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The role of the neighbourhood in adolescent alcohol use

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A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy in
Community Health, The University of Auckland, 2016.

Abstract

Background

In Aotearoa New Zealand, adolescents experience disproportionately more harm from their drinking when compared to older drinkers. The social gradient in adolescent drinking and harm presents important implications for health equity, underscoring the need to identify and address the social determinants of adolescent alcohol use, including the physical and social features of the neighbourhood environment. The overarching aim of this research was to identify salient neighbourhood exposures associated with adolescent drinking and subgroups of adolescents who may have heightened vulnerability to their effects.

Methods

This thesis comprises one systematic review of the literature and four studies utilising data from the Youth'07 and Youth'12 nationally-representative surveys of secondary school students in Aotearoa New Zealand:

- a) *Systematic review*: Multilevel studies of neighbourhood effects (excluding alcohol outlet density) on adolescent alcohol use were identified and synthesised.
- b) *Adolescent drinking typologies*: Latent Class Analysis (LCA) was undertaken to identify drinking typologies among current drinkers in the Youth'07 survey. Proximal predictors of each drinking typology were identified so that potential mediators on the pathway(s) of neighbourhood effects could be further investigated.
- c) *Changes in drinking between 2007 and 2012*: Changes in drinking were examined among demographic subgroups characterised by age, sex, and household and neighbourhood socio-economic position (SEP).
- d) *Neighbourhood typologies and adolescent alcohol use*: Ten indicators of the neighbourhood socio-economic, social, and physical environment were utilised in a LCA to identify

neighbourhood typologies. Associations between neighbourhood typology and alcohol use were examined using multilevel modelling.

- e) *Pathways of neighbourhood effects*: Multilevel path analysis was used to examine the direct and indirect pathways of neighbourhood disadvantage, physical disorder, collective efficacy, and alcohol outlet density on drinking behaviours.

Results

Systematic review: 30 multilevel studies examining 12 neighbourhood-level exposures were identified. The majority of studies found no associations between measures of adolescent drinking and residential mobility, neighbourhood disorder or crime, employment or job availability, neighbourhood attitudes to drinking, social capital, and collective efficacy. Inconsistent results were found across studies examining the effects of neighbourhood-level socio-economic disadvantage. High levels of both adult and adolescent alcohol use in the neighbourhood showed positive associations with adolescent alcohol use whilst protective effects were found for enforcement of liquor laws.

Adolescent drinking typologies: LCA revealed four drinking typologies amongst drinkers, reflecting an overall linear relationship between levels of consumption and alcohol-related harms. One class was an exception to this pattern, with moderate consumption associated with disproportionately high levels of alcohol-related harms. Having a positive attitude to regular alcohol use, buying own alcohol, peers using alcohol, and obtaining alcohol from friends and/or other adults were found to be the strongest predictors of belonging to high-risk drinking typologies.

Changes in drinking between 2007 and 2012: Aggregate data for students in all groups characterised by age, sex, household SEP, and neighbourhood SEP showed declines in the prevalence and frequency of drinking. Reductions in the typical quantity of alcohol consumed by drinkers were only apparent among young males (<16 years). The gradient of this change was

unequal across household SEP strata, whereby young males of low SEP showed smaller reductions compared to their more advantaged counterparts. Significant increases in high typical quantities (i.e. 5+ drinks per occasion) were evident in young females of low household and neighbourhood SEP.

Neighbourhood typologies and adolescent alcohol use: Three neighbourhood types were identified: (1) “high outlet density and economic disadvantage”; (2) “high disadvantage, disorder, and social disorganisation”; and (3) “higher income and socially organised”. Interaction analyses showed that the effects of neighbourhood type on drinking were moderated by age. Among young adolescents (<16 years), students residing in type 1 and 2 neighbourhoods were more likely to consume high typical quantities when compared to students in type 3. Students in type 1 neighbourhoods were also more likely to be current drinkers. No significant associations between neighbourhood type and measures of drinking were found among older (≥ 16 years) adolescents.

Pathways of neighbourhood effects: Neighbourhood disadvantage was positively associated with increased perceptions of physical disorder, which in turn was associated with lower levels of neighbourhood collective efficacy. Age was shown to moderate the relationship between collective efficacy and drinking. Specifically, collective efficacy was found to be protective against risky drinking among young adolescents (<16 years), but predicted increased risky drinking and current drinking in older adolescents (≥ 16 years). Alcohol outlet density was not implicated in the collective efficacy pathway, but showed direct relationships with drinking in both age groups. Among older adolescents, off-licence density was significantly associated with increased binge drinking and current drinking. Among younger adolescents, club density was positively associated with high typical quantities and current drinking.

Conclusion

An adolescent's place of residence is often beyond their control, yet the findings from this thesis indicate that the neighbourhood can be an important influence on their alcohol use. In particular, exposure to area-level socio-economic disadvantage, physical disorder, alcohol outlets, and low collective efficacy may give rise to experiencing inequalities in harmful alcohol use. The inter-related nature of neighbourhood characteristics and variations in effects based on age point to the need for future research to employ developmentally-appropriate innovative methods that can better capture relevant exposures, pathways, and interactions of adolescents with their neighbourhood environments.

Although we set out primarily to study reality, it does not follow that we do not wish to improve it; we should judge our researches to have no worth at all if they were to have only a speculative interest. If we separate carefully the theoretical from the practical problems, it is not to the neglect of the latter; but, on the contrary, to be in a better position to solve them.

(Durkheim, 1933, p. 33)

Acknowledgements

At 15 years of age a conversation with my high school careers counsellor resulted in a decision to undertake a PhD at some point in my life. It was my Everest and I wanted to climb it. I didn't know what a PhD entailed, what I needed to do to get there, what topic I may study, but I knew it would be underpinned by a strong commitment to equality. At that age, all I was concerned about was female rights, and in particular, the equal opportunity to have challenging and fulfilling careers.

I would not be at the summit of my Everest had it not been for opportunities to be taught and inspired by many exceptional leaders in their field who are also some of the kindest people on this planet. There are too many to list, but include Professor Murray Skeaff, Associate Professor John Elliott, (late) Professor Elizabeth Waters, and Associate Professor John F Smith.

To guide me throughout my PhD journey and allow me the freedom to venture into the absolute unknown I am grateful to my supervisors Professor Shanthi Ameratunga and Associate Professor Simon Denny. I also sincerely acknowledge one of the many leaders in the field, Professor Robert J. Sampson, for dedicating his career to setting the standard for neighbourhood research and publishing his voluminous works in a very accessible manner. I acknowledge the Adolescent Health Research Group for permission to access the Youth 2000 series data and providing feedback on proposals and publication manuscripts. I also acknowledge the statistical support provided by Arier Lee and assistance of Brandon De Graaf (University of Otago) in the geocoding of alcohol outlets. To my anonymous peer reviewers, I am deeply grateful for your valuable comments on my manuscripts.

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Table of Contents

Abstract	ii
Acknowledgements	vii
Table of Contents	ix
List of Tables	xiii
List of Figures	xiv
Role of the candidate	xv
Glossary	xvi
Chapter 1 Introduction	1
1.1. Thesis goal and aims	1
1.2. Background and significance	2
1.3. Measuring adolescent alcohol use	5
1.4. Aetiology of adolescent alcohol use	7
1.4.1 Theoretical foundation	8
1.4.2 The ecology of adolescent alcohol use	11
1.5. Neighbourhoods and adolescent development	13
1.5.1 Social cohesion	17
1.5.2 Social networks and social capital	19
1.5.3 Collective efficacy	23
1.5.4 The role of physical disorder in social disorganisation	27
1.6. The study of neighbourhood effects	29
1.6.1 Neighbourhood-based designs	31
1.6.2 Classification of ‘neighbourhood’	35
1.6.3 Confounding and mediation	38
1.6.4 Heterogeneity of effects	42
1.6.5 Data collection and the reliability of aggregated neighbourhood exposures	43
1.6.6 Spatial autocorrelation or spill-over effects	45

1.6.7	Analysis of neighbourhood effects	45
1.7	Conclusion.....	48
Chapter 2	Neighbourhood effects on adolescent alcohol use	49
2.1	Preface	49
2.2	Abstract.....	50
2.3	Introduction	51
2.4	Methods	54
2.5	Results	57
2.6	Discussion.....	73
2.7	Conclusion.....	80
2.8	Addendum	80
Chapter 3	Methodology of the Youth 2000 survey series	88
3.1	Introduction	88
3.2	Survey methodology.....	88
3.3	Sampling.....	90
3.4	Characteristics of the sample.....	92
Chapter 4	Typologies of adolescent alcohol use.....	95
4.1	Preface	95
4.2	Abstract.....	96
4.3	Introduction	97
4.4	Methods	98
4.5	Results	102
4.6	Discussion.....	108
Chapter 5	Changes in adolescent alcohol use over time.....	113
5.1	Preface	113
5.2	Abstract.....	115
5.3	Introduction	116
5.4	Methods	119

5.5	Results	123
5.6	Discussion.....	129
Chapter 6 Neighbourhood typologies and adolescent alcohol use		133
6.1	Preface	133
6.2	Abstract.....	134
6.3	Introduction	135
6.4	Methods	137
6.5	Results	143
6.6	Discussion.....	151
Chapter 7 Pathways of neighbourhood effects on adolescent alcohol use.....		156
7.1	Preface	156
7.2	Abstract.....	157
7.3	Introduction	158
7.4	Methods	163
7.5	Results	170
7.6	Discussion.....	179
Chapter 8 Discussion and implications for research and practice.....		185
8.1	Overview of research.....	185
8.2	Strengths of research	188
8.3	Limitations of research	190
8.3.1	Causal inference from observational designs.....	190
8.3.2	Specific methodological limitations.....	194
8.4	Implications for research	201
8.4.1	Measures or typologies of alcohol use.....	201
8.4.2	Neighbourhood-based designs and the operationalisation of ‘neighbourhood’	203
8.4.3	Collection of neighbourhood exposures	207
8.4.4	Disentangling the mechanisms of effects.....	208
8.5	Implications for health promotion practice	212

8.5.1	Build healthy public policy	213
8.5.2	Creating supportive environments	217
8.5.3	Strengthening community action	219
8.5.4	Developing personal skills	221
8.5.5	Reorienting health services	222
Conclusion		224
Appendix 1. PRISMA checklist.....		226
Appendix 2. Medline search strategy: details and results.....		228
Appendix 3. Details of included studies		229
Appendix 4. Summary of quality assessment for included studies.....		245
Appendix 5. Copyright forms for published papers.....		249
References.....		250

List of Tables

Table 1-1	<i>Dimensions of Social Cohesion (Forrest & Kearns, 2001)</i>	18
Table 1-2	<i>Domains of Social Capital (Forrest and Kearns, 2001)</i>	21
Table 1-3	<i>Collective Efficacy Scale (Sampson et al., 1997)</i>	24
Table 1-4	<i>Levels of Neighbourhood Scale (Kearns and Parkinson, 2001)</i>	36
Table 2-1	<i>Associations Between Neighbourhood Socio-demographic Factors and Adolescent Alcohol Use</i>	59
Table 2-2	<i>Associations Between Neighbourhood Social Processes and Adolescent Alcohol Use</i>	64
Table 2-3	<i>Updated Systematic Review: Details of Included Studies</i>	84
Table 3-1	<i>Questions Regarding Alcohol Consumption in the Youth'07 and Youth'12 Surveys</i>	89
Table 3-2	<i>Characteristics of Schools and Students in the Youth'07 and Youth'12 Surveys</i>	93
Table 4-1	<i>Distribution of Drinking Behaviours and Alcohol-related Harms, Among Drinkers</i>	103
Table 4-2	<i>LCA Fit Indices</i>	104
Table 4-3	<i>Item-response Probabilities of Drinking Measures and Outcomes, by Latent Class Membership</i>	105
Table 4-4	<i>Predictors of Latent Class Membership</i>	107
Table 5-1	<i>Demographic Characteristics of the Study Population, 2007-2012</i>	124
Table 5-2	<i>Changes in Measures of Drinking Between 2007 and 2012, Among All Students and Drinkers</i>	126
Table 6-1	<i>Neighbourhood Indicators Used to Identify Neighbourhood Types</i>	140
Table 6-2	<i>Individual- and Neighbourhood-level Characteristics of the Study Population</i> ...	144
Table 6-3	<i>Fit Indices for the Latent Class Analysis of Neighbourhood Types</i>	145
Table 6-4	<i>Item-response Probabilities of Latent Class Indicators, by Neighbourhood Type</i>	146
Table 6-5	<i>Individual-level Demographic Characteristics of Latent Neighbourhood Types</i>	147
Table 6-6	<i>Results of Multilevel Modelling of Neighbourhood Types on Adolescent Alcohol Use and Harm</i>	150
Table 7-1	<i>Characteristics of the sample population and neighbourhoods they resided in</i>	171
Table 7-2	<i>Zero-order correlations among the study variables</i>	172

List of Figures

<i>Figure 1-1.</i>	Social Disorganisation Theory.....	15
<i>Figure 2-1.</i>	Results of study selection process.	57
<i>Figure 3-1.</i>	Example of Area Unit (dark lines, labelled) and meshblock (lighter lines) boundaries.....	92
<i>Figure 5-1.</i>	Distribution of logged typical quantity among young females in 2007 and 2012, by level of household socio-economic position.....	129
<i>Figure 7-1.</i>	Hypothesised multilevel path model.....	163
<i>Figure 7-2.</i>	Structural model of neighbourhood exposures and high typical quantity in young adolescents.....	175
<i>Figure 7-3.</i>	Structural model of neighbourhood exposures and binge drinking in young adolescents.....	175
<i>Figure 7-4.</i>	Structural model of neighbourhood exposures and current drinking in young adolescents.....	175
<i>Figure 7-5.</i>	Structural model of neighbourhood exposures and high typical quantity in older adolescents.....	177
<i>Figure 7-6.</i>	Structural model of neighbourhood exposures and binge drinking in older adolescents.....	177
<i>Figure 7-7.</i>	Structural model of neighbourhood exposures and current drinking in older adolescents.....	177
<i>Figure 8-1.</i>	Distribution of Pacific people across socio-economic deprivation deciles.....	193

Role of the candidate

The topic for this thesis arose from problems experienced in advocacy efforts to reduce inequalities in alcohol-related harm in Auckland, New Zealand. In 2010, eight legacy councils were merged to form the Auckland Council, represented by 21 Local Boards. As the Project Manager for alcohol and tobacco harm reduction in a large public health organisation, my responsibility was to submit recommendations to each Local Board and the wider Council on actions that should be taken to reduce the burden of alcohol harm experienced by communities across the region. Beyond Council's important role as a regulatory agency in the sale and supply of alcohol I was left with little evidence to guide recommendations on further efforts that the Council and Local Boards should be taking to reduce harm. There was simply a dearth of international and local evidence on the social processes and physical features (beyond alcohol outlet density) within neighbourhoods which give rise to alcohol-related inequities. The studies included in this thesis aim to go some way towards guiding policy decisions at a local level. As a practitioner and academic of health promotion, I also wished to conduct pragmatic research which could be used to inform the development of community-based programmes to reduce alcohol-related harm.

It should be noted that this thesis is an examination of secondary data collected in the Youth 2000 survey series, undertaken by the Adolescent Health Research Group at the University of Auckland. As such, I was not involved in any part of the research process relating to funding applications, ethical approval, survey design, data collection or data cleaning. However, I conceived, led, and managed all aspects of the research included in this thesis and am the first author on all of the included publications.

Glossary

AIC	Akaike Information Criteria
BIC	Bayesian Information Criteria
CAYAD	Community Action on Youth and Drugs
CI	Confidence Interval
GPS	Global Positioning System
LCA	Latent Class Analysis
LRT	Lo-Mendell-Rubin adjusted likelihood ratio test
MOR	Median Odds Ratio
NS	Non-significant
OR	Odds Ratio
PHDCN	Project on Human Development in Chicago Neighborhoods
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SD	Standard deviation
SDM	Social Development Model
SEP	Socioeconomic Position
SSABIC	Sample size adjusted Bayesian Information Criteria
SSO	Systematic Social Observation
US	United States

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Please indicate the chapter/section/pages of this thesis that are extracted from a co-authored work and give the title and publication details or details of submission of the co-authored work.

Chapter 2. Neighbourhood effects on adolescent alcohol use.

From: Jackson, N., Denny, S., & Ameratunga, S. (2014). Social and socio-demographic neighborhood effects on adolescent alcohol use: a systematic review of multi-level studies. *Social Science and Medicine*, 115, 10-20.

Nature of contribution by PhD candidate	Formulating the review question, undertaking the electronic database search, screening of titles, critical appraisal, data extraction, narrative synthesis, manuscript preparation
Extent of contribution by PhD candidate (%)	90%

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Certification by Co-Authors

The undersigned hereby certify that:

- ❖ the above statement correctly reflects the nature and extent of the PhD candidate's contribution to this work, and the nature of the contribution of each of the co-authors; and
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Chapter 4. Typologies of adolescent alcohol use. From: Jackson, N., Denny, S., Sheridan, J., Fleming, T., Clark, T., Teevale, T., & Ameratunga, S. (2014). Predictors of drinking patterns in adolescence: a latent class analysis. *Drug and Alcohol Dependence*, 135, 133-139.

Nature of contribution by PhD candidate	Formulating research proposal, undertaking statistical analysis, completion of manuscript
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Extent of contribution by PhD candidate (%)	80%
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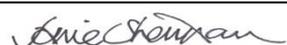
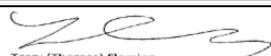
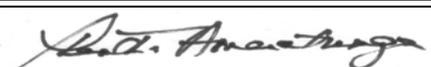
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Please indicate the chapter/section/pages of this thesis that are extracted from a co-authored work and give the title and publication details or details of submission of the co-authored work.

Chapter 5. Changes in adolescent alcohol use over time.

From: Jackson, N., Denny, S., Sheridan, J., Fleming, T., Clark, T., Peiris-John, R., & Ameratunga, S. (2016). Uneven reductions in high school students' alcohol use from 2007 to 2012 by age, sex and socio-economic strata. Substance Abuse, doi10.1080/08897077.2016.1252827.

Nature of contribution by PhD candidate	Formulating the research proposal, undertaking statistical analysis, and completion of manuscript	
Extent of contribution by PhD candidate (%)	85%	

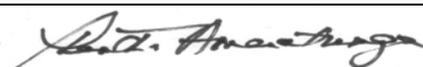
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Roshini Peiris-John	Approving research proposal and appraising manuscript
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Chapter 6. Neighbourhood typologies and adolescent alcohol use.

From: Jackson, N., Denny, S., Sheridan, J., Zhao, J. & Ameratunga, S. (2016). Differential effects of neighborhood type on adolescent alcohol use in New Zealand. *Prevention Science*, 17(7), 841-851.

Nature of contribution by PhD candidate	Formulating the research proposal, undertaking statistical analysis, and completion of manuscript
Extent of contribution by PhD candidate (%)	85%

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Chapter 7. Pathways of neighbourhood effects on adolescent alcohol use

From: Jackson, N., Denny, S., Sheridan, J., Zhao, J. & Ameratunga, S. (2016). The role of neighborhood disadvantage, physical disorder, and collective efficacy in adolescent alcohol use: a multilevel path analysis. *Health & Place*, 41, 24-33.

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Extent of contribution by PhD candidate (%)	90%	

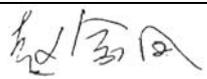
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Chapter 1 Introduction

1.1. Thesis goal and aims

The goal of this thesis is to inform community-based health promotion practice by understanding how features of the neighbourhood context influence adolescent alcohol use in Aotearoa New Zealand. Specifically, the objectives of the thesis are to:

- Systematically review the evidence from multilevel studies of neighbourhood effects on adolescent alcohol use;
- Identify proximal risk and protective factors associated with typologies of drinking among New Zealand adolescent drinkers;
- Examine the influence of neighbourhood socio-economic position (SEP) in relation to changes in drinking;
- Identify neighbourhood typologies associated with adolescent alcohol use; and
- Explore the mediating and interacting pathways of neighbourhood effects on adolescent alcohol use.

The overall body of work is strongly underpinned by the principles of social epidemiology and health promotion, through addressing the social determinants of health, being committed to social justice, and viewing health as a human right (Jackson, Birn, Fawcett, Poland, & Schultz, 2013; Krieger, 2001). Whilst this thesis identifies ethnic differences in alcohol consumption, related harm, and vulnerability to the neighbourhood environment, it does not seek to further undertake ethnic-based analyses of the findings. However, this thesis is founded on an understanding that many findings related to ethnicity, in particular those for indigenous groups, are not the result of biological determinism (Robson & Reid, 2001), but rather reflect inequalities in access to goods, services, and opportunities within Aotearoa New Zealand (Becares, Cormack, & Harris, 2013).

As this thesis comprises a series of publications, some material may be found to be repeated throughout the body of work. However, it is the intention that each chapter demonstrates development in the depth and understanding of the important concepts in this field.

1.2 Background and significance

Adolescence, the period between the onset of puberty and the assumption of adult roles and broadly denoting the second decade of life (i.e. 10-19 years), marks a stage of development with heightened vulnerability to alcohol use and its consequences (U.S. Department of Health and Human Services, 2007). The dramatic changes and expanding opportunities which take place across this period signal the need for adolescent alcohol use to be understood within a developmental framework (Masten, Faden, Zucker, & Spear, 2008). This translates to the consideration of multiple influences on development, including maturation, expanding interactions with multiple social and cultural contexts (including neighbourhoods), environmental exposures and sanctions, and the genetic, psychological, and social factors specific to each adolescent (U.S. Department of Health and Human Services, 2007). Factors and experiences in the pre-adolescent period also shape development in adolescence, including the presence of conduct disorder, attentional deficits, aggressiveness, and relationships among family, peers, and schools (Zucker, Donovan, Masten, Mattson, & Moss, 2008). The complex intertwining of these influences evolves over time (Masten et al., 2008), resulting in adolescents of different ages and stages of development having different needs and requiring different protective structures and skills to succeed (U.S. Department of Health and Human Services, 2007).

Initiation of alcohol use commonly occurs in adolescence (Petit, Kornreich, Verbanck, Cimochovska, & Campanella, 2013). In New Zealand, adolescents typically commence drinking (more than an occasional sip) by the age of 15 years, and of significant concern, one in five has consumed alcohol by the age of 13 (Research New Zealand, 2011). The majority of adolescent drinking sessions occur at a friend's house or their own home (Ministry of Health, 2009a).

Overall, adolescents drink more per episode than adults, and have notable differences in alcohol sensitivities as a result of a combination of factors relating to their metabolism and developing hormonal and neurotransmitter systems (Spear, 2014). For example, social facilitation and the rewarding aspects of alcohol may be enhanced in response to low doses of alcohol among adolescents, who are also less sensitive to the motor impairment and sedative effects of alcohol (Spear, 2014). As a result of these differing sensitivities and patterns of drinking, young drinkers experience disproportionately more harm from their drinking in comparison to older drinkers (Ministry of Health, 2009a; National Health and Medical Research Council, 2009). Those aged under 15 years are at particularly high risk, with the rates of harm remaining somewhat elevated among drinkers aged 15–17 years (National Health and Medical Research Council, 2009). Consequently, there is a consensus among guidelines developed in Canada (Butt, Beirness, Gliksman, Paradis, & Stockwell, 2011), Australia (National Health and Medical Research Council, 2009), New Zealand (Health Promotion Agency, n.d.) and the United Kingdom (Donaldson, 2009) that young people delay alcohol consumption for as long as possible, particularly those under the age of 15 years. Guidelines further recommend that if drinking has initiated, it should occur under guidance, and at low levels and frequency.

The impairment of brain functioning is a significant harm which may result from heavy alcohol consumption during adolescence. Areas of the brain, including the hippocampus and prefrontal cortex, which are not yet mature and are thought to be particularly sensitive to alcohol use (Bellis et al., 2005; Nagel, Schweinsburg, Phan, & Tapert, 2005; Schweinsburg, McQueeney, Nagel, Eyler, & Tapert, 2010), have been shown to be reduced in adolescents with alcohol use disorders. Altered frontal lobe development is of significant import to academic success during adolescence (Schweinsburg et al., 2010), given that this area of the brain is responsible for learning and memory abilities. In adolescents with heavy alcohol use, altered responses during working memory tests and difficulties experienced with planning and decision-making have been found (Johnson et al., 2008; Tapert et al., 2004).

Alcohol consumption also increases the risk of unintentional and intentional (e.g. self-harm, violence) injury, with consumption of more than 4 standard drinks on a single occasion at least doubling the risk of injury over the next 6 hours (National Health and Medical Research Council, 2009). Between 2005 and 2007, almost one-quarter (24%) of all deaths in children and young people aged under 16 years in New Zealand were attributable to their own alcohol consumption, with motor vehicle accidents by far the most prevalent cause of alcohol-related deaths (Child and Youth Mortality Review Committee, Te Rōpū Arotake Auau Mate o te Hunga Tamariki, & Taiohi, 2009). Injury (to oneself) was the most common alcohol-related problem reported by New Zealand adolescent drinkers in 2012, followed by doing things which could result in serious trouble, having unsafe sex, and having performance at school or work affected (Clark, Fleming, Bullen, Crengle, Denny, Dyson, Fortune, et al., 2013). Inequalities are also evident, whereby students of Māori and Pacific ethnicity and/or living in socio-economic disadvantage are more likely to report a range of alcohol-related harms (Ameratunga et al., 2011).

Beyond immediate risks, there are also concerns that behaviours during adolescence may be important gateways to good (or bad) health in middle and later adulthood (Raphael, 2013a). A systematic review of longitudinal studies examining the longer-term consequences of adolescent alcohol use found consistent evidence of associations with subsequent alcohol use in later life (McCambridge, McAlaney, & Rowe, 2011). Despite some individual studies finding links between adolescent alcohol use and other outcomes such as increased levels of sexually transmitted infections (Boden, Fergusson, & Horwood, 2011), major depression (Fergusson, Boden, & Horwood, 2009), and violence (Wells, Horwood, & Fergusson, 2004), the review concluded that there was insufficient high-quality evidence to suggest a causal association with physical, mental health, and social problems in later life. It is suggested however, that rather than considering the gateways between adolescent behaviours and adult outcomes, focus should turn to the environments which embed these behaviours, and the public policies which shape these environments (Raphael, 2013a).

The disproportionate financial, social and physical harms reported by young people from others' drinking is also a significant concern (Casswell, You, & Huckle, 2011; Connor & Casswell, 2012). For example, between 2003 and 2007, half of all alcohol-related traffic injuries in the 15-19 year age group in New Zealand were due to someone else's drinking (Connor & Casswell, 2009); the highest proportion in comparison to other age groups.

All of the negative acute and long-term effects of adolescent alcohol use suggest that the behaviour should be considered problematic. In reality, adolescent alcohol use has always been one of the major rituals in the rites of passage to adulthood (Butler, 1990). It takes place in a period of time when experimentation and risk-taking are common, as young people strive to obtain independence in their decision-making (Leslie, 2008). Across cultures, there is variation in the 'social clock' for when adolescent drinking becomes acceptable (Room, 2004). As such, this thesis supports the 'harm reduction' approach, which acknowledges the reality of adolescent drinking and attempts to identify the mechanisms or factors to reduce the significant harms associated with it. Harm reduction is argued to be more congruent with the known stages of adolescent development and decision-making (Leslie, 2008).

1.3 Measuring adolescent alcohol use

Alcohol use in adolescence is a complex behaviour, reflected by its inconsistent, temporal, highly situational and in some cases experimental nature (Strunin, 2001). This presents many challenges within the field of alcohol-related research. Nuanced approaches to describing adolescent alcohol use, that incorporate the complexity of the behaviour, will be important to provide a more person-centred understanding of the aetiology of alcohol use and its harm.

A wide variety of measures have been used to describe adolescent drinking behaviour, including frequency of alcohol consumption and binge drinking (in a given reference period), age of initiation, and typical quantity consumed in a drinking occasion. Researchers have begun to question the characterisation of adolescent drinkers to include those who have had a sip of

alcohol with those who have consumed whole beverages, arguing that the two are distinct behaviours with different sets of predictors (Wadolowski, Bruno, et al., 2015; Wadolowski, Hutchinson, et al., 2015). Furthermore, the limited utility of uni-dimensional measures of alcohol consumption (e.g., drinking frequency) to capture the diverse drinking occasions and to predict harm (Cable & Sacker, 2008; Thombs & Beck, 1994) signals the need for an individual's pattern (or typology) of drinking to be examined within alcohol-related research (Rehm et al., 1996).

Regardless of the chosen drinking measure, it is imperative that it be both valid and reliable (Greenfield & Kerr, 2008). Population-based surveys, utilising self-reports of alcohol use, have been found to grossly underestimate the actual amount of alcohol consumed in the population when compared to estimates of taxable alcohol available for consumption (Casswell, Huckle, & Pledger, 2002; Northcote & Livingston, 2011; Stockwell et al., 2004). The discrepancy between population-based surveys and estimates of taxable alcohol available has been estimated to be in the range 50 to 75% (Stockwell et al., 2004). Such a substantial underestimation has important implications for the investigation of risks associated with varying levels of alcohol consumption (Dawson & Room, 2000). Due to the presence of under-reporting of alcohol use it has generally been accepted that measures which result in higher reported volumes of use are considered more valid, although Del Boca and Darkes (2003) believe this needs further consideration.

Consensus in the field maintains that if assessment situations in surveys are structured to minimise known sources of bias, self-reports of drinking can show adequate reliability and validity for most alcohol-related research purposes (Brenner, Billy, & Grady, 2003; Del Boca & Darkes, 2003). Consequently, most debate in this field centres on the factors or characteristics which threaten the veracity of responses in population surveys and the usefulness of different measures (Del Boca & Darkes, 2003). Researchers (Del Boca & Darkes, 2003; Greenfield & Kerr, 2008) have described a number of variables which influence the interpretation and responses within population surveys. These include demographic characteristics (e.g., age, gender, ethnicity, religious preference), personality traits (e.g., need for approval, sociopathy),

attitudes, values and beliefs (e.g., perceived norms regarding drinking), intelligence (or cognitive impairment), personal circumstances (e.g., justice system involvement), and physical and mental health, including sobriety, fatigue, depression and anxiety (Del Boca & Darkes, 2003). Assurance of anonymity and confidentiality are also important for enhancing the validity of self-reported alcohol use by adolescents (Brener et al., 2003).

The ability to recall drinking behaviour in surveys is said to be dependent on the regularity of drinking occasions (Conrad, Brown, & Cashman, 1998), and may be more reliable when behaviours of question are rare, or have considerable importance (Schwarz, 1999). The characteristic adolescent drinking pattern being inconsistent and highly situational can make recall particularly problematic (Strunin, 2001). However, self-reported consumption by adolescents has been found to be reasonably reliable and valid (Campanelli, Dielman, & Shope, 1987; Lintonen, Ahlstrom, & Metso, 2004). Higher reports of alcohol use in adolescents have been found when computer-assisted telephone interviews are used, rather than paper-based questionnaires (Wright, Aquilino, & Supple, 1998), and when large values within response categories are provided which may assist in legitimising problem behaviours (Greenfield & Kerr, 2008). In addition, higher reports by adolescents have been found in school settings in comparison to home settings (Kann, Brener, Warren, Collins, & Giovino, 2002).

1.4 Aetiology of adolescent alcohol use

Measures of drinking which capture the complexity of adolescent drinking behaviour can assist in providing a more nuanced approach to exploring the aetiology of adolescent alcohol use and related harm. Adopting an ecological approach, which acknowledges that aetiological risk and protective factors may operate across many social settings and systems to influence drinking patterns, will be essential for alcohol-related research and the development of effective community prevention programmes. This section provides the theoretical foundation of this thesis

to explore neighbourhood-level influences on adolescent alcohol use and outlines the key risk and protective factors, as found in the literature, which may mediate or moderate these effects.

1.4.1 Theoretical foundation

The need to consider the entire ecology, or social systems, which influence adolescent behaviour is described within Bronfenbrenner's Ecological Systems Model (Bronfenbrenner, 1979). Social systems are characterised to be like Russian dolls encased inside another, and include settings such as families, peer groups, schools, workplaces, and neighbourhoods. Of great importance, this model strongly contends that it is the interaction(s) among and between these systems which are salient to understanding behaviour.

Similarly, the Social Development Model (SDM) posits that adolescents learn patterns of behaviour as a result of their bonds to the socialising agents of peers, family, school, and religious and other community institutions (Catalano & Hawkins, 1996; Catalano, Kosterman, Hawkins, Newcomb, & Abbott, 1996; Hawkins & Weis, 1985). Grounded in criminological theory, adolescents are proposed to adopt pro-social or anti-social orientations which reflect the attitude and behaviour of the social unit to which they are closely bonded (Catalano, Kosterman, Hawkins, Newcomb, & Abbott, 1996). These units provide socialisation through processes involving four constructs: (1) opportunities for involvement in activities and interactions, (2) the degree of involvement and interaction, (3) the skills to participate in these involvements and interactions, and (4) the reinforcement they perceive as a result of performance in activities and interactions. The SDM has been widely used to examine risk and protective factors of adolescent behaviours and has been empirically shown to predict adolescent alcohol use (Catalano et al., 1996; Lonczak et al., 2001).

The SDM further suggests that risk and protective factors will vary in their salience, or operate differently, across the stages of adolescence (Aber, Gephart, Brooks-Gunn, Connell, & Spencer, 1997). For example, the role of the neighbourhood may become more salient as adolescents gain

independence and spend more time outside their home setting (Snedker, Herting, & Walton, 2009). It may have a deeper importance in younger adolescents who traditionally spend more time in their immediate neighbourhood when compared to older adolescents, with the latter having more opportunities to interact more frequently with friends from other areas (Brenner, Bauermeister, & Zimmerman, 2011). Evidence is emerging of an increased vulnerability to the neighbourhood environment for younger adolescents, in comparison to older adolescents (Cleveland, Feinberg, Bontempo, & Greenberg, 2008; Fagan, Van Horn, Hawkins, & Arthur, 2007; Ferguson & Meehan, 2011; Rowland, Toumbourou, Satyen, Tooley, et al., 2014), particularly in those adolescents who initiate alcohol consumption at an early age (Abadi, Shamblen, Thompson, Collins, & Johnson, 2011).

Both Bronfenbrenner's ecological model and the SDM emphasise the dynamic nature of behaviour whereby reciprocal or bi-directional mechanisms may occur across systems or contexts, as well as the direct and indirect pathways between predictors and behaviours (Lonczak et al., 2001). Reciprocal relationships have been shown in relation to adolescent alcohol use and parenting behaviours (Trucco, Colder, Wieczorek, Lengua, & Hawk, 2014), peer affiliations (Dishion & Owen, 2002), school engagement (Roebroek & Koning, 2015), and violence (Scholes-Balog, Hemphill, Kremer, & Toumbourou, 2013). Longitudinal studies which are able to consider the temporal nature of pathways of effect will be instrumental to the field of neighbourhood research.

The social determinants framework (Commission on the Social Determinants of Health, 2008), political economy of health perspective (Navarro et al., 2006) and principles of health promotion (Jackson et al., 2013) also provide the foundation and motivation for the candidate's social epidemiological investigation into neighbourhood effects. The strong influence of the wider determinants on positive youth development and the relationship between health in adolescence and in adult life suggest that addressing the social determinants will be crucial to the future health of the population and the economic development of society (Raphael, 2013a; Viner et al., 2012).

Social epidemiology is characterised by its focus on the social determinants of health (Krieger 2001) and is underpinned by a commitment to social justice. The approach to social justice is one which is further characterised as being strongly egalitarian, rights-based and focusing on distributive justice and its effects on marginalised groups (Braveman, 2006; Krieger, 2001). Adopting a social justice lens brings much-needed attention to the dearth of evidence concerning the impact on health of the unequal distribution of power, income, goods, and services (including education and access to health care), and conditions of the immediate environment, including neighbourhoods (Commission on the Social Determinants of Health, 2008; Roche et al., 2015). Social epidemiological examination of neighbourhoods as a social determinant of health is supported, given the likelihood that power relations at a societal level are often expressed through relations at the neighbourhood level (Bayoumi & Guta, 2012).

Fundamental to the examination of the social determinants of health is considering the political economy of health, whereby the decisions of political and economic institutions create or perpetuate economic and social privilege giving rise to health inequalities (Krieger, 2001; Navarro et al., 2006). Taking a political economy of health perspective, or engaging in ‘political epidemiology’ (Muntaner et al., 2012), shifts attention further upstream to the root causes of social inequalities in adolescence (Raphael, 2013a). It has been suggested that social epidemiologists need to ‘shake hands’ with political economy more often (Shankardass & Dunn, 2012).

Health promotion approaches are also based on a commitment to addressing social justice, although have been overshadowed by individually-focused behavioural change strategies. This is believed to partly result from such approaches fitting with the ideologies of governments and medical models of health and evidence, and not being seen to be “rocking the boat” by seeking to address the underlying determinants of unequal power and resources (Jackson et al., 2013). Settings-based approaches (e.g. neighbourhoods) provide opportunities to move past individual-focused strategies by diverting attention to addressing the ecological or environmental context of

the setting which is often beyond the control of the individual, and particularly beyond the control of an adolescent. It is said that the true potential of settings-based approaches to systematically tackle the social determinants of health remains underexplored (Shareck, Frohlich, & Poland, 2013).

1.4.2 The ecology of adolescent alcohol use

Adopting an ecological approach points to the consideration of proximal risk and protective factors of adolescent alcohol use as being mediators or moderators in the pathways of neighbourhood effects (Mallery, 2011). An abundance of high-quality evidence has documented the salient risk and protective factors for alcohol use across the main ecological settings where an adolescent may live, study, work, or play. Key factors are highlighted below:

- Individual-level:

- early onset of drinking (Fergusson, Lynskey, & Horwood, 1994; Schaaf & Scragg, 2004);
- individual personality traits, including aggressiveness, impulsivity, sensation seeking, reward responsivity, anxiety/depression, deficits in attention, low resiliency, sleep difficulties, social inhibition/shyness, and conduct disorder (Fergusson et al., 1994; Skidmore, Juhasz, & Zucker, 2011)
- low individual (or family-level) socio-economic position (Droomers, Schrijvers, Casswell, & Mackenbach, 2003; Fergusson et al., 1994);
- early pubertal timing (Biehl, Natsuaki, & Ge, 2007; Westling, Andrews, Hampson, & Peterson, 2008); and
- positive beliefs and expectancies about alcohol (Donovan, 2004; Hawkins, Catalano, & Miller, 1992; National Institute on Alcohol Abuse and Alcoholism, 2004/05).

- Peer-level:
 - perceived and actual peer alcohol use, perceived deviant or unconventional peer group behaviours (Leung, Toumbourou, & Hemphill, 2014);
- Family-level:
 - parental modelling of alcohol use, provision of alcohol, parental approval of adolescent alcohol use (Ryan, Jorm, & Lubman, 2010b); and
 - parental monitoring, general discipline and communication (Ryan, Jorm, & Lubman, 2010a). There are mixed findings with regards to the effects of parent-child relationships (Visser, de Winter, & Reijneveld, 2012).
- School-level:
 - mean levels of alcohol consumption within the school (Rehm et al., 2005);
 - individual- and school-level attachment to school and school bonding (Henry & Slater, 2007; Henry, Stanley, Edwards, Harkabus, & Chapin, 2009); and
 - value-added education, i.e. a combined measure of observed versus expected examination success within schools as well as truancy rates, has been shown to be protective against alcohol use among adolescents residing in England (Bisset, Markham, & Aveyard, 2007), but not Scotland (Markham, Young, Sweeting, West, & Aveyard, 2012).

Neighbourhood-level risk and protective factors are described in Chapter Two, and are the focus of the studies included in this thesis. Adopting the ecological approach also recognises that there will be factors at the societal-level which may differentially shape drinking behaviour across neighbourhoods. These may include alcohol marketing (Anderson, de Bruijn, Angus, Gordon, & Hastings, 2009; Smith & Foxcroft, 2009), levels of adult alcohol use in the population (Bendtsen et al., 2014; Fuhr & Gmel, 2011), country-level income inequality (Elgar, Roberts, Parry-

Langdon, & Boyce, 2005) and alcohol policy and legislation, including minimum legal purchase age, drink driving limits, trading hours, and price of alcohol (Babor, Caetano, et al., 2010). For example, in 1999, New Zealand lowered the minimum legal purchase age for alcohol from 20 years to 18 years. Empirical studies have shown that this law change was associated with an increase in a number of alcohol-related harms for young people, including alcohol-related hospitalisations (Everitt & Jones, 2002), prosecutions for driving with excess alcohol and disorder (Huckle, Pledger, & Casswell, 2006), and traffic crashes (Kypri, Davie, McElduff, Langley, & Connor, 2016; Kypri et al., 2006).

Examining the complex causal processes in the ecology of adolescent drinking will require epidemiological methods that are person-centred (Muthen & Muthen, 2000). Latent Class Analysis and multilevel modelling are just two examples of epidemiological methods which retain the adolescent at the forefront of investigation whilst examining their behaviour within the relevant social context in which it takes place.

