population:* Canadian adults resident in British Columbia	28%. 57% follow-up rate at two months. Respondents better educated than Census population. Walking measured using the Godin Leisure Time Exercise Questionnaire.	Leisure-time walking largely predicted by intention to walk, which was in turn predicted by attitude to walking and perceived behavioural control. Leisure-time walking also predicted by proximity to neighbourhood shops. Effect of neighbourhood aesthetics and walking infrastructure mediated by attitudes and intentions. Relationship of intention to walking moderated by conscientiousness and proximity to neighbourhood shops (having shops close by resulted in a larger effect of intention on walking).	Small sample size. Walking self-reported.
Riva 2007[143] Use of local area facilities for involvement in physical activity in Canada: insights for developing environmental and policy interventions QS: 4.4/5	*Type*: Survey *Aim*: Individual and local area characteristics associated with use of local PA facilities *Population*: Canadian adults	Telephone survey conducted with 3,191 randomly selected adults in three Canadian provinces. Data analysis on a sub-sample of 1,006 physically active participants. Response rate 75%. PA measure adapted from the Canadian Community Health Survey.	Predicted probability of using PA facilities varied significantly for women between regions, but not for men. Different level of usage by women explained by local area characteristics. Living in more affluent areas or small urban centres associated with higher likelihood of PA facility use. No association between number of facilities and likelihood of use.	Cross-sectional data cannot determine causality. Small number of local areas for comparison.
Sallis 2007[152] Perceived environmental predictors of physical activity over 6 months in adults: activity counselling trial QS: 4.4/5	*Type:* Prospective study *Aim:* Whether physical and social environment predicts PA *Population:* Inactive adults aged 35-75 years in three US regions	861 participants from the Activity Counselling Trial, recruited from primary care clinics. PA measured with a validated 7-day PA recall of moderate to vigorous PA at six months. Perceived environment assessed with	Characteristics predicting higher levels of PA (50-75 minutes more) in women were no unattended dogs and low crime in neighbourhood. For men, frequently seeing other people exercising predicted higher level of PA than those with different environmental characteristics. Older adults may be more affected by environment	Self-reported measures only. Baseline data collected in mid-1990s. Limited number of environmental variables studied, and used a non-validated instrument.

Author	Design	Methods	Results	Limitations
		Neighbourhood Environment Scale at baseline.	than younger adults. Older women who reported pleasant scenery and residential neighbourhood (vs mixed land use), and older men who reported hilly neighbourhood more active than older people not reporting those characteristics.	
Taylor 2007[201] Changing social and built environments to promote physical activity: recommendations from low income, urban women QS: 3.8/5	*Type:* Nominal Group Technique sessions *Aim:* Environmental changes recommended by ethnic minority women *Population:* Ethnic minority women aged 50 years and over	Women recruited from two community health centres in New York City which serve uninsured and low income women. Nine group sessions were held, and 45 women participated.	Most important environmental changes recommended to promote PA: • More police • Cleaner streets • Removing drug dealing from streets • More street lighting • Walking groups • Free gyms	Recommendations may be specific to the community involved. Sample may not be representative.
Trayers 2006[202] Improving health through neighbourhood environmental change: are we speaking the same language? A qualitative study of views of different stakeholders QS: QN	*Type:* Focus groups *Aim:* Perspectives of four groups of stakeholders on a new walking/cycle path *Population:* Neighbourhood residents, local primary school students, college students and tutors, and planners from a deprived ward in South-West England	Four focus groups run with 10 participants each from different stakeholder groups in 2004 to discover attitudes to a proposed cycle/walkway on disused land (the land ran between two rows of backyards). Residents recruited by letter delivered to all in neighbourhood, students were recruited through the school, and planners by open invitation.	All four groups concerned with safety. Residents concerned cycle/walkway would bring in outsiders and criminals. Residents concerned with having enough space to park cars outside house. School students perceived neighbourhood as dirty and unsafe and wanted a clean, safe place to play off the streets. Antisocial behaviour a problem in the neighbourhood and concern that cycle/walkway would increase it. Residents did not expect any health benefits from the cycle/walkway and were more concerned with safety and vandalism. Only college students thought it might improve PA level, but concerned about safety on isolated paths.	Likely to be respondent bias and results not generalisable.