1.5 Neighbourhoods and adolescent development

Accumulating evidence points to the importance of structural and social conditions of neighbourhoods as social determinants or “causes of the causes” of poor health (Macintyre & Ellaway, 2003). As sources of inequalities in alcohol consumption and harm (Roche et al., 2015) are often rooted in the social determinants of health, many international and national organisations are increasingly recognising the need to address health inequities in a systematic way by focusing their research and efforts beyond the traditional individual behavioural factors (Satcher, 2010).

Neighbourhoods can be conceived as socially-constructed spatial entities with variable organisational features nested within larger communities (Sampson, 2012). They are considered to be competitive in nature, not only influencing behaviour but can also determine one’s social position in society (Kearns & Parkinson, 2001). Interest on their impact on human health has a

long history, reaching its peak in the late 19th century when public health movements were active in Europe and America (Macintyre & Ellaway, 2003). Focus centred on the physical aspects of the built environment which were believed to be responsible for differences in health outcomes and life expectancy between areas (Chadwick, 1842; Macintyre & Ellaway, 2003). Attention to the environmental causes of disease lead to significant public health gains, through increased provision of clean water and air, proper drainage and sewerage, adequate housing, education for the working classes, and regulation of working conditions (Macintyre & Ellaway, 2003).

In 1895, the influential work of French sociologist Émile Durkheim (1895) drew attention to the influence of the external social environment on shaping and restricting individual behaviour. He is considered to have introduced the concept of emergent properties, now commonplace in neighbourhood research, which describes features such as social interactions that are experienced only at the collective level and are irreducible to the actions and motives of individuals. With this view, neighbourhoods are considered more than the sum of its parts.

In the early 20th century, sociologists in the United States came to the fore, deeply concerned about the effects of rampant urbanisation on those living in poor neighbourhoods. In 1942, Chicago School sociologists Clifford Shaw and Henry D. McKay (Shaw & McKay, 1942), published "*Juvenile delinquency in urban areas*", considered to be one of the most seminal pieces of work within the field of neighbourhood research. Examining juvenile delinquency in urban neighbourhoods in Chicago, Shaw and McKay found an enduring effect of delinquency despite turnover of residents, suggesting that delinquency was due to factors at the neighbourhood level and not the result of the particular constitution of the individual. This laid the foundations for the Social Disorganisation Theory, which posited that structural features at the neighbourhood level (e.g., area-level disadvantage, residential mobility and/or ethnic heterogeneity) were responsible for social disorganisation within neighbourhoods. Social disorganisation was reflected in weak ties and solidarity among residents which limited their ability to build a normative consensus of behaviour, and to supervise, intervene or control

behaviour of children and adolescents in the community (Figure 1-1). Accordingly, variation in the levels of delinquency across neighbourhoods was believed to be attributed to variation in the levels of social disorganisation.

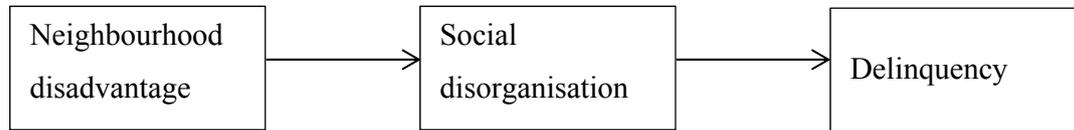


Figure 1-1. Social Disorganisation Theory.

The interest in ecological explanations of behaviour waned in the 1950s as individual-level theories became popular and dominant (Kubrin & Weitzer, 2003). In 1987, William Julius Wilson’s *“The truly disadvantaged”* (Wilson, 1987) began to reorient the debate from individualism through describing the negative effects of a shifting American economy on neighbourhood-level poverty, ruling out alternative (and discriminatory) beliefs at the time that increased joblessness was the result of a culture associated with poverty.

From this point of reference an increased focus on neighbourhood-level effects emerged. Bursik’s (1988) critique of the Social Disorganisation Theory offered many ways forward, helping to quell the many misbelievers who felt that the theory should be dismissed given the reliance on ecological and cross-sectional inferences and lack of operationalisation of theory constructs. Alternative perspectives on the association between neighbourhood characteristics and health outcomes (particularly substance use) also became prevalent, through research examining the direct role of the tension reduction hypothesis (reviewed by Pohorecky (1990)) and the self-medication hypothesis (Khantzian, 1997). The tension reduction hypothesis, emanating from work with cats made neurotic with stress who improved after treatment with alcohol, seeks to explain alcohol consumption by individuals as a mechanism to alleviate stress and negative life events experienced in disadvantaged neighbourhoods. A review of studies found overall support for this pathway in the general population (Veenstra et al., 2006). In adolescents, the study of

tension reduction or relaxation has been more commonly examined within a range of expectancies of drinking or motives to drink (Kuntsche, Knibbe, Gmel, & Engels, 2005).

In 1990, Jencks and Mayer's review of the evidence examining the social consequences of growing up in poor neighbourhoods catalysed intellectual attention to neighbourhood-level research. The authors provided a comprehensive assessment of the methodological issues pertaining to the study of neighbourhood effects and proposed a number of theoretical frameworks or pathways which sought to explain how neighbourhoods influence individual behaviour. Five pathways were described: neighbourhood institutional resources, collective socialisation, contagion, competition, and relative deprivation. The first pathway pointed to the role of adults and institutions in the surrounding areas, such as teachers, the Police, and the presence of community organisations, which may influence adolescent pro-social behaviour. The collective socialisation pathway highlighted the importance of adults in the neighbourhood enforcing social control and modelling appropriate behaviours. The contagion pathway, which has subsequently received significant attention in the literature, described the role of neighbourhood peer influence, where "like begets like" (Jencks & Mayer, 1990, p.113). Finally, the competition pathway explained behaviour as the result of competition for scarce resources whilst the relative deprivation pathway represented a psychological effect on behaviour resulting from an individual judging their success or failure by comparing themselves to others in the neighbourhood.

A subsequent review of neighbourhood effects on children and adolescents, by Leventhal and Brooks-Gunn (2000), showed that the total amount of variance or clustering of child and adolescent outcomes at the neighbourhood level was small. They affirmed, however, that a small variance in outcomes across neighbourhoods did not rule out large effect sizes of neighbourhood exposures, as was shown by Duncan and Raudenbush (1999). The review identified three mechanisms or pathways of neighbourhood effects on children and adolescents which resemble the pathways described by Jencks and Mayer (1990) above: relationships and ties, the availability

of institutional resources, and norms and collective efficacy. The relationships and ties pathway suggested that area-level disadvantage predicted harsher parenting, lower parental well-being and ineffective monitoring (often mediated by lower levels of social support), leading to deviant peer associations which are strongly associated with anti-social behaviour. The institutional resources pathway suggested that disadvantage lead directly to deviant peer behaviour, through adolescents engaging in fewer community-organised activities (Mahoney & Stattin, 2000; Tibbits, Caldwell, Smith, & Wegner, 2009). Finally, the collective efficacy pathway suggested that low levels of informal social control of adolescent behaviour resulted in higher levels of deviance.

The collective socialisation and collective efficacy pathways, first proposed by Wilson (1987), have since received wide attention in the literature, contending that relationships amongst adults in socially cohesive neighbourhoods are capable of enforcing against problem behaviour. This pathway gained particular popularity in the 1990s and underpins many studies included in this thesis. Concepts used within this pathway have evolved over time and are described in the following subsections, followed by a detailed discussion regarding the methodological issues pertaining to their examination in neighbourhood research. It must be noted that each concept is described only briefly, acknowledging the wealth of (contrasting) literature that is available.

1.5.1 Social cohesion

Social cohesion, a term whose meaning has been considered nebulous, generally refers to the presence of connectedness and solidarity among groups (Kawachi & Berkman, 2000). Kearns and Forrest (2000) suggest that social cohesion is characterised by minimal conflict and disruptive behaviours, adding that it may be an important component in the development of resilience to a decaying and unattractive neighbourhood environment (Forrest & Kearns, 2001). The concept is perceived as an emergent concept operating at the collective level, and occurring across many spatial scales (e.g., national, city, neighbourhood-level) (Forrest & Kearns, 2001). Dimensions of

social cohesion, as found within the literature, are detailed by Forrest and Kearns (2001) in Table 1-1 below.

Table 1-1

Dimensions of Social Cohesion (Forrest & Kearns, 2001)

Domain	Description
Common values and a civic culture	Common aims and objectives; common moral principles and codes of behaviour; support for political institutions and participation in politics
Social order and social control	Absence of general conflict and threats to the existing order; absence of incivility; effective informal social control; tolerance; respect for difference; intergroup co-operation
Social solidarity and reductions	Harmonious economic and social development and common standards; redistribution of public finances and of opportunities; equal access to services and welfare benefits; ready acknowledgement of social obligations and willingness to assist others
Social networks and social capital	High degree of social interaction within communities and families; civic engagement and associational activity; easy resolution of collective action problems
Place attachment and identity	Strong attachment to place; intertwining of personal and place identity

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A strong comparative landscape is said to embed social cohesion within a neighbourhood, whereby the ability for residents to form identities and maintain cohesiveness depends greatly on how they believe themselves to be perceived by external agencies and ‘outsiders’ (Forrest & Kearns, 2001; Kearns & Forrest, 2000). The reputations held by others are believed to be very durable and may result in reinforcing cohesive groupings and reputations (Forrest & Kearns, 2001). In contrast to social capital (described below) social cohesion relates more to an “emotional and social investment in a neighbourhood and sense of shared destiny among residents” (Uchida, Swatt, Solomon, & Varano, 2015, p. 2), emphasising the importance of social

identity and neighbourhood meaning. In comparison, social capital may be considered as a component of social cohesion, representing the collective social networks which may give rise to collective action and social control (Kawachi & Berkman, 2000). Others describe the relationship differently, suggesting that social cohesion is a component of social capital (Hawe & Shiell, 2000; Macinko & Starfield, 2001).

1.5.2 Social networks and social capital

An abundant literature, beginning in the 1980s, has focused on the role of social networks and social capital on health outcomes, and in particular, health inequalities. Although there has been much debate with regards to the level at which social capital operates (Kawachi, Kim, Coutts, & Subramanian, 2004; Poortinga, 2006), it is mostly considered a collective, or ecological, dimension of society, whereas aspects relating to social networks and social support have been mostly considered at the individual level (Kawachi & Berkman, 2000). Numerous descriptions of social capital have been proposed, focusing on a functionalist approach (i.e. the capital component) and/or the importance of networks (i.e. the social component) (Macinko & Starfield, 2001). These vast differences in definition have significant implications for the measurement of social capital in neighbourhood research and within community-based health promotion interventions (Hawe & Shiell, 2000). The key writings by Bourdieu, Coleman, and Putnam will be described briefly.

Bourdieu (1986) conceptualised the concept as the aggregate level of mutual acquaintances and recognition within a group which provides its members with the backing of its collectivity-owned capital. Social capital was perceived to have a role in the reproduction of class and inequality, whereby the amount of social capital a person possessed was related to the size of their network connections and their stocks of economic and cultural capital.

Coleman (1988; 1990) viewed social capital as a public good, benefitting society as a whole. Acknowledging that social capital was not lodged in persons, his central focus was placed on the

role of the family in generating durable social networks to achieve common goals. Three forms of social capital were conceptualised; 1) obligations, expectations and trustworthiness, 2) information channels, and 3) social norms and effective sanctions. The presence of tight social networks and voluntary organisations were suggested to facilitate the development of social capital. For example, he describes the concept of intergenerational closure, whereby positive adolescent outcomes may result from closed social networks between parents.

Putnam (1993), a political scientist, extended these ideas with a focus on volunteering and civic action as key components of social capital. He suggested that social capital was necessary for economic growth, good governance and peaceful societies; a perspective which The World Bank also adopts (Grootaert & Van Bastelar, 2002). Putnam's central thesis was that the sense of community in the United States had been lost, exhibited by loosening social ties and fewer organisational memberships. His introduction of two types of social capital, bonding and bridging social capital (Putnam, 2001), was an important step towards acknowledging that tight bonds or social networks may have negative externalities. Bonding social capital was used to refer to ties between people in similar situations, such as those found in church-based reading groups and fashionable country clubs. Bridging social capital encompassed more distant ties between like persons, such as among members of civil rights groups. Negative externalities were thought to relate to bonding social capital given its potential to exclude others in order to maintain group homophily. In contrast, bridging social capital was considered to be more inclusive of people from different social divides.

Critics (Morrow, 1999) have argued that the focus on social capital has become engulfed within 'deficit theory syndromes' which concentrate on the problems which give rise to unsuccessful neighbourhoods. In contrast, preference is given to Bourdieu's notion of social capital which views the concept as an unequal resource of privilege, rather than inadequacy. The domains of social capital, as found in the literature, are detailed overleaf in Table 1-2 (Forrest & Kearns, 2001).

Table 1-2

Domains of Social Capital (Forrest and Kearns, 2001)

Domain	Description
Empowerment	That people feel they have a voice which is listened to; are involved in processes that can affect them; can themselves take action to initiate changes
Participation	That people take part in social and community activities; local events occur and are well-attended
Associational activity and common purpose	That people co-operate with one another through the formation of formal and informal groups to further their interests
Supporting networks and reciprocity	That individuals and organisations co-operate to support one another; and expectation that help would be given or received from others when needed
Collective norms and values	That people share common values and norms of behaviour
Trust	That people feel they can trust their co-residents and local organisations responsible for governing or servicing their area
Safety	That people feel safe in their neighbourhood and are not restricted in their use of public space by fear
Belonging	That people feel connected to their co-residents, their home area, have a sense of belonging to the place and its people

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A third type of social capital has been proposed, known as ‘linking social capital’. It is defined as the “norms of respect and networks of trusting relationships between people who are interacting across explicit, formal or institutionalised power or authority gradients in society” (Szreter & Woolcock, 2004, p. 655). When conceptualised as a neighbourhood-level resource, the vertical ties between residents and institutions of power is perceived to improve health through increasing residents’ perceptions of efficacy with regards to combatting situations and through opportunities to secure health-promoting resources such as parks and healthcare (Blakely & Ivory, 2006).

Davis (2007) describes the use of social capital in the New Zealand political discourse, whereby its proponents focused on its potential to create or preserve wealth. He suggests that Robert Putnam's visit to New Zealand in 1996 (and later in 2003) catalysed attention to the role of social capital in saving taxes and preserving profits, by devolving the role of Government and increasing community accountability for health and social outcomes. In the late 1990s the positive discourse surrounding social capital within the National-led government appeared to be in stark contrast to the use of free market ideology which destroyed communities, and their potential to develop social capital (Davis, 2007).

In the early 2000s, Statistics New Zealand produced a framework for the measurement of social capital in New Zealand (Spellerberg, 2001), with some measures subsequently included in the General Social Survey and New Zealand Quality of Life Survey (conducted in 12 New Zealand cities). For example, the General Social Survey 2014 (Statistics New Zealand, 2015c) included questions relating to the length of time in neighbourhood, the number of supportive neighbours, methods to connect with neighbours, and frequency of neighbourhood connection. The Quality of Life Survey (Quality of Life Project, 2007) asked similar questions, such as perception of contact with neighbours, perception of diversity in cities, perception of local community strength and support, and level of unpaid work done.

The framework also identified elements of social capital which may have salience for Māori (Spellerberg, 2001). This included the importance of networks among the wider family network, hapu, and iwi, which may be perceived to represent the 'community' (as opposed to social networks outside the family). 'Place' could also represent more than a locality; it could have no spatial boundaries and could relate to where a person feels they belong. Finally, constructs such as manaaki (nurturing), tautoko (supporting), and hapai (up-lifting) were also said to contribute to 'community' norms for the building of social capital. In contemporary times, Davis (2007) argues that the idea of social capital is no longer fashionable in the political discourse, with concepts such as "social connectedness" and "social cohesion" coming to the fore.

1.5.3 Collective efficacy

Sampson, Raudenbush, and Earls (1997) argued that the presence of mutual trust and strong networks were not sufficient to control problem behaviours. Rather, the strong bonds present in neighbourhoods with high levels of social capital were capable of impeding informal social control (Sampson, 2006). What was required beyond neighbourhood ties was purposive action and shared beliefs in capability for action (Duncan, Duncan, & Strycker, 2002; Sampson et al., 1997). In reality, neighbours were perceived to want trusting relationships with each other but seldom wanted to sit down for dinner together (Sampson, 2012). Moreover, the spatial scale of a neighbourhood meant that knowing everyone and developing strong social bonds or social capital was a mathematical impossibility. Consequently, Sampson et al. (1997) relaxed the definition of the Social Disorganisation Theory to focus on the benefits of weak ties, rather than dense social ties, which provide for communication linkages (i.e., “bridging ties”) across local cliques and enable residents to use everyday strategies to control behaviour. Weak ties could be created through regular interactions with neighbours, observing interactions, and/or being aware of potential interactions (Sampson, 2012). The concept of collective efficacy was thus proposed, defined as the “linkage of mutual trust and the willingness to intervene for the common good” (Sampson et al., 1997, p. 919) and was subsequently found to be significantly associated with neighbourhood variation in levels of crime. The role of neighbourhood-level disadvantage in reducing collective efficacy was thought to relate to the same process which operates at the individual level to reduce personal efficacy. As such, years of exploitation and alienation resulting from resource deprivation was believed to stymie the development of collective efficacy through its effects on distorting a community’s reputation, leading to further levels of community mistrust (Sampson, 2012).

Collective efficacy captures two important elements; social cohesion and informal social control, believed to be tapping into the same latent construct as a result of the strong correlation between the two components (Sampson, 2006). The scale used by Sampson et al. (1997) to measure

collective efficacy is provided below in Table 1-3, with the first section tapping into social control and the latter assessing social cohesion. Both components were assessed using a 5-point scale, with responses for the informal social control component ranging from very likely to very unlikely and the social cohesion component responses ranging from strongly agree to strongly disagree.

Table 1-3

Collective Efficacy Scale (Sampson et al., 1997)

Indicators of collective efficacy

Likelihood that the neighbours could be counted on to intervene in various ways if:

- children were skipping school and hanging out on a street corner
- children were spray-painting graffiti on a local building
- children were showing disrespect to an adult
- a fight broke out in front of their house
- the fire station closest to their home was threatened with budget cuts

Indicate the extent of agreement with the listed statements:

- people around here are willing to help their neighbours
- this is a close-knit neighbourhood
- people in this neighbourhood can be trusted
- people in this neighbourhood generally don't get along with each other
- people in this neighbourhood do not share the same values

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Sampson (2006) later acknowledged that the discriminant validity of ‘lumping’ social processes together needed to be questioned, supported by others who believed that the overlapping of concepts did not mean that they tapped into the same construct, nor that a monotonic and linear relationship between the two components could be assumed (Gau, 2014). For example, Gau (2014) described the possibility whereby networks may give rise to incremental increases in social control up to a point, whereupon the presence of unhealthy networks may actually

attenuate the effects of control within the neighbourhood. This scenario had been demonstrated by Browning, Dietz, and Feinberg (2004), finding that increasing levels of dense ties among neighbours reduced the effects of collective efficacy in curbing problem behaviour. The authors suggested that this finding affirmed that negotiated coexistence model, which describes the negative effects of social networks in the absence of informal social control, facilitating the spread of problem behaviour. This also supported Wilson's (1998) earlier description of network-facilitated contagion of problem behaviours in disadvantaged neighbourhoods.

Secondly, Gau (2014) suggests that the two components of collective efficacy could be conceptualised as part of a causal process, whereby cohesion increases the communication of norms and values which gives rise to expectations of willingness to intervene or take control. The finding by Cancino (2005) that social cohesion and collective efficacy were two distinct, but related, dimensions of neighbourhood functioning, adds further weight to Gau's argument that they are best treated as different constructs.

Although developed to explain neighbourhood variations in crime, collective efficacy has since been shown to have wide reach in relation to a range of adult and adolescent health and social outcomes. Among children and adolescents, it has been shown to be positively associated with the use of preventative services (Frankenberg, 2004), and general health (Browning & Cagney, 2002), and inversely associated with obesity (Cohen, Finch, Bower, & Sastry, 2006), anti-social behaviour (Odgers et al., 2009), sexual initiation (Browning, Leventhal, & Brooks-Gunn, 2005), and violence (Maimon & Browning, 2010). These findings suggest that it may be perceived as a general capacity, and not just directed towards crime control issues (Uchida et al., 2015). Among adolescents, collective efficacy is thought to exert its effects through a number of mechanisms. Parents may play direct roles within high collective efficacy neighbourhoods, whereby they may exert subtle or not-so-subtle pressures upon the parents of deviant youth to become more responsible caregivers (Simons, Simons, Burt, Brody, & Cutrona, 2005). Parents may also work together to supervise local adolescents, disseminate information regarding their behaviour, and

may reinforce to adolescents the appropriate neighbourhood social norms (Maimon & Browning, 2012). This may result of adolescents feeling an added layer of surveillance and supervision, leading to a lower likelihood of engaging in risky behaviour for fear that such action may be noticed by others, sanctioned, and result in disappointment by those who care about them (Fagan, Wright, & Pinchevsky, 2014; Sampson et al., 1997). Adolescents may also feel protected knowing that there are others looking out for their welfare who can be trusted to intervene on their behalf (Aisenberg, Ayon, & Orozco-Figueroa, 2008). Collective efficacy has been questioned for its ability to control adolescent behaviours which occur in private settings (Browning & Erickson, 2009), although others have demonstrated its effects on more private behaviours such as suicide (Maimon, Browning, & Brooks-Gunn, 2010) and sexual initiation (Browning et al., 2005).

Sociologists have played the major role in describing the collective efficacy pathway. However, early writings from Jane Jacobs, a journalist and activist in the area of urban studies, continues to have a profound influence in the field. Her renowned book "*The Death and Life of Great American Cities*", published in 1961, effectively portrays the early conceptualisations of what is now known as collective efficacy:

The trust of a city street is formed over time from many, many little public sidewalk contacts. It grows out of people stopping by the bar for a beer, getting advice from the grocer and giving advice to the newsstand man, comparing opinions with other customers at the bakery and nodding hello to the two boys drinking pop on the stoop, eying the girls while waiting to be called for dinner, admonishing the children, hearing about a job from the hardware man and borrowing a dollar from the druggist, admiring the new babies and sympathising over the way a coat faded.

Most of it is ostensibly utterly trivial but the sum is not trivial at all. The sum of such casual, public contact at a local level-- most of it fortuitous, most of it associated with

errands, all of it metered by the person concerned and not thrust upon him by anyone -- is a feeling for the public identity of people, a web of public respect and trust, and a resource in time of personal or neighbourhood need. The absence of this trust is a disaster to a city street. Its cultivation cannot be institutionalised (Jacobs, 1961, p. 56).

1.5.4 The role of physical disorder in social disorganisation

Physical disorder in the neighbourhood is considered a dynamic force, fundamental to the understanding of the urban neighbourhood context, and one of the most underappreciated causes of socio-economic and racial inequality often found in cities (Sampson, 2012). Perceptions of disorder within neighbourhoods are a collective or emergent phenomenon, and implicated within the Social Disorganisation pathway (Wilson & Kelling, 1982). Their effects are believed to be compelling, going well beyond the visible signs of rubbish or ‘Broken Windows’ (Sampson, 2012; Skogan, 1992; Wilson & Kelling, 1982). It is further suggested that disorder takes a tenacious hold in stigmatised and disreputable neighbourhoods (Sampson, 2012; Sampson & Raudenbush, 2004), where residents attribute a social meaning to disorder, associating their neighbourhood reputation or label with a deep neighbourhood malaise (Forrest & Kearns, 2001). Sampson (2012) labels this mechanism as the “looking-glass neighbourhood”, where an individual’s sense of self grows out of interactions with others in the wider society who have prior perceptions regarding the neighbourhood they reside in (Sampson, 2013).

Such images and labels may have profound impacts on health and behaviour, the intentions of residents to remain in the neighbourhood, and can be notoriously stubborn to shift (Dean & Hastings, 2000; Sampson, 2012; Stephens, 2008). Using Photovoice, adolescents living in two disadvantaged communities in Auckland, New Zealand, were able to communicate some negative images which they felt portrayed the reputation of their community (Jensen, Kaiwai, McCreanor, & Moewaka Barnes, 2006). It is suggested that disorder and stigma has a close (and reciprocal) relationship with collective efficacy, and has considerable effects on the negative trajectory of

stigmatised neighbourhoods, arising from outmigration, disinvestment, withdrawal from community life and deepening of neighbourhood poverty (Sampson, 2012; Sampson & Raudenbush, 1999).

Results from neighbourhood studies demonstrate the greater importance of collective perceptions of disorder for health and social outcomes when compared to more objective measures of the neighbourhood environment (Macintyre & Ellaway, 2003; Sampson, 2012). It is suggested that the discrepancy between the subjective and objective reality may be due to the additional role of the perceived ethnic composition of the neighbourhood, whereby automatic responses (e.g., fear) to environmental stimuli (e.g. ethnic composition) have been described as ‘stereotype activation’ (Cohen, Inagami, & Finch, 2008). Both quantitative and qualitative studies have demonstrated how the social structure (i.e. disadvantage, race/ethnicity) of a neighbourhood can be a powerful predictor of perceived disorder, which is filtered through a reasoning based on disreputable areas and stigmatised groups (De Koninck & Pampalon, 2007; Quillian & Pager, 2000; Sampson & Raudenbush, 2004; Sampson & Raudenbush, 2005). For example, in Chicago and Australia, studies have demonstrated that the strongest predictor of perceptions of disorder, but not observed disorder, was the perceived ethnic composition of the neighbourhood, and this relationship was held regardless of the ethnicity of the participant (Sampson, 2012; Zahnw, Wickes, Haynes, & Mazerolle, 2013). However, in Baltimore, neighbourhood-level poverty was found to predict perceptions of disorder and not ethnic composition (Franzini, Caughy, Nettles, & O’Campo, 2008).

Alcohol outlets are also considered to hinder the development of social organisation (Gorman, Speer, Gruenewald, & Labouvie, 2001), by providing a spatial focus for physical (e.g. graffiti, advertising, rubbish) and social disorder (e.g. loitering) which gives rise to perceptions that informal social control is low (Scribner et al., 2007; Theall et al., 2009). Higher levels of alcohol outlets are often found in disadvantaged communities (Morrison, Ponicki, & Smith, 2015), presenting additional challenges to social organisation. Understanding the relationship between

collective efficacy and outlet density also needs to take into account the possibility of a reciprocal relationship, wherein communities lacking social cohesion may be unable to mobilise and use political or legal means to oppose the opening of outlets (Peterson, Krivo, & Harris, 2000). The findings of neighbourhood studies examining the relationship between alcohol outlet density and adolescent alcohol use are described in (Chapter 2).

1.6 The study of neighbourhood effects

Methodological developments in statistical modelling and the availability of large datasets (e.g., census data) have given rise to an increasing focus on the empirical examination of neighbourhood effects (Browning, Soller, & Jackson, 2015; Macintyre, Ellaway, & Cummins, 2002; Sampson, Morenoff, & Gannon-Rowley, 2002) and a renewed interest in the wider determinants of health (Diez Roux, 2001). The identification of neighbourhood variation in health outcomes or behaviours is said to be explained by three factors: composition, contextual, and collective (Macintyre et al., 2002). The first factor suggests that a concentrated composition of residents' characteristics (e.g., personal income) within a neighbourhood explains varying levels of behaviour across neighbourhoods. The contextual explanation suggests that emergent (i.e. non-reducible) exposures in the social and physical environment (e.g., neighbourhood disadvantage, alcohol outlet density) influence individual behaviour. Thirdly, the collective explanation points to the socio-cultural and historical features including customs, beliefs, and traditional practices which may also vary across neighbourhoods. This latter factor is receiving increased attention in the neighbourhood literature, as critiques of the Social Disorganisation Theory (Kubrin & Weitzer, 2003) draw attention to the role of subcultures in neighbourhoods, previously described by Shaw and McKay (1942). Subculture may be seen as distinct from socio-economic disadvantage, and relate more to the distinctive values and beliefs within a neighbourhood which endorse certain behavioural patterns (Kubrin & Weitzer, 2003; Sampson, 2012; Stewart & Simons, 2010). Concepts such as moral or legal cynicism or "Code of the Street" (Anderson,

1999; Soller, Jackson, & Browning, 2014) have been used to describe subcultures which may condone behaviours and which may or may not be evident in disadvantaged neighbourhoods.

At the contextual level, which is the focus of this thesis, there are considered three main mechanisms for which neighbourhoods may affect health outcomes and/or behaviours (Blakely & Woodward, 2000):

1. Direct association (direct cross-level effect) e.g., exposure to alcohol outlets may directly affect an adolescent's decision to purchase and consume alcohol;
2. Modifying the relationship between other factors and the behaviour (effect modification or moderation) e.g., collective efficacy may moderate the effects of alcohol outlet density on adolescent alcohol use; and
3. Affecting other exposures which are associated with the behaviour (indirect or mediated effect) e.g., neighbourhood disadvantage may reduce collective efficacy which increases adolescent alcohol use.

It is widely believed that neighbourhood influences are unlikely to be direct, rather they operate through more proximal behaviours or mediators (Leventhal & Brooks-Gunn, 2000). Despite this, research has focused on the main effects of neighbourhood exposures, while mediation and moderation models remain largely untested (Ayer et al., 2011; Jackson, Denny, & Ameratunga, 2014).

In the realm of contextual effects a number of challenges arise in the determination of causality. It is argued that advances in statistical methods to incorporate hierarchical relationships among social systems is in danger of outpacing the conceptual or theoretical understanding of how neighbourhoods influence health and behaviour (Diez-Roux, 2009). The following subsections outline the key methodological issues that arise in the study of neighbourhood effects.

1.6.1 Neighbourhood-based designs

Many studies and data sets used to investigate neighbourhood effects have not been designed specifically from the outset for this purpose (Leventhal & Brooks-Gunn, 2000). In neighbourhood-based designs, sampling is conducted to ensure that certain types of neighbourhoods are included, as well as a range of neighbourhoods that are representative of the target population of neighbourhoods. Leventhal and Brooks-Gunn (2000) recommend that only neighbourhood-based observational or experimental designs should be used to analyse neighbourhood effects, as they are more likely to contain sufficient numbers of participants per neighbourhood and variation across types of neighbourhoods to permit appropriate statistical modelling (i.e. multilevel modelling, discussed later). The view of Oakes (2004), discussed in more detail to follow, has stricter beliefs with regards to neighbourhood studies suggesting that only experimental designs are capable of causal inference.

The Project on Human Development in Chicago Neighborhoods (PHDCN) is the most notable example of a rigorous neighbourhood-based design. This project or study has played a substantial role in the methodological development of neighbourhood effects research, particularly in relation to the reliability of aggregated neighbourhood measures (i.e. *ecometrics* (Raudenbush & Sampson, 1999)) and the use of systematic, visual observations of the neighbourhood environment (Sampson & Raudenbush, 1999). In an overview, the study comprised the following components (Sampson, 2012):

- a longitudinal cohort study of 6,200 children and families over a period of 7 years (over 70% were followed up, regardless of where they moved in the United States);
- a representative community survey of 8,782 Chicago residents in 1999, followed up by a survey of 3,105 randomly selected residents in 2002;
- a systematic social observational study (through videotaping from car windows) of more than 23,816 street segments;

- a Network Panel study of 2,800 key leaders in 1995 and over 1,000 in 2002;
- a study of 4,000 collective action events in Chicago from 1970 to 2000; and
- a “field experiment” in 2002 and 2010 designed to measure community-level differences in the propensity of neighbourhood residents to mail back ‘lost letters’.

A detailed history of the PHDCN has been provided by Robert J. Sampson (2012), a renowned sociologist and one of the lead investigators, which makes for very interesting reading. At its inception, it was hoped that the study would include collections of biological measures from participants in order to understand the role of the neighbourhood in the expression of genetic variation. Unfortunately, this aspect of the study was later dropped. The rigorous nature of the PHDCN was reflected in its scale; at one point approximately 200 people were employed in the study. The physical and emotional dangers of conducting neighbourhood research were also highlighted as some interviewers collapsed in the heat, were robbed at gunpoint, sexually harassed, and witnessed drive-by shootings and dead bodies on the footpath. Due to the pioneering nature of PHDCN difficulties also arose in the determination of the likely budget to carry out data collection, exemplified by the contractors hired to do the surveys discovering that they had underbid for the massive project, resulting in law suits to ensure the project was completed. Since the PHDCN, many other neighbourhood-based studies have attempted to emulate its design, with Robert Sampson continuing to be involved in many of their efforts. Examples of two large longitudinal neighbourhood designs include the Los Angeles Family and Neighborhood Survey (Sastry, Ghosh-Dastidar, Adams, & Pebley, 2006) and The Australian Community Capacity Study (Mazerolle et al., 2007).

Experimental designs to assess neighbourhood effects are rare. The Gatreux housing programme (Rosenbaum, 1995) and ‘Moving to Opportunity’ (Ludwig et al., 2008) are the most well-known examples of neighbourhood experiments, both conducted in the United States and designed to lift families out of poverty. The Gatreux housing programme resulted from a 1976 Supreme Court

decision that ruled in favour of Dorothy Gatreaux, who claimed that the substandard conditions found in Chicago's public housing violated the Fifth Amendment and the Civil Rights Act of 1964. Following this decision, the Gatreaux programme provided vouchers to low-income, Black public housing residents to move to private-sector apartments in mostly White suburbs or within the city. Families with more than 3 children, history of unacceptable housekeeping, or large debts were excluded from the programme, potentially eliminating up to one-third of all eligible residents (Rosenbaum, 1995). Up until 1998, half of the 7,000 families who accepted the vouchers moved to the suburbs (DeLuca & Rosenbaum, 2003). The quasi-random allocation (although without a control group) permitted insight into whether a different environment could affect the life chances of those most disadvantaged, overcoming barriers with regards to self-selection into neighbourhoods or selection bias (Rosenbaum & DeLuca, 2008). Evaluation findings revealed that mothers who moved to the suburbs, when compared to those who moved to the city, reported higher employment rates and adolescents who moved to the suburbs were more likely to graduate from high-school, attend college, and be employed (Rosenbaum, 1995). Qualitative research greatly informed the findings, with mothers who moved to the suburbs reporting increased efficacy and control over their lives, feeling good about where they lived, and liked not having to put down a public housing address in employment applications (Rosenbaum, Reynolds, & DeLuca, 2002). In addition, many felt they could rely on neighbours for support to intervene if a child was misbehaving, were willing to change their own behaviour in order to comply with the social norms and rules of their new neighbourhood, and believed that teachers extended extra efforts to help their children in school. Since the Gatreaux programme, the Baltimore Department of Housing and Urban Development has also been found to violate housing laws, and has offered over 1,000 families the opportunity to relocate to safer and less disadvantaged neighbourhoods (Rosenbaum & DeLuca, 2008).

Following the success of Gatreaux, the United States Department of Housing and Urban Development launched 'Moving to Opportunity', a randomised controlled trial design, to more

formally examine the counterfactual paradigm of moving from public housing in high-poverty neighbourhoods to private rental households in low-poverty neighbourhoods. Using a randomised controlled trial design also meant that selection bias would be greatly minimised (Gennetian et al., 2012). Between 1994 and 1998, Moving to Opportunity randomised 4,604 families from five cities in the United States to one of three conditions; 1) the experimental group, who were offered a private housing voucher to live in neighbourhoods where the poverty rate was 10% or less; 2) a Section 8 housing group, who were offered housing vouchers which allowed them to live in any private rental dwelling in any neighbourhood, and 3) the control group, who received standard care from social services. Vouchers were required to be used within a period of one year, contributing to only 47% of the experimental group and 63% of the Section 8 group redeeming their vouchers (Sciandra et al., 2013), with desires for safety and better schooling being the dominant reasons for wanting to move (Gennetian et al., 2012).

Long-term evaluations of Moving to Opportunity were disappointing in comparison to Gatreux, with few detectable differences in outcomes across the three allocated groups. At follow-up, benefits were found to mostly accrue in young adolescent females who moved, being significantly less likely to engage in drinking and experiencing less psychological distress and fewer serious behavioural or emotional problems (Sciandra et al., 2013). In contrast, young adolescent males who moved were more likely to be smokers at follow-up. There were no detectable differences across groups in reading and mathematics scores, perceptions of school climate, education and employment outcomes, and physical health. In adults, there were no detectable differences found in levels of employment, welfare participation or government assistance (Kling, Liebman, & Katz, 2007), although the experimental group were less likely than the control group to be obese or experience psychological distress at follow-up.

One possible reason for the discrepancy between the two experimental studies is believed to relate to the distance in which families moved. Gatreux programme families moved, on average, 25 miles away, whilst the Moving to Opportunity families in the experimental arm moved, on

average, less than 10 miles (Rosenbaum & DeLuca, 2008). The short proximity to the former residence meant that many children in Moving to Opportunity moved within segregated neighbourhoods characterised by low levels of support and collective efficacy and experienced continual exposure to nearby disadvantaged neighbourhoods (Sampson, 2012), especially through attending the same school and interacting with former friends (Rosenbaum & DeLuca, 2008). The weaker employment findings from Moving to Opportunity are also thought to relate to a period in time when a booming labour market was present (Rosenbaum & DeLuca, 2008).

The contribution of both social experiments to causal inference of neighbourhood effects has been criticised, due to the samples representing a highly selective and extreme end of the poverty tail (DeLuca & Rosenbaum, 2003; Sampson, 2012). As the majority of eligible participants were Black or Latino single mothers living in concentrated public housing, it is suggested that these experiments do not provide a generalisable test of neighbourhood effects (Sampson, 2012). Furthermore, the level at which causal inference can be made has been challenged. Sampson (2012) suggests that, as neighbourhoods are not the unit of allocation, inference can only be made at the individual level. In reality, he believes that the research question pertains more to the efficacy of offering housing vouchers, and not the examination of any contextual effect. He further adds that the experiments were incapable of separating out the disrupting effects of moving.

1.6.2 Classification of ‘neighbourhood’

Fundamental to the study of neighbourhood effects is determining the appropriate spatial scale at which exposures operates. Many agree that mechanisms of neighbourhood exposures are unlikely to be neatly bounded into geographical areas, but rather extend over multiple spatial contexts which vary in size and complexity (Owen, Harris, & Jones, 2015; Sampson, 2012). Taking a discrete view of space, or treating neighbourhoods as containers, is suggested to render models

which are insensitive to the likelihood of spatial interaction or dependencies across groups (Auchincloss, Gebreab, Mair, & Roux, 2012; Owen et al., 2015; Shankardass & Dunn, 2012).

Kearns and Parkinson (2001) describe three levels of neighbourhood scale (Table 1-4), proposing that the home area plays an important role in social connections. This supports recent research from Sweden examining the effects of different spatial dimensions of collective efficacy, showing its mechanism is likely to be captured at smaller (~1000 residents) rather than larger (~3000 residents) geographic units (Gerell, 2015).

Table 1-4

Levels of Neighbourhood Scale (Kearns and Parkinson, 2001)

Scale	Predominant function	Mechanism(s)
Home area (i.e. 5-10 minute walk)	Psychosocial benefits (e.g. identity, belonging)	Familiarity Community
Locality	Residential activities Social status and position	Planning Service provision Housing market
Urban district or region	Landscape of social and economic opportunities	Employment connections Leisure interests Social networks

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Misclassification of the neighbourhood exposure may result if the decisions regarding the choice of neighbourhood boundaries are not equivalent to the mechanism or level of its effect. Non-differential misclassification generally results in bias towards the null (Blakely & Woodward, 2000). Most commonly, statistical administrative units derived from the census (e.g., area units or meshblocks in New Zealand) are chosen for convenience. The pitfalls of using such an approach are described by the “Modifiable Areal Unit Problem” (Openshaw, 1984) and the “Uncertain Geographic Context Problem” (Kwan, 2012). The former is described as a statistical issue pertaining to the aggregation of variables on geographically-imposed boundaries or zones. Gerrymandering, whereby political boundaries are manipulated to establish political advantages

for a particular party, is a well-known example of the Modifiable Areal Unit Problem (Openshaw, 1984). In neighbourhood research, where it is common to aggregate a given series of smaller geographic units (e.g., meshblocks in New Zealand) to form larger statistical units (or modifiable areal units), consideration must be given to how alternative combinations may have created very different areal units (Openshaw, 1984). Researchers are reminded not to use their “whims and fancies” in creating geographical units, but rather that the “process of defining or creating areal units would be quite acceptable if it were performed using a fixed set of rules, or so that there was some explicit geographically meaningful basis for them” (Openshaw, 1984, p. 3). Sensitivity analyses are therefore important to determine if alternative methods of creating areal units or neighbourhoods result in any meaningful differences in findings.

Kwan (2012) also proposed a fundamental problem to the study of neighbourhood effects: the “Uncertain Geographic Context Problem”. This problem is distinct from the above as it is not due to the use of different zonal schemes but rather it calls into question the use of static neighbourhood models. As an example, the activity space of a resident may not be clearly delineated and may not occur across continuous geographical units. There is also temporal uncertainty with regards to when individuals experience their exposure which cannot be captured in static models. Aggregation of contiguous geographical units will consequently be unlikely to capture the social networks which constitute the resident’s activities and the time they spend in each unit. To address the “Uncertain Geographic Context Problem” it is recommended that Global Positioning System-based (GPS) and ecological momentary assessments are used, whereby technologies (e.g. mobile phones) can collect information about exposures throughout the day, the perceptions of the participant, and the behaviours in real time. These types of approaches are believed to be especially important in the study of neighbourhood effects on adolescents, whereby ‘situational contingencies’ or interactions with others within a context may promote or inhibit a behaviour (Kwan, 2012).

With regards to static neighbourhood models, the most robust method identified to create ecologically homogenous and meaningful neighbourhoods can be found in *The Project on Human Development in Chicago Neighborhoods*, wherein Chicago's 847 populated census tracts were combined to create 343 neighbourhood clusters, each with a population of approximately 8,000 people (Sampson et al., 1997). A series of cluster analyses guided their construction, by combining geographically contiguous census tracts which were homogeneous in relation to census indicators (i.e. racial-ethnic mix, socio-economic position, housing density, and family organisation) and sufficiently large to yield adequate and almost-balanced sample sizes for analysis. Intra-cluster correlation coefficients were calculated to determine the resultant degree of homogeneity, revealing success in producing internal homogeneity of neighbourhood clusters. In addition, geographic boundaries (e.g., railroad tracks and motorways) and knowledge of traditional local community areas guided the process of constructing neighbourhood clusters which had ecological integrity (Earls & Buka, 1997).

Static neighbourhood models, most commonly utilised in cross-sectional studies, also present problems due to the (usually) implausible assumption of a zero lag time between exposure and expression of outcome or behaviour (Macintyre & Ellaway, 2003). Rather, many neighbourhoods may have had their impact earlier in the life course, prior to the assessment of outcome (Macintyre & Ellaway, 2003). Sampson (2012) suggests that the enduring and stable nature of disadvantage and collective efficacy may lessen the misclassification bias arising from the lag time between exposure and outcome.

1.6.3 Confounding and mediation

The most common concern in studies of neighbourhood effects is the ability to distinguish social causation from social selection (Kawachi & Berkman, 2003). In other words, it is essential to be able to distinguish between the effects of the neighbourhood contextual exposure and the effects resulting from the characteristics of the people residing in the neighbourhood (i.e. compositional

effects). In reality, it is artificial to assume that the context and composition can be isolated, when it is likely that there is a mutually reinforcing and reciprocal relationship between individuals and place (Cummins, Curtis, Diez-Roux, & Macintyre, 2007; Merlo & Chaix, 2006).

To attempt to control for selection bias and reduce cross-level confounding, studies must collect sufficient data on the individual-level factors which may relate to neighbourhood selection and the outcome of interest. The most commonly described example of cross-level confounding is individual-level income confounding the association between income inequality and health (Blakely & Woodward, 2000), i.e. varying proportions of people with low income living in the spatial units investigated could confound the association between income inequality (assessed using area-level measures) and health. However, it must be acknowledged that individual-level composition characteristics may actually lie on the causal pathway of neighbourhood effects (described later). For example, individual-level income or education may be affected by area-level inequality, whereby unequal jurisdictions may underinvest in school education (Kaplan, Pamuk, Lynch, Cohen, & Balfour, 1996).

Recommendations to address selection bias in the study of neighbourhood effects on children and adolescents concentrate on the minimum controlling of parental income and education and ethnicity (Leventhal, Dupéré, & Shuey, 2015). In contrast, Kawachi and Berkman (2003) suggest that controlling for personal or family income may mask the mediating effect of neighbourhood contexts as residential sorting or segregation mechanisms, giving rise to differential access to education and labour markets which affects the level of income that families can command. The views of Sampson (2012) are aligned, stating that neighbourhood selection is not as much a statistical nuisance as something that has substantive interest in itself, being a form of neighbourhood effect. As such, understanding the movers or stayers in neighbourhoods can assist in identifying how individuals select into causal ‘treatments’ or neighbourhoods. Using the PHDCN longitudinal data, neighbourhood stratification was found to fall powerfully across ethnic lines and socio-economic factors, including education, income, and home ownership.

Other sources of selection bias, such as depression, IQ, impulsivity, and social support were found to have minimal importance in neighbourhood selection (Sampson, Sharkey, & Raudenbush, 2008). Odgers, Caspi, Russell, et al. (2012) also found that the association between neighbourhood socio-economic position and adolescent anti-social behaviour was robust to the inclusion of many confounders, including family-level income, parental anti-social behaviour, family mental health problems and exposure to domestic violence. However, it must be acknowledged that the reasons that families select into neighbourhoods extends to a variety of factors, not all of which are related to their own socio-economic position or health status. For example, a large neighbourhood study in the United States found that 75% of participants indicated child-related reasons for moving to their neighbourhood, including lower crime and better schooling (Billy, 2001).

In addition to issues surrounding selection bias, studies are fraught with challenges when distinguishing between confounders and intermediary variables in the pathway of neighbourhood effects (Blakely & Woodward, 2000; Macintyre & Ellaway, 2003; Pickett & Pearl, 2001). The latter may actually lie on the causal pathway between neighbourhood exposures and health outcomes and so controlling for them as confounders will lead to overlooking their role as a mediator in indirect effects (Blakely & Woodward, 2000). Wodtke, Harding, and Elwert (2011) argue that most studies mishandle the dynamic nature of neighbourhood selection processes by over-controlling the indirect effects of neighbourhoods that operate through family characteristics. As such, understanding the temporal sequence of exposures is essential to building a valid mediation model to examine neighbourhood pathways of effect.

The conceptualisation of the mediator/confounder distinction is rarely explicit within contextual studies. An exception is found in a systematic review of school-level influences on smoking, whereby Aveyard, Markham, and Cheng (2004) grouped possible confounders or mediators into ‘family characteristics’, ‘pupil characteristics not influenced by school’, ‘neighbourhood

characteristics’, and ‘pupil characteristics potentially influenced by schools’, with the latter representing factors which should not be controlled for in multilevel studies of school effects.

Original analytic approaches to mediation or identification of intermediary variables were based on a landmark paper by Baron and Kenny (1986), who proposed that for variable M to be a mediator it must assist in explaining the relationship between the independent variable (X) and the dependent variable (Y), and not found to interact with X. After establishing a direct association between X and Y, the mediator must then be shown to be associated with both variables, and when included in the model with X and Y, the direct relationship between X and Y should lose significance. In regression analyses, researchers commonly present the regression estimates with and without the potential mediator in the model, in order to give the reader the upper and lower limits in which the “true” neighbourhood effect may lie (Blakely & Woodward, 2000).

The application of the Baron and Kenny approach to the study of distal exposures (e.g. neighbourhood effects) has been questioned, as distal exposures are often transmitted through a number of additional links in a causal chain, many of which may work in opposing directions to cancel out an overall direct effect (Shrout & Bolger, 2002). For this reason, a direct effect between X and Y should not be considered a gatekeeper to undertaking mediation analyses, as it may miss more indirect pathways of effect (Hayes, 2009; Shrout & Bolger, 2002; Valeri & Vanderweele, 2013). Further, criticisms regarding the unrealistic expectation of a lack of interaction between M and X have given rise to new approaches which allow mediation analysis to be carried out in the presence of an interaction (Imai, Keele, & Tingley, 2010; Muthen, 2011; Valeri & Vanderweele, 2013).

Recent advancements in statistical modelling, including multilevel path analysis (Chapter 7), allow researchers to more formally test mediating pathways. These approaches allow researchers to progress straight to mediation testing, without first examining direct effects. This presents

exciting opportunities to identify distal factors which can be further tested in prevention efforts, so that in future the chain of neighbourhood impact can be broken (Kraemer, Kiernan, Essex, & Kupfer, 2008).

1.6.4 Heterogeneity of effects

As described earlier, the Ecological Systems Model (Bronfenbrenner, 1979) and the Social Development Model (Catalano & Hawkins, 1996) emphasise the importance of the interactions among and between social systems to understanding adolescent behaviour. Studies which seek to examine overall or average effects may mask heterogeneity across individuals, for which the neighbourhood may exacerbate or reduce the impact of other salient risk and protective factors (Scheier, Miller, Ifill-Williams, & Botvin, 2001). For example, the effect of neighbourhood disadvantage has been found to be exacerbated in adolescents with increased vulnerability, due to factors such as impulsivity (Neumann, Barker, Koot, & Maughan, 2010), and genetic predisposition to externalising behaviours (Kendler, Gardner, & Dick, 2011). Interactions among neighbourhood factors have also been demonstrated, wherein collective efficacy attenuated the negative effects of alcohol outlet density on adolescent alcohol use (Maimon & Browning, 2012). Others point to “evaporation” (Simons et al., 2002) or “contextual dissipation” (Wickrama & Bryant, 2003), in which risk factors (e.g., exposure to violence) lose their salience in stressed neighbourhoods due to their normative nature in the environment (Fagan, Wright, & Pinchevsky, 2015a).

Identifying the factors which may make individuals more or less vulnerable to neighbourhood influences has important implications for the targeting of interventions and policy. However, moderation analyses require sufficiently larger sample sizes than standard multilevel approaches (Duncan & Raudenbush, 1999), with at least 50 neighbourhoods and a minimum of 20 individuals per neighbourhood required to test interactions (Snijders & Bosker, 1999). It is therefore important, at the outset, that a sufficient number of study participants with certain

characteristics, e.g., ethnicity, are included to allow moderation models to be incorporated into the analysis (Macintyre & Ellaway, 2003).

1.6.5 Data collection and the reliability of aggregated neighbourhood exposures

Aggregating individual-level reports of the neighbourhood to produce a collective dimension (or derived variable) is commonplace in neighbourhood research. For example, aggregated levels of alcohol use behaviours within a neighbourhood may be used to test contagion effects on individual drinking behaviour, or individual perceptions of trust and informal social control may be aggregated to create the emergent concept of collective efficacy. The term ‘ecometrics’ has been coined to describe the principles of psychometrics (measurement of individual traits) applied to the assessment of bias and error in contextual assessments which are intrinsically multilevel (Raudenbush & Sampson, 1999). Reliability can be conceptualised at two levels; the item consistency and number of items in the individual assessment, and the intersubjective agreement among neighbourhood residents (Raudenbush, 2003). If there is substantial variation among residents in their perceptions of the neighbourhood then the ecometric reliability would be considered low. This can be somewhat overcome by sampling a large number of residents (Raudenbush, 2003). Low reliability may either indicate that the measure is flawed or that the a priori construction of ‘neighbourhood’ has no validity. The reliability of aggregated variables has been found to be satisfactory when a sufficient number (i.e. 20 or more) of respondents per neighbourhood are included, with some neighbourhood measures (e.g., physical disorder) able to be measured reliably with fewer respondents (Duncan & Raudenbush, 1999). Reliability of the neighbourhood-level measure is calculated by (Snijders & Bosker, 1999):

$$Reliability = \frac{Neighbourhood\ variance}{Neighbourhood\ variance + (individual\ variance \div group\ size)}$$

More recently, Ludtke et al. (2008) have questioned the observed group average as an approximation of the unobserved “true” group mean and distinguishes between formative

aggregations of constructs and reflective aggregations. The former is described as aggregated measures of an individual-level (or level 1) construct, such as mean levels of positive attitudes towards drinking. In this scenario, it is not expected that the individual and aggregated variables represent the same construct, so within-level agreement should not be required to establish construct validity of the aggregated neighbourhood measure. Rather, reflective aggregated variables attempt to provide a reflective measure of the level 2 construct. For example, residents may be asked to report on the level of physical disorder within the neighbourhood. Scores in this sense should be interchangeable (Ludtke et al., 2008). In this case, lack of agreement among residents within the same neighbourhood would infer unreliability. Ludtke et al. (2008) have sought to take into account the level 2 sampling error in reflective neighbourhood measures by introducing an approach which regards the observed group mean as a latent variable in the estimation of contextual effects.

In relation to reliability and identification of effects, same source bias may also arise if the same group of respondents is used to collect data on both neighbourhood exposures and health outcomes or behaviours (Macintyre & Ellaway, 2003). For example, an individual's mental health status may affect their reporting of neighbourhood cohesion. Or an adolescent's drinking status may provide greater exposure to neighbourhood conditions, particularly if drinking occurs in public spaces. It is therefore recommended that there should be independence between the samples used to collect data on exposures and outcomes in order to reduce same source bias (Leventhal & Brooks-Gunn, 2000). Similar to this is Manski's (1993) 'reflection problem' found in the study of endogenous or contagion effects, resulting from regression models which contain both the aggregated level of behaviour in a group as well as the behaviour of the individual.

To overcome such problems it is recommended that neighbourhood studies should aim to collect data from multiple sources, including government agencies (e.g., Police), census, community surveys, and systematic social observations (Gruenewald, Treno, Taff, & Klitzner, 1997). The bundling of risks in neighbourhoods can also present problems of multi-collinearity between

exposures in regression models (Duncan & Raudenbush, 1999), resulting in difficulties estimating the independent effects for more than one ecological exposure simultaneously (Blakely & Woodward, 2000).

1.6.6 Spatial autocorrelation or spill-over effects

To further complicate matters, adolescents are also exposed to, and influenced by, the collection of surrounding neighbourhoods in which they engage during their routine activities (e.g., school, work). The sharing of parental custody may also mean that some adolescents spend considerable time across a number of neighbourhoods. This scenario was striking in a recent study by Byrnes et al. (2015) showing that older adolescent activity spaces intersected with 24 census tracts during a one-week period. The influence of nearby neighbourhoods is neatly described by Tobler's law of geography, that "everything is related to everything else, but near things are more related than distant things" (Tobler, 1970, p. 236). This has important implications for the study of neighbourhood effects, as one cannot consider neighbourhoods to be islands unto themselves (Sampson, 2012). The independent or spill-over effects of neighbouring levels of disadvantage, collective efficacy (Sampson, 2012), and ethnic diversity (Jackson, Browning, Krivo, Kwan, & Washington, 2015) on health and social outcomes strongly indicate the need to incorporate spatial dependence models in neighbourhood-level studies (Sampson, 2012). Accounting for this spill-over also acknowledges that there are macro-level influences that extend into neighbourhoods (Sampson, 2012). In addition, spatial dependence models account for the lack of independence or randomness of neighbourhoods, which prevents violation of the assumption of independence of observations in regression models (Chakraborty, 2011).

1.6.7 Analysis of neighbourhood effects

Analysis of neighbourhood effects is confronted by the issue that individuals within neighbourhoods are more alike than individuals across neighbourhoods. This violates the assumption within regression methods which require samples to be independent of each other

(Oakes, 2004). Failing to account for the non-random allocation of individuals to neighbourhoods is likely to lead to downwardly biased standard errors of contextual effect estimates, leading one to conclude that a significant effect exists.

Some neighbourhood studies seek to address the statistical nuisance of correlated observations by adjusting for it within individual-level regression models. An abundance of literature examining neighbourhood effects has utilised this approach, measuring both the dependent and independent variables at the individual level. For example, the association between individual perceptions of neighbourhood safety and alcohol use may be examined, whilst adjusting for the clustering of responses at the neighbourhood level. It must be noted that these studies are not examining the effect of group-level contextual factors, rather they are only capable of explaining inter-individual variation in health outcomes or behaviours (Diez-Roux, 2009). Of conceptual importance, measures of neighbourhood exposures at the individual level may not necessarily represent the same construct when measured at the neighbourhood level; a debate which has surrounded the level at which social capital should be conceptualised (Poortinga, 2006).

Drawing group-level inferences from individual-level studies is considered biased, referred to as the atomistic fallacy (Diez-Roux, 1998). This also occurs in studies which attach a contextual-level variable (e.g., neighbourhood socio-economic position) to an individual and include this in an individual-level regression model. Such studies are not suited to informing the development of place-based interventions (Chilenski, Greenberg, & Feinberg, 2010), as the unit of analysis remains the individual, and only inter-individual variation, and not group-to-group variability, can be explained (Diez-Roux, 2009). In order to make inferences at the neighbourhood level it is recommended that multilevel designs are used (Diez-Roux, 2009; Merlo & Chaix, 2006). Such designs allow for more conservative estimates of the standard error of contextual effects, by permitting a separate random error term for each neighbourhood (Blakely & Woodward, 2000).

Oakes (2004) has been highly critical of the use of observational designs (including multilevel analyses) for causal inference of neighbourhood effects, stating that prior neighbourhood research is likely to “reflect measurement error and misspecification rather than causal effects” (p. 1941). As such, he contends that, at best, observational designs can be used to assist with the development of theory and preliminary testing of neighbourhood effects. A summary of his arguments is provided below, with a more in-depth discussion of the methodological issues pertinent to causal inference from observational designs described in the Discussion (Chapter 8).

Oakes centres on the difficulties in observational designs to adequately control for selection bias (previously described), extrapolate conditional neighbourhood estimates, and assume that people are exchangeable between neighbourhoods when the endogenous nature of neighbourhoods means that they are determined by the people that live in. This is suggested to violate the Stable Unit Treatment Value Assumption, described in further detail in Chapter 8. Oakes further believes that controlling for social stratification (i.e. residents sharing similar characteristics) into neighbourhoods eliminates all neighbourhood variance for which to test neighbourhood effects. As such, he suggests that multilevel designs are most suitable to the study of exogenous effects, such as school-based exposures, or where possible, he proposes the use of community trials whereby neighbourhoods are the unit of allocation. His focus remains on social interventions as the basis for the randomised controlled trial, including neighbourhood-level strategies such as political mobilisation, local policy development, and removal of physical disorder.

Others (Diez Roux, 2004a; Merlo & Chaix, 2006; Shankardass & Dunn, 2012) refute Oakes’ view to reject observational designs, claiming that experimental studies are incapable of replicating the internal dynamics or idiosyncrasies of the neighbourhood which produce their effect. The non-exchangeability of individuals between neighbourhoods is acknowledged but “rather than a nuisance to dissolve by randomisation” (Merlo & Chaix, 2006, p.1362) suggest that social epidemiologists should embrace the differences in individual resources and vulnerabilities which determine neighbourhood effects and the ability to transfer the findings to other

geographical contexts (Shankardass & Dunn, 2012). The problems with multi-faceted community trials are also highlighted given their problems in identifying multiple causal pathways (Merlo & Chaix, 2006). Finally, Merlo and Chaix (2006) suggest that social stratification into neighbourhoods is not as extreme as Oakes suggests, and that many neighbourhood exposures can be considered exogenous, including healthcare and urban design.

1.7 Conclusion

This chapter has provided an overview of adolescent drinking and placed it within an ecological and developmental framework. The methodological issues pertaining to the examination of neighbourhood effects on adolescent alcohol use have been introduced, highlighting the complexities of research in this field. The following chapter presents a systematic synthesis of findings from multilevel studies of neighbourhood effects on adolescent alcohol use.

Chapter 2 Neighbourhood effects on adolescent alcohol use

2.1 Preface

Publication

This chapter includes content from the article “Jackson, N., Denny, S., & Ameratunga, S. (2014). Social and socio-demographic neighborhood effects on adolescent alcohol use: a systematic review of multi-level studies. *Social Science and Medicine*, 115, 10-20.” Permission to reprint was obtained from Elsevier on April 13, 2016.

Link to thesis objectives:

- To systematically review the evidence from multilevel studies of neighbourhood effects on adolescent alcohol use

Why was this study needed?

In 2013, Bryden, Roberts, Petticrew, and McKee (2013) published a systematic review of community-level factors associated with alcohol use. The reviewers’ decision to include studies which examined factors measured at either the individual-level or neighbourhood-level may have contributed towards its inconsistent findings. This is because constructs of the same name (e.g. social capital) measured at different levels (individual *vs.* collective) may have different mechanisms of effect on adolescent drinking behaviour. Other reviews of area-level effects on adolescent substance use have also been conducted (Karriker-Jaffe, 2011; Leventhal & Brooks-Gunn, 2000), although the inclusion criteria for these reviews did not focus exclusively on alcohol use or the use of multi-level designs.

As such, there was a need for a systematic review to describe the findings from multilevel or contextual studies assessing a wide range of neighbourhood-level exposures. Results of the review would be used to inform the salient neighbourhood-level risk and protective factors to include in the thesis, as well as identify the relevant theoretical pathways of effects.

What was undertaken?

A systematic review was undertaken to identify multilevel studies of neighbourhood-level exposures associated with adolescent alcohol use. A recommended critical appraisal tool for public health studies was required to be amended in order to address the issues of multilevel designs. The available evidence base as at January 9, 2014 (i.e. the date of the electronic literature search) was described, appraised, and published in *Social Science and Medicine*. This publication excluded multilevel studies examining the effects of alcohol outlet density, due to the previous reviews on this topic (Bryden, Roberts, McKee, & Petticrew, 2012; Popova, Giesbrecht, Bekmuradov, & Patra, 2009). An addendum can be found at the end of this chapter, detailing the findings from an updated electronic search together with the findings from studies examining the role of alcohol outlet density in adolescent alcohol use.

2.2 Abstract

There is growing interest in the role of the neighbourhood environment on adolescent alcohol use. Multilevel designs are ideally suited to this investigation due to their ability to examine area-level effects over and above the effects due to neighbourhood composition. To date, most research in this area has focused on the physical availability of alcohol in the neighbourhood.

A review of the multilevel evidence on neighbourhood-level risk and protective factors which influence adolescent alcohol use was undertaken, excluding studies which assessed the impact of neighbourhood-level alcohol availability and advertising. Systematic searches in Medline, EMBASE, CINAHL Plus, PsycINFO, Sociological Abstracts and SCOPUS identified 23 studies, examining 11 different neighbourhood-level exposures. The majority of studies found no associations with residential mobility, neighbourhood disorder or crime, employment or job availability, neighbourhood attitudes to drinking, social capital and collective efficacy. For studies examining neighbourhood-level socio-economic disadvantage mixed results were found. High levels of both adult and adolescent alcohol use in the community appeared to be associated

with alcohol use whilst protective effects were found for enforcement of liquor laws. Methodological limitations within studies were evident.

The dearth of high-quality, multilevel studies indicate that further research is required to inform the development of multi-faceted place-based policy and preventative interventions to reduce adolescent alcohol use. Future studies should consider the neighbourhood context from the outset of study design and identify the individual-level control variables to adequately isolate neighbourhood effects. Inclusion of moderation and mediation analyses would greatly contribute towards the understanding of causal pathways of neighbourhood effects.

2.3 Introduction

Adolescent drinking poses significant public health concerns. In comparison to older drinkers young people experience a greater level of harm from their drinking (National Health and Medical Research Council, 2009). Although some countries are experiencing positive declines in the frequency of alcohol use, the average volume consumed by young people that drink may be increasing (Department of Health, 2010; Johnston, O'Malley, Bachman, & Schulenberg, 2013; Meier, 2010). To reduce harm to this vulnerable population practitioners and policy makers need to continue to identify and target the key risk and protective factors for alcohol use.

According to Bronfenbrenner's ecological model (1979), adolescent socialisation and consequent development occurs across various social settings or levels, including families, peer groups, schools, and neighbourhoods. It is thought that the interactions between these levels are especially important in influencing adolescent behaviour. Decades of research has produced a wealth of literature on the salient individual and interpersonal risk and protective factors which influence adolescent alcohol use. However, to achieve more sustainable and equitable reductions in harmful alcohol use it is important that the upstream factors are identified and targeted within harm reduction policies and interventions. The variation in adolescent alcohol use across neighbourhoods (Jonkman, Steketee, Tombourou, Cini, & Williams, 2014) suggests that there

may be factors within neighbourhoods which can be targeted to achieve significant population health gains. Shifting the focus away from more proximal factors related to alcohol use will require all sectors in society to consider their role in reducing alcohol-related harm. An upstream approach may also be more conducive than blaming individuals, particularly adolescents whose brains are still developing, for making ‘poor decisions’ in relation to their drinking.

However, the evidence to guide decision makers and practitioners on the important neighbourhood-level exposures is unclear. Previous reviews of neighbourhood effects on adolescent alcohol use have found mixed results for most neighbourhood-level exposures, including socio-economic disadvantage, social disorganisation, employment, crime, and alcohol-related social norms (Bryden et al., 2013; Karriker-Jaffe, 2011). Stronger associations have been found in relation to the positive impact of social capital (Bryden et al., 2013) and the negative impact of liquor outlets and exposure to alcohol advertising in the neighbourhood (Bryden et al., 2012).

These equivocal findings of neighbourhood effects may be partly due to the measurement of exposure within studies. Results from studies which measure ‘community-level’ factors only at the individual level (e.g. perceptions of community attachment) are likely to differ from results from studies which use multilevel designs to examine the contextual effects of the community-level factors (e.g. aggregated measures of community attachment) over and above the individual-level effects. The former studies are considered to be treating social processes within neighbourhoods as individual-level characteristics, rather than as emergent properties of the neighbourhoods in which they reside (Sampson et al., 2002). As such, individual-level exposures and their group-level analogue may represent very different constructs which exert independent effects (Diez, 2002; Keyes et al., 2012). For example, the mechanisms of social capital at the individual level may be different when viewed at the collective level (Kawachi et al., 2004).

Results from individual-level studies of community factors can only help to explain inter-individual variation in alcohol use and cannot assist in determining which neighbourhood-level factors are associated with group-to-group variability (Diez-Roux, 2009). Drawing group-level inferences from these types of studies is therefore biased, and has been referred to as the atomistic fallacy (Diez-Roux, 1998). As such, individual-level studies are unable to inform place-based interventions as they cannot distinguish whether it is the perceptions of the community context or the community context itself that needs to change to improve health (Chilenski et al., 2010).

Even when exposures are measured at the group or neighbourhood level inconsistency in results across studies may reflect the varying ability of studies to take into account the non-independence of individuals nested within neighbourhoods. Regression techniques which ignore correlations between individuals within the same cluster may result in incorrect estimation of standard errors of parameters, leading to the detection of significant associations where none exist (Pickett & Pearl, 2001; Subramanian, Jones, & Duncan, 2003). In contrast, multilevel designs are ideally suited to the analysis of contextual effects by simultaneously analysing individual and neighbourhood-level variables, whilst accounting for the non-independence of individuals (Diez, 2002). However, for these designs to effectively isolate the contextual effects the characteristics relating to the composition of neighbourhoods must be controlled (Kawachi & Berkman, 2003; Poortinga, 2006). Omitted variables relevant to neighbourhood composition may result in residual confounding or endogeneity bias (Diez-Roux, 2000), resulting in an over-estimation of neighbourhood effects.

The influence of neighbourhood effects is widely understood to be indirect, operating through more proximal behaviours (Leventhal & Brooks-Gunn, 2000; Oakes, 2004). Examining causal pathways within multilevel models, by including mediation analyses, will contribute greatly to the evidence on neighbourhood effects. In addition, factors at the neighbourhood-level may moderate the relationship between individual-level exposures and outcomes, and hence it is also

important to consider cross-level interactions in the investigation of neighbourhood effects (Macintyre & Ellaway, 2003).

This is the first systematic review that examines the multilevel evidence of neighbourhood effects on adolescent alcohol use. It examines the effects of socio-demographic characteristics of neighbourhoods (e.g. socio-economic disadvantage, employment) and the social processes (e.g. social capital, informal social control) which may lie behind the neighbourhood demography (Raudenbush & Sampson, 1999). Results from studies using mediation and/or moderation analyses are also reported to aid the identification of causal pathways and effect modification of neighbourhood effects.

2.4 Methods

A systematic review of intervention and observational studies (cross-sectional and longitudinal) was conducted. The PRISMA Statement (Liberati et al., 2009) was utilised to guide the conduct of the review (Appendix 1).

Inclusion and exclusion criteria

Studies were included if they examined the association between neighbourhood-level exposures and adolescent alcohol use. Only studies incorporating a multilevel design, whereby neighbourhood-level and individual-level characteristics could be simultaneously examined, were included. The exposure was required to be either aggregated to the neighbourhood-level (e.g. aggregated measures of perceived neighbourhood attachment) or collected at the neighbourhood level (e.g. crime rates) and not combined with other exposures. Individual-level studies which only sought to examine the neighbourhood exposure at the individual level were excluded as were ecological designs which assessed group level exposures and outcomes. The effect of commercial alcohol availability and advertising in the neighbourhood were excluded as primary exposures due to a previously published systematic review which included studies utilising multi-level designs (Bryden et al., 2012). However, results from studies which examine these exposures

as potential mediators or moderators were reported. In addition, studies measuring neighbourhood levels of immigrant populations or ethnic groups were excluded, as, in agreement with Bryden et al. (2013) these factors are much less amenable to policy or practice interventions.

Adolescents were defined as being between the ages of 10 and 19 years, which is consistent with the World Health Organisation's definition of adolescence. Study populations which included both adolescents and young adults (20 years and over) were excluded. Any type of alcohol use was considered, including past week, month or year, ever or lifetime drinking, binge drinking, and drunkenness. Studies which combined alcohol and drug use outcomes or examined alcohol-related consequences were excluded.

Search strategy

Primary studies were identified by searching six electronic databases including Medline (from 1946), SCOPUS, PsycINFO (from 1806), EMBASE (from 1980), CINAHL Plus (from 1937) and Sociological Abstracts (from 1952). The last search was run on January 9, 2014. A Google search was also conducted to identify grey literature and further studies were identified by searching the reference lists of included studies and relevant articles. As multilevel designs are not indexed within electronic databases all studies investigating neighbourhood exposures were first identified, with only multilevel designs being selected for inclusion in the review.

The following search terms were applied to the databases (Medline search shown in the following): (young adult\$ OR adolescen\$ OR youth\$ OR young person\$ OR young people\$ OR teen\$ OR Adolescent/ OR Young Adult/) AND (alcohol\$ OR intoxicat\$ OR liquor\$ OR beer\$ OR wine\$ OR binge\$ OR drunk\$ OR Alcohol Drinking/ OR Alcoholic Intoxication/ OR Alcohol-Induced Disorders/) AND (neighbourhood\$ OR neighborhood\$ OR communit\$ OR social capital OR collective efficacy OR informal social control OR Residence Characteristics/ OR place OR environment\$ OR norm OR norms OR area-level OR geograph\$ OR residence\$

OR deprivation OR poverty OR economic OR socioeconomic OR income). Details and results of the search are provided in Appendix 2.

Data extraction

Data were extracted from each paper on the study characteristics (e.g. author, country, year, study design), sample characteristics (e.g. age and demographics of sample, number and size of neighbourhoods), exposure and outcome measurement, covariates and intermediary variables examined, results of direct effects and results from mediation and moderation analyses (Appendix 3). Where an included study was missing methodological information further articles describing the study were retrieved or contact with the authors was made in order to fully extract the necessary details.

Quality assessment

Studies were appraised using the ‘Quality Assessment Tool for Quantitative Studies’ (Effective Public Health Practice Project, 2010). This tool is specifically designed for public health studies and in a review of 194 quality assessment tools for non-randomised designs was recommended as one of six tools suitable for use in systematic reviews (Deeks et al., 2003). The tool, designed for intervention studies, was adapted by the authors to address the specific needs of multilevel designs by requiring the consideration of selection bias at both the cluster and individual level, neighbourhood-level and cross-level confounding, control for intermediary or mediating variables, and same source bias within the methods of data collection. The assessment of blinding and intervention integrity was excluded from the quality assessment tool. Results from quality assessment are provided in Appendix 4.

Data analysis

Studies were grouped by type of exposure (e.g. disadvantage, social capital, etc.). Many studies examined more than one exposure and consequently appear in more than one category.

Heterogeneity in study design, sample population and outcome measurement precluded the use of meta-analysis. Results are therefore presented in narrative form.

2.5 Results

The database searches provided a total of 26,736 papers (excluding duplicates). Titles were first screened by NJ to determine eligibility. Following this, 269 abstracts were reviewed, with the full-text retrieved for 107 papers (Figure 2-1). Uncertainty regarding the eligibility of a primary study was discussed with SD. The majority of the excluded studies measured neighbourhood attributes at the individual level or included a combined drug use outcome. In total, 23 studies published in 24 papers were identified to be included in the review, with one study located from a reference list of an included study.

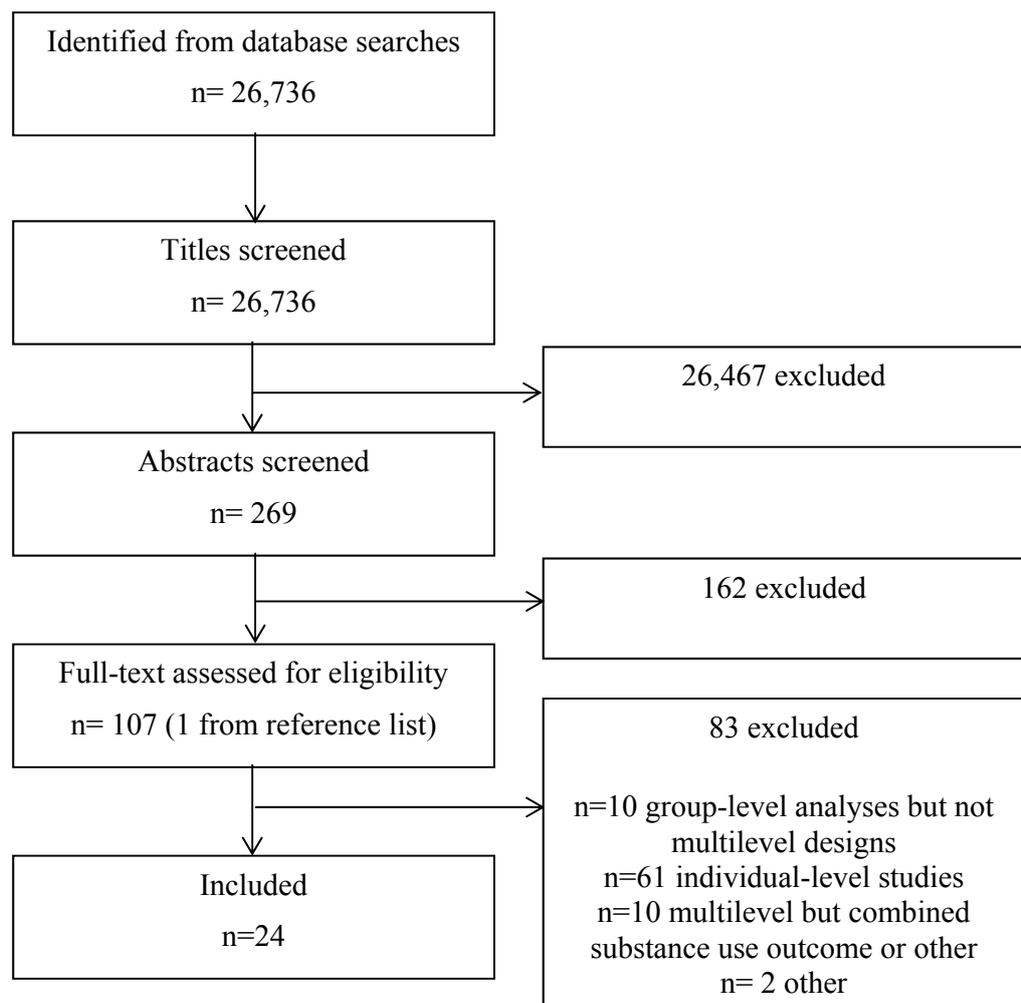


Figure 2-1. Results of study selection process.

Of the 23 studies, 19 used cross-sectional and four used longitudinal designs. These studies examined eleven different exposures. All but seven studies were carried out in the United States, with the remaining studies carried out in Sweden, Iceland, Canada, New Zealand, or Denmark.

The operationalisation of neighbourhood differed across studies, ranging from census blocks/units, to school catchment areas, cities, towns, health regions and counties. This represented a range in 'neighbourhood' populations from 300 to 200,000. Where the number of included neighbourhoods was stated, it ranged from 14 to 158. Studies differed in the choice of outcome variable, with some studies using a combined scale to define alcohol use, with others using single measures such as lifetime use of alcohol, past year and month drinking, binge drinking in the past two weeks, and typical quantity consumed in a drinking occasion. Eight studies reported the intra-class correlation (ICC) to indicate the degree of clustering of alcohol use behaviours, finding that the differences across neighbourhoods were small to modest (median ICC=0.009).

Half of all studies were rated 'weak' in quality due to issues such as cross-sectional design or failure to include all relevant variables to control for selection bias/composition effects. More than one-half of all studies used probabilistic sampling. Only five studies conducted mediation analyses, reporting results with and without adjustment of the intermediary variables. Where mediation analyses were carried out the measure of direct effect without controlling for the potential mediator is presented within the tables. With regards to mediation analyses, only studies rated 'moderate' or 'strong' in quality are reported within this section.

Given the diversity of interaction/moderation effects reported in studies, only studies which were rated 'moderate' or 'strong' in quality and deemed to have a sufficient sample size to effectively estimate cross-level interactions are discussed. It is generally recommended that 50 neighbourhoods, with a minimum of 20 respondents/neighbourhood is necessary to perform such analyses (Subramanian et al., 2003). Results from all studies are reported in Tables 2-1 and 2-2.