Author	Design	Methods	Results	Limitations
Table 9: New Zealand				
Badland 2006[203] Perceptions of replacing car journeys with non-motorized travel: exploring relationships in a cross-sectional adult population sample QS: 3.9/5	*Type*: Postal survey *Aim*: Relationship between socio-demographics, PA, and transport-related PA travel mode *Population*: Nationally representative sample of adult New Zealanders	7,894 respondents, randomly selected from electoral roll, completed an Obstacles to Action Survey. 56% response rate. Self-reported PA over previous seven days.	21% strongly agreed and 17% agreed they could replace car trips with walking/cycling on at least 2 days/week. Respondents with higher income or more education less likely to agree could replace car journeys with transport-related PA. Respondents already sufficiently active more likely to agree could replace car journeys with transport-related PA.	Cross-sectional data. Actual transport-related PA not assessed. Self-reported data. Possible response bias. Distance of travel not assessed.
Badland 2006[204] Understanding the relationship between town size and physical activity levels: a population study QS: 3.9/5	*Type:* Postal survey *Aim:* Differences in PA and barriers to PA according to town size *Population:* Nationally representative New Zealanders	Survey adapted for New Zealand from the American Cancer Society questionnaire. Survey posted to participants randomly selected from electoral roll in 2003. 7,916 eligible responses, with a response rate of 58%. Questionnaire assessed self-reported PA over previous 7 days, and perceived physical and social environment.	Small and medium-sized towns reported more barriers to PA related to infrastructure than small and large cities (inadequate or poorly sidewalks or poorly maintained, inadequate lighting or facilities hard to get to). Cities more likely than towns to report barriers related to aesthetics or crime. Crime prevalence and inadequate number of sidewalks the only two variables significantly different between each town and city size. Heavy traffic and inadequate number of cycle lanes also barriers.	Cross-sectional data. Self-reported data. Low response rate.
Badland 2007[205] Objectively measured commute distance: associations with travel modes and perceptions to	*Type*: Telephone survey *Aim*: Relationship between objectively measured commute distance with actual and perceived	772 participants from the Active Friendly Environments Survey included. Population-based CATI survey with participants randomly selected	10% of sample commuted using transport-related PA, and 50% perceived they could use transport-related PA. Perceived and actual use of transport-related PA declined as commute distance increased.	Cross-sectional data. Low response rate may introduce respondent bias. Self-reported data.

Author	Design	Methods	Results	Limitations
place of work or study in Auckland, New Zealand QS: 1.9/5	transport-related PA *Population*: Adults resident in North Shore City	from telephone directory. Response rate 31%. GIS mapping of shortest street network distances.		
Badland 2008[206] Travel behaviour and objectively measured urban design variables: associations for adults travelling to work QS: 2.9/5	*Type:* Telephone survey *Aim:* How urban design characteristics are associated with transported-related PA *Population:* Adult residents of North Shore City who travelled less than 5km to their place of employment	Sub-sample of 364 participants randomly selected from North Shore City telephone directory as part of the Active Friendly Environments Survey conducted in April 2005. Questionnaire and GIS data. 31% response rate.	Transport-related PA decreased as commute distance increased. Those with highest street connectivity seven times more likely to actively commute compared to least connectivity. However, those with limited connectivity less likely to actively commute than those with the least connectivity. Mixed land use and residential density not associated with transport-related PA.	Cross-sectional data. Low response rate. Only looked at commute distances under 5km. Commute routes modelled rather than actual commute routes. Objective variable measures only. Low variability in mixed land use and residential density in the area.
Cleland 2004[131] Why don't people walk and cycle? QS: 3.5/7	*Type:* Review *Aim:* Reasons people don't walk and cycle in New Zealand *Population:* Not stated	Review of New Zealand and international literature, and data collected by SPARC. Web, TRIS, and database searches (PsycINFO, Transport, Australian Transport Index, Te Puna, NTIS, Ei Compendex, Social SciSearch, Dissertation Abstracts Online, Inside Conferences, Wilson Social Sciences Abstracts, Pascal, and Gale Group Health & Wellness Database). LTSA and Opus provided some articles.	New Zealand research on barriers to cycling: • Fear of bike being stolen • Safety*/ inconsiderate drivers/absence of bike lanes/too much traffic • Lack of bike storage and shower facilities at work • Adverse weather* • Don't own a bike or don't want to bike • Time* and distance* • Terrain/hills* • Age* • Convenience of car* • Physically unfit or lazy* • Needing car for job or to pick up children* International literature also identified traffic fumes, personal image, sexual harassment, and disability or health impairment as barriers. Factors with an asterisk above also identified in	No differentiation between recreational and transport-related walking and cycling. Methodological quality of studies often poor or not reported limiting ability to draw firm conclusions.