Table 2-1

Associations Between Neighbourhood Socio-demographic Factors and Adolescent Alcohol Use

Reference	Population	Neighbourhood unit	Exposure measure	Outcome measure	Results (95% CI)	p	Mediation / moderation analysis
Neighbourhood disadvantage or income							
Aslund and Nilsson (2013)	7757, 13-18y	Housing area	Median income	Problem drinking	OR 1.00 (0.99-1.01)	NS	Not tested
Bernburg, Thorlindsson, and Sigfusdottir (2009)	5491, 15-16y	School district	Index: 3 items	Drunkenness	b=0.12	p<0.05	Disadvantage > community-level disrupted family processes
Brenner et al. (2011)	711, mean age 14.5y	Census blocks	Index: 5 items	Frequency of use and binge drinking	b=0.03	NS	Mediation model = NS
Breslin and Adlaf (2005)	8,080, 15-19y	Health regions	Low income	Binge drinking	b=-0.129	NS	Moderation model = NS
De Haan, Boljevac, and Schaefer (2010)	1424, 11-15y	School district	Index: 6 items	Lifetime use Past month use	OR 1.04 (0.92-1.17) OR 1.23 (1.06-1.42)	NS p<0.01	Disadvantage x individual economic strain
Ennett et al. (2008)	6544, 11-17y	Census blocks	Index: 11 items	Problem drinking	b=0.00	NS	Moderation model = NS
Fagan, Wright, and Pinchevsky (2013)	1856, 8-17y	Neighbourhood clusters	Index: 4 items	Past year use Binge drinking	b= 0.001 b= -0.039	NS NS	Not tested
Huckle, Huakau, Sweetsur, Huisman, and Casswell (2008)	1179, 12-17y	Census Area Unit	Index: 9 items	Typical quantity Annual frequency Drunkenness	b=0.002 b=0.001 b=0.001	p<0.05 NS NS	Not tested

Reference	Population	Neighbourhood unit	Exposure measure	Outcome measure	Results (95% CI)	p	Mediation / moderation analysis
<i>Neighbourhood disadvantage or income continued...</i>							
Kulis, Marsiglia, Sicotte, and Nieri (2007)	3570, 11-17y	School district	Poverty Single mother homes	Past month use	b= -0.034 b= 0.015	NS NS	Moderation model = NS
Lo, Anderson, Minugh, and Lomuto (2006)	73782, 6th to 12th grade	Counties	Index: 7 items	Lifetime use Past month use	b=-0.0045 b=-0.0010	p<0.05 NS	Disadvantage x religious attendance / protective role of family / protective role of self
Maimon and Browning (2012)	1135, 8-16y	Neighbourhood clusters	Index: 4 items	Past month use	Negative and significant	p<0.05	Not tested
Snedker and Herting (2008)	1721, 13-21yr	Census tracts	Index: 4 items	Past month use	b=-0.035	p<0.01	Disadvantage x deviant peer behaviour Disadvantage x family functioning = NS
Snedker et al. (2009)	2006, 13-21y	Census tract	Index: 4 items	Past month use	b=-0.015	p<0.05	Income x deviant peer behaviour Income x family support = NS Income x personal control = NS
Vinther-Larsen, Huckle, You, and Casswell (2013)	1144, 12-19y	Census Area Units	Index: 9 items	Typical quantity Past year use	J-shaped curve b =0.0253	p<0.05 NS	Not tested
Yabiku, Rayle, Okamoto, Marsiglia, and Kulis (2007)	4137, 11-13y	School district	Poverty High school education	Past month use	b=0.00 b=0.14	NS NS	Disadvantage x ethnicity High school education x ethnicity = NS

Reference	Population	Neighbourhood unit	Exposure measure	Outcome measure	Results (95% CI)	p	Mediation / moderation analysis	
Neighbourhood disorder								
Fagan et al. (2007)	>69,000 in grades 6, 8 and 10	Communities	Perceptions of disorder	Lifetime use	6 th to 8 th grade: b=0.14	NS	Not tested	
				Past month use	b=0.10	NS		
				Binge drinking	b=0.14	NS		
					8 th to 10 th grade:			
				Lifetime use	b=0.12	NS		
				Past month use	b=0.08	NS		
				Binge drinking	b=0.03	NS		
Kulis et al. (2007)	3570, 11-17y	School district	Violent crime rate	Past month use	b= 0.036	NS		Violent crime x ethnicity
Snedker and Herting (2008)	1721, 13-21y	Census tracts	Crime rate	Past month use	b=0.0001	NS		Crime x deviant peer behaviour = NS Crime x family support
Steen (2010)	50,529, 6th to 12th grade	Counties	Perceptions of abandoned buildings	Lifetime use	b=0.02	p<0.05	Not tested	
Yabiku et al. (2007)	4137, 11-13y	School district	Crime rate	Past month use	b=0.05	p<0.05	Moderation model = NS	
Enforcement of liquor laws								
Dent, Grube, and Biglan (2005)	3318, 16-17y	School district	Perception of being caught drinking	Past month use	b=-0.040	p<0.05	Enforcement x supply from underage peers Enforcement x alcohol supplied from home	
				Binge drinking	b=-0.035	NS		

Reference	Population	Neighbourhood unit	Exposure measure	Outcome measure	Results (95% CI)	p	Mediation / moderation analysis
<i>Enforcement of liquor laws continued...</i>							
Fagan et al. (2007)	>69,000 in grades 6, 8 and 10	Communities	Perception of being caught using alcohol and/or drugs	Lifetime use Past month use Binge drinking	6 th to 8 th grade: b=0.16 b=0.18 b=0.18	NS NS NS	Not tested
				Lifetime use Past month use Binge drinking	8 th to 10 th grade: b=0.26 b=0.25 b=0.23	p<0.05 p<0.05 p<0.05	
Paschall, Grube, Thomas, Cannon, and Treffers (2012), Paschall, Lipperman-Kreda, and Grube (2013)	1236-1478, 13-18y	Cities	Per capita enforcement funding	Past year use Binge drinking	At 1y: b=-0.11 At 2y: b=-0.085 At 1y: b=NS At 2y: b=-.002	p<0.05 p<0.05 NS NS	Enforcement > perceived alcohol availability, enforcement and acceptability of alcohol use (past year use) Moderation model = NS

Reference	Population	Neighbourhood unit	Exposure measure	Outcome measure	Results (95% CI)	p	Mediation / moderation analysis
Residential mobility							
Bernburg et al. (2009)	5491, 15-16y	School district	Mobility/5 years	Drunkenness	b=-0.13	NS	Not tested
Fagan et al. (2007)	>69,000 in grades 6, 8 and 10	Communities	Home or school mobility in past 5 years	Lifetime use Past month use Binge drinking	6 th to 8 th grade: b=0.07 b=0.02 b=0.04	NS NS NS	Not tested
				Lifetime use Past month use Binge drinking	8 th to 10 th grade: b=-0.04 b=-0.09 b=-0.08	NS NS NS	
Kulis et al. (2007)	3570, 11-17y	School district	Mobility/5 years	Past month use	b= 0.011	NS	Mobility x ethnicity
Maimon and Browning (2012)	1135, 8-16y	Neighbourhood clusters	Mobility/5 years	Past month use	b=-0.124	NS	Not tested
Snedker et al. (2009)	2006, 13-21y	Census tracts	Moved last 5 years, non-owned homes	Past month use	b=-0.002	NS	Moderation model = NS
Employment or job availability							
Breslin and Adlaf (2005)	8080, 15-19y	Health regions	Weeks looking for job	Binge drinking	b=0.006	NS	Moderation model = NS
Svensson and Hagquist (2010)	15206, 15-16y	Municipalities	Unemployment rate	Past year use Binge drinking	OR 0.96 (0.93-1.00) OR 0.94 (0.90-0.98)	p<0.05 p<0.01	Not tested
Yabiku et al. (2007)	4137, 11-13y	School district	Unemployment rate	Past month use	b=0.23	NS	Employment x ethnicity

NS = Not significant; b = regression co-efficient; OR = Odds ratio; y = years old

Table 2-2

Associations Between Neighbourhood Social Processes and Adolescent Alcohol Use

Reference	Population	Neighbourhood unit	Exposure measure	Outcome measure	Results (95% CI)	p	Mediation or moderation analysis
Neighbourhood attitudes to drinking							
De Haan and Boljevac (2010)	1424, 11-15y	School district	Adult perceptions of intolerance	Lifetime use Past month use	OR 1.02 (0.95-1.11) OR 0.69 (0.56-0.86)	NS p<0.01	Moderation model = NS
Fagan et al. (2007)	>69,000 in grades 6, 8 and 10	Communities	Adolescent perceptions of tolerance	Lifetime use Past month use Binge drinking	6 th to 8 th grade: b=0.18 b=0.12 b=0.12	NS NS NS	Not tested
				Lifetime use Past month use Binge drinking	8 th to 10 th grade: b=0.23 b=0.12 b=0.08	p<0.05 NS NS	
Musick, Seltzer, and Schwartz (2008)	838, 12-17y	Census tracts	Adult perceptions of intolerance	Frequency of use	b=-0.24	NS	Moderation model = NS
Neighbourhood-level disrupted family processes							
Bernburg et al. (2009)	5491, 15-16y	School district	Weak parental ties Violence, arguments	Drunkenness	b=0.90 b=1.58	p<0.01 p<0.01	Disrupted family processes > deviant peer association
Neighbourhood-level social capital							
Aslund and Nilsson (2013)	7757, 13-18y	Housing areas	Social capital	Problem drinking	OR 1.00 (0.99-1.02)	NS	Not tested
De Haan et al. (2010)	1424, 11-15y	School district	Neighbourhood support	Lifetime use Past month use	OR 0.97 (0.80-1.16) OR 0.91 (0.78-1.05)	NS NS	Not tested

Reference	Population	Neighbourhood unit	Exposure measure	Outcome measure	Results (95% CI)	p	Mediation or moderation analysis
<i>Neighbourhood-level social capital continued</i>							
Ennett et al. (2008)	6544, 11-17y	Census blocks	Neighbourhood bonding and trust	Problem drinking	b=-0.03	NS	Moderation model = NS
Fagan et al. (2007)	>69,000 in grades 6, 8 and 10	Communities	Neighbourhood attachment	Lifetime use	b=0.24	p<0.05	Not tested
				Past month use	b=0.24	p<0.05	
				Binge drinking	b=0.27	p<0.05	
					8 th to 10 th grade:		
				Lifetime use	b=0.22	NS	
				Past month use	b=0.18	NS	
				Binge drinking	b=0.18	NS	
Steen (2010)	50529, 6 th -12th grade	Counties	Neighbours to talk to	Lifetime use	b=0.02	p<0.01	Not tested
Neighbourhood-level pro-social rewards							
Fagan et al. (2007)	>69,000 in grades 6, 8 and 10	Communities	Rewards for good behaviour	Lifetime use	b=-0.14	NS	Not tested
				Past month use	b=-0.22	p<0.05	
				Binge drinking	b=-0.23	p<0.05	
					8 th to 10 th grade:		
				Lifetime use	b=-0.27	p<0.05	
				Past month use	b=-0.29	p<0.05	
				Binge drinking	b=-0.31	p<0.05	

Reference	Population	Neighbourhood unit	Exposure measure	Outcome measure	Results (95% CI)	p	Mediation or moderation analysis
Neighbourhood-level alcohol use							
Bendtsen, Damsgaard, Tolstrup, Ersboll, and Holstein (2013)	2911, ~13-16y	Municipalities	High alcohol use in adults Medium alcohol use	Drunkenness Binge drinking Binge drinking	OR 1.95 (1.19-3.22) OR 1.90 (1.21-2.98) OR 1.47 (0.94-2.14)	p<0.05 p<0.05 p<0.05	Mediation model = NS
Breslin and Adlaf (2005)	8080, 15-19y	Health regions	Adolescent drinking	Binge drinking	b=1.641 (0.262)	p<0.05	Community alcohol use x long work hours
De Haan and Boljevac (2010)	1424, 11-15y	School district	Adult perceptions Adolescent perceptions	Lifetime use Past month use Lifetime use Past month use	OR 1.38 (1.03-1.84) OR 0.38 (0.21-0.69) OR 0.50 (0.23-1.09) OR 0.48 (0.06-4.01)	p<0.05 p<0.01 NS NS	Community alcohol use x peer drinking
Ennett et al. (2008)	6544, 11-17y	Census blocks	Adolescent alcohol use	Problem drinking	b=0.67	p<0.01	Moderation model = NS
Musick et al. (2008)	838, 12-17y	Census tracts	Adult alcohol use	Frequency of use	b=-0.03	NS	Not tested
Paschall et al. (2012) Paschall et al. (2013)	1236-1478, 13-18y	Cities	Adult alcohol use	Past year use Binge drinking	At 1y: b=0.55 At 2y: b=-0.110 At 1y: b=0.32 At 2y: b=-0.026	p<0.05 NS p<0.05 NS	Community alcohol use x increases in alcohol use over 2 years At 1y: community alcohol use > perceived acceptability, perceived availability

Reference	Population	Neighbourhood unit	Exposure measure	Outcome measure	Results (95% CI)	p	Mediation or moderation analysis
Collective efficacy and informal social control							
De Haan et al. (2010)	1424, 11-15y	School district	Collective efficacy	Lifetime use Past month use	OR 1.72 (0.21-13.86) OR 0.34 (0.07-1.53)	NS NS	Not tested
Ennett et al. (2008)	6544, 11-17y	Census blocks	Neighbourhood informal control	Problem drinking	b=0.02	NS	Moderation model = NS
Maimon and Browning (2012)	1135, 8-16y	Neighbourhood clusters	Social cohesion and informal social control	Past month use	b=0.050	NS	Collective efficacy x alcohol outlet density

NS = Not significant; b = regression co-efficient; OR = Odds ratio; y = years old

Neighbourhood socio-economic disadvantage

Fifteen studies were identified which examined the association between neighbourhood disadvantage and adolescent alcohol use. Eleven studies used an index measure of neighbourhood disadvantage, incorporating a range of Census items including family income, proportions of single-headed families, families where the adult is unemployed, education level of the head of household, housing tenure, etc. Other studies used single measures to indicate disadvantage.

Using the quality assessment tool one study was rated as 'strong' (Maimon & Browning, 2012). This study found a significant, but negative, direct effect of neighbourhood disadvantage, despite appearing to over-control for confounders which may have been potential mediators in the causal pathway between disadvantage and alcohol use (e.g. parental monitoring, association with deviant peers).

Eight studies were rated 'moderate' quality, examining effects on three measures of alcohol use. No significant associations were found in seven studies which examined the association with high levels of alcohol consumption (e.g. binge drinking) (Aslund & Nilsson, 2013; Bernburg et al., 2009; Brenner et al., 2011; Breslin & Adlaf, 2005; Ennett et al., 2008; Fagan et al., 2007; Huckle, Huakau, et al., 2008) and in three studies which measured past year alcohol use (Fagan et al., 2007; Huckle, Huakau, et al., 2008; Vinther-Larsen et al., 2013). Two moderate-rated studies, both conducted in New Zealand between 2004 and 2005, found significant associations with typical quantity consumed (Huckle, Huakau, et al., 2008; Vinther-Larsen et al., 2013). Vinther-Larsen et al. (2013) found that this association was J-shaped. Six studies were rated 'weak' quality and are not discussed due to the availability of higher quality evidence.

Eight studies included interactions within the multilevel model, two of which met the criteria for quality and sample size of at least 50 neighbourhood units and 20 individuals per unit in their study. Breslin and Adlaf (2005) found that neighbourhood income did not moderate the association between long working hours and alcohol use. Ennett et al. (2008) found no

interactions between neighbourhood-level variables, including community alcohol use, neighbourhood bonding and social control.

Two studies tested mediating variables in their models. Bernburg et al. (2009) found that community-level disrupted family processes may mediate the effect of disadvantage, whereas Brenner et al. (2011) found that disadvantage had no indirect effects on alcohol use.

Neighbourhood disorder

Five studies examined neighbourhood disorder by assessing objective rates of neighbourhood crime or participants' self-report of the neighbourhood attributes such as criminal activities, fighting, and abandoned buildings (Fagan et al., 2007; Kulis et al., 2007; Snedker & Herting, 2008; Steen, 2010; Yabiku et al., 2007). All studies were rated as 'weak' due to their cross-sectional design, and/or lack of inclusion of relevant individual-level control variables, and/or selection bias relating to the characteristics of neighbourhoods included in the study. One of two studies measuring lifetime alcohol use found a significant association (Steen, 2010), with one of the four studies measuring monthly use also finding a positive association (Yabiku et al., 2007). No significant results were found in one study which examined binge drinking (Fagan et al., 2007). Mediation analyses were not conducted, with the results from three studies exploring moderation not reported due to small sample sizes or quality criteria.

Neighbourhood-level enforcement of liquor laws

Three studies, published in four papers, examined (aggregated) adolescents' perceived enforcement of liquor laws in the neighbourhood (Dent et al., 2005; Fagan et al., 2007) or level of funding for enforcement at the city level (Paschall et al., 2012; Paschall, Lipperman-Kreda, & Grube, 2014). All studies were conducted in the United States and rated 'weak' in quality, particularly due to the inadequate accounting for individual-level demographic factors (e.g. socio-economic position) which may give rise to compositional rather than contextual effects. Significant effects were found across all studies, with Fagan et al. (2007) finding that the

association was only present in older, rather than younger, adolescents. In a longitudinal study, enforcement funding was not related to changes in alcohol use over time or past-year heavy drinking, but was related to lower levels of past-year alcohol use at both one-year and two-year follow-up (Paschall et al., 2012; Paschall et al., 2014). Results from two studies examining moderation or mediation are not reported due to study quality.

Residential mobility

Five studies examined the effect of neighbourhood-level residential mobility, mostly occurring in the past five years (Bernburg et al., 2009; Fagan et al., 2007; Kulis et al., 2007; Maimon & Browning, 2012; Snedker et al., 2009). All studies found no significant associations with lifetime or past month alcohol use or binge drinking behaviour.

Employment and job availability

Two of the three studies examining employment-related features of the neighbourhood used objective employment rates to classify the neighbourhood exposure. One moderate-rated study found that aggregated time spent by adolescents looking for a job was not directly associated with alcohol use, and did not moderate the association between individual-level working hours and alcohol use (Breslin & Adlaf, 2005). Two ‘weak’ studies found mixed results, one finding no significant association (Yabiku et al., 2007) with the other study finding a significant association with annual use and binge drinking (Svensson & Hagquist, 2010). No studies examined mediators on the causal pathway.

Neighbourhood attitudes to drinking

Three studies aggregated perceptions of neighbourhood attitudes to drinking. One ‘weak’ study aggregated adolescent perceptions of community norms finding no association with heavy drinking in young or older adolescents (Fagan et al., 2007). Favourable community drinking attitudes were associated with increased lifetime drinking in older adolescents but not younger adolescents. Two studies examined adult perceptions of community norms and found no

significant associations with frequency of alcohol use (Musick et al., 2008) or lifetime alcohol use (De Haan & Boljevac, 2010). The latter study found an association between community intolerance and lower monthly alcohol use in adolescents. No studies conducted mediation analyses. Two studies assessed moderation but were deemed too small in size to effectively estimate the association.

Disrupted family processes at the neighbourhood level

One study, rated ‘moderate’ in quality, examined the effect of adolescent perceptions of weak social ties to their parents and coercive family interaction (Bernburg et al., 2009). Aggregate levels of disruptive family processes were found to be significantly associated with heavy drinking. When association with deviant peers was added to the model the significant effect of community disruptive process was reduced to insignificance. Therefore, deviant peer associations may mediate the effect of neighbourhood-level disruptive family processes. No interactions were tested in the model.

Neighbourhood-level social capital

Five studies examined constructs relating to social capital, neighbourhood attachment, support, etc. Of the three studies which collected this information from adolescents one ‘moderate’ quality study found no significant association with high levels of alcohol consumption (Aslund & Nilsson, 2013). Two ‘weak’ studies found significant relationships with lifetime alcohol use (Fagan et al., 2007; Steen, 2010), although in the study by Fagan et al. (2007) this association was restricted to younger but not older adolescents. No associations were found for monthly use or binge drinking behaviour. Two studies measured the perceptions of adults in the neighbourhood finding no significant associations with adolescent alcohol use (De Haan et al., 2010; Ennett et al., 2008). No studies examined mediating variables. In relation to moderation, Ennett et al. (2008) found no interactions between neighbourhood bonding and other neighbourhood-level exposures including neighbourhood alcohol use and social control.

Rewards for pro-social involvement

This exposure was measured in one study via aggregated adolescents self-report of neighbours noticing when they were doing a good job and letting them know, people in their neighbourhood being proud of them when they do something well, and people in their neighbourhood encouraging them to do their best. The cross-sectional study, rated 'weak', found significant and negative associations with monthly alcohol use and binge drinking in both younger and older adolescents (Fagan et al., 2007). No cross-level effects were examined.

Neighbourhood-level alcohol use

Four studies, published in five papers, aggregated levels of adult drinking or adult perceptions of adult drinking in the neighbourhood. Two were rated as 'moderate' quality. Of these, one study found an association with the frequency of drunkenness and binge drinking (Bendtsen et al., 2013), with the other study finding no significant association with past month use (Musick et al., 2008). One 'weak' rated study found that aggregated adult perceptions of community levels of drinking were associated with higher levels of adolescent lifetime and past month alcohol use (De Haan & Boljevac, 2010). The remaining 'weak' study found an effect on past year drinking and heavy drinking at one-year follow-up (Paschall et al., 2012) but no effect at two-year follow-up.

Three studies aggregated adolescent drinking levels or adolescent perceptions of community-level drinking. Two 'moderate' quality studies found significant and positive associations with binge drinking behaviour or problematic alcohol use (Breslin & Adlaf, 2005; Ennett et al., 2008). One 'weak' study found no significant association with lifetime or past month alcohol use (De Haan & Boljevac, 2010).

Bendtsen et al. (2013) found that parental alcohol use did not mediate the association between community-level adult alcohol use and adolescent alcohol use. In relation to moderation, it was found that longer working hours was more strongly associated with heavy alcohol use in

communities with low levels of drinking (Breslin & Adlaf, 2005). Ennett et al. (2008) found no interactions between neighbourhood-level variables.

Collective efficacy or informal social control

Three studies, one with a longitudinal design, examined neighbourhood-level informal social control and/or collective efficacy. All three studies found no association with alcohol use (De Haan et al., 2010; Ennett et al., 2008; Maimon & Browning, 2012). Ennett et al. (2008) found no interactions with other neighbourhood-level exposures including community alcohol use and neighbourhood bonding. Maimon and Browning (2012) found that a high prevalence of alcohol outlets was associated with a higher prevalence of alcohol use in communities with lower levels of collective efficacy.

2.6 Discussion

This review identified a number of studies utilising a multilevel approach to explore neighbourhood effects on adolescent alcohol consumption. More than three-quarters of all studies were published in the last five years, indicating growing interest in the use of multilevel designs to investigate neighbourhood effects. Despite their increasing use, almost one-half of the studies were rated ‘weak’ in quality, due to factors such as selection bias (at the neighbourhood level), cross-sectional design and/or inadequate controlling for confounders to account for compositional effects.

The majority of the studies examined whether neighbourhood variance was due, in part, to the effect of neighbourhood socio-economic disadvantage. A wide range of archival data (e.g. Census) was utilised to measure this exposure. All studies relied on the central tendency of administrative data (e.g. mean income), rather than examining inequalities in income or poverty which may also affect alcohol use (Elgar et al., 2005; Karriker-Jaffe, Roberts, & Bond, 2012). Three of the nine strong or moderate quality studies included in this review showed significant

associations, albeit in different directions. Overall, results should be taken with caution due to possible residual confounding related to neighbourhood composition.

The lack of effects of disadvantage is inconsistent with the Social Disorganisation Theory (Shaw & McKay, 1942) which would suggest that disadvantage results in diminished social organisation leading to increased problematic behaviour. Perhaps this theory operates differently for adolescents than adults, as has been suggested by others (Snedker et al., 2009) and shown within reviews of area-level socio-economic position effects on adult and adolescent substance use (Karraker-Jaffe, 2011). Future studies should seek to examine separately the constituent components of socioeconomic position, as evidence has demonstrated that these may be associated with different drinking patterns (Casswell, Pledger, & Hooper, 2003). In addition, it is important to consider from the outset that neighbourhood effects are unlikely to have a linear relationship with health and behaviours (Duncan & Raudenbush, 2001).

Studies examining other structural features of neighbourhoods, such as crime, disorder, residential mobility, and employment or job availability also found no associations with adolescent alcohol use. Also, social processes (i.e. neighbourhood attitudes to drinking, social capital, and collective efficacy or informal social control) did not appear to be associated with alcohol use. Although protective effects of enforcement of liquor laws were found, these studies were few and rated 'weak' in quality due to their lack of controlling for individual-level characteristics relevant to group composition. Previous results from a systematic review of enforcement interventions has demonstrated positive impacts relating to reduced alcohol sales to minors although it remains questionable as to whether this translates to reductions in alcohol use (Elder et al., 2007). Intervention trials, using multilevel designs, will be required to determine the impact of this exposure on consumption patterns.

The results of the current review are in contrast to results from a systematic review of community-level social factors and alcohol use (Bryden et al., 2013) that found more promising

results for the protective effect of social capital. However, on closer examination of the Bryden et al. (2013) review all four primary studies showing significant effects for adolescents examined social capital at the individual level. The primary studies included in the current multilevel review also found protective effects of social capital when analysed at the individual level. The evidence of protective effects at the individual level, but not at the contextual level, has also been demonstrated in multilevel studies of social capital and adult alcohol use (Lin, Witten, Casswell, & You, 2012). This absence of contextual effects may reflect the normative nature of adolescent drinking, perceived as typical adolescent initiation and experimenting behaviours. Consequently, the wider social acceptance of alcohol consumption may render alcohol use a less severe outcome to detect significant neighbourhood effects, in comparison to illicit drug use or smoking (Snedker & Herting, 2008). Furthermore, the private nature of underage drinking (i.e. occurring at home and/or parties) may limit the protective effects of neighbourhood social processes, such as collective efficacy, as neighbours may be less able to exert control over adolescent behaviours in private settings (Maimon & Browning, 2012). The ability to identify effects is also likely to depend on the prevalence of adolescent drinking in the neighbourhood, as neighbourhood effects may only be seen once a certain threshold of behaviour occurs (O'Campo & O'Brien Caughy, 2006). For example, collective efficacy may be less important in communities where few adolescents drink. Many studies in the current review included populations with a very low use of alcohol, limiting the ability to determine neighbourhood effects.

Only studies examining community levels of drinking (adult or adolescent use) showed somewhat more consistent positive associations, mostly with problematic alcohol use. It is possible, however, that higher levels of community drinking reflect residual confounding at the neighbourhood level, due to the presence of high densities of alcohol outlets. In relation to the total evidence on neighbourhood-level exposures, stronger evidence has been found linking alcohol outlet density with adolescent alcohol consumption (Bryden et al., 2012). It is believed that alcohol outlets may provide more direct opportunities for adolescents to obtain alcohol

through different sources, including purchasing alcohol themselves, asking others to purchase and a greater availability of alcohol in homes (Chen, Gruenewald, & Remer, 2009). Moreover, a high level of outlets may create an 'alcoogenic' environment within a community which may predispose adolescents to believe that underage drinking is common and socially accepted (Kuntsche, Kuendig, & Gmel, 2008).

The stronger findings in relation to outlet density do not negate further study into the role of other neighbourhood factors on alcohol use. The overall lack of significant findings in this review may reflect the spatial units (e.g. Census blocks) used in studies to operationalise an adolescent's neighbourhood. There was large variation in the size and types of neighbourhoods studied. Furthermore, Basta, Richmond, and Wiebe (2010) have shown that an adolescent's hand-drawn neighbourhood and activity path may not correspond to census boundaries. As alcohol consumption is a behaviour that occurs within a social context it can be expected that social processes are not necessarily constrained by artificial administrative boundaries (Sampson, Morenoff, & Earls, 1999). The non-spatial nature of multilevel models (Chaix, Merlo, Subramanian, Lynch, & Chauvin, 2005) will require researchers to consider methods to incorporate an adolescent's active interpretation of their environment and interaction within it (Byrnes, Chen, Miller, & Maguin, 2007). The inclusion of spatial lags into multilevel models is also important to account for the spatial dependence of alcohol use across nearby neighbourhoods (Logan, 2012). Combining geospatial models, which provide cartographic data on spatial variation, with multilevel models, may also hold promise as a way to build notions of space into statistical models (Chaix et al., 2005).

Studies in this review generally attempted to assess the impact of situational (or contemporaneous) neighbourhood conditions. The small number of longitudinal studies measured neighbourhood exposures at one point in time and assessed changes in alcohol use a few years later. Unfortunately, it is uncommon in studies of contextual effects to follow groups and individuals over time to determine if changes in exposures lead to changes in health behaviour

(Diez Roux, 2004b). This use of static neighbourhood models neglects the investigation of long-term neighbourhood influences and mediating pathways regarding individual, interpersonal, family and school-related characteristics (Sampson et al., 2002). However, Sampson (2012) believes that for some problem behaviours, young people might be more affected by the contemporaneous (situational) effects of the neighbourhood rather than developmental effects resulting from past circumstances. Regardless, the salience of neighbourhood exposures across the life course of an adolescent is difficult to establish.

It is uncertain if neighbourhood effects (if they exist) are more direct, or are mediated through other processes to affect adolescent alcohol use (Leventhal & Brooks-Gunn, 2000). Researchers are encouraged to consider the likely chain of causation in their examination of contextual effects (Blakely & Woodward, 2000; Macintyre & Ellaway, 2003). However, only five studies aimed to identify how other, more proximal, explanatory variables within neighbourhoods may mediate the association with adolescent alcohol use. If context does ultimately operate through individual-level processes (Diez-Roux, 1998) researchers will need to effectively distinguish between covariates and intermediary mediating variables in order to determine which processes to control in their models (Diez-Roux, 2009). Over-controlling for intermediary variables may result in a disappearing of the group-level effect. In the current review many studies appeared to over-control for variables which potentially lie on the causal pathway, overlooking their indirect cross-level effects. For example, parental supervision, parental alcohol use, and association with deviant peers are likely to be influenced by the neighbourhood and perhaps may be considered as intermediary variables rather than confounders within multilevel models. However, many studies opted to control for these variables in their models with the resultant regression coefficient effectively mixing both direct and indirect effects. More multilevel studies, with sufficient sample sizes to perform mediation analyses, will be required to disentangle the complex causal pathways of neighbourhood effects.

Similarly, very few studies carried out, or were sufficiently powered to carry out, moderation analyses to determine whether the neighbourhood effects depend on other characteristics within the neighbourhood. Considering only the marginal effect is likely to obscure the potentially divergent consequences of neighbourhood conditions among different subgroups of adolescents (Wodtke, Elwert, & Harding, 2012). Identifying moderation has important implications for prevention as intervention strategies can target vulnerability and soften the impact of neighbourhood conditions (Scheier et al., 2001). For example, Maimon and Browning (2012) found that a high prevalence of alcohol outlets is associated with a higher prevalence of alcohol use in neighbourhoods with lower levels of collective efficacy whilst action is taken to reduce disadvantage. Prevention efforts can then be tailored to enable collective efficacy to be developed. Moderation analyses also have the potential to widen the generalisability of results from studies to different cultural and demographic groups within neighbourhoods (Fairchild & McQuillin, 2010). For example, Fagan et al. (2007) showed that neighbourhood effects varied by age and stage of development. Neighbourhood attachment and disorder were found to be less important for older adolescents whilst the perceived enforcement of liquor laws and neighbourhood acceptability of drinking were more important to deter drinking. This is consistent with recent research showing that a higher density of liquor outlets in communities was only associated with a higher risk of alcohol use in adolescents aged between 12 and 14 years (Rowland, Toumbourou, Satyen, Tooley, et al., 2014). Together, these findings may signal the importance of the neighbourhood in the earlier years of adolescence, with diminishing importance as older adolescents spend more time away from their neighbourhood. Future multilevel studies should strongly consider the incorporation of interaction effects between age and neighbourhood exposures.

This review highlights both the complexity of conducting multilevel studies to examine neighbourhood effects and the lack of consideration of neighbourhood effects from the outset of study design. Many studies were flawed by an inability to control for factors that relate to both

neighbourhood composition and alcohol use (e.g. family socio-economic position, age). Same source bias was prevalent, whereby the same group of respondents was used to collect information on both the outcome and the neighbourhood exposure despite the recommendation for independence between the two samples (Leventhal & Brooks-Gunn, 2000). In addition, insufficient reporting was found in relation to power calculations and the number of neighbourhood units included in the sample. The development of critical appraisal tools, specific to the features of multilevel designs, might assist in better reporting of multilevel studies and also enable consistency across systematic reviews of contextual effects on health. The increasing number of multilevel studies and systematic reviews of contextual effects suggest that it is timely that a valid risk of bias tool be developed.

There are many limitations to this review. The search strategy was unable to identify any unpublished studies or studies in languages other than English. Restricting the search to studies which explicitly focused on alcohol as an outcome may have missed studies which embedded alcohol within the term 'substance use' or 'drug use'. Although some articles may have been missed due to titles being initially used to screen for eligibility, a recent comparison of systematic review methods found no difference in the identification of articles by screening titles first or titles and abstracts (Mateen, Oh, Tergas, Bhayani, & Kamdar, 2013). Furthermore, all bibliographies of included and excluded articles and reviews were scanned as recommended by Horsley, Dingwall, and Sampson (2011). It would be advantageous to reviewers and other multilevel researchers if publications of multilevel studies included the word 'multilevel' within the article title or keywords, to allow others to more efficiently locate such studies. Alternatively, the development of a multilevel subject heading within databases would be highly beneficial. A key limitation of this review is that the screening of articles, data abstraction and quality appraisal was carried out by one person, despite best practice that it is carried out by two or more persons (Higgins & Deeks, 2011). Including only multilevel designs excluded other approaches, such as second-order generalised estimating equations, alternating logistic regression (ALR) or

propensity score matching, which have also been used to examine factors relating to the clustering of drinking behaviours. The review criteria also resulted in the exclusion of community trials using multilevel designs, due to the multi-component nature of prevention programs which precludes the isolation and disentanglement of neighbourhood effects. Reviews of multilevel community trials are therefore warranted. Finally, the generalisability of findings is limited due to the majority of studies being conducted in the United States or in a limited number of Western high-income countries. It is likely that the influence of the neighbourhood is very context-specific. As such, more longitudinal studies from other countries are necessary before results can be confidently applied to other geographical settings.

2.7 Conclusion

Insufficient high-quality evidence on neighbourhood social and socio-demographic factors is available to further inform place-based preventative and policy interventions to address the variation in adolescent alcohol use at the neighbourhood level. Intervention studies or longitudinal designs are required to improve the quality of the evidence base on neighbourhood effects. It is imperative that these studies consider the examination of neighbourhood effects from the outset of study design, by including sufficient sample sizes, robust methods to reduce same source bias, and the collection of information from respondents necessary to control for compositional effects. Studies which only seek to examine the direct impact of neighbourhoods will continue to miss important mediating variables in the causal pathway and hinder the development of understanding neighbourhood effects on adolescents.

2.8 Addendum

- a) The role of neighbourhood-level alcohol outlet density on adolescent alcohol use

With regards to the neighbourhood effects literature, the impact of alcohol outlet density on alcohol use has received wide attention (Bryden et al., 2012; Campbell, Hahn, et al., 2009; Gmel, Holmes, & Studer, 2016; Popova et al., 2009). Overall findings remain inconclusive as to its role

in adult alcohol consumption, in part resulting from methodological differences across studies (Gmel et al., 2016). With regards to adolescents, six relevant studies were identified in a systematic review by Bryden et al. (2012), of which five found significant associations with increased drinking, particularly heavy drinking. Due to the recency of the authors' review at the time, a decision was made to exclude studies assessing the effects of alcohol outlet density from the systematic review included in the first part of this Chapter.

However, many years have passed since the last electronic search for literature (October, 2010) was conducted by Bryden et al. (2012). To provide an up-to-date account of the literature for this thesis, an electronic search was undertaken on March 1, 2016, revealing an additional 13 studies conducted in Australia, Scotland, and the United States. The majority confirmed the significant and positive association between outlet density and adolescent alcohol use (Azar et al., 2016; Paschall et al., 2012; Paschall et al., 2014; Reboussin, Song, & Wolfson, 2011; Rowland, Toumbourou, Satyen, Tooley, et al., 2014; Shamblen et al., 2011; Shih et al., 2015; Young, Macdonald, & Ellaway, 2013) whilst one study found a significant but negative effect among adolescents in rural neighbourhoods (Lo, Weber, & Cheng, 2013a). Two studies, both conducted in rural areas, found no association between alcohol outlet density and adolescent drinking (Lo, Weber, & Cheng, 2013b). In an effort to disentangle the pathways of effects, two studies, both conducted in Australian cities, found significant effects of density on parental supply of alcohol (Rowland, Toumbourou, Satyen, Livingston, & Williams, 2014) and self-purchasing of alcohol (Rowland, Toumbourou, & Livingston, 2015). However, formal mediation analyses to determine their impact on alcohol consumption was not undertaken.

Interaction analyses revealed interesting insights into the moderators of effects of outlet density. One study found effects to be restricted to young adolescents aged under 15 years (Rowland, Toumbourou, Satyen, Tooley, et al., 2014) whilst another study found effects to apply only to urban areas (Azar et al., 2016), assisting to explain the insignificant findings in the rural studies presented above. Off-licence outlets were found to increase parental supply in Australian-born

parents whilst stronger effects of on-premise outlets were detected among migrant parents (Rowland, Toumbourou, Satyen, Livingston, et al., 2014).

The ubiquity of cross-sectional designs in the study of outlet density presents problems with determining the temporal sequence of effects. Although it is believed to be unlikely that adolescent alcohol use encourages a market of alcohol retailers in the neighbourhood (Rowland et al., 2016), longitudinal studies (in the absence of randomised controlled trials) are imperative to assist with causal inference. In a one-year longitudinal study, Rowland et al. (2016) found that only total alcohol outlet density, and not the density of each type of licence (e.g. bar, off-licence), was associated with the prevalence of drinking one year later. Elasticity estimates demonstrated that a 10% increase in overall density was associated with a 17% increase in the odds of drinking in the following year.

b) Findings from an updated systematic review of neighbourhood effects

An updated search was also conducted to identify additional multilevel studies examining the neighbourhood exposures included in the published systematic review (Jackson, Denny, & Ameratunga, 2014). The electronic search strategy was repeated in the Medline, PsycINFO, and Scopus electronic databases on December 17, 2015. In addition, eight articles which have cited the published systematic review in this chapter (Jackson, Denny, & Ameratunga, 2014) were examined for relevance. Restricting the search to articles published from January 1, 2014, onwards (the date of the last electronic search) yielded a total of 1,496 papers. Following the screening of titles 12 papers were obtained in full-text to determine suitability. Of these twelve, five were excluded due to the focus on early adolescents aged 11-13 years (n=1), the sample including both adults and adolescents (n=1), analysis carried out at the individual level (n=2), and use of a combined substance use outcome (n=1).

Details of the seven remaining studies, assessing eight different neighbourhood-level exposures, are found in Table 2-3. Overall, the majority of studies found no associations between

neighbourhood exposures and adolescent alcohol use. Significant but discrepant findings were found in relation to the effects of neighbourhood socio-economic position (SEP), with Pedersen, Bakken, and Soest (2015) showing affluence to be associated with risky drinking in Norway whilst Whaley, Smith, and Hayes-Smith (2011) found disadvantage to be associated with risky drinking in the United States. Issues concerning the quality and methodology of the studies are similar to that found in the published systematic review, including the over-controlling for potential mediators on the causal pathway of neighbourhood effects. For example, in their study of the effects of neighbourhood socio-economic disadvantage on alcohol use Jonkman et al. (2014) controlled for physical disorder, attachment to the community and family relationships, which could be considered to mediate the effects of neighbourhood disadvantage. Only two studies (Fagan et al., 2015a; Fagan, Wright, & Pinchevsky, 2015b) utilised longitudinal designs, with the remaining studies comprising cross-sectional studies. Additionally, most of the studies failed to describe the size of the neighbourhood being examined which has important implications with regards to the internal and external validity of the neighbourhood effects. Finally, the lack of effects found across the studies may signal the importance of moderation analyses to unmask the heterogeneity of effects by individual characteristics, such as age and sex. Moderation was demonstrated by Fagan et al. (2015a), showing support for the cumulative impacts of disadvantage in their findings of a stronger relationship between victimisation and adolescent alcohol use for those living in socio-economically disadvantaged, compared to advantaged, neighbourhoods. Neighbourhood-level moderation was also shown by Lo et al. (2013a), whereby disadvantage and residential instability attenuated the positive effects of community protection. In addition, cross-level interactions showed that the effects of increasing age and peer drug use on drinking were stronger in disadvantaged communities, and the protective role of self (i.e. honesty with parents and school, and perceptions of illegal drug use) was weakened.

Table 2-3

Updated Systematic Review: Details of Included Studies

Reference	Population	Neighbourhood unit	Exposure measure	Outcome	Results	p	Mediation / moderation analysis
Socio-economic disadvantage							
Jonkman et al. (2014)	7,812 (Australia) / 15082 (Netherlands), 12-17y	Community areas (size not defined)	High disadvantage (Netherlands: income, education, employment / Australia: lowest 20% of socio-economic scores)	Binge drinking in past 2 weeks	Insignificant results not reported	NS	No
Lo et al. (2013a)	78,138 Grades 6-12	School catchment in rural area	11 indicators relating to ethnic composition, poverty, single-headed households, and education.	Binge drinking in past 2 weeks	-0.001	NS	Disadvantage x community protective role (i.e. disadvantage reduces positive effect of community protection) Disadvantage x protective role of self (i.e. disadvantage reduces positive effect of protective role of self)
Simetin, Kern, Kuzman, and Pfortner (2013)	1,601 15 years old	Town or municipality (# and size not defined)	Educational achievement	Drunkenness 2 or more times	High vs. low SEP OR 1.41 Moderate vs. low SEP OR 0.817	NS NS	No
Fagan et al. (2015a)	1,416 mean age 14 years	Community areas	% below poverty line, receiving welfare, unemployed, female headed households	Past year alcohol use Past month binge drinking	b= 0.01 b= -0.10	NS NS	Disadvantage x exposure to violence in the community (significant for past year use but not binge drinking)

Reference	Population	Neighbourhood unit	Exposure measure	Outcome	Results	p	Mediation / moderation analysis
<i>Socio-economic disadvantage continued...</i>							
Fagan et al. (2015b)	1,657 12-18 years	Community areas	% of residents below the poverty line, receiving public assistance, unemployed, and living under female headed households	Past year alcohol use	b= 0.001	NS	No
Whaley et al. (2011)	85,000 8 th - 12 th grade	202 school districts	% below the poverty line, unemployed, and median household income	Binge drinking in past 2 weeks	B= .05	p<0.05	No interaction with or mediation by peer drug approval
Socio-economic affluence							
Pedersen et al. (2015)	6,635 Grades 9-11	15 city districts	7 indicators: median income, employment, unemployment, educational achievement, single-headed households, immigrant status, death rate among residents aged 50–69.	Frequency of consumption Intoxication in the last 6 months Alcohol problems	b= 0.20 Similar results (not reported) b= 0.00	p<0.01 p<0.01 NS	No significant interaction terms for covariates such as gender, parental SES and parents' immigrant status in the analyses.