Author	Design	Methods	Results	Limitations
			New Zealand research as barriers to walking. Further barrier was having to carry things. Walking safety related to fear of assault or being dark. New Zealand research on reasons for not walking/cycling to school highlighted strong safety concerns (traffic and stranger danger), condition of roads and footpaths, distance too far, and children being too young or needing supervision.	
Bauman 2003[150] Evaluation of the national 'Push Play' campaign in New Zealand – creating population awareness of physical activity QS: 3.4/5	*Type:* Surveys *Aim:* Assess impact of Push Play on PA *Population:* Nationally representative sample of adult New Zealanders	Four population-based household surveys in 26 urban centres between 1999 and 2002. Response rates 64 to 70%. Sample sizes of 504 to 665.	Push Play resulted in substantial increase in awareness of any PA messages, but especially Push Play. Significant increase in number of people intending to be physically active. No sustained change in PA levels. Note that larger (n=12,000) SPARC surveys over the same time showed 3% increase in people meeting PA recommendations.	Cross-sectional data cannot show causality. Small sample sizes. Baseline measure carried out after initial Push Play messaging. Slightly different survey methods in the 2000 survey, controlled for in analysis. Only one question assessed PA.
Elley 2003[147] Effectiveness of counselling patients on physical activity in general practice: cluster randomised controlled trial QS: 4.8/5	*Type*: Cluster randomised controlled trial *Aim*: Assess effectiveness of Green Prescription *Population*: 40-79 year old patients of rural and urban general practices in the Waikato, who did less than ½ hour exercise five days/week	42 GP practices randomised, stratified by size. All potential participants attending GP practice over a 5-day period screened and invited to participate. 66% participated (n=878) in intervention (received Green Prescription) or control. 12-month follow-up completed by 85%. PA measured using self-administered	Proportion of participants achieving recommended level of PA increased by 15% in intervention and 5% in control group.	PA self-reported and possible recall bias. ⅓ declined to participate, and few details about them.