Reference	Population	Neighbourhood unit	Exposure measure	Outcome	Results	p	Mediation / moderation analysis
Neighbourhood norms							
Fagan et al. (2015a)	1,416 mean age 14 years	Community areas	Norms unfavourable to 13- to 19-year olds smoking cigarettes, using marijuana, and drinking alcohol	Past year alcohol use Past month binge drinking	b= 0.04 b= -0.19	NS NS	No
Fagan et al. (2015b)	1,657 12-18 years	Community areas	Residents' reports of how wrong they consider teenage smoking, drinking and marijuana use.	Past year alcohol use	b= 0.04	NS	No
Collective efficacy							
Fagan et al. (2015b)	1,657 12-18 years	Community areas	10 items representing social cohesion and informal social control.	Past year alcohol use	b= -0.02	NS	No
Legal cynicism							
Fagan et al. (2015b)	1,657 12-18 years	Community areas	Agreement to statements regarding the legitimacy of laws and social norms, such as "laws were meant to be broken"	Past year alcohol use	b= -0.01	NS	No

Reference	Population	Neighbourhood unit	Exposure measure	Outcome	Results	p	Mediation / moderation analysis
Neighbourhood-level social capital							
Fagan et al. (2015b)	1,657 12-18 years	Community areas	A scale of how often neighbours do favours for each other, ask for advice, have get-togethers, and visit each other	Past year alcohol use	b= -0.05	NS	No
Community instability							
Lo et al. (2013a)	78,138, Grades 6-12	School catchment in rural area	Residing in the same house 5 years prior	Binge drinking in past 2 weeks	b=0.000	NS	Community instability x community protective role (i.e. instability reduces positive effect of community protection) Community instability x protective role of self (i.e. instability reduces positive effect of protective role of self)
Neighbourhood-level pro-social rewards							
Lo et al. (2013a)	78,138, Grades 6-12	School catchment in rural area	Community protection: Adults to talk with; sports teams and social clubs offer pro-social activities, neighbours encourage and notice pro-social behaviour	Binge drinking in past 2 weeks	b=-0.036	p<0.01	Disadvantage x community protective role (i.e. disadvantage reduces positive effect of community protection) Community instability x community protective role (i.e. instability reduces positive effect of community protection)

NS = Not significant; b = regression co-efficient; β = standardised co-efficient; OR = Odds ratio

Chapter 3 Methodology of the Youth 2000 survey series

3.1 Introduction

The data for this thesis are drawn from the Youth 2000 survey series, representing over 26,000 students enrolled in secondary schools throughout New Zealand in 2001, 2007 and 2012. In particular, studies in this thesis derive heavily from the surveys completed in 2007 (Youth'07) and 2012 (Youth'12) when information was collected pertaining to the student's residential address. This chapter briefly outlines the development of the survey series, data collection methods, and characteristics of participating schools and students. The material is derived heavily from the synopsis documented by Denny (2011) and Clark, Fleming, Bullen, Crengle, Denny, Dyson, Peiris-John, et al. (2013), together with survey monographs (Adolescent Health Research Group, 2003, 2008; Clark, Fleming, Bullen, Denny, et al., 2013).

3.2 Survey methodology

The Youth 2000 survey series comprises three national cross-sectional surveys, self-administered to secondary school students in 2001, 2007, and 2012. Survey questions were developed in consultation with a wide range of stakeholders and researchers, and were pilot tested with students to assess comprehension and face validity. All questions and response options were available in both English and Te Reo Māori. In 2001 the survey was completed using Computer Assisted Self Interview and in 2007 and 2012 internet tablets were used (Denny et al., 2008). Both approaches permitted the survey questions to be displayed on-screen and transmitted via headphones.

The following areas of health and well-being were included in each survey: ethnicity, home and school; health and emotional health; nutrition, exercise, and activities; sexual health; substance use and gambling; injuries and violence; neighbourhood; and spirituality. Each survey comprised approximately 600 questions in total, although the use of a branching design meant that only

students who answered particular questions were then asked more in-depth questions. As a result, students typically only had to answer half of all questions, and on average took 70 minutes for survey completion. The key questions in the Youth'07 and Youth'12 surveys which were used throughout the thesis to explore adolescent alcohol consumption and drinking patterns are outlined in Table 3-1. It must be noted that no attempts were made to assess the validity and reliability of the self-reported estimates (e.g. by using weekly diaries, etc.). In addition, the questions did not pertain to specific drinking settings or types of beverages consumed, which may affect the reliability of alcohol consumption estimates (Strunin, 2001).

Table 3-1

Questions Regarding Alcohol Consumption in the Youth '07 and Youth '12 Surveys

Alcohol consumption measure	Response options
Ever drinking	
Have you ever drunk alcohol (not counting a few sips)?	Yes; no; I don't want to answer any further questions about alcohol
Frequency of drinking	
During the past 4 weeks, about how often did you drink alcohol?	Not at all - I don't drink alcohol now; not in the last 4 weeks; once; two or three times; once a week; several times a week
Typical quantity consumed	
How many alcoholic drinks do you usually have in one session - within 4 hours? (Count a drink as one small glass of wine, one can or stubbie, one ready-made alcoholic drink, e.g. rum & coke or one nip of spirits)	1; 2; 3 to 4 drinks; 5 to 9 drinks; 10 to 20; more than 20
Binge drinking	
Thinking back over the past four weeks, how many times did you have 5 or more alcoholic drinks in one session - within 4 hours?	Not at all; several times a week; weekly; about monthly; two or three times; only the once

Current drinkers were subsequently defined as those who reported ever consuming alcohol and who did not indicate that they no longer drank. Students were also asked to report any experience

of the following alcohol-related problems in the previous 12 months: had friends or family tell you to cut down your alcoholic drinking; had your performance at school or work affected by your alcohol use; had unsafe sex (no condom) when you had been drinking alcohol; had unwanted sex when you had been drinking alcohol; done things that could have got you into serious trouble (e.g. stealing, etc.) when you had been drinking alcohol; been injured when you had been drinking alcohol; been injured and required treatment by a doctor or nurse when you had been drinking alcohol; injured someone else when you had been drinking alcohol; had a car crash when you had been drinking alcohol.

Other survey questions relevant to the examination of drinking behaviours included sources of alcohol supply, peer alcohol use, attitudes to alcohol, and parental alcohol use. Location of drinking was included in the 2001 survey but omitted in further surveys. Other risk and protective factors relevant to alcohol use were also collected, including connection to school, family, and friends, and parental knowledge of adolescent daily activities. Questions concerning the neighbourhood context were asked at the end of the survey and included features relating to perceived social cohesion, neighbourhood disorder, safety, neighbourhood facilities (i.e. things to do), as well as membership of community organisations. Each indicator is described in further detail within the chapters of the thesis.

3.3 Sampling

Determination of survey sample size was based on the ability to obtain estimates of health and wellbeing indicators among the different age groups, sexes and major ethnic groups. Taking into account the clustering of students within schools the aim of each survey was to collect data from 10,000 randomly selected students from 100 randomly selected schools. This represented approximately 3% of the total New Zealand secondary school roll.

In 2007 there were 476 composite (i.e. schools which offer both primary and secondary schooling) and secondary schools in New Zealand, which increased to 498 in 2012. Schools with

50 or fewer students were excluded from the survey due to difficulties in surveying smaller schools. In addition, surveys of total immersion Kaupapa Māori schools were conducted separately and are not utilised within this thesis.

Upon ethical approval from the University of Auckland Human Subject Ethics Committee written consent was obtained from the principal of each school to take part in the survey. Information pertaining to the survey and the voluntary nature of participation was then sent home to the parents or guardians of each student to inform them about the purposes of the survey.

To protect anonymity, the number of students enrolled in the participating school determined the number which were randomly selected and invited to participate. Each randomly student was provided with a random code in order to log on to the computer or tablet but only students that provided informed consent were able to complete the survey. Part way through the survey students were invited to have their height and weight measured in a private setting. In the 2007 and 2012 surveys, this time also provided for the opportunity to collect data on each student's usual residential address. Each student's address was automatically coded to the census meshblock using geocoding software and then deleted to provide for student anonymity.

Meshblock boundaries are designed to align to physical features of the environment and/or property boundaries (Statistics New Zealand, 2015b) and are regularly updated to incorporate changes to the physical landscape, such as number of dwellings (preferably between 30 and 60) and type of dwelling (e.g. residential, institutional, and commercial). The 2006 New Zealand Deprivation Index (Salmond, Crampton, & Atkinson, 2007) is collected at this level, and represents the meshblock level of material resources, such as access to the internet, employment, educational qualifications, and home ownership. Area units are the next largest populated geographic units in the hierarchy or building blocks of geography, comprising aggregations of meshblocks and encompassing 3000-5000 residents. Within main or secondary urban areas they are reported to generally coincide with suburbs or parts thereof. It is this geographical unit which

is utilised in this thesis to capture the student’s neighbourhood. Figure 3-1 provides an example of meshblock and area unit boundaries.

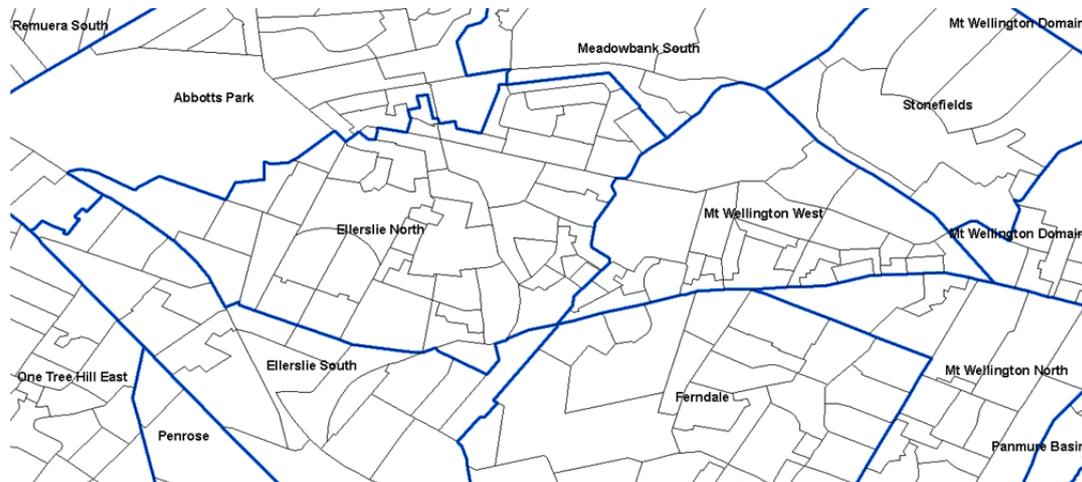


Figure 3-1. Example of Area Unit (dark lines, labelled) and meshblock (lighter lines) boundaries.

3.4 Characteristics of the sample

As shown in Table 3-2, 83.5% and 72.8% of invited schools in 2007 and 2012 agreed to participate. The majority of participating schools were state-funded, co-educational, large, and of medium socio-economic decile. The decile of a school relates to the extent that each school draws their students from low socio-economic communities, relative to other schools in New Zealand (Ministry of Education, 2016). Decile 1 schools draw the largest proportion of students from lower socio-economic communities, while decile 10 schools draw the least. It is important to note that area-level deprivation deciles are in reverse order e.g. decile 10 is the most disadvantaged area.

When compared to eligible schools, participating schools included a higher proportion of large schools (reflected by the exclusion of small schools from the survey), boys’ schools, and slightly fewer decile 6 and 7 schools. Similarly, schools which chose not to participate in the surveys were mostly state schools, large in size, co-educational and based in large urban areas.

Characteristics of the participating students can be found in Table 3-2. Student response rates dropped from 74.0% in 2007 to 68.0% in 2012. Common reasons for not participating were absence from school, being unavailable, or declining to take part. Difficulties collecting information on non-attending students meant that differences between responders and non-responders could not be ascertained. Comparisons between participating and eligible students revealed that participating students were slightly younger and more likely to be male.

Table 3-2

Characteristics of Schools and Students in the Youth '07 and Youth '12 Surveys

	2007		2012	
	n	%	n	%
Schools				
Eligible	389		397	
Invited	115		125	
Participated	96	83.5	91	72.8
<i>Authority</i>				
Private, fully registered	8	8.3	8	8.8
State, integrated	21	21.9	16	17.6
State, not integrated	67	69.8	67	73.6
<i>Type of school</i>				
Coeducational	69	71.8	71	78.0
Boys' school	15	15.6	6	6.6
Girls' school	12	12.5	14	15.4
<i>School size</i>				
Large (≥ 350 students)	67	70.0	57	62.6
Small–medium (< 350 students)	29	30.2	34	37.4
<i>School decile grouping</i>				
Low (decile 1–3)	15	16.3	26	28.6
Medium (decile 4–7)	52	56.5	36	39.6
High (decile 8–10)	25	27.2	29	31.9
Students				
Invited	12 355		12 503	
Participated	9 107	74.0	8 500‡	68.0

<i>Year</i>				
Year 9	2 176	24.3	2 061	24.3
Year 10	2 090	23.4	1 936	22.8
Year 11	1 933	21.6	1 727	20.4
Year 12	1 669	18.7	1 534	18.1
Year 13	1 077	12.0	1 227	14.5
<i>Gender</i>				
Male	4 911	54.0	3 874	45.6
Female	4 187	46.0	4 623	54.4
<i>Age</i>				
≤13	1 860	20.4	1 838	21.7
14	2 101	23.1	1 896	22.3
15	1 973	21.7	1 755	20.7
16	1 743	19.2	1 578	18.6
≥17	1 415	15.6	1 422	16.8
<i>Ethnicity</i>				
European	4 797	52.8	4 024	47.4
Māori	1 702	18.7	1 701	20.1
Pacific	924	10.2	1 201	14.1
Asian	1 126	12.4	1 051	12.4
Other	531	5.8	511	6.0
<i>Meshblock-level deprivation</i>				
Low deprivation	3 218	36.3	2 718	32.4
Medium	3 397	38.3	3 001	35.8
High deprivation	2 250	25.4	2 674	31.9

Chapter 4 Typologies of adolescent alcohol use

4.1 Preface

Publication

This chapter includes content from the article “Jackson, N., Denny, S., Sheridan, J., Fleming, T., Clark, T., Teevale, T., & Ameratunga, S. (2014). Predictors of drinking patterns in adolescence: a latent class analysis. *Drug and Alcohol Dependence*, 135, 133-139.” Permission to reprint was obtained from Elsevier on April 13, 2016.

Link to thesis objectives:

- To identify proximal risk and protective factors associated with typologies of drinking among New Zealand adolescent drinkers

Why was this study needed?

The highly situational and temporal nature of adolescent drinking can result in limited utility of uni-dimensional drinking measures (e.g. frequency of binge drinking) to predict alcohol-related harm. Person-centred methods such as Latent Class Analysis (LCA), which group individuals into typologies of similar drinking patterns, may be more appropriate to understand the aetiology of adolescent drinking. Identifying proximal risk factors which may be differentially associated with drinking typologies may further highlight important mediators on the causal pathway of neighbourhood effects to adolescent alcohol use and harm.

What was undertaken?

Utilising the Youth’07 survey data on alcohol consumption and related-harm, LCA was utilised to examine the number and prevalence of drinking typologies among current drinkers. Proximal risk and protective factors of each typology were investigated using multinomial regression to identify potential mediators on the pathways of neighbourhood effects.

The findings in this study of a mostly-linear relationship in the measures of drinking and harm across the four identified typologies indicated that the use of single-dimensions of alcohol use (e.g. high typical quantity) as binary dependent variables in the study of neighbourhood effects may be appropriate. The use of single dimensions of alcohol use, in comparison to typologies, provided for increased power in later studies to identify interaction effects within neighbourhood pathways; a necessity in the examination of ecological exposures. Proximal risk factors were found to not vary substantially across drinking typologies further supporting the use of single dimensions of consumption in later studies.

4.2 Abstract

Uni-dimensional measures of alcohol consumption may be unable to fully capture the complexity of adolescent drinking and experience of alcohol-related harms. Latent class analysis (LCA) provides an empirical method to understand different adolescent drinking patterns. This study utilised LCA to create typologies of drinking among the 5,018 current drinkers in the national Youth '07 survey. Determinants of drinking patterns were identified using multinomial logistic regression. In total, four latent classes were identified, demonstrating an overall increase in risk of alcohol-related harms from increasing consumption. One class strongly deviated from this pattern, having moderate consumption patterns but disproportionately high levels of alcohol-related harms. Multinomial logistic regression found that the strongest predictors of belonging to high-risk drinking typologies were having a positive attitude to regular alcohol use, buying own alcohol, peers using alcohol, and obtaining alcohol from friends and/or other adults. Other significant predictors included being male, having a strong connection to friends, having parents with a low level of knowledge of their daily activities and poor connection to school. Class membership also varied by ethnicity. The LCA approach was found to be useful in identifying variability in alcohol-related harms across groups of students with different drinking patterns. Longitudinal studies are necessary to determine the causes of this variability in order to inform the development of targeted policy and preventative interventions. Legislative controls, such as

increasing the legal purchase age and reducing the commercial availability of alcohol, will continue to be important strategies for reducing harm in young people.

4.3 Introduction

Effective, preventative interventions to reduce adolescent alcohol use must address the most significant risk and protective factors of underage drinking. The social development model (Catalano & Hawkins, 1996) guides the identification of relevant contextual factors within a target population by suggesting that adolescents learn patterns of behaviour from their primary units of socialisation including peers, family, and school.

A number of systematic reviews have identified the most salient peer (Leung et al., 2014), family (Hayes, Smart, Toumbourou, & Sanson, 2004) and school-related factors (Fletcher, Bonell, & Hargreaves, 2008) in the initiation and use of alcohol during adolescence. However, given the heterogeneity in the measurement of alcohol use in these reviews it remains uncertain as to how each of these factors is associated with different levels (or types) of drinking.

Understanding drinking typologies is necessary to inform the development of appropriate intervention and policy approaches. Researchers (Carey, 2001; Gmel, Kuntsche, & Rehm, 2011; White, 1987) are increasingly calling for a move away from broad classifications of drinkers (e.g. binge drinkers) to considering more distinct types of drinkers. For example, it is claimed that the averaging across binge drinkers in studies is likely to combine different types of drinkers with very different frequencies of binge drinking and/or amounts consumed, masking potentially different levels of risk of alcohol-related harms. Consequently, there are compelling reasons to undertake research that can differentiate regular heavy drinkers from those who demonstrate risky episodic patterns of drinking.

Researchers also argue that such insensitivity to differences in drinking patterns will obscure the understanding of risk relationships associated with lower levels of drinking (Thompson, Stockwell, & MacDonald, 2012). Studies have found that drinkers who consume low and

moderate volumes with occasional episodes of risky binge drinking account for the majority of alcohol-related problems (e.g. accidents, problems at work) (Dawson, 2011; Gmel, Klingemann, Muller, & Brenner, 2001). Among adolescents and young adults, the association between consumption and alcohol-related concerns may begin with consumption levels as low as two drinks per occasion (Gruenewald, Johnson, Ponicki, & Lascala, 2010; Thompson et al., 2012).

The failure of uni-dimensional measures to capture the complexity of adolescent drinking and experience of alcohol-related harms has resulted in the use of more sophisticated methods, such as latent class analysis, to identify drinking typologies and risks associated with varying types of drinking (Percy & Iwaniec, 2007; Wells et al., 2004). This categorical, person-centred approach is argued to be more appropriate for alcohol-related questions, as it focuses on the relationships among individuals who are similar to each other in their drinking pattern and different from individuals in other drinking typologies (Muthen & Muthen, 2000). Despite the opportunities afforded by these methods to describe more nuanced typologies of drinking, there has been inconsistency in the selection and definition of variables (e.g. frequency of drinking, binge drinking, amount typically consumed and experience of alcohol-related outcomes) to construct drinking typologies (Cable & Sacker, 2008). Consequently, comparisons between studies remain difficult.

Using a comprehensive data resource from a nationally-representative health and well-being survey of New Zealand secondary school students, the current study aims to identify adolescent drinking profiles and to determine if these profiles are differentiated by levels of risk and protective factors.

4.4 Methods

The anonymous, computer-assisted survey was self-administered to 9,107 New Zealand secondary schools students in 2007, using hand-held internet tablets. The survey contained 622 questions covering a broad range of health and wellbeing issues, including alcohol use.

One hundred and fifteen schools were randomly selected for participation, from the 389 eligible secondary schools in New Zealand. Eighteen per cent of eligible students (or 30 students if the roll was less than 166) were randomly selected from each school's roll and invited to participate. The school and student response rate were 84% and 74% respectively. The survey instrument (Adolescent Health Research Group, n.d.) and a detailed description of the survey methodology are available elsewhere (Adolescent Health Research Group, 2008).

Latent class analysis was used to examine the underlying structure of co-occurring drinking behaviours and associated alcohol-related problems among the current drinkers. Current drinkers were defined as students who stated that they had consumed alcohol and did not indicate they no longer drank. Seven binary parameters were used to create homogeneous groups with similar drinking patterns, three of which were consumption measures: 1) frequency of consumption in the past 4 weeks (up to 3 times, once a week or more); 2) number of standard drinks (10g alcohol) typically consumed during a drinking occasion (1-4 drinks, 5+); and 3) frequency of binge drinking (5 or more drinks) during the past 4 weeks (once or less in the last 4 weeks, twice or more). Four self-reported problems associated with the young person's drinking (referred from hereon as 'alcohol-related harms') were also included: having performance at school or work affected, having unsafe sex and/or unwanted sex, doing things that could have resulted in serious trouble (e.g. stealing), been injured and/or injuring another and/or being involved in a car crash. Students were asked to report whether they had experienced any of the harms in the previous 12 months.

Predictors of latent class membership

A range of individual, peer, family, and school factors related to adolescent drinking were included in the analysis. All composite scales relating to peer, school, and family connection were drawn from the Adolescent Resilience Questionnaire (Gartland, Bond, Olsson, Buzwell, & Sawyer, 2011).

Individual factors

- a) Demographics: Age, sex, and ethnicity were determined by self-report. Ethnicity was categorised and prioritised into one of four ethnic groups, according to the New Zealand census ethnicity question (Statistics New Zealand, 2007): Māori, Pacific, Asian, and New Zealand European or other ethnicity.

Socioeconomic position (SEP) was determined using a combination of measures including the 2006 New Zealand Deprivation Index (Salmond et al., 2007) and other indicators of deprivation (i.e. use of a sleep-out for a bedroom, perception that parents worry about having enough money to buy food, number of times the young person has moved home and absence of TV, computer, mobile, phone, or car at the family home). The combined SEP measure was found to have a moderate reliability (Cronbach's alpha = 0.67).

- b) Other individual factors included having a regular job outside of school hours in the last year, belonging to a sports team or club outside of school time or in the weekend, buying their own alcohol, and having a permissive attitude to regular alcohol use by people their age. Students who responded "yes" were compared to students who answered "no".

Peer factors

Three peer variables were analysed: peer use of alcohol, acquisition (i.e. social supply) of alcohol from friends and/or another adult (i.e. other than parents) and connection to friends. The latter measure was determined by responses from a number of survey questions, including number of friends, ability to make and keep friends, having a group of friends to hang out with and have fun, having close friends, perceiving that friends care, having friends that like doing the same thing, and having friends that help out ($\alpha = 0.77$).

Family factors

Four family factors were included: parental alcohol use, parents supplying alcohol to the adolescent, connection to family, and parental knowledge of youth daily activities. Connection to family was a composite measure of questions relating to the frequency of the family having fun together, perceptions of family relationships and closeness, and time spent with parents ($\alpha = 0.84$). Parental knowledge of youth daily activities (hereon referred to as 'parental knowledge') was composed of three questions relating to how well the young person's parents knew about their friends and where they go after school and at night ($\alpha = 0.67$).

School factors

A composite measure, assessing connection to school, was chosen as the predictor within the school setting. This measure assessed the young person's perceptions about how they feel about school, whether they feel part of the school, whether people at school care about them, whether teachers go out of their way to help students and whether they show a special interest in the young person's culture or ethnic group. The measure also included students' participation in school sports teams, social clubs, and activities that help others at school ($\alpha = 0.67$).

Data analysis

Beginning with a parsimonious one-class model, a series of models with increasing number of classes were conducted to find the model that provided the best fit to the data. As described by Lanza, Collins, Lemmon, and Schafer (2007) model assessment took a heuristic approach, using the Akaike Information Criterion, sample size adjusted Bayesian Information Criterion, and Lo-Mendell-Rubin adjusted likelihood ratio test as tools to guide the determination of how well the different number of classes separated the different drinking patterns. Other considerations of model fit included being able to assign meaningful labels to each class and having no individual class which was too small in size.

The maximum number of latent classes examined was six, using the method of maximum likelihood in Mplus (Version 7.11). This method is iterative, with the estimation algorithm ideally converging on the parameter values associated with the single largest log likelihood. However, in latent class analysis the maximum reached may in fact be the best solution in a local neighbourhood of parameter space, but not the global maximum (Uebersax, 2009). This is because the latent class algorithm cannot distinguish whether the maximum is a global or local, a problem that is more common in complex models with a high number of latent classes and indicators. This problem has been described as akin to climbing a mountain in the dark, with the first peak you reaching not necessarily being the highest peak of the mountain (Uebersax, 2009). To ensure that the global maximum was reached in this study, several runs with random starting values were performed for each number of latent classes.

Multinomial regression was used to explore the significant predictors of latent class membership. The new R3STEP method in Mplus (Version 7.11) was utilised, as this method incorporates the measurement error (from the determination of most likely latent class) in the independent evaluation of the relationship between the latent class variable and the predictor variables (Asparouhov & Muthen, 2013). This has many advantages over traditional methods of assigning individuals to the most likely latent class and subsequently conducting standard multinomial logistic regression (Vermunt, 2010).

Due to the unequal probabilities of selection of students within schools and likely clustering of responses by school all standard errors and model fit statistics were adjusted for clustering using the Mixture Complex feature in Mplus (Version 7.11). Results are reported as odds ratios with their 95% confidence intervals.

4.5 Results

Of the 8,294 students who responded to the alcohol questions within the survey, 5,018 (60.5%) were current drinkers, of whom 57% reported they had participated in binge drinking at least

once in the past 4 weeks. One in every six (17.5%) current drinkers drank 10 or more standard drinks during a usual drinking occasion. The distribution of drinking behaviours and alcohol-related harms in the entire sample of current drinkers is shown in Table 4-1.

Latent class analysis

Fit indices for the latent class analysis are shown in Table 4-2. Model fit indices, including the Bayesian Information Criterion and Lo-Mendell-Rubin likelihood ratio test, indicated that the four class model was the best fit for the data. Examination of bivariate model fit information revealed no standardised residuals between pairs of indicators, indicating that the categorical latent class indicators were independent within a latent class.

Table 4-1

Distribution of Drinking Behaviours and Alcohol-related Harms, Among Drinkers

Measure	<i>n</i>	(%)
Frequency of drinking alcohol/ last 4 weeks		
Up to 3 occasions	3541	70.6
At least weekly drinking occasions	1477	29.4
Typical amount consumed		
1-4 drinks	2685	54.0
5 or more drinks	2288	46.0
Frequency of binge drinking (5+ drinks)/ last 4 weeks		
Not in the last 4 weeks or once	3320	67.0
Twice or more	1632	33.0
Alcohol-related harms		
Performance affected	478	9.8
Unsafe and/or unwanted sex	806	16.5
Trouble*	968	19.9
Injury and/or car crash	1174	24.0

*Doing things that could have resulted in serious trouble (e.g. stealing)

Table 4-2

LCA Fit Indices

	Model				
	2 classes	3 classes	4 classes	5 classes	6 classes
AIC	31461.71	31029.38	30702.88	30677.28	30659.57
BIC	31559.52	31179.36	30905.03	30931.59	30966.05
SSABIC	31511.86	31106.27	30806.52	30807.66	30816.70
LRT p value	0.00	0.00	0.00	0.24	0.38
Entropy	0.80	0.83	0.80	0.78	0.73

Note: AIC: Akaike Information Criteria; BIC: Bayesian Information Criteria; SSABIC: Sample size adjusted Bayesian Information Criteria; LRT: Lo-Mendell-Rubin adjusted likelihood ratio test.

Overall, the four latent classes represented the continuum of levels of alcohol consumption (Table 4-3). The majority (55.0%) of current drinkers were assigned to Class One, a low-risk group with a low prevalence of frequent and heavy drinking and alcohol-related harms. One in eight current drinkers was assigned to Class Two, labelled as the moderate-risk group, due to their overall low frequency of drinking and binge drinking. Classes Three and Four were labelled high-risk and very high-risk, respectively, due to exhibiting a high prevalence of at-risk drinking behaviours and alcohol-related harms. Although students in Class Two were characterised by a pattern of low to moderate alcohol consumption, the group suffered disproportionately higher rates of alcohol-related harms in comparison to Class Three, the high-risk group. On further analysis, a significant difference was found in the proportion of moderate-risk drinkers compared to high-risk drinkers (17.0% v. 12.6%, $p < 0.05$) who had ever tried to cut down or had cut down their drinking.

Table 4-3

Item-response Probabilities of Drinking Measures and Outcomes, by Latent Class Membership

	Class One	Class Two	Class Three	Class Four
	Low-risk	Moderate-risk	High-risk	Very high-risk
	55.0%	12.5%	19.7%	12.7%
	(n=2761)	(n=628)	(n=990)	(n=639)
Frequency of drinking in past 4 weeks				
Up to 3 occasions	0.90	0.82	0.42	0.19
At least weekly	0.10	0.18	0.58	0.81
Typical quantity consumed				
1-4 drinks	0.80	0.39	0.19	0.10
5 or more drinks	0.20	0.61	0.81	0.90
Frequency of binge drinking in past 4 weeks				
Up to once	0.98	1.00	0.0	0.03
Twice or more	0.02	0.00	1.00	0.97
Alcohol-related outcomes				
Performance affected	0.00	0.22	0.05	0.47
Unsafe and/or unwanted sex	0.02	0.30	0.22	0.57
Trouble*	0.03	0.43	0.17	0.73
Injury and/or crash	0.04	0.49	0.27	0.83

*Doing things that could have resulted in serious trouble (e.g. stealing)

Multinomial regression

Table 4-4 presents the results of multinomial regression, with Class One (i.e. the low-risk group) treated as the reference group. The strongest individual-level predictor of belonging to a high-risk drinking group was buying one's own alcohol, with the high-risk group and very high-risk group being almost three (OR 2.83 (95% CI 2.02-3.96)) to six times (OR 5.74 (95% CI 3.76-8.74)) more likely to buy their alcohol than the low-risk group. In addition, students in the very high-risk group were three times more likely to be of Māori ethnicity (OR 3.16 (95% CI 2.44-4.09)), have a permissive attitude to regular alcohol use (OR 3.36 (95% CI 2.42-4.66)) and almost twice as likely to be of Pacific descent (OR 1.91 (95% CI 1.11-3.28)). Being male and of older age was also found to be associated with belonging to the high-risk and very high-risk drinking groups.

Peer-level factors were found to be strong predictors of class membership across all risky drinking typologies, including peer use of alcohol, obtaining alcohol from friends and/or others, and having a strong connection to friends. In relation to family and school-level factors, parental knowledge of youth daily activities and connection to school reduced the likelihood of membership across all drinking profiles, particularly in the very high-risk group.

Table 4-4

Predictors of Latent Class Membership

	Moderate-risk (OR (95% CI))	High-risk (OR (95% CI))	Very high-risk (OR (95% CI))
Individual factors			
Age ^a			
14yrs	1.24 (0.74-2.09)	1.51 (1.01-2.27)*	1.05 (0.58-1.92)
15yrs	1.07 (0.61-1.85)	2.38 (1.48-3.83)*	1.53 (0.86-2.74)
16yrs	1.75 (1.02-3.01)*	3.99 (2.51-6.34)*	2.10 (1.13-3.89)*
17yrs+	1.49 (0.80-2.78)	4.41 (2.64-7.38)*	2.32 (1.23-4.38)*
Sex ^b			
Male	1.36 (1.04-1.79)*	1.79 (1.47-2.18)*	1.93 (1.37-2.72)*
Ethnicity ^c			
Maori	2.90 (1.97-4.26)*	2.70 (2.08-3.52)*	3.16 (2.44-4.09)*
Pacific	3.17 (1.91-5.26)*	1.10 (0.65-1.87)	1.91 (1.11-3.28)*
Asian	0.29 (0.15-0.56)*	0.32 (0.22-0.46)*	0.15 (0.05-0.45)*
Socio-economic position (SEP) ^d			
Low SEP	1.10 (0.77-1.57)	1.27 (0.98-1.64)	1.42 (0.98-2.07)
Mid SEP	0.81 (0.54-1.20)	1.05 (0.81-1.37)	0.95 (0.68-1.31)
Regular job	1.63 (1.22-2.19)*	1.22 (1.03-1.45)*	1.35 (0.99-1.83)
Belong to sports club	0.97 (0.74-1.27)	0.97 (0.81-1.15)	0.79 (0.61-1.03)
Positive attitude to alcohol	1.79 (1.30-2.47)*	2.14 (1.74-2.63)*	3.36 (2.42-4.66)*
Buys own alcohol	1.91 (1.17-3.12)*	2.83 (2.02-3.96)*	5.74 (3.76-8.74)*
Peer factors			
Friends use alcohol	4.41 (2.13-9.10)*	3.33 (2.17-5.11)*	4.85 (2.28-10.34)*
Peers and/or others supply alcohol	3.99 (2.61-6.09)*	2.21 (1.73-2.82)*	3.67 (2.34-5.76)*
Connection to friends	1.25 (1.10-1.43)*	1.72 (1.45-2.04)*	1.53 (1.26-1.86)*
Family factors			
Parents supply alcohol	0.78 (0.56-1.07)	1.01 (0.80-1.28)	1.09 (0.83-1.43)
Parents use alcohol	0.62 (0.42-0.92)*	1.03 (0.82-1.31)	1.08 (0.76-1.53)
Connection to family	0.72 (0.60-0.87)*	1.05 (0.92-1.19)	0.71 (0.63-0.80)*
Parental knowledge	0.74 (0.63-0.87)*	0.74 (0.65-0.85)*	0.56 (0.47-0.66)*
School factors			
Connection to school	0.79 (0.69-0.90)*	0.79 (0.72-0.86)*	0.62 (0.52-0.74)*

Note. All Latent Classes are compared to the low risk drinking group. ^a reference group= aged 13 years and under, ^b reference group = female students, ^c reference group European and other ethnicities, ^d reference group = high SEP, * p≤0.05

4.6 Discussion

The current study identified four latent classes of adolescent drinking patterns in New Zealand secondary school students. Although over one-half of current drinkers were categorised as having a low-risk drinking pattern, it must be emphasised that health guidelines (Donaldson, 2009; National Health and Medical Research Council, 2009) recommend that no drinking is the safest option for young people under the age of 18 years. Of particular concern was the finding that almost one-third (32.4%) of all current drinkers exhibited high or very high-risk drinking patterns.

Interestingly, a group of moderate-risk drinkers reporting a disproportionate number of alcohol-related harms was found. This group, which deviates from general continuum pattern, was also found in a latent class study of British adults (Smith & Shevlin, 2008). There are many possible explanations to this finding, all of which require further scrutiny. One explanation may be that alcohol-related harms occur at low volumes of alcohol consumption, as has been found by others (Gruenewald et al., 2010; Thompson et al., 2012). However, only 39% of this group usually drank low volumes of alcohol, defined as drinking less than 5 standard drinks on any occasion. Two other scenarios are more likely to elucidate this anomaly. One is the difference between the reference period for drinking behaviours (i.e. 4 weeks) and drinking-related harms (i.e. 12 months). As shown, more students in this group had tried to cut down, or had cut down, their drinking in the past twelve months. It is unknown if this action was taken as the result of experiencing adverse harms from their previous high levels of drinking. This scenario is further described by Gmel et al. (2001), in their study examining why adult drinkers, characterised at moderate risk in terms of average consumption and binge drinking occasions, reported a substantial number of alcohol-related problems. Using the Stages of Change Model they found that 40% of moderate drinkers were at the action stage of beginning to reduce their risky drinking pattern. It was therefore suggested that alcohol-related harms may have been overstated in this group, as the problems may have originated earlier when they were high-risk drinkers. However,

as stated by the authors, this scenario cannot fully explain the substantial number of harms reported by the moderate-risk group.

Another explanation for the disproportionate prevalence of adverse harms is the result of usual drinking patterns (or variability in drinking) moderating the association between alcohol-related harm and acute intake of alcohol (Gmel et al., 2006; Watt, Purdie, Roche, & McClure, 2004). The majority of students in the moderate-risk group drank alcohol infrequently and if they did have a binge drinking episode, it occurred on average once per month or less. This would suggest that infrequent drinkers may be more vulnerable to the effects of consuming a large amount of alcohol on any given drinking occasion. Many studies have found this to be true in the adult drinking population (Gmel et al., 2006; Gruenewald, Mitchell, & Treno, 1996; Treno, Gruenewald, & Ponicki, 1997), showing that drinkers who usually drank little, but sometimes drank heavily, were at particular risk of injury. This was demonstrated also for traffic crashes, where the risk curve increases more steeply in less frequent drinkers (Hurst, Harte, & Frith, 1994). It is believed that this phenomenon is the result of heavier drinkers having a higher tolerance to alcohol. Further study would be required to determine if this theory holds true for adolescents.

The difference in alcohol-related harms between the moderate-risk group and the high-risk group may also be due to the environment in which drinking occurs. Again, future research would be required to investigate if high-risk drinkers (in comparison to the other drinking typologies) consume alcohol in different locations, resulting in them being less exposed to situations where some harms may occur (Gmel et al., 2006). It must be noted, however, that although the prevalence of any alcohol-related harm in the past 12 months is lower in the high-risk group in comparison to the moderate-risk group, the groups may differ in the total number of harms experienced during that time period.

The current study also identified ethnic inequalities across drinking typologies. Māori students showed increasing odds of belonging to high-risk drinking groups, a finding consistent with previous research (Clark, Robinson, et al., 2013). In contrast, Asian students were significantly

less likely to engage in risky drinking behaviours, with mixed results for students of Pacific origin. Identifying the causes of these inequalities, particularly for Māori (the indigenous population in New Zealand), is paramount and it is likely that such inequalities are socially determined. For example, a separate analysis of the same survey utilised in this study found that students (including Māori) who had experienced ethnic discrimination were more likely to report an episode of binge drinking in the past four weeks (Crengle, Robinson, Ameratunga, Clark, & Raphael, 2012). Hence, appropriate interventions to address alcohol harm for Māori will need to address the wider determinants of health and, as such, solutions may be found outside of the health sector.

The strongest predictors of membership across the risky drinking latent classes were purchasing one's own alcohol and social supply of alcohol. This suggests that evidence-based policies (Babor, Caetano, et al., 2010), such as reducing the commercial availability of alcohol and increasing the legal purchase age (to have a trickledown effect on social supply), will continue to be the most appropriate strategies to reduce alcohol-related harm for most adolescents, not just those deemed to demonstrate "hazardous drinking" patterns.

Peer use of alcohol was also a significant predictor of membership of riskier drinking latent classes. For the moderate-risk group, peer factors and social supply were the two strongest predictors of membership. It is uncertain if these factors are associated with the higher prevalence of alcohol-related harm in this group. Reboussin et al (2006) and Fergusson et al (1995) also found peer factors to be strongly associated with drinking typologies, with the latter study finding that the effects of other individual, familial and social factors on alcohol abuse were mediated via their effect on peer affiliations in adolescence. This is confirmed in a systematic review of peer influences on alcohol use, demonstrating that parental acceptance of adolescent alcohol use influences peer selection and affiliation (Leung et al., 2014). Interventions to address peer factors will, therefore, need to involve multiple components, targeting families in addition to adolescents.

The influence of parental knowledge is noteworthy, with findings suggesting that it is particularly protective against high-risk drinking. A systematic review of parenting factors found that parental knowledge was the factor most consistently and directly associated with adolescent alcohol use (Hayes et al., 2004). A lack of parental knowledge was found to be associated with earlier onset of drinking and heavier drinking patterns, in addition to having a secondary effect on peer selection, whereby poorly supervised adolescents were found to be more likely to associate with “deviant” peers. Interestingly, recent research (Kerr, Stattin, & Özdemir, 2012) suggests that parental knowledge exerts its positive effect through adolescent disclosure of information, rather than from parents’ direct monitoring of adolescent behaviour. Unfortunately, evidence from high quality interventions to address parental knowledge is scarce. One four-year, family-centred randomised controlled trial to improve parental knowledge in very young, high-risk adolescents found reduced substance use by the first year of high school and maintenance of parental monitoring behaviours (Dishion, Nelson, & Kavanagh, 2003). Hence, parenting interventions may need to be considered early in the life course of adolescence and trajectory of alcohol use.

All of the above findings clearly demonstrate the need for approaches, such as latent class analysis, to fully understand the risk from, and determinants of, varying patterns of drinking. Using single, broad measures of drinking, such as binge drinking or typical amount consumed, would result in the combination of young people who frequently drink heavily with those who have a low overall intake with very occasional binges. This study finds that the consequences of these drinking patterns is different and needs to be fully explored. Despite the advantages of this approach only a small number of studies have utilised latent class analysis to determine drinking typologies in young people without clinical alcohol dependence (Fergusson et al., 1995; Percy & Iwaniec, 2007; Reboussin et al., 2006). Many have limitations due to the assigning of individuals to the most likely latent class (a process which includes measurement error) in order to conduct multinomial regression. Furthermore, it has been found that assignment of individuals to latent classes, whether this is by modal, random or proportional assignment, underestimates the

relationships between predictors and class membership (Vermunt, 2010). Researchers should take advantage of advances in software which now permit the regression to take into account this error from assigning individuals to latent classes. Future latent class analyses could also utilise a multilevel approach to identify the upstream determinants of drinking patterns, such as factors at the neighbourhood level.

Notwithstanding the knowledge gained, the findings of this study must be interpreted in light of several limitations. The cross-sectional design of this study precludes determination of the direction of causation between predictors and drinking typologies. Recall bias may also be present given the retrospective reference periods for drinking and its outcomes. Finally, as this study was limited to students who attended secondary school, the findings are not necessarily generalisable to young people who are not at school (or did not attend the day of the survey), home-schooled, or in alternative education. Drinking patterns in these groups may differ from the sample population included in this study.