Author	Design	Methods	Results	Limitations
		questionnaire, recalling PA over previous three months.		
Elley 2004[148] Cost effectiveness of physical activity counselling in general practice QS: 4.8/5	*Type:* Cost effectiveness analysis *Aim:* Cost effectiveness of Green Prescription *Population:* 40-79 year old general practice patients in the Waikato who are 'less active'	Programme costs, primary, secondary and tertiary costs for each patient, self-reported sick days, and average wage included in analyses, which were adjusted for inflation.	Per patient programme cost $170. Incremental cost to convert one sedentary person to an active state $1,756.	Costs were for 2001 and may have increased since. Private hospital data not available. Confidence intervals large.
Garrett[137] Active friendly environments: physical activity and the built environment. Research executive summary QS: 0.9/5	*Type*: Multi-method: focus groups, telephone survey, site audit, GIS database *Aim*: Relationship between PA and the North Shore City built environment *Population*: Adult residents of North Shore City	Focus groups used to develop survey content. Population-based CATI survey completed with 2000 participants randomly selected from telephone directory in 2005. Response rate 31%. Audit of PA facilities/sites. Data combined in a GIS database.	Focus groups identified main perceived barriers to PA were lack of information and poor transport infrastructure (public transport, safe cycling, poor footpath quality). Site survey showed females more likely to engage in unstructured PA, whereas men preferred structured PA. Population survey showed perceptions of aesthetically pleasing neighbourhood increased likelihood of PA. Regular users of parks, beach walking, and walking tracks, or having gym membership or home exercise equipment, more likely to be sufficiently active. Barriers to transport-related PA were time and distance, as well as carrying heavy items. Majority deemed it appropriate to walk 21-30 minutes for transport. Active transport to work associated with high street connectivity, and increased likelihood of meeting PA	Cross-sectional data. Low response rate.

Author	Design	Methods	Results	Limitations
			recommendations. GIS data showed high street connectivity and living close to coast associated with sufficient PA.	
Ministry for the Environment 2005[138] Summary of The Value of Good Urban Design: the economic, environmental and social benefits of urban design QS: 1/7	*Type:* Report / literature review *Aim:* Evidence linking urban design and economic, social, cultural and physical environments *Population:* Not stated	Review of more than 300 international and New Zealand studies on urban design and environment, mostly since 2000. Evidence was quality graded. Full methodology not provided.	Good urban design can encourage PA – neighbourhood safety (interconnected streets and mixed use areas) and street safety, connectivity, density, and aesthetics.	Very little New Zealand specific research. Design features often found in conjunction with others and difficult to separate out individual effects. Unable to assess methodology.
Richards 2007[144] Predictors of physical activity participation during adolescence and young adulthood (thesis) QS: 3.6/5	*Type*: Longitudinal study *Aim*: Factors associated with PA and how they change during the lifespan *Population*: Birth cohort of ~1000 people born in Dunedin between April 1972 and March 1973	Data from the Dunedin Multidisciplinary Health and Development Study. Response rates 82 to 97% over the years. Participation in sports clubs tracked (n=770), and associations between childhood and contemporaneous factors and level of PA in childhood and adulthood (21 and 26 years). Minnesota Leisure Time Physical Activity Questionnaire used to assess PA.	Sports club participation had low or moderate rate tracking between childhood and adulthood. Participants inactive in child- and adulthood had less socially and PA oriented families. Participants active in child- and adulthood watched less television in adulthood than less active peers. Home activities (eg climbing, ball games, riding bikes) in childhood associated with declining PA participation (active in child- but not adulthood). Non participation in vigorous PA at 26 years associated with lower family SES in childhood, being inactive in childhood and adolescence, and poor childhood motor ability.	Measured tracking of sports participation only, not all PA. Only included those with complete PA data, and those with complete data had a slightly higher SES. Measure of involvement in vigorous activity not validated, and captures only one aspect of PA.
SPARC 2003[207] and McLean[142] Obstacles to action: a study of New Zealander's physical activity	*Type*: Report *Aim*: Why and why not people exercise *Population*: Representative	Random sample of 8,300 households from the electoral roll responded to a posted questionnaire. Response rate of 61%.	Sample divided into three groups: inactive, active, and target group (not regularly active, but intending to become so). Target group (45% respondents) split into six segments. Each segment	Cross-sectional data.