There was no single predictor in the current study which discriminated between the different drinking patterns or fully explained the variability in alcohol-related outcomes experienced by students with different drinking patterns. It is imperative to continue to explore drinking typologies so that causes of variability in risk between groups can be identified and addressed within targeted interventions. The current study highlights that, for those at highest risk, it is universal policy approaches that are likely to have the greatest impact on reducing alcohol-harm. This includes reducing the commercial availability of alcohol and increasing the legal purchase age in order to prevent social supply of alcohol from older friends. These policy initiatives should complement community-action programmes which are also informed by a thorough understanding of the specific risk and protective profiles as they pertain to the adolescents in their community.

Chapter 5 Changes in adolescent alcohol use over time

5.1 Preface

Publication

This chapter includes content from the article “Jackson, N., Denny, S., Sheridan, J., Fleming, T., Clark, T., Peiris-John, R., & Ameratunga, S. (2016). Uneven reductions in high school students’ alcohol use from 2007 to 2012 by age, sex and socio-economic strata. *Substance Abuse*, doi10.1080/08897077.2016.1252827.” Permission to reprint was obtained from the Taylor and Francis Group on October 26, 2016.

Link to thesis objectives:

- To examine the influence of neighbourhood socio-economic position (SEP) in relation to changes in drinking

Why was this study needed?

The focus on reducing per capita consumption, or shifting the distribution curve of alcohol consumption among the population, remains a focus in public health and alcohol policy as a means to reduce the harm from risky or heavy drinking. In his seminal work, Skog (1985) proposed that changes in alcohol consumption occur consistently across the distribution of consumption due to the mutual interaction between drinkers, although later acknowledged (Skog, 2001) that factors such as socio-economic position (SEP) and sex may provide barriers to informal social control in relation to behavioural change.

A proliferation of published papers appeared between 2012 and 2014 testing the theory of collectivity within a number of countries and population groups, although none examined changes across levels of consumption among groups characterised by household or neighbourhood SEP. This chapter represents months of toil to examine changes in levels of

adolescent drinking across socio-economic strata, in an effort to understand the impact of the neighbourhood socio-economic context on mutual interaction to enable behavioural change.

What was undertaken?

Absent from this chapter is the description and results of efforts to utilise a range of methodological approaches to examine changes in adolescent drinking between 2007 and 2012 among demographic groups characterised by age, sex and SEP. Firstly, a multilevel model was applied to the data, conceptualising the demographic group as a random effect. That is, individuals were conceptualised to belong to, cluster within, and be mutually influenced by their demographic group. This approach was later abandoned due to the inability to correctly specify the hierarchical model and reach model convergence. Following this, a standard linear regression model was utilised by assigning each individual to the percentile grouping of per capita consumption (e.g. 90%) of the demographic group to which they belonged in the year that the survey took place. It became evident that splitting the sample population by age, sex, SEP and percentile grouping of alcohol consumption reduced the power of the study to examine changes across levels of consumption within each demographic subgroup. Following discussion at an international conference it was recommended that quantile regression is best suited to the aims of the current study, as it retains power without splitting the demographic group further into percentile groupings. Quantile regression proved valuable; it highlighted some particular and divergent changes in drinking among young females of low household and neighbourhood SEP. However, concerns remained regarding the power of the study, resulting in the abandonment of examining changes across percentiles of alcohol consumption within groups characterised by age, sex, and SEP. Instead, focus was directed to overall changes in a range of drinking measures across demographic subgroups. This study is the first of its kind to be identified which seeks to examine changes over time in a range of drinking dimensions and among groups defined by household and neighbourhood SEP. The study provides further understanding of the role of

neighbourhood disadvantage in relation to mutual influence to support positive behavioural change, particularly in relation to high-risk drinking.

5.2 Abstract

Many Western countries have reported declines in adolescent alcohol use. This study aimed to examine changes in adolescent alcohol use in New Zealand between 2007 and 2012 and explore variations across socio-demographic strata. Data were drawn from two nationally-representative, cross-sectional high school surveys conducted in New Zealand in 2007 (n=9,107) and 2012 (n=8,500). Changes in the overall prevalence of drinking in the past 4 weeks, together with the frequency of drinking and typical quantity consumed among those that drink, were investigated within four demographic groups characterised by age (<16yrs, ≥16yrs) and sex. Interactions with household- and neighbourhood-level socio-economic position (SEP) identified any differential changes in alcohol use between socio-economic strata. Results showed that from 2007 to 2012, significant reductions in the overall prevalence of drinking and frequency of drinking among drinkers were evident among all demographic groups. Reductions did not differ by household or neighbourhood SEP. The typical quantity reduced among drinkers, but was mostly driven by reductions in young (<16yrs) males. Interaction analyses demonstrated that the reduction was significantly greater among young males of moderate and high household SEP when compared to those of low household SEP (i.e. economic disadvantage). Among young females, significant interactions revealed a shift towards increasing typical quantities among those of low household and neighbourhood SEP, whilst their more advantaged counterparts showed lower typical quantities over time. No significant changes in typical quantity were found among older (≥16 years) adolescents. In conclusion, fewer drinking occasions characterised the major declines in adolescent drinking between 2007 and 2012. Only young male adolescents of socio-economic advantage showed progression away from intoxicated drinking styles. An examination of changes in both the overall shift and shape of the distribution curve are required to address the uneven distribution of alcohol-related harm and improve the targeting of health and social policy.

5.3 Introduction

Trends in adolescent alcohol consumption have followed similar patterns across many Western countries, with increasing use in the 1990s and peaking in the early 2000s (Huckle, Pledger, & Casswell, 2012; Lintonen, Karlsson, Nevalainen, & Konu, 2013; Measham, 2008). During this period, some countries described a doubling in the typical quantity of alcohol consumed (Measham, 2008) and a closing gender gap, as girls increased their consumption to such an extent that they overtook boys in levels of binge drinking and drunkenness (Hibell et al., 2012; Payne & Phelps, 2013). The postulated reasons for these trends were varied, ranging from specific product developments (e.g. ready-to-drink spirit mixers) and sophisticated marketing approaches which appealed to young people (Huckle, Sweetsur, Moyes, & Casswell, 2008; Measham, 2008), a liberalisation of alcohol policy resulting in a proliferation of premises selling alcohol (Huckle et al., 2012), a reduction among young females in the stigma associated with reporting alcohol consumption (Keyes, Grant, & Hasin, 2008), as well as a zeitgeist of experimentation with legal and illegal substances (Measham, 2008).

In contrast, the last decade has seen some declines in adolescent drinking. Frequency of drinking and binge drinking have decreased (Elgar, Phillips, & Hammond, 2011; Grucza, Norberg, & Bierut, 2009; Richter, Kuntsche, de Looze, & Pfortner, 2013), with increasing numbers of abstainers across countries (de Looze et al., 2015; Elgar et al., 2011). Once again, explanations proffered range from a real change in drinking behaviour (Goddard & Green, 2006), an increasing trend to under-report consumption in an increasingly dryer climate of alcohol use (Rehm, 2014), decreases in parental alcohol use and supply (Simons-Morton et al., 2009), increased use of the internet for leisure activities (Pennay, Livingston, & MacLean, 2015), and cultural shifts in the population, resulting from growing numbers of ethnic minority and religious groups which do not drink or do so at low levels (Measham, 2008).

The complex nature of drinking behaviour can result in variable shifts over time depending on the drinking measure considered (Demers & Kairouz, 2003). For example, increases in the proportion of young people consuming very high amounts of alcohol have been reported in the presence of overall declines in the frequency of use (Department of Health, 2010; Hallgren, Leifman, & Andreasson, 2012; Johnston et al., 2013; Meier, 2010). These differential trends can reveal important changes in the contexts and culture of drinking. Reductions in the frequency of drinking occasions could point towards changes in the cultural position of drinking in an adolescent's world – for example, its contemporary place in weekly, monthly or holiday routines and its association with 'time out' and celebration (Room, Osterberg, Ramstedt, & Rehm, 2009). Changes in typical quantity could reflect the cultural or social significance of drunkenness during a drinking occasion. It is commonly believed that any changes in drinking, such as the observed reductions in the frequency of adolescent binge drinking, relate more to the number of occasions than to the style of drinking (Room et al., 2009).

Given the social interaction or mutual influence between drinkers in the population, changes in drinking are believed to occur collectively (Skog, 1985). These changes may be catalysed by broader shifts in the determinants of population drinking e.g. alcohol tax increases. It is acknowledged that there may be exceptions to collectivity due to barriers of mutual influence, for example between the different sexes or socio-economic strata (Skog, 2001). The Diffusion of Innovations Theory (Rogers, 1962) suggests that behavioural changes are often adopted first by higher income or socio-economic groups, as evident with declines in adolescent tobacco use (Green, Leyland, Sweeting, & Benzeval, 2014; Kuipers, Nagelhout, Willemsen, & Kunst, 2014). Identifying inequalities in alcohol use trends, particularly those which can be mitigated early in the life course, is imperative to address the uneven distribution of alcohol-related harm (Roche et al., 2015). It is recommended (Room et al., 2009) that researchers should seek to explain alcohol consumption trends in subpopulations characterised by socio-economic position (SEP), as well as by sex, age, and ethnicity. Such an approach highlights the need for researchers to draw attention

to both the overall shift and shape of the distribution curves (Benach, Malmusi, Yasui, Martínez, & Muntaner, 2011).

Recent studies have shown reductions in the frequency of weekly (Richter et al., 2013) and past-year drinking (Livingston, 2014) to have occurred among adolescents of all socio-economic strata, including levels of neighbourhood disadvantage. However, the effects of SEP have been found to vary dramatically across different measures of adolescent drinking (Casswell et al., 2003; Huckle, Huakau, et al., 2008; Vinther-Larsen et al., 2013) and geographical contexts (Lemstra et al., 2008), having important implications for examining consumption trends across socio-economic strata. In New Zealand, higher individual-level income has been shown to be associated with higher drinking frequencies amongst young people, whilst lower educational achievement predicts higher typical quantities (Casswell et al., 2003). Low neighbourhood-level SEP (i.e. economic disadvantage) has been found to be associated with higher typical quantities in adolescents, but not related to the frequency of drinking occasions (Huckle, Huakau, et al., 2008; Vinther-Larsen et al., 2013). Identifying socio-economic trends across different drinking measures could further assist in exploring the mechanisms of both household and neighbourhood SEP on adolescent drinking. Investigating changes at both levels could also point to the level at which mutual influence for behavioural change may occur.

Differences between adolescent males and females in the gradient of recent declines in alcohol use have been observed, with many Western countries showing that females have decreased their frequency of drinking less when compared to males (Kuntsche et al., 2011; Sigfusdottir, Kristjansson, Thorlindsson, & Allegrante, 2008; Simons-Morton et al., 2009). In the United States, the frequency of binge drinking has decreased among adolescent males, but remained stable among females, or increased within ethnic minority females (Grucza et al., 2009). Young adolescent females in Spain have been shown to particularly diverge from their wider adolescent cohort, showing increases in drinking whilst others have declined (Sánchez-Queija, Moreno, Rivera, & Ramos, 2015).

Given the heterogeneity of changes in adolescent alcohol use over time, the aims of this study were to 1) examine changes in a range of drinking measures within high school students and 2) to explore whether household and/or neighbourhood-level SEP presented barriers to mutual influence in changing behaviour.

5.4 Methods

Participants

Two national, cross-sectional, self-administered surveys were carried out in New Zealand high schools in 2007 (n=9,107) and 2012 (n=8,500). A broad range of health and wellbeing issues were covered, including alcohol use. Survey questions and response options utilised in the current study were consistent between surveys. Details of ethical approval, the survey methodologies and characteristics of participating schools and students are available elsewhere (Clark, Fleming, Bullen, Crengle, Denny, Dyson, Peiris-John, et al., 2013). In brief, of over 380 schools eligible for participation in each survey, 115 (in 2007) and 125 (in 2012) were randomly selected and invited to participate. School response rates in 2007 and 2012 were 84% and 73%, respectively. Of the students randomly selected to participate, response rates were 74% in 2007 and 68% in 2012.

Drinking measures

Students were initially asked to report whether they had ever consumed alcohol (i.e. more than a sip). Those who had consumed alcohol indicated their frequency of drinking in the past 4 weeks, with responses options: not at all - I don't drink alcohol now, not in the last 4 weeks, once, 2-3 times, weekly, several times a week, and most days. To explore changes in drinking among the whole student population, a binary measure of drinking in the past 4 weeks was created by categorising students according to whether or not they had consumed alcohol at least once in the past 4 weeks.

Two drinking measures were assessed among students who reported consuming alcohol at least once in the past 4 weeks (hereon referred to as ‘drinkers’). The *frequency of drinking* in the past 4 weeks was derived from the question described above, with responses converted into a numerical score. Similar to the recommended selection of a mid-point when response options include a range (Dawson, 2003), a random number between 2 and 3 was generated for students who reported drinking 2-3 times, drinking several times a week was given a score of 8 (i.e. a minimum of 2 occasions/week), and drinking on most days was given a score of 12 (i.e. a minimum of 3 drinking occasions/week). Students were also asked about their *typical quantity* consumed in a drinking occasion, with response options: 1, 2, 3-4, 5-9, 10-20, and >20 standard (10g alcohol) drinks in a usual (<4-hour) drinking session. Students who reported a range of quantities (e.g. 5-9 drinks) were allocated a random number within the range. A cut-off of 21 drinks was assigned as the upper-limit of consumption. As the drinking measures were heavily skewed, they were log-transformed to prevent any violation of parametric test assumptions.

Demographics

Age, sex, and ethnicity were self-reported. Age was dichotomised into young (<16 years) and older adolescents (≥ 16 years) reflecting differences in these stages of development with regards to drinking and alcohol-related problems (Brown et al., 2008) and major role transitions. Evidence of differential changes in drinking between the sexes (Hallgren et al., 2012; Sánchez-Queija et al., 2015) resulted in the creation of four demographic groups for the current study; young males (<16years), older males (≥ 16 years), young females (<16years), and older females (≥ 16 years). Ethnicity was prioritised according to the New Zealand census ethnicity question (Ministry of Health, 2004) and categorised into one of four groups; Māori, Pacific, Asian and European/other.

Household SEP

Given that adolescents do not reliably report household income (Schnohr et al., 2008), household SEP was constructed from a combination of household and small area-level deprivation indicators. Self-reported household socio-economic indicators included residential mobility, household overcrowding, perceptions of whether parents worry about money, and access to material resources such as a car. Collection of each student's usual home address permitted the assignment of a socio-economic decile to the smallest non-administrative geographic unit in which the student resided, i.e. a meshblock (~60-100+ residents). Each student's address was deleted following meshblock assignment to protect anonymity. The socio-economic decile (known as the 2006 and 2013 New Zealand Deprivation Index (Atkinson, Salmond, & Crampton, 2014; Salmond et al., 2007)), represents small area-level deprivation, and was derived from a principal component analysis of meshblock deprivation features (e.g. income, access to the internet, employment, educational qualifications, home ownership, single parent families). Each student's meshblock-level deprivation decile was combined with the self-reported household income indicators to produce a standardised score of household SEP (Cronbach's alpha 2007 = 0.63, 2012= 0.64). Scores were divided into tertiles, with low household SEP indicating high economic disadvantage.

Neighbourhood-level SEP

For the purposes of this study, each student's 'neighbourhood' represented the area unit in which they usually resided. Area units are aggregations of meshblocks (described above), comprising a population size of 3000-5000, and generally coincide with a student's neighbourhood suburb. Area unit socio-economic deciles were obtained (University of Otago, 2014) from population-weighted, aggregated deprivation scores of the meshblocks which comprise each area unit. Deciles were divided into tertiles for the current study; 1-3 = high SEP, 4-6 = moderate SEP, and 7-10 = low SEP (i.e. high neighbourhood economic disadvantage).

Data analysis

Unconditional, cross-classified, multilevel models (without covariates) were undertaken for each drinking measure to determine the degree of clustering of responses within the school and neighbourhood setting. The design effect, which quantifies the likely underestimation of parameter standard errors in a clustered sample (Maas & Hox, 2005), was found to be <2 at the neighbourhood-level for all drinking measures and thus indicated that accounting for clustering of responses within the neighbourhood was not required. Clustering was indicated at the school level as shown by design effects of 2.4 for typical quantity and drinking frequency among drinkers, pointing to the need to use survey regression procedures which account for the non-independence in the sample.

Changes in the drinking measures were explored using linear and logistic procedures in SAS software Version 9.3 (Cary, NC). Among the total student population, changes in the prevalence of drinking in the past 4 weeks were examined. Among drinkers, changes in the frequency of drinking and typical quantity were assessed. Interactions between demographic group and time were conducted to examine if changes over time were differential across groups. Concerns about study power prevented the use of 3-way interactions (i.e. demographic group x time x SEP) to identify nuanced changes between demographic groups characterised by SEP. Instead, subgroup analysis (using the domain command in SAS) was used to test interactions between SEP and time within each of the four demographic groups. Interactions with household and neighbourhood SEP were conducted separately.

All analyses incorporated the clustering of students within schools and utilised sampling weights to provide nationally-representative estimates. Household SEP was included as a covariate in all analyses of changes across neighbourhood SEP. Chi-square tests examined any differences in the characteristics of participants between surveys. Characteristics found to differ were included as covariates in analyses. Sensitivity analyses were conducted by excluding students who reported excessive levels of consumption, equating to typically consuming more than 20 standard drinks

on most days of the week. In addition, sensitivity analyses using the lowest and mid-point of the response ranges of typical quantity were conducted to examine whether the results differed from the use of a random number within the response range.

5.5 Results

Characteristics of the overall student sample and of drinkers are presented in Table 5-1. Chi-square tests revealed significant differences between the two surveys in the sex, ethnicity, and levels of neighbourhood SEP among the overall student sample and among drinkers ($p < 0.001$). In addition, there were fewer young adolescent (<16yrs) drinkers in 2012 compared to 2007 ($p < 0.001$). Sensitivity analyses using different estimates of consumption within the response ranges for typical quantity and excluding students who reported excessive consumption revealed identical patterns to those described below.

Table 5-1

Demographic Characteristics of the Study Population, 2007-2012

	All students		All drinkers	
	2007 n (%)	2012 n (%)	2007 n (%)	2012 n (%)
Total	9107	8500	3834	2557
Age ^b				
<16 years	5934 (65.2)	5489 (64.7)	1995 (52.0)	1089 (42.6)
≥16 years	3166 (34.8)	3000 (35.3)	1839 (48.0)	1468 (57.4)
Sex ^{a, b}				
Female	4187 (46.0)	4623 (54.4)	1746 (45.5)	1392 (54.4)
Male	4911 (54.0)	3874 (45.6)	2088 (54.5)	1165 (45.6)
Ethnicity ^{a, b}				
Māori	1702 (18.7)	1701 (20.0)	890 (23.2)	612 (24.0)
Pacific	924 (10.2)	1201 (14.1)	239 (6.2)	193 (7.6)
Asian	1126 (12.4)	1051 (12.4)	248 (6.5)	149 (5.8)
European/other	5328 (58.7)	4535 (53.4)	2456 (64.1)	1601 (62.7)
Household SEP				
High	2968 (33.0)	2803 (33.0)	1437 (37.5)	1019 (39.8)
Moderate	3061 (34.0)	2889 (34.0)	1330 (34.7)	816 (31.9)
Low	2967 (33.0)	2804 (33.0)	1067 (27.8)	724 (28.3)
Neighbourhood SEP ^{a, b}				
High	2962 (33.5)	2148 (25.7)	1347 (35.5)	714 (28.3)
Moderate	2454 (27.8)	2477 (29.6)	1089 (28.7)	786 (31.2)
Low	3423 (38.7)	3733 (44.7)	1354 (35.7)	1021 (40.5)

SEP = socio-economic position (low=economic disadvantage). Chi-square tests for differences $p < 0.001$; ^a= among total sample, ^b = among drinkers.

Drinking in the past 4 weeks (all students)

From 2007 to 2012, the prevalence of drinking in the past 4 weeks significantly reduced from 42% to 30% ($p < 0.001$). A significant interaction ($p < 0.01$) between demographic group and time (Table 5-2) indicated that the extent of reduction over time in the prevalence of drinking differed between groups, with greater reductions found among young males and young females. Reductions in the prevalence of drinking were found across all household and neighbourhood socio-economic strata (i.e. no interactions were present in the SEP x time relationship within each demographic group).

Table 5-2

Changes in Measures of Drinking Between 2007 and 2012, Among All Students and Drinkers

	All students		Among drinkers			
	Prevalence of any drinking in the past 4 weeks		Frequency of drinking occasions in the past 4 weeks		Typical-occasion quantity (standard drinks)	
	2007 % (95% CI)	2012 % (95% CI)	2007 Median (95% CI)	2012 Median (95% CI)	2007 Median (95% CI)	2012 Median (95% CI)
Total	42.2 (41.1-43.2)	30.2 (29.2-31.1) ^a	2.7 (3.2-3.4)	2.4 (2.3-2.4) ^a	5.5 (5.1-6.0)	5.1 (4.7-5.5) ^a
<i>Demographic group</i>						
Young males (<16yrs)	34.2 (32.6-35.8)	20.2 (18.7-21.8) ^a	2.6 (2.5-2.7)	2.2 (2.1-2.4) ^a	4.6 (4.2-5.0)	3.7 (3.2-4.1) ^a
Young females (<16yrs)	33.0 (31.2-34.8)	19.5 (18.1-21.0) ^a	2.6 (2.5-2.6)	2.3 (2.1-2.4) ^a	4.7 (4.5-4.9)	4.5 (4.2-4.9)
Older males (≥16yrs)	59.1 (56.7-61.5)	48.7 (46.0-51.4) ^a	2.9 (2.7-3.0)	2.6 (2.5-2.7) ^a	7.3 (7.0-7.7)	7.3 (6.5-8.1)
Older females (≥16yrs)	56.9 (54.4-59.5)	49.1 (46.7-51.5) ^a	2.7 (2.6-2.8)	2.3 (2.2-2.4) ^a	5.0 (4.4-5.6)	5.0 (4.6-5.3)
Interaction:						
Demographic group x time	p= 0.01		p= 0.80		p= 0.03	

^a p<0.001 (covariate-adjusted analysis of change between 2007 and 2012)

Frequency of drinking (among drinkers)

As shown in Table 5-2, the frequency of drinking in the past 4 weeks was found to reduce significantly over time ($p < 0.001$). There was no significant interaction between time and demographic group, or between time and SEP within each demographic group.

Typical quantity (among drinkers)

Overall, the typical quantity of alcohol consumed in a drinking occasion reduced significantly over time ($p < 0.001$). A significant interaction between demographic group and time indicated that this reduction was mostly driven by reductions among young males, whilst the remaining demographic groups showed no significant changes over time. Among young males, further interaction analyses demonstrated that the significant reductions were limited to those of moderate or high household SEP. No interaction was found with neighbourhood SEP, i.e. all neighbourhood SEP strata among young males significantly reduced their typical quantity.

A significant interaction revealed divergence in the direction of change across socio-economic strata among young females. Whilst those of high and moderate household SEP demonstrated near significant reductions in typical quantity ($p = 0.08$ moderate SEP), those of low household SEP showed non-significant increases. At the neighbourhood-level, the interaction nearly reached significance ($p = 0.06$), showing similar differences in the direction of change between strata. Figure 5-1 shows the divergence over time in the logged distribution of typical quantity among young females of varying levels of household SEP. To further examine changes among this demographic group in the right tail of the distribution curve, a post-hoc analysis, utilising a binary measure of high typical consumption (i.e. 5 or more drinks in one occasion), was undertaken. A significant interaction with household SEP was found, showing young females of low household SEP to have significantly (42% to 49%, $p < 0.05$) increased their high typical consumption whilst reductions were found amongst moderate (36% to 31% $p > 0.05$) and high SEP (31% to 22%, $p < 0.05$) strata. An interaction was also found at the neighbourhood-level, although the increase in

high typical consumption among young females living in low neighbourhood SEP (42% to 45%, $p=0.08$) approached significance. Given the differential effects of neighbourhood exposures in rural versus urban areas, a post-hoc analysis was conducted by limiting the sample to urban neighbourhoods (>1000 population). Significant increases in high typical quantity were found among young females living in low neighbourhood SEP in urban neighbourhoods ($p=0.04$). No differences over time in high typical quantities were observed in young females living in rural neighbourhoods of varying levels of disadvantage.

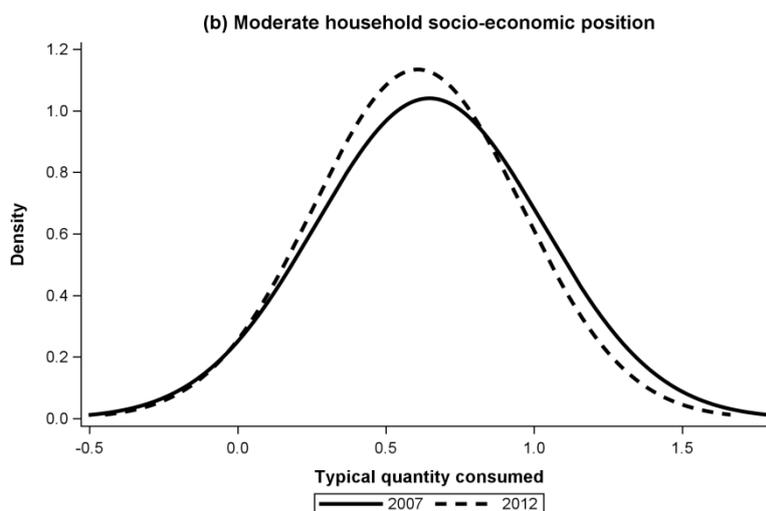
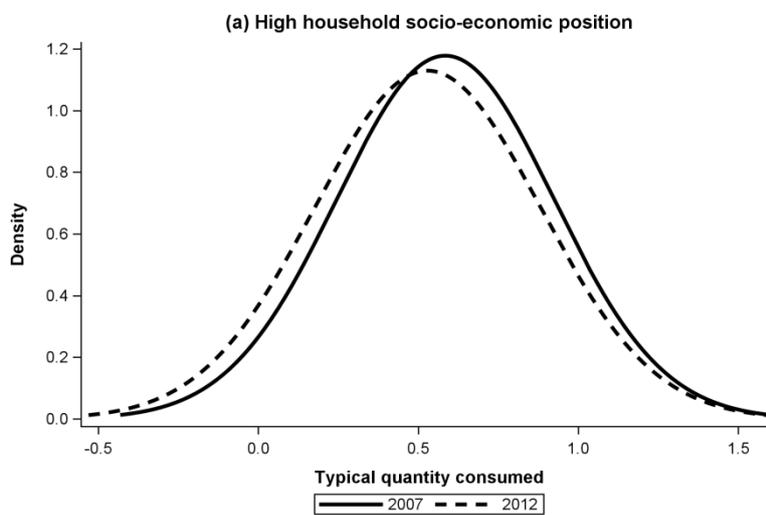




Figure 5-1. Distribution of logged typical quantity among young females in 2007 and 2012, by level of household socio-economic position.

5.6 Discussion

Positive changes in adolescent alcohol consumption have taken place in New Zealand from 2007 to 2012, with significantly fewer students drinking in the past 4 weeks and with fewer drinking occasions among those who drink. The increasing prevalence of non-drinkers occurring alongside reductions in the frequency of use among drinkers suggests that a collective change is taking place in the adolescent population as a whole and that demographic characteristics do not appear to present barriers to mutual influence. The findings of the current study are consistent with others who have shown that changes in the frequency of drinking (Richter et al., 2013) and past-year drinking (Livingston, 2014) have occurred across all socio-economic strata, including levels of neighbourhood disadvantage.

Among young adolescent past-month drinkers, however, collectivity of changes was less evident in relation to typical quantities consumed in a drinking occasion. Specifically, low household SEP appeared to constrain mutual influence for positive behavioural change in both young males and females. A disadvantaged neighbourhood socio-economic environment, particularly in urban environments, also appeared to negatively influence young females. Future studies seeking to

explore changes in adolescent alcohol use across socio-economic strata should consider the likelihood that patterns of change may vary by age, sex, and geographical location. This is consistent with the Social Development Model (Catalano & Hawkins, 1996) which suggests that risk factors, such as SEP, may operate differently across the stages of adolescence (Aber et al., 1997). The finding of an overall divergence in the typical quantity consumed by young males and young females (particularly young females of low SEP) warrants further study, but supports recent findings in the United States of a continual increase in preference for risk-taking among adolescent females whilst males have plateaued (Keyes et al., 2015). Differential trends between the sexes have resulted in calls for gender-sensitive policy development and analysis, with particular attention drawn to the need to examine the effects of initiatives on young adolescent females of low SEP, given that they are often found to experience inequities across a range of health determinants (Greaves & Jategaonkar, 2006; Greaves, Vallone, & Velicer, 2006)50,51. It is suggested that specific sub-populations are now exhibiting trends in health outcomes which require even more nuanced analyses (Greaves & Jategaonkar, 2006).

Identifying the pathways through which SEP hinders positive shifts in typical quantities consumed by young adolescents is imperative. One mechanism may relate to affordability. In New Zealand, affordability of alcohol has increased (Gunasekara & Wilson, 2012), which may pose challenges for disadvantaged groups to reduce their consumption given their particular sensitivity to low prices (Babor, Holder, et al., 2010). In addition, New Zealand experienced increasing socio-economic inequities as a result of the Global Financial Crisis (beginning in 2008), as many poor groups became poorer (Mills, 2010). Increasing disadvantage may have resulted in increased drinking in some groups via the tension reduction mechanism (Pohorecky, 1990). New Zealand also implemented zero blood alcohol concentration laws for drivers under 20 years of age in 2011, pointing to possible differential effects of this policy among demographic and socio-economic groups. Finally, high levels of economic disadvantage in urban

neighbourhoods may lower levels of social cohesion (Sampson et al., 1997), providing a barrier for social reinforcement for behavioural change (Vishwanath, 2006).

The differential changes in consumption across socio-economic strata have serious consequences for the reduction of inequities in alcohol-related harm in adolescence (Norström & Pape, 2015). Increasing typical quantity, albeit in the presence of fewer drinking occasions, warrants urgent attention given the vulnerability of the young adolescent brain to the effects of alcohol (Schweinsburg et al., 2010). Furthermore, action is required to avoid enduring inequalities over the life course, whereby high levels of consumption in adolescence may result in alcohol use problems in later adulthood (McCambridge et al., 2011), with the consequences of drinking being more severe for those experiencing economic disadvantage (Grittner, Kuntsche, Graham, & Bloomfield, 2012; Mäkelä & Paljärvi, 2008). Longer-term studies will be required to examine whether the low SEP strata of young males and females catch up to their higher SEP counterparts with regards to typical quantities consumed, although data in tobacco smoking suggests that this is unlikely (Kuipers et al., 2014).

The study's findings point to an overall change in the importance of drinking occasions relative to other adolescent activities, but limited cultural change in the significance of drunkenness. The pattern of decreasing frequency of drinking among adolescents, whilst typical quantity remains unchanged, has also been demonstrated across more than 25 European countries (Agalioti-Sgompou, 2015; Hibell et al., 2012). This scenario aligns with the hypothesis that changes in drinking are mostly brought about by a change in the nature of social activities, where drinking is found to be more (or less) normative, rather than any change to the style in which alcohol is consumed (Room et al., 2009). Future attention could be directed to examining whether engagement in alternative leisure activities, such as social media and computer gaming, has given rise to fewer drinking occasions. If this was the case, one may be concerned that, should other activities arise in the future which are more compatible with drinking, the higher frequencies of

drinking observed in the first decade of the new millennium may re-emerge later (Room et al., 2009).

The current findings must be taken in light of several limitations. Self-reported alcohol use may be prone to under-reporting and changes in veracity over time. However, the declines in self-reported use are aligned with the findings from other national alcohol surveys (Ministry of Health, 2013) and data showing similar reductions in alcohol-related outcomes, such as teenage pregnancy and youth crime (Statistics New Zealand, 2014b, 2014c). The analysis was also restricted to only two cross-sectional surveys in a period of time which included the Global Financial Crisis, pointing to the need for further studies to examine longer-term trends in consumption across socio-economic strata. In addition, low power prevented a detailed analysis of how changes in drinking patterns across SEP were also influenced by ethnicity. This important aspect, with implications for health equity, requires further investigation. Relatedly, the inability to conduct 3-way interactions may also have given rise to spurious subgroup findings within demographic groups (Brookes et al., 2001). As such, results should be taken as exploratory or hypothesis-generating. Finally, selection bias may limit the generalisability of findings, particularly to older adolescents. Students who were absent from school on the day of the survey or had legally left school once reaching 16 years of age were excluded from the study, potentially omitting students with different drinking patterns to the sampled population.

In conclusion, despite reductions in alcohol use in recent years among New Zealand adolescents overall, there are groups that are disproportionately more at risk of alcohol-related harm. Identifying disparities in use over time can assist in the identification of causal mechanisms of socio-economic conditions on alcohol consumption and improve the tailoring and targeting of health and social policy.

Chapter 6 Neighbourhood typologies and adolescent alcohol use

6.1 Preface

Publication

This chapter includes content from the article “Jackson, N., Denny, S., Sheridan, J., Zhao, J. & Ameratunga, S. (2016). Differential effects of neighborhood type on adolescent alcohol use in New Zealand. *Prevention Science*, 17(7), 841-851.” Permission to reprint was obtained from Springer on October 27, 2016.

Link to thesis objectives:

- To identify neighbourhood typologies associated with adolescent alcohol use

Why was this study needed?

The importance of utilising person-centred approaches throughout this thesis underscored the need to examine typologies of neighbourhoods associated with adolescent alcohol use. This approach had been used within studies to examine the role of the neighbourhood on health outcomes such as obesity, but was absent in the field of alcohol-related research. Typology-based approaches can be useful as a starting point to determine which exposure(s) have more salience in distinguishing risky neighbourhoods for adolescent alcohol use. Once identified, multilevel designs can be used to investigate their effects. In this way, problems with collinearity when correlated exposures are first included together in regression models can be minimised.

What was undertaken?

Neighbourhood-level indicators derived from the Youth’12 survey, Census 2013 and the Ministry of Justice were utilised in Latent Class Analysis to create neighbourhood typologies. Multilevel modelling examined the association between neighbourhood type and adolescent alcohol use.

Cross-level interactions assisted to identify subgroups of adolescents who may be more vulnerable to neighbourhood effects.

6.2 Abstract

Identifying neighbourhood typologies associated with adolescent alcohol use can inform the development of harm reduction strategies. Utilising data from a nationally-representative youth survey (n=4267) in New Zealand latent class analysis was used to categorise neighbourhood types (defined by 10 demographic, social and environmental indicators) to investigate their association with alcohol consumption and related harm. Three neighbourhood types were distinguished: (1) “high outlet density and economic disadvantage” (30.6% of all neighbourhoods); (2) “high disadvantage, disorder, and social disorganisation” (38.8%); and (3) “higher income and socially organised” (30.6%). Significant ethnic variation was evident in the likelihood of residing within particular neighbourhood types. There was an age-group interaction in the main effects with significant associations between neighbourhood type and drinking measures and harm most apparent among younger adolescents (<16yrs), as described next. Compared to students residing in “higher income and socially organised” neighbourhoods, the frequency of high typical consumption was significantly higher in students residing in “high outlet density and economic disadvantage” and “high disadvantage, disorder, and social disorganisation” neighbourhoods. Students living in “high outlet density and economic disadvantage” neighbourhoods were also more likely to be current drinkers. The findings that neighbourhoods characterised by low social organisation, high levels of socio-economic disadvantage, alcohol outlet density and collective perceptions of disorder were associated with young adolescent drinking underscores the importance of adopting a developmental approach to the study of contextual effects on adolescents.

6.3 Introduction

The assessment of risk and protective factors for adolescent alcohol use, with the aim of identifying elevated (or depressed) factors to target, is at the core of community-based strategies to reduce alcohol-related harm. To achieve more sustainable reductions in harm and reduce inequities it is important that the root causes of alcohol use are identified and addressed through population-level approaches (Loring, 2014). The significant variation across neighbourhoods in the prevalence of adolescent alcohol use (Jackson, Denny, & Ameratunga, 2014; Leventhal & Brooks-Gunn, 2000) suggests that some of these root causes may be located within the neighbourhood setting. Identifying the salient neighbourhood features for adolescent drinking, particularly through methods such as community-based participatory research, is imperative to guide action and stimulate community readiness and buy-in to take action at a local level (Minkler, 2010).

The Social Disorganisation Theory (Shaw & McKay, 1942) proposes that variation in delinquency across neighbourhoods reflects variation in social organisation. Neighbourhood-level socio-economic disadvantage is said to weaken residents' ability to establish behavioural norms and intervene in problem behaviour, otherwise known as 'collective efficacy' (Sampson et al., 1997). Collective perceptions of physical disorder (e.g. graffiti, rubbish) may also play a significant role in reducing collective efficacy, through stifling the development of neighbourhood trust, attachment and participation (Cohen et al., 2008; Diez Roux, 2001). Alcohol outlet density may be implicated, through attenuating the development of collective efficacy as a result of reduced perceptions of safety (Theall et al., 2009), perceptions of low informal control (Scribner et al., 2007), or increasing alcohol availability through social networks (Chen, Grube, & Gruenewald, 2010). Other sources of neighbourhood variation in delinquency have been described, including the institutional resources pathway (Leventhal & Brooks-Gunn, 2000), which suggests that neighbourhoods with low levels of adolescent engagement in community-organised activities have higher levels of deviance.

Systematic reviews of neighbourhood-level effects on adolescent alcohol use have found mixed results for a range of socio-economic, social and environmental exposures (Bryden et al., 2012; Bryden et al., 2013; Jackson, Denny, & Ameratunga, 2014). More consistent evidence has been shown for the negative impacts of alcohol outlet density, exposure to neighbourhood alcohol advertising (Bryden et al., 2012) and levels of adult and adolescent alcohol use (Jackson, Denny, & Ameratunga, 2014). These inconsistent findings may reflect the multi-dimensional and complex nature of neighbourhoods, limiting the ability of studies using single variable or domain approaches to identify effects (Jones & Huh, 2014; Weden, Bird, Escarce, & Lurie, 2011). Neighbourhoods should be viewed as the result of a synthesis of different combinations of social, demographic, economic, structural and geographic features (Weden et al., 2011), which can bundle together in complex ways (Adams et al., 2013) and exhibit non-linear relationships with health (Duncan & Raudenbush, 2001). Furthermore, contextual effects are often mediated by other factors on the causal pathways and/or are moderated in the presence of other exposures (Leventhal & Brooks-Gunn, 2000). For example, moderation of neighbourhood effects by age (Rowland, Toumbourou, Satyen, Tooley, et al., 2014) and ethnicity (Ayuka, Barnett, & Pearce, 2014) suggests that the salience of the neighbourhood (and mediating factors) may depend on the characteristics and stage of development of the adolescent. The finding that the impact of alcohol outlet density is stronger in the presence of low levels of collective efficacy (Maimon & Browning, 2012) also points to moderation at the neighbourhood level.

Attempting to address this multi-dimensionality by including multiple exposures in a multilevel model can be problematic, as collinearity between contextual variables may result in instability in the direction and size of effects (Adams et al., 2013; Jones & Huh, 2014). Useful methods to capture neighbourhood complexity point towards the identification of distinct neighbourhood profiles (Arcaya et al., 2014) based on a range of exposures or attributes. These profiles may display meaningful between-group variation across a range of indicators which could, together, influence health behaviour (Jones & Huh, 2014). Latent class analysis provides an empirically-

based, data-driven method for grouping neighbourhoods into profiles or typologies of risk. To date, this approach has been mostly used in the study of the built environment and physical activity or obesity (Adams et al., 2013; Jones & Huh, 2014). Using a model-based approach to identify high-risk neighbourhoods for adolescent alcohol use could assist community prevention practitioners in the prioritisation of limited resources so that efficacious interventions are targeted to those most in need (Arcaya et al., 2014; Tobler, Komro, & Maldonado-Molina, 2009). The aims of this study were to examine the association between neighbourhood types and adolescent alcohol use and harm, and to identify adolescent subgroups which may be more vulnerable to their effects.

6.4 Methods

Participants

A national, cross-sectional, self-administered survey (Youth'12) was carried out in 2012 of a random sample of high schools in New Zealand. A broad range of health and wellbeing issues were covered, including alcohol use. The survey instrument (Adolescent Health Research Group, 2012) and detailed description of the survey methodology (Clark, Fleming, Bullen, Denny, et al., 2013) are available elsewhere.

In total, 125 randomly selected high schools were invited to participate, of which 91 (73%) agreed. Of the 12,503 students invited to participate 8,500 (68%) agreed, representing 3% of the New Zealand high school roll in 2012. When compared to the invited population, the sampled population was more likely to be of young age, female and of Pacific ethnicity.

Measures

a) Alcohol use

Four binary dimensions of drinking and alcohol-related harm from data collected in the Youth'12 survey were examined for their relationship with neighbourhood types. *Current drinking* was

defined as students who stated that they had ever consumed alcohol and did not indicate they no longer drank. *Binge drinking* was defined as any occasion in the last 4 weeks of consuming 5 or more standard drinks (10g alcohol) on one occasion. *High typical quantity* was defined as usually consuming 5 or more standard drinks in a drinking occasion. *Alcohol-related harm* was defined as experiencing two or more of the following harms resulting from their own drinking in the past 12 months: had performance at school or work affected, had unsafe sex (e.g. no condom) or unwanted sex, done things that could have resulted in serious trouble (e.g. stealing, etc.), been injured or injured someone else, or had a car crash.

b) Contextual measures

Ten neighbourhood-level latent class indicators (Table 6-1) were utilised to identify neighbourhood types. These indicators were selected from research investigating neighbourhood effects on adolescent alcohol use (Bryden et al., 2012; Bryden et al., 2013; Jackson, Denny, & Ameratunga, 2014) and were deemed to play significant roles in the social disorganisation and institutional pathways to adolescent outcomes. For this study, 'neighbourhood' was represented by the area unit in which the student usually resided. An area unit is a non-administrative area with an average population 3000-5000, and generally coincides with a student's neighbourhood suburb (Statistics New Zealand, 2014a). The Youth'12 survey collected data from students residing in 1171 area units, or 58% of the total number of area units throughout New Zealand. Each unit was categorised into one of three geographical areas: main urban ($\geq 30,000$ population), secondary urban (1000-29,999), and rural areas (< 1000). To ensure the reliability of aggregated neighbourhood-level measures (Raudenbush & Sampson, 1999), any area unit from which 10 or fewer students answered any of the aggregated latent class indicators (n=3662 students) was excluded from the analysis. In addition, area units coded as rural (n=571 students) were excluded due to evidence demonstrating dissimilar associations between alcohol outlet density and adolescent alcohol use in rural versus urban areas (Azar et al., 2016). This resulted in a final sample of 209 urban and semi-urban area units (n=4267 students) on which to conduct the latent

class analysis. Area units had a median population of 3750 (range 249-8238), and a median of 17 survey respondents (range 11-68).

Five neighbourhood indicators were collected at the individual level, from questions included in the Youth'12 survey. Perception of safety was coded 'yes' if the student perceived that they always or usually felt safe in their neighbourhood. Membership in community organisations was coded 'yes' if the student belonged to one or more community groups or clubs. The prevalence of each indicator was calculated per area unit. Collective efficacy was determined using a range of individual-level questions relating to perceptions of neighbourhood social cohesion and parental knowledge of adolescent activities, with response options ranging from all the time, sometimes, not often, or never ($\alpha=0.74$). All response options were converted into numerical scores, with mean scores per student calculated prior to area unit-level aggregation. Aggregated levels of parental knowledge of adolescent activities were included to represent the community-level, informal social control component of collective efficacy, as it has been shown that parental knowledge is positively associated with neighbourhood levels of collective efficacy (Fulkerson, Pasch, Perry, & Komro, 2008). Students also reported on features pertaining to neighbourhood disorder (e.g. broken footpaths) as well as their access to neighbourhood facilities such as youth centres, sports fields and movie theatres. The presence of each feature of disorder (e.g. broken footpaths) and facilities (e.g. park) was coded '1', with mean scores calculated for each student prior to aggregation.

The remaining five indicators were collected at the neighbourhood-level using national datasets. Data on licensed alcohol outlet density were obtained from the Ministry of Justice, with only off-premises (i.e. bottle stores, supermarkets, and grocery stores), bars (including taverns and night-clubs), sports clubs and restaurants/café included in the analysis. This excluded a number of outlets perceived to have very low access for adolescents, such as Veterans' organisations, vineyards and catering companies. Restaurants were included in light of evidence of their significant and positive relationship with a range of police events (e.g. violence, dishonesty

offences (Cameron et al., 2012)) and adolescent alcohol use (Rowland, Toumbourou, Satyen, Tooley, et al., 2014). Previous New Zealand research has found regulatory officers to perceive that some restaurants operate as de facto bars and pubs (Hill & Stewart, 1996).

All outlets were geocoded to street level using ArcMap and aggregated to the area unit level, with a 500m buffer added from the border of the area unit to allow for a degree of student mobility across area units. Area unit-level outlet density by total population size (per 1,000 residents) was calculated rather than area-based density, which may underestimate density in less intensified but larger area units. Area unit-level deprivation (in deciles) was obtained (University of Otago, 2014) and divided into tertiles (deciles 1-3 = low disadvantage; deciles 4-6 moderate disadvantage; deciles 7-10 high disadvantage). The skewness of many of the neighbourhood indicators resulted in the determination of categorical tertiles for each latent class indicator, rather than undertaking a Latent Profile Analysis which requires continuous indicators to be normally distributed.

Table 6-1

Neighbourhood Indicators Used to Identify Neighbourhood Types

Indicator	Items
Perceptions of safety	Do you feel safe in your neighbourhood?
Membership in community organisations	Do you belong to a group, club or team which is not run by your school? [a church group; a sports team or group; a cultural group; an environment organisation (e.g. Greenpeace); a volunteer group who help people with disabilities or in hospital; a volunteer group involved with young people, e.g. Youthline; another type of group or club]
Collective efficacy	<p><i>Social cohesion</i></p> <p>Do you trust the people in your neighbourhood?</p> <p>Do you feel you really belong in your neighbourhood?</p> <p>Do the people in your neighbourhood help each other?</p> <p>Are people in your neighbourhood friendly?</p> <p>Do you like your neighbourhood?</p>

	<i>Parental knowledge</i>
	Does your family want to know who you are with and where you are?
Neighbourhood facilities	What things are there to do in the area where you live that you can walk to from home? [park; youth centre; movies; skateboard ramp; basketball court or sports field; swimming pool or place to go swimming; gym; bike track; place to play video games]
Neighbourhood disorder	What are the bad things about the area where you live? [footpaths are rough and broken; not enough street lighting; no-one cares about how this place looks; too many dogs; rubbish and mess]
Off-premises density	Number of bottle stores (500m buffer), per 1,000 population
Bar density	Number of bars (500m buffer), per 1,000 population
Club density	Number of clubs (500m buffer), per 1,000 population
Restaurant density	Number of restaurants (500m buffer), per 1,000 population
Area-level disadvantage	Population-weighted average deprivation scores. Deprivation dimensions: Access to the Internet at home, proportion receiving welfare, low income, unemployment, educational qualifications, home ownership, single parent families, overcrowded living, access to car

c) Individual-level variables

Age, sex, and ethnicity were self-reported. Responses for ethnicity were prioritised and categorised into one of four groups according to New Zealand protocols (Ministry of Health, 2004); Māori (the indigenous people of New Zealand), Pacific (of Pacific Island descent), Asian (people with origins in the Asian continent), and New Zealand European (e.g. New Zealanders of European descent) or other ethnicity. Māori and Pacific peoples were given priority in the recording of ethnicity due to the significant health inequalities experienced by these groups. Age was dichotomised into young (<16 years) and older adolescents (≥ 16 years), with the latter age group typically characterised by major role transitions (including being able to legally leave school in New Zealand) and escalation of drinking and alcohol-related problems (Brown et al.,

2008). Family-level socio-economic indicators derived from a latent class analysis of the Youth'12 sample (Denny, 2016) were used to categorise whether a student's family was of low socio-economic position (SEP) and included: residential mobility, parental employment, perceptions of family worries regarding money to buy food, having family holidays, family ownership of a car, telephone, a mobile phone, a computer/laptop, a television, and living in an over-crowded home.

Data analysis

Beginning with a parsimonious one-class model, a series of models were run in Mplus (Version 7.3) to find the model that provided the best fit to the data. Neighbourhood sample size (n=209) was deemed adequate, especially in light of the high number of indicators used to clearly interpret the resulting classes (Nylund, Asparouhov, & Muthén, 2007; Wurpts & Geiser, 2014). Assessment of model fit centred on the Akaike Information Criterion (AIC), sample size adjusted Bayesian Information Criterion (BIC), and the Lo–Mendell–Rubin adjusted likelihood ratio test (LRT). Bivariate residuals between indicators were examined to ensure the assumption of conditional independence was met and multiple runs with random starting values were used to avoid local maxima. Following the identification of the best latent class solution, area units were assigned to neighbourhood types based on their most likely class membership. Variable-specific entropy was examined to determine the contribution of each indicator in the latent class analysis. Descriptive analyses of differences in demographic and neighbourhood-level characteristics between neighbourhood types were carried out using Chi-Square tests or ANOVA followed by the Tukey multiple comparison test ($\alpha=.05$).

Cross-classified multilevel modelling was used to analyse the association between neighbourhood types and drinking outcomes. A generalised linear regression model with a log link function in SAS 9.3 (SAS Institute, Inc. NC) regressed the binary outcomes on the derived latent classes, controlling for individual-level demographic characteristics. Cross-level interactions with all

demographic characteristics were examined. Both area unit and school were included as random effects to account for clustering in the data. Individual-level covariates were included at Level 1, with neighbourhood type at Level 2. Odds ratios (OR) and 95% confidence intervals (CI) are reported for all binary outcomes.

6.5 Results

The restricted sample (n=4267) of students, when compared to the excluded sample (n=2999), was found to have a higher proportion of Māori and Pacific students ($p<0.001$), more students of low family socio-economic position ($p<0.001$), and more males ($p<0.01$). The neighbourhoods in the included sample (n=209) were also found to have significantly higher mean neighbourhood disadvantage scores (101.34 vs 99.63, $p<0.05$) when compared to the excluded urban and semi-urban neighbourhoods. No differences between the samples were found in the age of participants or prevalence of drinking outcomes.

Table 6-2 outlines the demographic and neighbourhood-level characteristics of the overall sample, prior to latent class analysis. Almost two-thirds of students were less than 16 years of age, and almost half were of European or other ethnicity. In general, neighbourhoods to which the students belonged were characterised by high levels of perceived safety, moderate levels of community group membership and collective efficacy, and low levels of perceived neighbourhood disorder. In contrast, students reported low levels of neighbourhood facilities such as a place to play video games, skate ramp, gym, or youth centre. Findings from empty multilevel models (without explanatory variables) revealed variation in drinking and harm across area units.

Table 6-2

Individual- and Neighbourhood-level Characteristics of the Study Population

	All students (n=4267)
Demographics	
<16 years	64%
Female	54%
European or other ethnicity	47%
Māori	18%
Pacific	21%
Asian	14%
Low socio-economic position	23%
Alcohol consumption and harm	
Current drinking	40%
Binge drinking	20%
High typical quantity	18%
Alcohol-related harm	6%
All neighbourhoods (n=209)	
Latent class indicators: neighbourhood level	
Belong to a neighbourhood group (prevalence, SD)	69% (13%)
Perceptions of safety (prevalence, SD)	90% (9%)
Neighbourhood disorder (mean, SD, max=1)	0.10 (0.06)
Collective efficacy (mean, SD, highest score=3)	2.13 (0.18)
Neighbourhood facilities (mean, SD, highest score=1)	0.35 (0.11)
Area-level disadvantage (mean, SD, highest score =10)	6 (2.99)
Off-premises / 1,000 population (mean, SD)*	1.43 (1.19)
Bars / 1,000 population (mean, SD)*	1.04 (1.14)
Sports clubs/ 1,000 population (mean, SD)*	0.86 (1.31)
Restaurants / 1,000 population (mean, SD)*	1.78 (2.25)
SD = Standard Deviation, *Includes 500m buffer from boundary of area unit.	

Latent class analysis

The maximum number of latent classes examined was five. Although all fit statistics (Table 6-3) decreased from one though to five classes, the LRT test was significant at a three-class ($p < 0.001$),

but not four-class solution, suggesting that this model was most appropriate for the data. Closer examination of the three identified classes also demonstrated meaningfulness in assigning labels to each class. The entropy for this model was 0.88, indicating adequate precision in assigning area units to latent classes/types. Variable-specific entropy showed that measures of outlet density (excluding clubs), collective perceptions of disorder, area-level disadvantage, and collective efficacy contributed the greatest information to distinguishing the latent classes.

Table 6-3

Fit Indices for the Latent Class Analysis of Neighbourhood Types

	2 classes	3 classes	4 classes	5 classes
Log likelihood	-2177.09	-2082.17	-2053.90	-2023.95
AIC	4436.18	4288.33	4273.81	4255.91
BIC	4573.21	4495.56	4551.22	4603.51
Sample adjusted BIC	4443.30	4299.11	4288.23	4273.99
LRT adjusted	0.00	0.00	0.32	0.80
Entropy	0.83	0.88	0.90	0.91

AIC: Akaike information criteria; BIC: Bayesian information criteria; LRT: Lo–Mendell–Rubin adjusted likelihood ratio test.

Based on the indicator response probabilities (Table 6-4), Type 1 was characterised by high alcohol outlet densities, moderate-high levels of area-level socio-economic disadvantage and low-moderate levels of collective efficacy and perceptions of safety. This type was labelled “high outlet density and economic disadvantage”. Type 2 was similar, with item response probabilities indicating low levels of collective efficacy, high perceptions of disorder and low-moderate outlet densities. This class was labelled “high disadvantage, disorder, and social disorganisation”. Type 3 was treated as the reference group and was characterised by low-moderate outlet densities, low area-level disadvantage and perceptions of disorder, and moderate-high levels of collective efficacy. It was referred to as “higher income and socially organised”.

Table 6-4

Item-response Probabilities of Latent Class Indicators, by Neighbourhood Type

	High outlet density, economic disadvantage (n=64, 30.6%)	High disadvantage, disorder, and social disorganisation (n=81, 38.8%)	Higher income and socially organised (n=64, 30.6%)
Collective efficacy			
Low levels	0.29	0.54	0.08
Moderate levels	0.52	0.28	0.27
High levels	0.19	0.18	0.66
Belonging to a neighbourhood group			
Low levels	0.32	0.35	0.31
Moderate levels	0.27	0.37	0.31
High levels	0.41	0.28	0.38
Perceptions of safety			
High levels	0.25	0.11	0.69
Moderate levels	0.39	0.37	0.28
Low levels	0.36	0.52	0.03
Neighbourhood disorder			
Low levels	0.29	0.07	0.80
Moderate levels	0.34	0.41	0.19
High levels	0.38	0.53	0.00
Things to do in the neighbourhood			
Low levels	0.18	0.47	0.31
Moderate levels	0.35	0.34	0.35
High levels	0.48	0.20	0.34
Density of bars			
Low levels	0.05	0.52	0.37
Moderate levels	0.14	0.41	0.44
High levels	0.81	0.07	0.19
Density of off-premises			
Low levels	0.00	0.54	0.37
Moderate levels	0.07	0.40	0.55
High levels	0.93	0.06	0.08
Density of clubs			
Low levels	0.14	0.41	0.40
Moderate levels	0.28	0.41	0.32
High levels	0.58	0.17	0.29
Density of restaurants			
Low levels	0.03	0.65	0.20
Moderate levels	0.25	0.35	0.44
High levels	0.72	0.00	0.36
Neighbourhood disadvantage			
Low levels	0.12	0.00	0.69
Moderate levels	0.42	0.43	0.26
High levels	0.46	0.57	0.05

There were significant differences in individual-level demographic characteristics across the three neighbourhood types (Table 6-5). In general, the “high outlet density and economic disadvantage” and “high disadvantage, disorder, and social disorganisation” neighbourhood types had higher proportions of students of Māori and Pacific ethnicity, younger adolescents, and students living in families of low socio-economic position. Neighbourhood-level analyses found significant differences ($p < 0.05$) between types in mean population density per square kilometre, with higher levels in “high disadvantage, disorder, and social disorganisation” (2417/km²) compared to “high outlet density and economic disadvantage” (1925/km²) and “higher income and socially organised” (1909/km²). The proportions of neighbourhoods located in main urban areas ($\geq 30,000$ population) also differed significantly ($p < 0.001$), ranging from 98% in “higher income and socially organised”, to 91% in “high disadvantage, disorder, and social disorganisation”, and 75% in the “high outlet density and economic disadvantage” neighbourhood type.

Table 6-5

Individual-level Demographic Characteristics of Latent Neighbourhood Types

	High outlet density, economic disadvantage n=1252 (29%)	High disadvantage, disorder, and social disorganisation n=1856 (44%)	Higher income, socially organised n=1159 (27%)
<16 years*	62%	66%	64%
Female*	53%	52%	57%
European/other***	44%	35%	69%
Māori***	19%	22%	12%
Pacific***	21%	30%	4%
Asian	16%	13%	14%
Low SEP***	25%	31%	8%

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ based on Chi-Square test

Multilevel modelling

Table 6-6 presents the results of multilevel modelling, using “higher income and socially organised” as the reference group in all analyses. At the individual level, ethnicity significantly predicted drinking and harm, with more students of Māori ethnicity engaging in all drinking behaviours and experiencing alcohol-related harm in comparison to the reference group (European/other students). In contrast, students of Pacific or Asian ethnicity were less likely to drink and experience harm. Students of low family SEP were found to be particularly vulnerable to alcohol-related harm when compared to students of higher family SEP.

At the neighbourhood-level no significant associations were found between neighbourhood type and any of the drinking measures or harm. However, significant interactions with age were found in the neighbourhood level associations with all measured outcomes. No overall interaction was found with ethnicity and socio-economic position in any of the drinking outcomes. An interaction with sex was shown for high typical quantities, with females showing higher odds of consuming high typical quantities if living in “high disadvantage, disorder, and social disorganisation” neighbourhoods, when compared to the reference neighbourhood. As shown in Table 6-6 young adolescents (<16yrs) residing in “high outlet density and economic disadvantage” and “high disadvantage, disorder, and social disorganisation” had higher odds of consuming high typical quantities, compared to the reference neighbourhood type. Both neighbourhood types also had higher odds of binge drinking, which nearly reached significance ($p=0.05$ and $p=0.08$ respectively). Young adolescents living in “high outlet density and economic disadvantage” were also more likely to report current drinking. In contrast, among older adolescents (≥ 16 yrs), no significant associations were found between neighbourhood type and any of the drinking or harm measures.

Sensitivity analyses revealed that the effects of neighbourhood types varied according to the cut-off points used to define younger adolescents (i.e. <17years, <15years). Using the cut-off of <17

years revealed an interaction with age group for current drinking and alcohol-related harm, with young adolescents living in “high outlet density and economic disadvantage” having significantly higher odds of reporting alcohol-related harm (OR 1.5, 95% CI 1.0-2.3) compared to the reference group. Using the cut-off of <15 years demonstrated a significant interaction between age group and neighbourhood type for high typical quantities, current drinking, and binge drinking. No interaction was present in the association with alcohol-related harm. When compared to the reference neighbourhood type, young adolescents (<15 years) in the “high outlet density and economic disadvantage” (OR 1.6, 95% CI 1.2-2.3) or “high disadvantage, social disorganisation and unsafe” (OR 1.6, 95% CI 1.2-2.2) neighbourhoods exhibited significantly higher odds of current drinking. Stronger relationships were observed for more risky drinking patterns whereby young adolescents living in the “high outlet density and economic disadvantage” (OR 2.7 95% CI 1.4-5.2) or “high disadvantage, disorder, and social disorganisation” (OR 3.3, 95% CI 1.8-6.1) neighbourhoods exhibited significantly higher odds of consuming high typical quantities. Similar findings were evident for binge drinking.

Exploratory post-hoc interaction analyses were conducted to determine whether there were differential neighbourhood effects among subgroups of young adolescents (≤ 16 years). No significant cross-level interactions were found for sex or family socio-economic position.

Table 6-6

Results of Multilevel Modelling of Neighbourhood Types on Adolescent Alcohol Use and Harm

	Current drinking OR (95%CI)	Binge drinking OR (95%CI)	High typical quantity (OR 95%CI)	Alcohol-related harm (OR (95%CI))
Male ^a	0.88 (0.76-1.02)	1.03 (0.87-1.22)	1.12 (0.93-1.34)	0.77 (0.59-1.00)
Low SEP ^b	1.00 (0.83-1.19)	1.18 (0.95-1.46)	1.22 (0.98-1.52)	1.62 (1.17-2.24)**
Māori ethnicity ^c	1.49 (1.23-1.80)***	1.76 (1.42-2.18)***	2.54 (2.03-3.17)***	1.69 (1.23-2.31)**
Pacific ethnicity ^c	0.51 (0.40-0.64)***	0.65 (0.49-0.86)**	0.85 (0.63-1.15)	0.47 (0.30-0.73)**
Asian ethnicity ^c	0.29 (0.23-0.37)***	0.24 (0.17-0.34)***	0.28 (0.19-0.40)***	0.28 (0.15-0.51)***
<i>Young adolescents (<16yrs)</i>				
High outlet density, economic disadvantage ^d	1.33 (1.03-1.72)*	1.43 (1.00-2.06)	1.54 (1.01-2.34)*	1.65 (0.95-2.84)
Disadvantage, disorder, and social disorganisation ^d	1.25 (0.98-1.60)	1.35 (0.96-1.91)	1.82 (1.24-2.68)**	1.27 (0.74-2.18)
<i>Older adolescents (≥16yrs)</i>				
High outlet density, economic disadvantage	0.81 (0.60-1.11)	0.77 (0.56-1.05)	0.94 (0.68-1.30)	0.94 (0.59-1.50)
Disadvantage, disorder, and social disorganisation ^d	0.84 (0.63-1.13)	0.76 (0.56-1.02)	0.99 (0.73-1.35)	0.80 (0.51-1.26)

* p<0.05, ** p<0.01, *** p<0.001, ^a = compared to females, ^b = compared to higher family SEP, ^c= compared to European/other, ^d= compared to “higher income and socially organised” neighbourhood type

6.6 Discussion

This is the first study, to the authors' knowledge, to examine the relationship between neighbourhood types and adolescent alcohol use. Three types were identified, demonstrating variation in neighbourhood exposures and ethnic composition. Model results showed that area-level disadvantage, collective efficacy, alcohol outlet density, and collective perceptions of disorder showed discriminatory power in distinguishing the risk posed by the neighbourhood environment to adolescent alcohol use.

Only one other study could be identified which has investigated neighbourhood types relevant to adolescent alcohol use (Tobler et al., 2009). In this study, nine neighbourhood indicators relating to social capital, exposure to alcohol outlets and advertisements, and underage alcohol sales were used to describe the neighbourhoods to which multi-ethnic, early adolescents were exposed. Five neighbourhood types were revealed, with the ethnic distribution also varying considerably among types. In particular, African American youth were disproportionately exposed to high risk neighbourhoods. However, the association between neighbourhood type and adolescent alcohol use was not examined.

Many reasons may explain the similar risk in consuming high typical quantities consumed by students living in "high outlet density and economic disadvantage" and "high disadvantage, disorder, social disorganisation" neighbourhoods, despite some differences in neighbourhood attributes. Both types were characterised by moderate-to-high area-level disadvantage, supporting the findings from multilevel research of New Zealand adolescents which has demonstrated significant effects of neighbourhood disadvantage on high typical consumption (Huckle, Huakau, et al., 2008; Vinther-Larsen et al., 2013). Additionally, both types were characterised by low-to-moderate levels of collective efficacy which has been found to mediate the association between neighbourhood disadvantage and anti-social behaviour (Duncan, Duncan, Okut, Strycker, & Hix-Small, 2003; Sampson et al., 1997). Although the levels of outlet density differed between the

two risky neighbourhood types, the use of tertiles may have misrepresented the overall high levels of outlet density in the New Zealand context. Although “high disadvantage, disorder, social disorganisation” had lower outlet densities when compared to “high outlet density and economic disadvantage”, post hoc analyses found that the mean bar density (without a buffer for comparison purposes) in “high disadvantage, disorder, social disorganisation” neighbourhoods was similar to densities found to be associated with alcohol-related harm in Australia (Livingston, 2011; Rowland, Toumbourou, Satyen, Tooley, et al., 2014). Of concern, when compared to the Australian studies, the density of off-premises in “high disadvantage, disorder, social disorganisation” neighbourhoods was much higher. As such, a low tertile of outlet density is not truly low in an environment where alcohol outlets are ubiquitous. The presence of higher levels of drinking in risky neighbourhoods may provide further support for the larger effects of outlet density in deprived neighbourhoods (Mair, Gruenewald, Ponicki, & Remer, 2013). Although mechanisms for this increased vulnerability to harm in disadvantaged populations is unclear, it is suggested that alcohol-related problems may be related to the many negative amenity effects which alcohol outlets bring to disadvantaged communities (Livingston, Chikritzhs, & Room, 2007).

The possibility of misclassification of an adolescents’ neighbourhood may have led to erroneous assignment of contextual exposures. For example, it is plausible that adolescents residing in “high disadvantage, disorder, social disorganisation” neighbourhoods spent time in “high outlet density and economic disadvantage” neighbourhoods, as it has been shown that low and middle income groups spend more time across areas of disadvantage than high income groups (Shareck, Kestens, & Frohlich, 2014). This is aligned with findings that adolescent drinking in neighbourhoods with low outlet densities may be mitigated by having friends with a car (Chen et al., 2010). Moreover, Sampson (2012) has shown that the social characteristics of a “neighbourhood’s neighbour”, especially the level of disadvantage and collective efficacy, may be independently associated with individual-level outcomes. The increasing spatial separation or segregation of disadvantage in

New Zealand (Morrison, 2011) strongly highlights the need to incorporate spatial dependence into neighbourhood studies.

Despite the uncertain mechanisms of neighbourhood effect, the latent class approach highlighted key exposures which may be interrelated with adolescent drinking, namely area-level disadvantage, collective perceptions of physical disorder, collective efficacy and outlet density. Further research is required, using methods such as multilevel path analysis, to identify the causal pathways of these key neighbourhood exposures. Exposures relating to the institutional resources pathway, such as community organisation membership or having things to do in the neighbourhood, were found to contribute little to distinguishing between neighbourhood types.

The moderation by age in the current study signifies the need to take a developmental approach to the study of neighbourhood effects in adolescents. The Social Development Model (Catalano & Hawkins, 1996) posits that different factors will be more or less important through the stages of adolescence, or may operate differently across developmental periods (Aber et al., 1997). Evidence has documented the salience of neighbourhood factors in early adolescence in comparison with older adolescence (Abadi et al., 2011; Cleveland et al., 2008; Ferguson & Meehan, 2011). The differential effects found in the current study may point to area-level disadvantage and perceptions of disorder reducing collective efficacy within neighbourhoods, with the latter being more salient to young adolescents. For example, there may be a threshold for communities to intervene to reduce adolescent drinking, which may be considered normative or a 'rite of passage' among older adolescents but not so among those younger. This may be especially so in countries such as New Zealand, where the legal purchase age (18 years) may be lower than is found in other countries. Furthermore, collective efficacy is considered to be situational, whereby the community intervenes on behaviours that occur within neighbourhood borders (Sampson, 2012). Perhaps older adolescents' lived spaces for drinking do not coincide with area unit boundaries as much as they do for younger adolescents. Furthermore, young adolescents have been shown to be more vulnerable to the effects of outlet density (Rowland,

Toumbourou, Satyen, Tooley, et al., 2014), with suggestion that this may reflect their reliance of neighbourhood sources of alcohol (e.g. home, friends) in contrast older adolescents who may be more mobile to acquire alcohol from elsewhere. Finally, the combination of exposures in the latent class model may have combined different pathways of effect, many of which may work in opposing directions in older adolescents to cancel out an overall direct neighbourhood effect (Shrout & Bolger, 2002).

Relevant theories to the causal pathways of neighbourhood effects also point to the likelihood that effects may vary by stage of development. Neighbourhood influences are widely believed to indirectly affect behaviour, by operating through more proximal factors (Leventhal & Brooks-Gunn, 2000). For example, the effects of neighbourhood disadvantage and collective efficacy may be mediated through family functioning and parenting practices, which in turn may influence an adolescent's peer associations which are strongly associated with alcohol use (Trucco et al., 2014). As studies have shown that family-level protective factors have the strongest effects in early adolescence (Abadi et al., 2011; Cleveland, Feinberg, & Jones, 2012), it would seem reasonable that younger age groups may be more vulnerable to neighbourhood effects. Also, evidence from epigenetics suggests that environmental moderation of genetic effects on alcohol consumption occurs in early adolescence. For example, the impact of perceived alcohol availability may have a stronger effect on consumption in young adolescents with genetic risk factors for alcohol use disorders (Kendler et al., 2011).

These findings help to explain the mixed findings to date regarding neighbourhood effects on adolescent alcohol use. By disregarding the developmental approach to the study of contextual pathways, the heterogeneity of neighbourhood effects across demographic groups may be masked. In a systematic review of multilevel studies examining neighbourhood effects on adolescent alcohol use (Jackson, Denny, & Ameratunga, 2014) very few studies reported moderation analyses, despite well-known theory and evidence to indicate its importance. Masking these harms on early adolescents is of particular concern given the damaging effect of alcohol

consumption on the early adolescent brain (Schweinsburg et al., 2010), the increased likelihood of high-risk drinking in adulthood due to early initiation, and the multitude of educational and social harms which often result from drinking in early adolescence (Viner & Taylor, 2007).

Inherent in this cross-sectional study are a number of limitations. Firstly, the observational nature of this study precludes causal inference or the ability to examine reciprocal or bidirectional mechanisms which may influence behaviour (Trucco et al., 2014). Misclassification of a student's area unit may have arisen as almost 30% of the total student sample lived in two or more homes. This "uncertain geographic context problem" (Kwan, 2012) is common in contextual studies and may be partly addressed through the use of GPS technology to track activity spaces and real time of exposure to neighbourhood attributes. The low variability and reliability of some of the aggregated neighbourhood indicators and the inability to obtain independent assessments of neighbourhood social factors may have biased the contextual effect (Ludtke et al., 2008). This study is also at risk of residual confounding if the measures of neighbourhood composition were not perfectly specified (Oakes, 2004) or other important contextual exposures were omitted which give rise to alcohol use. The applicability of the findings (especially for older adolescents) may not extend to students who were truant on the day of the survey, home-schooled, in alternative education, dropped out of school or resided in rural settings. The neighbourhood influences relevant to drinking behaviours in these omitted groups, particularly youth in rural settings, requires further research.

In conclusion, the study's findings highlight the necessity of adopting a developmental approach to the study of contextual effects in adolescents. Key neighbourhood exposures which characterised risky neighbourhoods, such as disadvantage, perceptions of disorder, collective efficacy, and outlet density provide impetus for further examination of mediating and moderating neighbourhood processes. Research which captures an adolescent's lived experience of their neighbourhood would greatly assist in understanding the salience of the neighbourhood across different ages and improve the delivering of targeted programmes to reduce harm.

Chapter 7 Pathways of neighbourhood effects on adolescent alcohol use

7.1 Preface

Publication

This chapter includes content from the article “Jackson, N., Denny, S., Sheridan, J., Zhao, J. & Ameratunga, S. (2016). The role of neighborhood disadvantage, physical disorder, and collective efficacy in adolescent alcohol use: a multilevel path analysis. *Health & Place, 41*, 24-33.”

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Link to thesis objectives:

- To explore the mediating and interacting pathways of neighbourhood effects on adolescent alcohol use

Why was this study needed?

The previous chapter identified key neighbourhood exposures which may give rise to adolescent drinking. The role of each exposure in directly affecting alcohol use, or moderating or mediating the effects of other exposures, was not explored. In addition, the preceding chapter did not incorporate spatial dependence (i.e. spill-over effects) in the examination of neighbourhood effects. The theoretical likelihood that drinking outcomes in the previous chapter were the result of neighbourhood-level and cross-level interactions, which exacerbate or attenuate risk, pointed to the need to take advantage of recent software developments which permit multilevel approaches to further explore the pathways of neighbourhood effects.

What was undertaken?

A multilevel path analysis was undertaken to examine the effects of neighbourhood disadvantage, alcohol outlet density, collective perceptions of physical disorder, and collective efficacy on adolescent drinking. Neighbourhood-level and cross-level interactions were utilised to provide a

richer understanding of the pathways of effects. The significant effects of outlet density on alcohol use and the post-hoc analyses of pathways of collective efficacy were not included in the submitted manuscript but have been inserted into the following chapter. This study is the first of its kind to be identified which seeks to undertake an empirical examination of the Social Disorganisation Theory on adolescent alcohol use.

7.2 Abstract

The neighbourhood is a primary social context for adolescent development. Research into the salient exposures which explain neighbourhood variation in adolescent alcohol use remains inconclusive. The Social Disorganisation Theory suggests that neighbourhood-level disadvantage may reduce collective efficacy to control adolescent risky behaviour. The compelling effects of collective perceptions of physical disorder and alcohol outlet density may also be implicated in this pathway of neighbourhood effects. Drawing on data from a nationally-representative survey of urban high school students in New Zealand, multilevel path analysis was used to estimate the direct and mediating effects of neighbourhood disadvantage, physical disorder, collective efficacy, and alcohol outlet density on adolescent drinking. The findings supported an indirect pathway from disadvantage to increased risky drinking in young adolescents (<16 years), mediated by physical disorder and reduced collective efficacy. Collective efficacy was unrelated to current drinking, suggesting a threshold or tipping point effect. Opposing effects of collective efficacy were evident among older adolescents (≥ 16 years), demonstrated by positive associations with drinking. Alcohol outlet density was not implicated in the collective efficacy pathway, but showed direct effects on drinking in both young and older adolescents. Implications for future research are discussed.

7.3 Introduction

An accumulating body of empirical evidence supports the role of the neighbourhood in adolescent development, suggesting that many adolescent outcomes result from common underlying structural and social processes (Booth & Crouter, 2001). Extant research has focused on the Social Disorganisation Theory (Shaw & McKay, 1942), which suggests that neighbourhood structural disorganisation (e.g. area-level disadvantage, residential mobility, and/or ethnic heterogeneity) weakens the bonds between neighbours, reducing their ability to build a normative consensus and control problematic behaviour (Kubrin, 2009).

The potential for the presence of strong bonds among neighbours or unhealthy networks to act as a contagion to facilitate problem behaviour in disadvantaged neighbourhoods (Browning et al., 2004; Gau, 2014; Wilson, 1987) led many to consider the importance of “what was being connected” (Sampson, 2012, p.151). It was further suggested that neighbourhood bonds were insufficient on their own to control behaviour but rather, what was required was shared expectations for informal social control (Sampson et al., 1997). Moreover, within a transformed urban environment, neighbours were considered to be more satisfied with a level of working trust and infrequent social interaction, rather than sitting down for dinner together (Sampson, 2012). Consequently, the traditional definition of the Social Disorganisation Theory was relaxed to include the mediating concept of ‘collective efficacy’, incorporating the components of social cohesion (established through weak rather than strong ties) and informal social control (Sampson et al., 1997).

A number of mechanisms may explain the role of neighbourhood disadvantage hindering the development of social cohesion. Firstly, the creation and maintenance of neighbourhood ties requires time and energy (Sampson & Groves, 1989), with low-income area residents being more likely to have less regular working hours, commute for longer, and consequently have less free time for neighbourhood interaction (Valdimarsdóttir & Bernburg, 2015). Secondly, collective perceptions of physical disorder (e.g. broken footpaths, rubbish) in disadvantaged

areas may have compelling effects on the development of neighbourhood trust, attachment, and participation in community life (Burchfield, 2009; Diez Roux, 2001; Skogan, 2012). Within a disordered environment, many neighbours may be reluctant to venture outside, reducing their ability to form ties and observe positive neighbourhood interaction (Cohen et al., 2008). Additionally, the effects of disorder may go beyond the visible signs of decay (Sampson & Raudenbush, 2004; Skogan, 1992), whereby residents attribute the stigma or neighbourhood reputation associated from disorder with a deeper social meaning of community malaise (Forrest & Kearns, 2001).

The ability for neighbours to establish common values and shared expectations for social control may also be impeded in disadvantaged communities. High levels of adult alcohol use, resulting from high densities of alcohol outlets coupled with low prices (Morrison et al., 2015), may give rise to a high prevalence of adult drinkers. This could affect the overall tolerance to alcohol use and willingness to intervene (Fagan et al., 2015a). The ability to build a normative consensus may also be compromised when there is a co-occurring presence of anti-social role models in the community, such as gangs (Pattillo, 1998; Valdimarsdóttir & Bernburg, 2015). Others refer to an increased prevalence of moral or legal cynicism or “Code of the Street” (Anderson, 1999; Soller et al., 2014) in disadvantaged communities, resulting from heterogeneity or ambiguity in value systems regarding deviance which weakens overall opposition to its occurrence (Kubrin & Weitzer, 2003; Sampson, 2012; Stewart & Simons, 2010). Notwithstanding, disadvantaged communities are not condemned to reduced collective efficacy as some studies have shown that high levels of monitoring and control can co-exist with area-level economic disadvantage (Chuang, Ennett, Bauman, & Foshee, 2005; Sampson, 2012). Sampson (2012) suggests that disadvantaged communities may have latent collective efficacy which is suppressed by cumulative disadvantage.

Although the emergent, protective concept of collective efficacy was originally developed to explain neighbourhood variation in crime (Sampson et al., 1997) it has since been shown to

have wide reach in relation to a range of adult and adolescent health and social outcomes. Among children and adolescents, it has been found to be positively associated with the use of preventative services (Frankenberg, 2004), and general health (Browning & Cagney, 2002), and inversely associated with obesity (Cohen et al., 2006), anti-social behaviour (Odgers et al., 2009), sexual initiation (Browning et al., 2005), and violence (Maimon & Browning, 2010). It may also act as a moderator, enhancing the protective effect of family attachment and support on suicide attempts (Maimon et al., 2010) and attenuating the relationship between victimisation and substance use (Fagan et al., 2014).

The demonstration of protective health effects suggests that collective efficacy may be perceived as a general capacity, not just directed towards crime control issues (Uchida et al., 2015). As such, neighbourhood-level supervision or regulation may play a broad role in neighbourhood well-being (Sampson, 2012). With regards to adolescents, a number of mechanisms may explain its protective effects. Parents within high collective efficacy neighbourhoods may exert subtle or not-so-subtle pressures upon the parents of deviant youth to become more responsible caregivers (Simons et al., 2005). They may also work together to supervise local youth, disseminate information regarding their behaviour, and reinforce to adolescents the appropriate social norms (Maimon & Browning, 2012). These processes may lead to adolescents feeling an added layer of surveillance and supervision, reducing their engagement in risky behaviour for fear that such action may be noticed by others, sanctioned, and result in disappointment (Fagan et al., 2014; Sampson et al., 1997). Adolescents may also feel protected knowing that there are others looking out for their welfare that can be trusted to intervene on their behalf (Aisenberg et al., 2008).

To date, the intervention literature linking the concepts of the Social Disorganisation Theory to adolescent alcohol use is scarce. Moving to Opportunity, which tested the effects of moving from high- to low-poverty neighbourhoods, showed positive effects on reduced drinking in young adolescent females but not their male counterparts (Sciandra et al., 2013).

However, the findings have been questioned due to the highly selective sample, the inability to control for the disrupting effects of moving, and the level of inference permitted from the study design (DeLuca & Rosenbaum, 2003; Sampson, 2012).

Observational, multi-level studies have found mixed results for the role of neighbourhood disadvantage, disorder, and collective efficacy on adolescent alcohol use (Bryden et al., 2013; Fagan et al., 2015b; Jackson, Denny, & Ameratunga, 2014; Smith et al., 2014; Whaley et al., 2011) which may, in part, be due to methodological limitations. In particular, studies often control for potential mediators (e.g. parental and peer factors) on the causal pathway, consequently masking the neighbourhood effect (Jackson, Denny, & Ameratunga, 2014). Heterogeneity of neighbourhood effects is often neglected, whereby factors such as age (Matjasko, Needham, Grunden, & Farb, 2010; Rowland, Toumbourou, Satyen, Tooley, et al., 2014), genetics (Kendler et al., 2011), impulsivity (Neumann et al., 2010), or location of residence (Azar et al., 2016) may moderate the effect of the neighbourhood on adolescent drinking behaviour. Adolescent development theory (Catalano & Hawkins, 1996) emphasises the potential for moderation, indicating that risk and protective factors will have varying salience across the non-linear stages of adolescent development. The lack of findings in previous studies could also reflect the choice to combine the use of different substances under the umbrella of 'substance use', concealing the likelihood that collective efficacy is a behaviour-specific construct (Erickson, Harrison, Cook, Cousineau, & Adlaf, 2012). To reduce same-source bias, some studies measure collective efficacy from the parents of adolescents or general residents. This may present problems if perceptions differ between adults and adolescents, as shown by others (Witherspoon & Ennett, 2011), and if the mechanisms of collective efficacy are via adolescent perceptions rather than that of adults. Many studies also seek to examine the effect of collective efficacy on less risky drinking patterns (e.g. past year use), negating the likelihood that community social processes are not set in motion until thresholds or severity of behaviour are met (Ahern, Margerison-Zilko,

Hubbard, & Galea, 2013; Diez Roux, 2001; Galster, 2010; Livingston, 2008). Furthermore, the use of city-based samples in studies may produce downward bias if the included neighbourhoods have limited variation across exposures to identify important effects (Leventhal & Brooks-Gunn, 2000). Finally, the unit of geography to demarcate neighbourhoods is important to consider, given that the study of large units may dilute the effects of social mechanisms which may operate at smaller levels of geography (Gerell, 2015).