Author	Design	Methods	Results	Limitations
and nutrition QS: 3.5/5	sample of New Zealanders	Follow-on qualitative interviews with 41 participants.	had different perceived barriers to exercise. These barriers included: • Discouragement from others • Health problems making PA uncomfortable • Lack of time or under pressure • Environment threatening (eg. dogs, traffic, lighting) • Financial constraints or cost • Access difficulties • Lack of commitment Qualitative work showed successful strategies for sustaining PA were goal setting, support networks, and having a repertoire of activities. PA may be seen as selfish, especially amongst Maori, Pacific, and women – needs to be seen as important to needs of community and family.	
SPARC 2007[112] SPARC Facts QS: 3.5/5	*Type*: Report *Aim*: Facts and figures about New Zealanders' participation in PA *Population*: New Zealanders	Combined results of the Hillary Commission's 1997, 1998, and 2000 Sport and PA surveys.	Young people more likely to be active if parents active, and more likely to be inactive if parents inactive. Little difference in levels of activity between households by income. Adults with a tertiary education more likely to be active. Main reasons for being more active than the previous year: health and fitness, enjoyment and challenge, available time, managing weight, playing a new sport or joining a gym. Main reasons for being less active than the previous year: increased working hours, poor health, and limited time (due to young family, being busy or studying). 88% report that PA	Cross-sectional data.

Author	Design	Methods	Results	Limitations
			participation not influenced by anything seen, heard, or read. Information sources that changed adults level of activity were: written sources, television, organisations, gym promotions, and GPs. 68% of adults used stairs in the last seven days.	
Taylor 2007[116] APPLE Project: 2-y findings of a community-based obesity prevention program in primary school-aged children QS: 3.8/5	*Type:* Pilot study *Aim:* Effectiveness of a community-based intervention to prevent obesity in children *Population:* Primary school aged children in two semi-rural locations in Otago	730 children from 4 intervention and 3 control schools participated in a two-year school-based nutrition and PA program. Activity program to increase variety and opportunities for PA, with a focus on lifestyle-based activities (eg. outdoor games, gardening, beach hikes). PA assessed with accelerometers over 1-5 days each year and with the Physical Activity Questionnaire for Older Children. Response rates 81% to 92%.	Average accelerometer counts significantly higher in intervention group at one year, but not significiant at two years. However, self-reported PA less in intervention group at both time points. No effect of intervention on television viewing time. BMI *z*-score significantly lower in intervention group at year 1 and 2 in normal-weight children, but no effect of intervention on overweight children.	Pilot study and not powered to determine changes in individual components of PA or nutrition. Limited use of accelerometers due to funding constraints.
Utter 2006[124] Perceived access to community facilities, social motivation, and physical activity among New Zealand youth QS: 3.4/5	*Type:* National survey *Aim:* Relationship between recreational facilities and PA in youth *Population:* Nationally representative sample of New Zealand high school students	Data collected as part of Youth2000 survey. 9,699 randomly selected high school students completed multimedia survey in 2001. Vigorous PA assessed with two questions.	Most students perceived presence of recreational facilities within walking distance of home. Perceived access within walking distance to park, skateboard ramp, sports field, place to swim, gym, or bicycle track significantly related to vigorous PA. Less likely to be PA if perceived nothing to do where they lived. Neighbourhood safety positively associated with regular PA.	Cross-sectional data. Self-reported environmental measures only.

Author	Design	Methods	Results	Limitations
Williden 2006[149] The APPLE project: an investigation of the barriers and promoters of healthy eating and physical activity in New Zealand children aged 5-12 years QS: QN	*Type:* Telephone survey *Aim:* Identify barriers and promoters of PA in children *Population:* School children aged 5-12 years in rural towns in Otago	A questionnaire was developed following stakeholder interviews and administered to 101 parents of children attending four schools. 89% response rate. Relevant questions for the School Health Index used to assess school nutrition and PA environment.	Parents reported the following as barriers to children's PA: • Not enough places for child to play • Lack of variety of sports to choose from • Lack of sports coaches • Parental time commitments • Cost of some activities • Skateboards banned at school and in public areas, with no alternative facilities • Lack of parental rules limiting television viewing • Children choosing sedentary activities over active ones	Descriptive statistics only. Not able to obtain contact information for most of the parents in one school, and therefore limited representation from them. Small sample size.

Figure 10: Evidence informed model of the potential determinants of sport/physical activity (in Jones 2007, from a Sport England review 2005) [118]

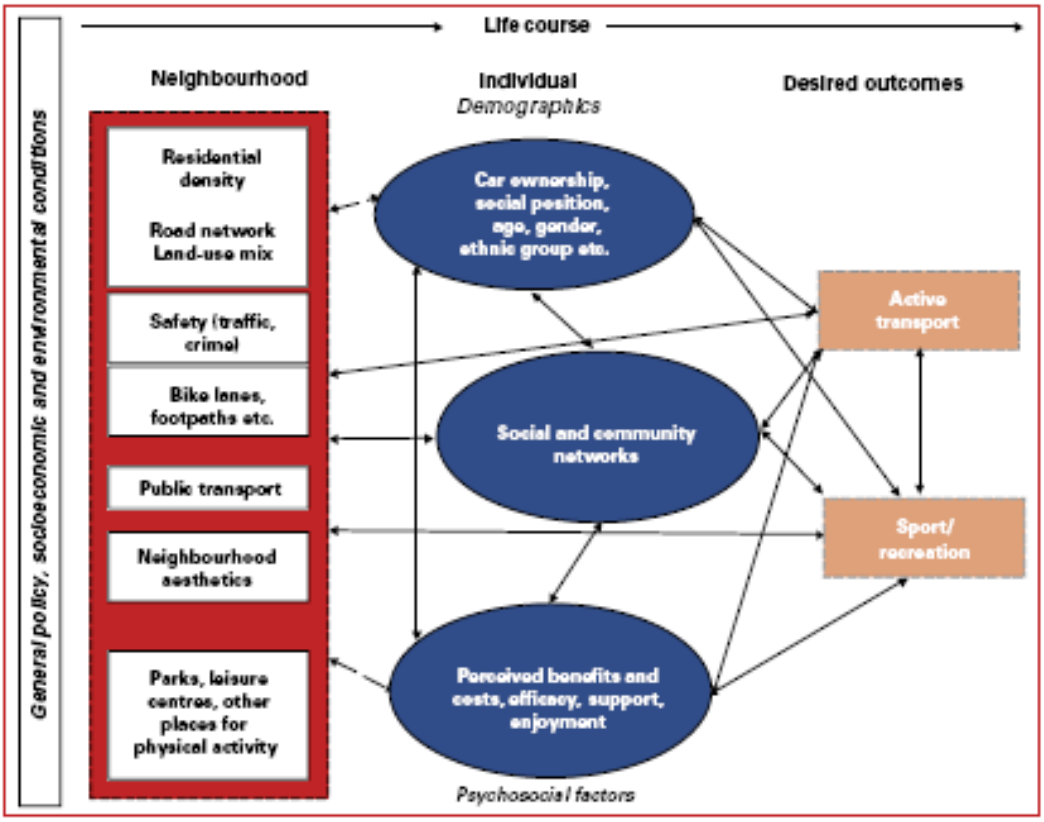


Figure 11: Ecological model of four domains of active living (Source: Sallis 2006)[208]

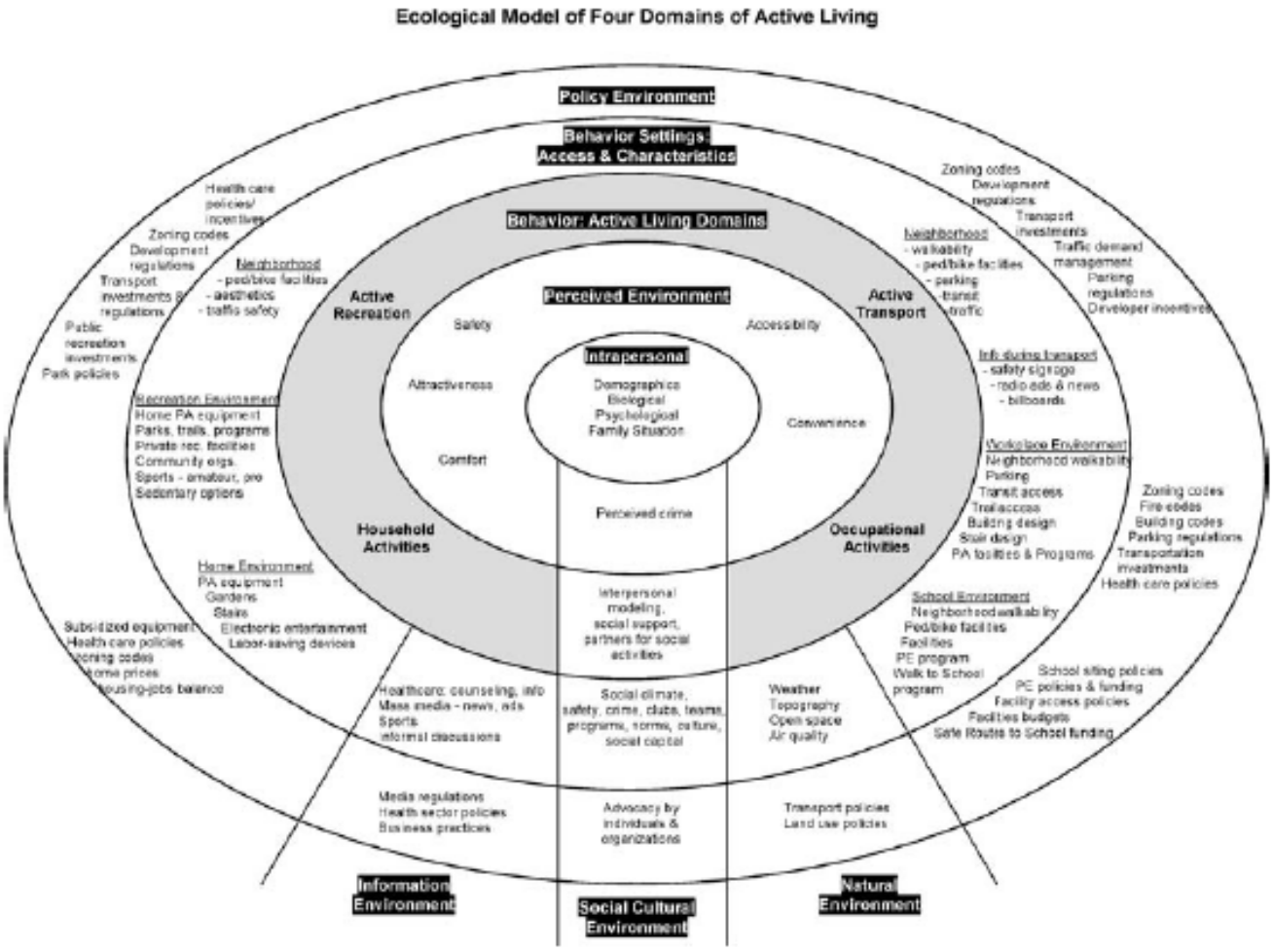


Figure 12: Proposed ecological model of neighbourhood environmental influences on walking and cycling (Saelens 2003)[134]

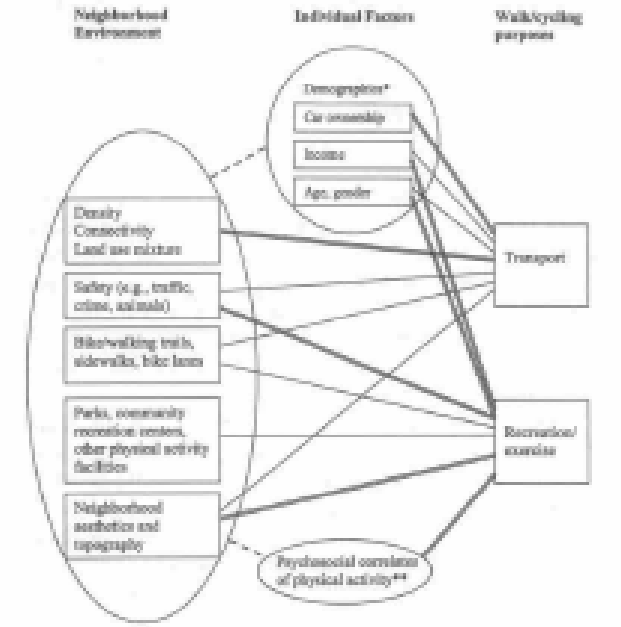


FIGURE 2 A proposed ecological model of neighborhood environment influence on walking and cycling. Double lines denote stronger relations; single lines denote weaker relations; dashed lines denote mediated relations. *Some examples of demographic variables are provided, but should not be considered comprehensive. **Psychosocial correlates of physical activity would include, but are not limited to, such variables as self-efficacy, perceived benefits, perceived barriers, social support, and enjoyment of physical activity.

Figure 13: Environmental research framework for weight gain prevention (Kremers 2006[209])

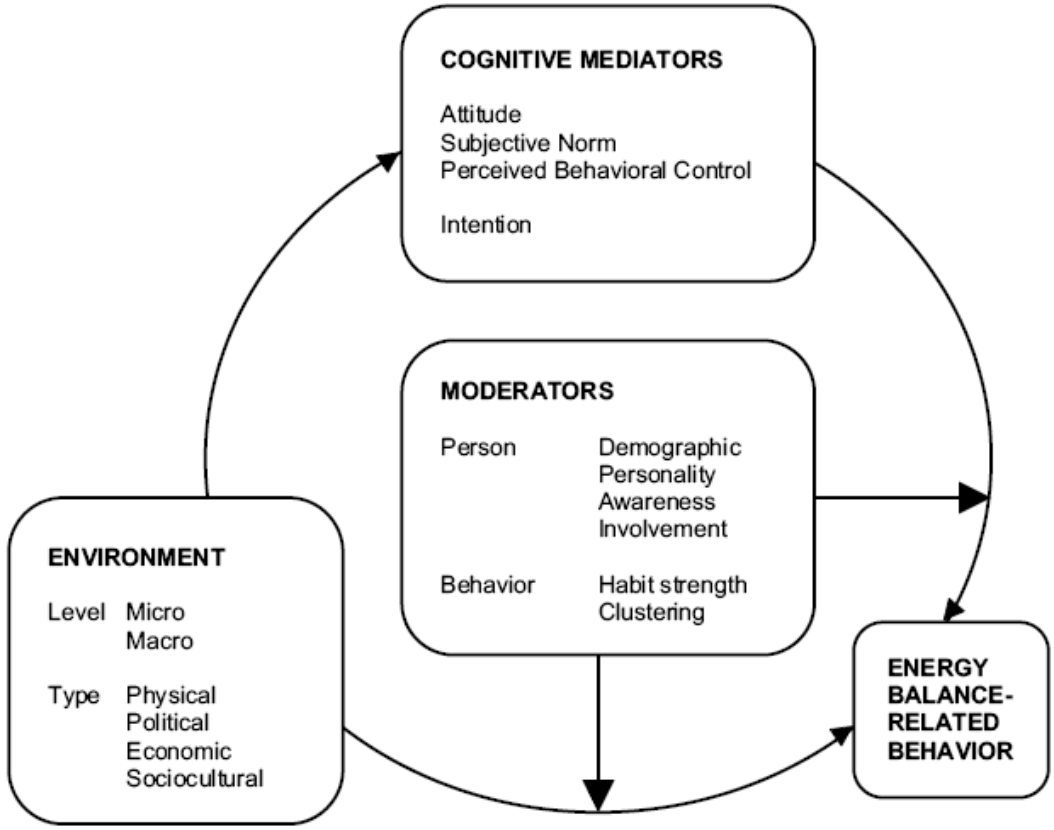


Figure 1
Environmental Research framework for weight Gain prevention (EnRG).