To further complicate matters, adolescents are also exposed to, and influenced by, the characteristics of their surrounding neighbourhoods, including those contiguous to their school. This has considerable implications for neighbourhood effect studies, highlighted by Byrnes et al. (2015) showing that older adolescent activity spaces intersected with 24 census tracts during a one-week period. The findings of independent or spill-over effects of the surrounding neighbourhood's level of disadvantage, collective efficacy (Sampson, 2012), and ethnic diversity (Jackson et al., 2015) on health and social outcomes strongly indicate the need to incorporate spatial dependence models in neighbourhood-level studies (Sampson, 2012).

Finally, the majority of studies have focused on direct effects, rarely exploring the mediating pathways which neighbourhood conditions may influence (Jackson, Denny, & Ameratunga, 2014). This is particularly important in the study of neighbourhoods effects, whereby distal exposures are often transmitted through a number of additional links in a causal chain, many of which may work in opposing directions to cancel out an overall direct effect (Shrout & Bolger, 2002). Recent advancements in statistical software, which permit mediation modelling within a multilevel framework, provide exciting opportunities for researchers to take the next steps towards understanding the salient pathways of neighbourhood exposures. In the current study, it was primarily hypothesised (Figure 7-1) that a specific indirect effect would be found, whereby neighbourhood disadvantage was associated with physical disorder

which reduced collective efficacy within neighbourhoods to control adolescent risky drinking patterns. A secondary hypothesis was tested to explore if alcohol outlet density was implicated in the pathway, through its effects on perceptions of disorder or collective efficacy (Maimon & Browning, 2012). Based on previous findings in Chapter 6, age was expected to moderate the effects of neighbourhood exposures.

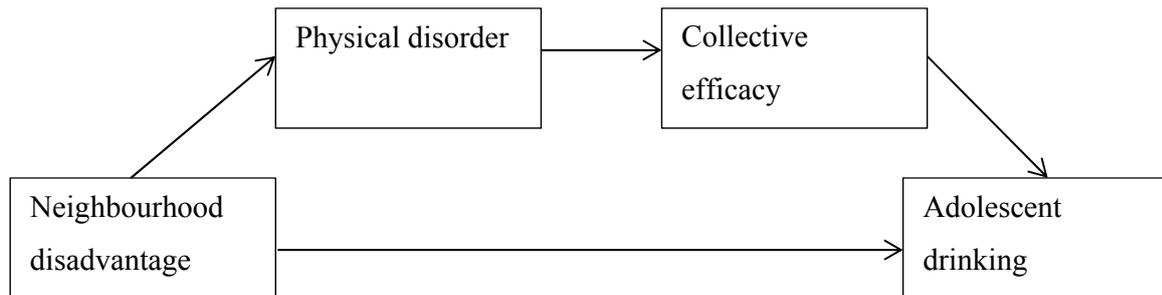


Figure 7-1. Hypothesised multilevel path model

7.4 Methods

Participants

In 2012, a national cross-sectional, self-administered survey (Youth'12) was carried out among a random sample of high schools in New Zealand. The survey, completed using a hand-held computer tablet, covered a broad range of health and wellbeing issues including alcohol use. Details regarding the survey questions (Adolescent Health Research Group, 2012) and methodology are available elsewhere (Clark, Fleming, Bullen, Denny, et al., 2013).

Of 397 eligible high schools, 125 were randomly selected and invited to participate. Ninety-one (73%) schools agreed to take part. Participation was lowest for boys' schools and schools with a deprivation decile of 6 or 7 (1=high, 10=low). Of the 12,503 students randomly selected and invited to participate 8,500 (68%) agreed, representing 3% of the New Zealand high school roll in 2012. Common reasons for not participating were absence from school, being unavailable, or declining to take part. Comparisons between participating and eligible students revealed that participating students were slightly younger and more likely to be male.

Dependent measures

Binge drinking, high typical quantity, and current drinking were included as binary dependent variables. *Binge drinking* was defined as one or more occasions in the last 4 weeks of consuming 5 or more drinks on one occasion. This was derived from the question “In the past 4 weeks, how many times did you have 5 or more alcoholic drinks in one session - within 4 hours?, with response options including none at all, once, two or three times, every week and several times a week. *High typical quantity* was defined as typically consuming 5 or more drinks on any drinking occasion. This was derived from the question “How many alcoholic drinks do you usually have in one session - within about 4 hours?” with responses including 1, 2, 3-4, 5-9, 10-20 and more than 20 drinks. *Current drinking* was defined as having ever consumed alcohol and not indicating current abstention. Students who were not current drinkers were coded as non-binge drinkers and typically consuming less than 5 drinks on any drinking occasion.

Independent measures

Between-level

‘Neighbourhood’ was conceptualised in this study by the area unit in which the student usually resided. An area unit is a non-administrative area with an average population of 3000-5000, generally coinciding with a student’s neighbourhood suburb (Statistics New Zealand, 2014a). Each area unit comprises a number of smaller geographic units, known as meshblocks. The Youth’12 survey collected data from students residing in 1171 area units, or 58% of the total number of area units throughout New Zealand. Area units were categorised into one of three geographical areas: main urban ($\geq 30,000$ population), secondary urban (1000-29,999), and rural areas (< 1000), with the latter (n=1234 students, 225 neighbourhoods) excluded from the analysis to prevent the masking of differences of neighbourhood effects for students from rural versus urban areas (Azar et al., 2016). To

enhance the reliability of neighbourhood-level measures derived from individual-level aggregation (Raudenbush & Sampson, 1999) area units with fewer than 11 students were dropped from the analysis (n=2999 students). This resulted in a sample of 4267 urban and semi-urban students residing in 209 area units, with a median area unit population of 3750 (range 249-8238), and a median of 17 respondents per area unit (range 11-68). Comparisons between the excluded neighbourhood sample (n=737 neighbourhoods) and the included sample (n=209) revealed the latter to have significantly higher mean neighbourhood disadvantage scores (101.34 vs 99.63, $p<0.05$). Comparisons between the excluded (n=2999) and included (n=4267) students also revealed significant differences, with the included sample including more students of Māori or Pacific ethnicity ($p<0.001$), more students of low family socio-economic position ($p<0.001$), and more males ($p<0.01$). No differences between the two samples were found in the age of participants or prevalence of drinking outcomes.

Four neighbourhood-level exposures were investigated using multilevel path analysis: neighbourhood disadvantage, physical disorder, collective efficacy, and alcohol outlet density. These indicators were drawn from a prior latent class analysis of the same urban adolescent sample, which identified distinguishing features of risky neighbourhoods associated with adolescent alcohol use (Chapter 6).

1) Neighbourhood disadvantage

Population-weighted neighbourhood disadvantage scores were obtained (University of Otago, 2014) from aggregation of census data from each comprising meshblock. Disadvantage scores had been derived from a principal component analysis of meshblock-level deprivation features collected in the 2013 census (e.g. income, access to the internet, employment, qualifications, home ownership, single parent families, overcrowding, and access to a car) to create the national NZDep2013 score (Atkinson et al., 2014). Among the 209 neighbourhoods included in the study, the disadvantage scores ranged from 890-1278. For the current study, the score was divided by 10, so that the regression co-efficient could be more easily

interpreted to reflect the change in the outcome for every 10 unit increase in disadvantage score.

2) Neighbourhood physical disorder

The Youth'12 survey asked students to report on the following features of their neighbourhood: rough or broken footpaths, poor street lighting, no one caring about how the neighbourhood looks, too many dogs, and too much rubbish. Each indicator was given a value of one, with mean scores per student calculated prior to area unit aggregation. The internal consistency (Cronbach's $\alpha=0.58$) and the neighbourhood-level reliability (reliability=0.56) of the aggregated measure (Bosker, 2012) were considered low, although in the range reported by others (Mujahid, Roux, Morenoff, & Raghunathan, 2007).

3) Collective efficacy

Collective efficacy was determined using a range of Youth'12 individual-level questions relating to perceptions of social cohesion and parental knowledge of adolescent activities (hereon referred to as parental knowledge). Dimensions of social cohesion were obtained by asking each student about the following features of their neighbourhood environment: 1) perceived trust towards neighbours; 2) feeling of belonging to the neighbourhood; 3) perception that neighbours help each other; 4) friendliness of neighbours; and 5) liking their neighbourhood. Response options ranged from all the time, sometimes, not often, to never (individual-level $\alpha=0.89$). Each response was converted into a numerical score, with mean scores calculated for each student prior to neighbourhood-level aggregation (maximum=3). Parental knowledge was assessed by students reporting on whether their family wanted to know who they were with and where they were, with responses including always, usually, sometimes, and almost never. Aggregated scores of parental knowledge were included to represent the community-level informal social control component of collective efficacy, as it has been shown that parental knowledge is positively associated with neighbourhood levels of

informal control (Fulkerson et al., 2008). Collective efficacy at the neighbourhood-level was determined by summing the scores of neighbourhood-level social cohesion and neighbourhood-level parental knowledge (low=0, high=6). Reliability of the aggregated neighbourhood-level measure of social cohesion was deemed somewhat low at 0.57, and the reliability of parental knowledge was considered poor (reliability=0.24). Individual-level social cohesion and parental knowledge scores were included as covariates in all models.

4) Alcohol outlet density

Data on licensed alcohol outlet density were obtained from the New Zealand Ministry of Justice, with only off-licenses (i.e. bottle stores, supermarkets, and grocery stores), bars (including taverns and night-clubs) and sports clubs included in the analysis. This excluded a number of outlets which were perceived to have very low access for adolescents, such as Returned Servicemen Associations, vineyards, function centres, restaurants, and catering companies. Each of the three outlet types was geocoded to street level using ArcMap and aggregated to the area unit level. Area unit-level outlet density by total population size (per 1,000 residents) was calculated rather than area-based density, which may underestimate density in less intensified but larger area units.

Within-level control variables

A number of individual-level variables were included in the analysis to control for neighbourhood composition, whilst acknowledging a perceived false dualism of composition and context given that there can be a mutually reinforcing and reciprocal relationship between individuals and place (Cummins et al., 2007; Merlo & Chaix, 2006). Indeed, selection into, and remaining within, a neighbourhood is considered a neighbourhood effect in itself (Sampson, 2012). Composition characteristics including age, sex, and ethnicity were self-reported, with the latter categorised into one of four groups according to the New Zealand classification of ethnicity (Ministry of Health, 2004); Māori, Pacific, Asian, and New Zealand

European or other ethnicity. To increase predictive power and achieve model parsimony ethnicity was dichotomised into Māori or Pacific (two ethnic groups in New Zealand who experience significant health inequities) and European or other. Age was dichotomised into two groups; young adolescents (<16 years) and older adolescents (≥ 16 years). A binary measure of family-level socio-economic position (SEP) was derived from a prior latent class analysis of the Youth'12 sample (Denny, 2016) and included a range of indicators to categorise whether a student's family was of low socio-economic position. Socio-economic indicators included: residential mobility, parental employment, perceptions of level of family worry about not having enough money to buy food, having family holidays, family ownership of a car, telephone, a mobile phone, a computer/laptop, a television, and living in an overcrowded home. A binary measure of parental alcohol use (yes/no) was also included as a covariate, as well as self-reported neighbourhood exposures measured at the individual level (e.g. perceptions of physical disorder).

Data analysis

Spatial autocorrelation between area units was tested for neighbourhood disadvantage and for each type of alcohol outlet. Significant spatial autocorrelation, as indicated by Moran's I, was present for disadvantage and off-licence and bar density signifying the need to include spatial lags, i.e. the average disadvantage value or outlet density of a specified number of neighbours of an area unit, to prevent violation of the assumption of independence of observations. A spatial disadvantage and alcohol outlet lag was calculated using ArcMap 10.3, based on the weighted (by inverse Euclidean distance between the centre of an area unit and the centres of its neighbours) average disadvantage and outlet density scores of the nearest 8 area units (neighbours). Spatial lags for the self-reported measures of physical disorder or collective efficacy could not be calculated due to insufficient numbers of students across contiguous area units.

Multilevel path analysis examined the mediating pathways of neighbourhood disadvantage on adolescent drinking. The non-normality of the neighbourhood-level exposures, frequency of zero cells for the binary outcomes, as well as the non-linear approaches required (De Stavola, Daniel, Ploubidis, & Micali, 2015) suggested the need to conduct the analyses using MLR estimation in Mplus Version 7.3 (Muthen, Muthen, & Asparouhov, 2015). A range of measures were used to assess model fit; comparative fit index (CFI) >0.95, root mean-square error of estimation (RMSEA) <0.06, and a standardised root-mean-square residual (SRMR) <.08 (Kline, 2011). It is acknowledged that these standard model fit indices for single-level models may not adequately capture model fit in higher-level models (Ryu, 2014). Fit indices are not available when using MLR, but can be identified using the WLSMV estimator in Mplus. MLR estimates are however more interpretable, given the use of logistic, rather than probit regression used in WLSMV. For each drinking outcome, interactions between neighbourhood-level exposures were first investigated, as recommended by Muthen (2011). All neighbourhood-level variables were grand-mean centred to obtain meaningful parameters in neighbourhood-level interaction analyses and to reduce the likelihood of multi-collinearity.

Mediation modelling investigated the proposed pathway of disadvantage→physical disorder→collective efficacy→drinking outcome. Analysis of direct effects between the neighbourhood exposures and outcome was not undertaken prior to mediation analysis as this may miss important distal effects (Hayes, 2009; Shrout & Bolger, 2002; Valeri & Vanderweele, 2013). Alcohol outlet density was included in the model and hypothesised to either increase perceptions of physical disorder, reduce collective efficacy, or interact with collective efficacy in the relationship with drinking. Cross-level interactions using random slope models with age group, sex, ethnicity, and family SEP were entered alone in each analysis to assess heterogeneity of effects among demographic strata. To find the most parsimonious model for the data, all paths between the predictor variables and the outcome were first included. Subsequently, non-significant paths were removed and all covariates were

retained. Results are reported as unstandardised path coefficients and their respective p value or odds ratios and 95% confidence intervals (CI).

7.5 Results

Table 7-1 outlines the demographic and neighbourhood-level characteristics of the sample. Almost two-thirds of students were <16 years of age, and almost half were of European or other ethnicity. Tests of differences between the two age groups showed more young adolescents reported Māori or Pacific ethnicity ($p<0.001$), family level poverty ($p<0.05$), and higher levels of parental knowledge ($p<0.001$). A significantly higher proportion of older adolescents reported binge drinking ($p<0.001$), consuming high typical quantities ($p<0.001$), currently drinking ($p<0.001$), and had parents that drank alcohol ($p<0.001$). Neighbourhoods to which the students belonged were characterised by moderate levels of collective efficacy and disadvantage and low levels of physical disorder. Students appeared to be exposed to higher densities of off-licence outlets than their counterparts in Australia (Livingston, Laslett, & Dietze, 2008; Rowland et al., 2015).

Findings from unconditional, cross-classified, multilevel models (without explanatory variables) revealed variation across neighbourhoods in adolescent drinking, which further varied by age. Median odds ratios (MOR) were calculated (Merlo et al., 2006) indicating differences in the probability of drinking between high and low risk neighbourhoods. Almost 4% of the variation in high typical quantity in young adolescents was found at the neighbourhood level (MOR 1.42) compared to 2% within older adolescents (MOR 1.31). In contrast, only 1% (MOR 1.17) of the variation in binge drinking in young adolescents was found at the neighbourhood level compared to 4% within the older adolescent age group (MOR 1.43).

Table 7-1

Characteristics of the sample population and neighbourhoods they resided in

	Young adolescents (< 16 yrs) (n=2738, 64%)	Older adolescents (≥ 16 yrs) (n=1519, 36%)
<i>Demographics</i>		
Female	1464 (53%)	815 (54%)
Māori or Pacific ethnicity ^a	1151 (42%)	506 (33%)
Low socio-economic status ^b	651 (24%)	316 (21%)
Parental alcohol use ^a	1375 (50%)	928 (61%)
Parental knowledge (mean, SD, max=3) ^a	2.54 (0.67)	2.46 (0.73)
Perceived social cohesion (mean, SD, max=3)	2.19 (0.67)	2.15 (0.68)
Perceived physical disorder (mean, SD, max=1)	0.10 (0.18)	0.09 (0.18)
<i>Alcohol consumption and harm</i>		
Binge drinking ^a	314 (11%)	540 (36%)
High typical quantity ^a	269 (10%)	478 (31%)
Current drinking ^a	775 (29%)	925 (63%)
All neighbourhoods (n=209)		
<i>Neighbourhood-level</i>		
Physical disorder (mean, SD, max=1)	0.10 (0.06)	
Collective efficacy (mean, SD, max =6)	4.69 (0.31)	
Area-level disadvantage (mean, SD)	101.34 (9.50)	
Disadvantage spatial lag (mean, SD)	101.94 (7.33)	
Off-licence density* (mean, SD)	0.51 (0.62)	
Off-licence spatial lag* (mean, SD)	0.87 (1.41)	
Bar density* (mean, SD)	0.34 (0.69)	
Bar spatial lag* (mean, SD)	0.86 (1.88)	
Club density* (mean, SD)	0.31 (0.43)	

SD = standard deviation; ^a= $p < 0.001$; ^b= $p < 0.05$ (comparisons between age groups); *per 1,000 population

Table 7-2

Zero-order correlations among the study variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Age group	1.00																			
2 Male	0.00	1.00																		
3 Ethnicity	-0.09	-0.02	1.00																	
4 Low family SEP	-0.03	0.00	0.35	1.00																
5 Parental alcohol use	0.10	-0.09	-0.11	-0.08	1.00															
6 Physical disorder	-0.02	-0.03	0.10	0.12	0.00	1.00														
7 Social cohesion	-0.03	0.01	0.01	-0.09	0.01	-0.21	1.00													
8 Parental knowledge	-0.04	-0.09	-0.01	-0.07	-0.01	-0.02	0.03	1.00												
9 Ngh. disadvantage	-0.06	-0.01	0.53	0.36	-0.17	0.20	-0.10	0.00	1.00											
10 Ngh. physical disorder	-0.05	0.02	0.32	0.21	-0.06	0.33	-0.13	-0.01	0.60	1.00										
11 Ngh. collective efficacy	-0.02	-0.08	0.06	0.00	0.02	-0.09	0.27	0.12	-0.07	-0.26	1.00									
12 Ngh. disadvantage lag	-0.05	-0.02	0.50	0.32	-0.13	0.14	-0.04	0.00	0.81	0.43	0.09	1.00								
13 Ngh. off-licence density	-0.02	0.02	0.00	-0.01	-0.02	0.03	-0.02	0.02	0.09	0.07	0.00	-0.02	1.00							
14 Ngh. off-licence lag	-0.04	-0.01	0.08	0.06	0.02	0.05	0.00	-0.01	0.15	0.17	-0.02	0.21	-0.03	1.00						
15 Ngh. bar density	-0.02	0.02	-0.02	-0.02	-0.01	0.01	0.02	-0.01	0.04	0.04	0.04	-0.02	0.71	0.06	1.00					
16 Ngh. bar spatial lag	-0.03	-0.01	0.00	0.00	0.05	0.02	0.01	-0.02	0.03	0.07	-0.04	0.10	-0.02	0.90	0.03	1.00				
17 Ngh. club density	-0.02	0.00	-0.07	-0.07	0.03	0.01	0.03	0.00	-0.02	0.04	0.03	-0.06	0.39	0.34	0.37	0.34	1.00			
19 High typical quantities	0.27	0.02	0.09	0.02	0.19	0.03	0.00	-0.08	0.01	0.06	-0.04	-0.02	0.02	0.01	0.02	0.03	0.05	1.00		
20 Binge drinking	0.29	0.01	0.03	-0.01	0.22	0.02	0.01	-0.09	-0.04	0.02	-0.04	-0.05	0.03	0.01	0.02	0.02	0.04	0.66	1.00	
21 Current drinking	0.32	-0.01	-0.01	-0.04	0.30	0.03	-0.01	-0.08	-0.06	0.03	-0.03	-0.08	0.03	0.02	0.02	0.04	0.07	0.56	0.61	1.00

Ngh= Neighbourhood. Age group was coded 0 (<16 years) and 1 (\geq 16 years). Male, low family SEP, parental alcohol use, and parental knowledge were coded 0 (no) and 1 (yes). Ethnicity was coded 0 (European/other) and 1 (Māori or Pacific). Correlations in boldface are significant with p at least <0.05 .

Correlations between study variables

Zero-order correlations are shown in Table 7-2. Neighbourhood disadvantage positively correlated with neighbourhood-level physical disorder, off-licence and bar density and negatively correlated with collective efficacy. Neighbourhood-level disorder also correlated with collective efficacy and outlet density. As expected, drinking outcomes were positively correlated with increasing age and parental alcohol use, and negatively correlated with parental knowledge. Neighbourhood collective efficacy was found to correlate positively with parental knowledge.

Multilevel path analysis

Random slope models indicated significant heterogeneity in the effects of disadvantage, disorder, and collective efficacy on drinking by age group. No cross-level interactions were found between neighbourhood exposures and sex, ethnicity, or family SEP. Given the findings, separate path analyses were run for young and older adolescents. All paths between neighbourhood-level exposures were controlled for sex, family SEP, and ethnicity by using cluster means. All six multilevel path models showed similar results using the WLSMV and MLR estimators. For all drinking outcomes, paths showed good fit with a CFI of >0.95, RMSEA <0.06, and a SRMR <0.08 once insignificant neighbourhood paths were removed. No evidence of collinearity was present within any of the regression models.

In the young adolescent path, those reporting Māori or Pacific ethnicity (OR 3.4, 95% CI 2.3-4.9) or having parents that drink alcohol (OR 3.2, 95% CI 2.3-4.4) were significantly more likely to consume high typical quantities compared to the reference group. In contrast, parental knowledge was found to be protective for high typical quantities (OR 0.6, 95% CI 0.4-1.0). Similar results were found for current drinking and binge drinking with the exception that family SEP was significantly associated with binge drinking (OR 1.5, 95% CI 1.1-2.0).

Similar findings were found for older adolescents. Male students (OR 1.6, 95% CI 1.2-2.1), students of Māori or Pacific ethnicity (OR 2.3, 95% CI 1.7-3.1), and those whose parents drink alcohol (OR 2.3, 95% CI 1.8-3.0) were significantly more likely to consume high typical quantities when compared to the reference group. No differences were found by level of family SEP. Parental knowledge was found to be protective (OR 0.5, 95% CI 0.4-0.7). Similar findings were evident for current drinking and binge drinking with the exception that being male was not found to be a significant predictor of either drinking behaviour and low family SEP was associated with a lower prevalence of current drinking.

Indirect effects

Figures 7-2 to 7-4 display the unstandardised co-efficients in the young adolescent path models, showing only statistically significant associations with p at least $<.05$. Among young adolescents, neighbourhood disadvantage was positively associated with physical disorder ($B=0.004$, $SE_{robust}=0.001$, Figures 7-2 to 7-4). In turn, disorder was negatively associated with collective efficacy ($B=-1.97$, $SE_{robust}=0.43$), which was found to significantly predict both binge drinking ($B=-0.88$, $SE_{robust}=0.29$) and high typical quantities ($B=-0.88$, $SE_{robust}=0.24$). No relationship between collective efficacy and current drinking was observed. The disadvantage spatial lag was not found to be associated with the neighbourhood exposures or drinking outcomes. Consistent with the hypothesis, a specific indirect effect was found to be significant for both binge drinking ($B=0.007$, $SE_{robust}=0.003$, $p<0.05$) and high typical quantities ($B=0.007$, $SE_{robust}=0.003$, $p<0.05$). A direct effect of disadvantage was observed for high typical quantities ($B=0.04$, $SE_{robust}=0.018$, $p<0.05$), binge drinking ($B=0.04$, $SE_{robust}=0.014$, $p<0.01$), and current drinking ($B=0.03$, $SE_{robust}=0.013$, $p<0.01$) as well as a remaining indirect effect of disadvantage→disorder on high typical quantities ($B=0.02$, $SE_{robust}=0.007$, $p<0.05$) and current drinking ($B=0.02$, $SE_{robust}=0.007$, $p<0.05$). An alternative path from disadvantage→collective efficacy→physical disorder→drinking was not supported.

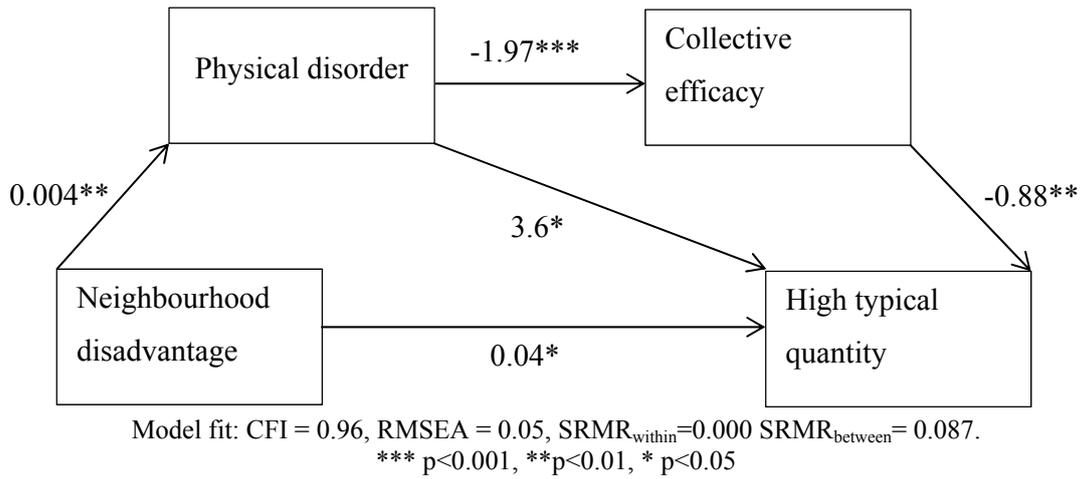


Figure 7-2. Structural model of neighbourhood exposures and high typical quantity in young adolescents

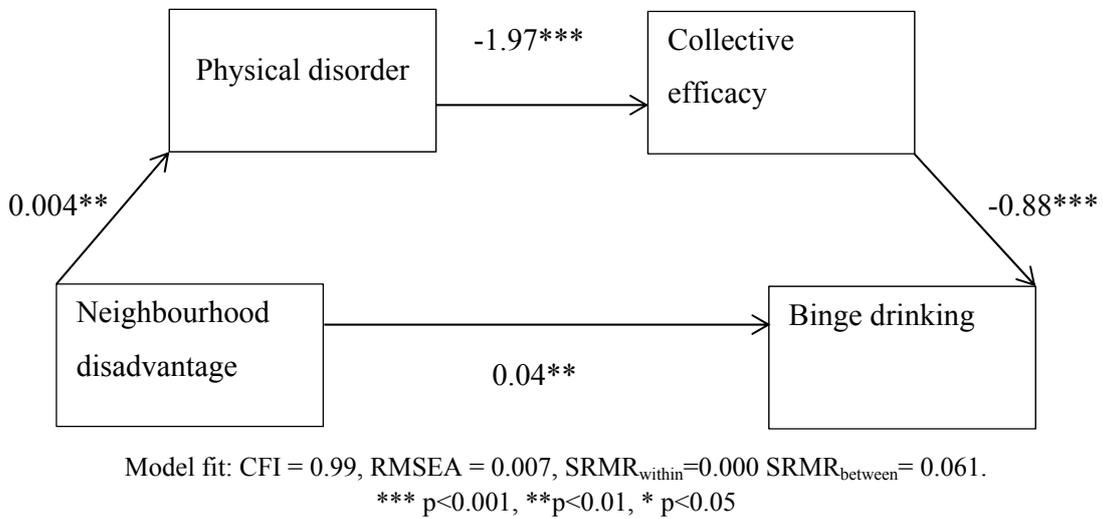


Figure 7-3. Structural model of neighbourhood exposures and binge drinking in young adolescents

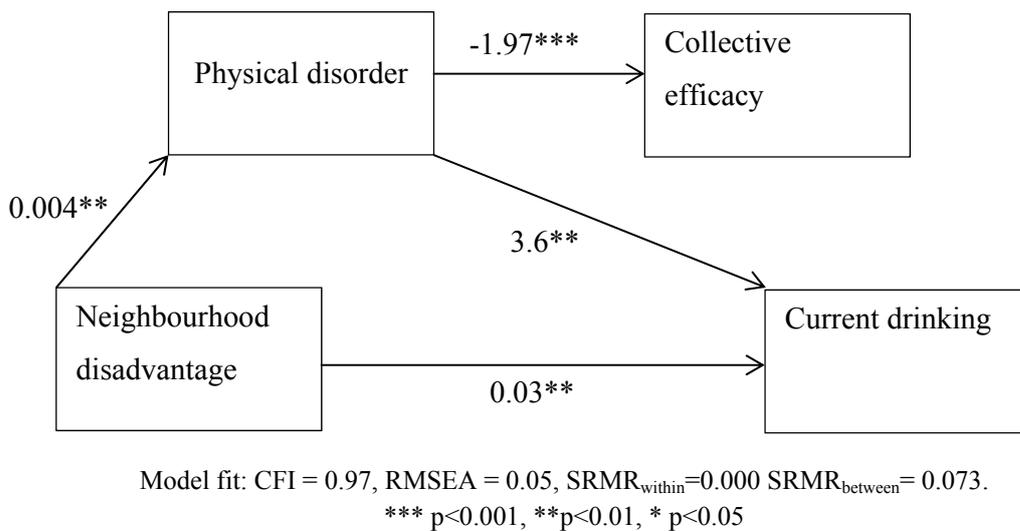


Figure 7-4. Structural model of neighbourhood exposures and current drinking in young adolescents

Figures 7-5 to 7-7 display the unstandardised co-efficients in the older adolescent path models, showing only statistically significant associations with p at least $<.05$. Among older adolescents, neighbourhood disadvantage was positively associated with physical disorder ($B=0.005$, $SE_{\text{robust}}=0.001$) which, in turn, was negatively associated with collective efficacy ($B=-2.23$, $SE_{\text{robust}}=0.400$). In contrast to expectations, collective efficacy was found to significantly predict a *higher* risk of consuming high typical quantities ($B=0.56$, $SE_{\text{robust}}=0.23$) and current drinking ($B=0.89$, $SE_{\text{robust}}=0.26$, $p<0.001$), but was not associated with binge drinking. Again, the disadvantage spatial lag was not found to be associated with the neighbourhood exposures or drinking outcomes. The specific indirect path from disadvantage to high typical quantities was significant ($B=-0.006$, $SE_{\text{robust}}=0.003$, $p<0.05$) and to current drinking ($B=-0.007$, $SE_{\text{robust}}=0.003$, $p<0.05$). No significant paths remained for high typical quantities in older adolescents. Again, an alternative path from disadvantage→collective efficacy→physical disorder→drinking was not supported. In relation to binge drinking, the only significant path identified was from neighbourhood disadvantage→physical disorder→binge drinking ($B=0.02$, $SE_{\text{robust}}=0.008$, $p<0.05$, Figure 7-6). In addition to the specific indirect path, two remaining paths were identified for current drinking (Figure 7-7); 1) neighbourhood disadvantage→physical disorder→current drinking ($B=0.02$, $SE_{\text{robust}}=0.008$, $p<0.05$), and 2) neighbourhood disadvantage→collective efficacy→current drinking ($B=-0.01$, $SE_{\text{robust}}=0.005$, $p<0.05$).

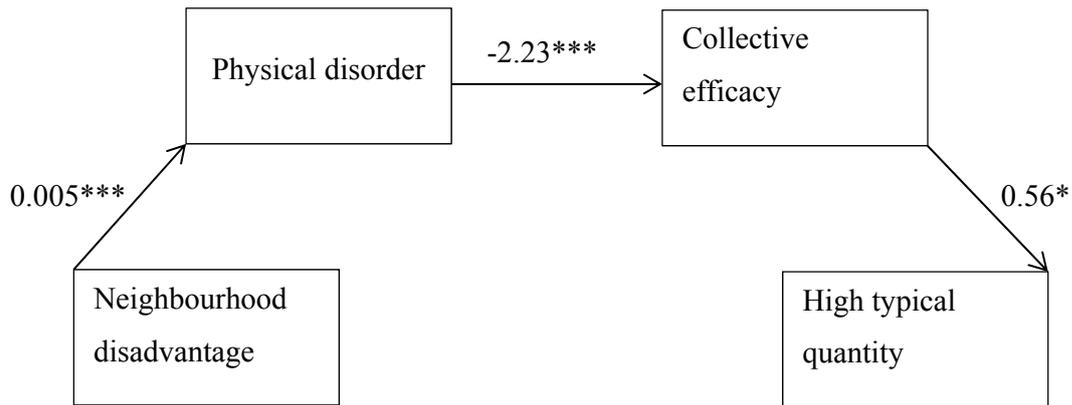


Figure 7-5. Structural model of neighbourhood exposures and high typical quantity in older adolescents

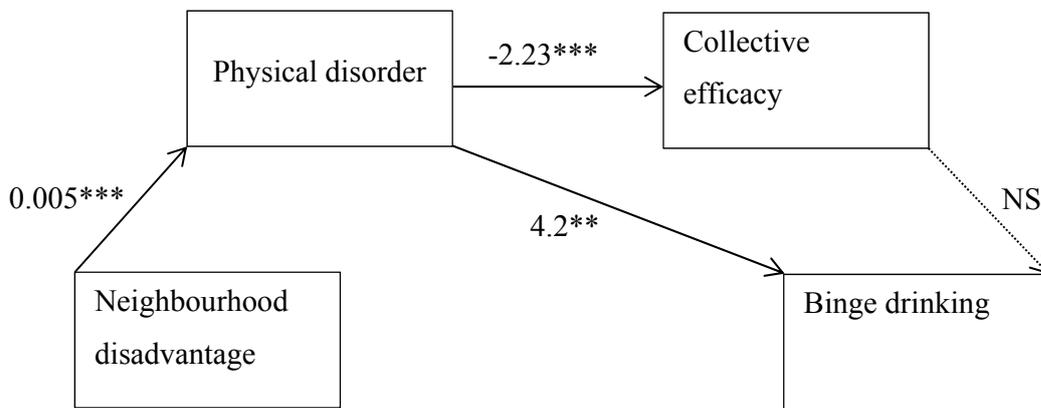


Figure 7-6. Structural model of neighbourhood exposures and binge drinking in older adolescents

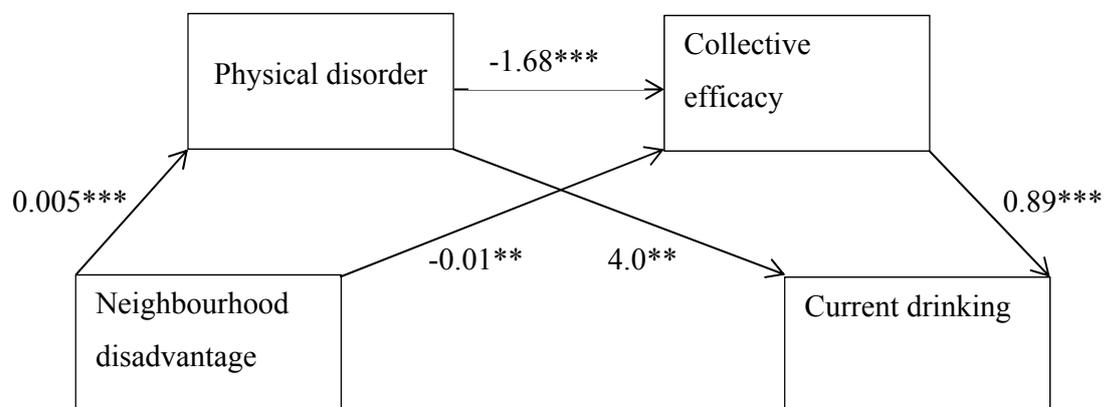


Figure 7-7. Structural model of neighbourhood exposures and current drinking in older adolescents

Sensitivity analyses were conducted in light of the finding that collective efficacy was shown to increase risky drinking in older adolescents. The parental knowledge component of collective efficacy, which was shown to have low reliability when aggregated to the neighbourhood level, was removed from the measure so that only the neighbourhood-level social cohesion component remained. Subsequent path analyses showed that the social cohesion component alone was positively associated with high typical quantities ($B=0.91$, $SE_{\text{robust}}=0.31$, $p<0.01$) and current drinking in older adolescents ($B=1.05$, $SE_{\text{robust}}=0.34$, $p<0.01$). No significant relationships were observed for high typical quantities ($B=-0.82$, $SE_{\text{robust}}=0.43$, $p>0.05$) or current drinking in young adolescents ($B=0.07$, $SE_{\text{robust}}=0.30$, $p>0.05$).

Mediators of collective efficacy

Post-hoc analyses were conducted to examine the mediators in the relationship between collective efficacy and drinking. A path was constructed from disorder→collective efficacy→mediator→high typical quantities. Mediators were selected from Chapter 4 and included buying own alcohol, social supply of alcohol, positive attitude to alcohol use, and peer alcohol use. None of the individual-level mediators were found to be significant in the path models for both young and older adolescents. Interaction analyses revealed that the positive effects of collective efficacy were moderated by individual characteristics, exerting stronger protective effects on young adolescents who reported that they liked their neighbourhood and/or did not possess a positive attitude to adolescent drinking. No interactions were found for older adolescents.

Alcohol outlet density

Controlling for neighbourhood disadvantage, alcohol outlet density types were not found to be implicated in the collective efficacy pathway. No associations between alcohol outlet type and perceptions of disorder or collective efficacy were demonstrated. Further, outlet types were

not found to interact with collective efficacy in the relationship with adolescent drinking. Rather, direct effects between off-licence outlet density and binge drinking ($B = 0.31$, $SE_{\text{robust}} = 0.11$, $p < 0.01$) and current drinking ($B = 0.27$, $SE_{\text{robust}} = 0.13$, $p < 0.05$) were evident among older adolescents. No direct effects were found in relation to the densities of bars or clubs. For younger adolescents, club density was significantly associated with current drinking ($B = 0.28$, $SE_{\text{robust}} = 0.13$, $p < 0.05$) and high typical quantities ($b = 0.34$, $SE_{\text{robust}} = 0.14$, $p < 0.05$). No direct effects were evident for off-licence or bar density.

7.6 Discussion

This study, of a large nationally-representative sample of high school students, aimed to examine the mediating pathways of neighbourhood effects on adolescent alcohol use. The findings provide initial support to the role of the Social Disorganisation Theory in explaining drinking in young adolescents (<16 years), whereby socio-economic disadvantage reduced collective efficacy in neighbourhoods to control drinking behaviour. Of interest, collective perceptions of physical disorder were also found to be implicated in the pathway, mediating the pathway from disadvantage to reduced collective efficacy. A contrasting pathway was identified among older adolescents (≥ 16 years), whereby high levels of collective efficacy (or rather social cohesion) significantly predicted an increased likelihood of drinking.

The protective effect of collective efficacy on young adolescent drinking is in contrast to the insignificant findings found in other studies (De Haan et al., 2010; Ennett et al., 2008; Fagan et al., 2015b; Maimon & Browning, 2012). The findings from the current study suggest that the lack of effects found in previous studies may reflect the masking of heterogeneity of effects by age. In addition, the mechanisms of collective efficacy in rural areas (De Haan et al., 2010) may differ to that required to combat the problems experienced in urban areas. Furthermore, the current study demonstrated that, in young adolescents, a tipping point existed for collective efficacy, whereby it only exerted its effects on risky drinking behaviours. As previous studies showing insignificant findings had sought to examine its

effects on past year or past month drinking, it suggests that lower-risk forms of drinking may not be conceived to be anti-social by adolescents or community members, negating the need for the latter to intervene. Post-hoc analyses also showed its effects to be moderated by perceptions of feeling attached or liking one's neighbourhood, supporting the research of others (Burchfield, 2009; Warner, 2014). This suggests that an adolescent's reaction to neighbourhood cues may be governed by their level of neighbourhood attachment.

The finding from sensitivity analyses that neighbourhood social cohesion was positively associated with drinking in older adolescents (≥ 16 years) supports the importance of informal social control in the presence of unhealthy networks that may facilitate opportunities for problem behaviour. Others have shown a similar path to increased tobacco (Musick et al., 2008) and substance use (Fagan et al., 2014) in adolescents, arguing that this may result from closer relationships between adolescents and adults who use substances, a reduced likelihood of parents supervising their children if they feel others are looking out for them, and the potential for social connections to facilitate the availability of substances such as alcohol.

The use of mobile phone-based GPS data collection techniques could greatly improve the study of neighbourhood effects, especially with regards to the differential effects of collective efficacy or social cohesion. These methods have the potential to provide unprecedented insights into human mobility patterns and spatial exposures, including the time spent at different settings, the factors which may promote resilience to neighbourhood risks, and the ensuing impact of the neighbourhood on health and behaviour (Aber & Nieto, 2000; Browning et al., 2015). They may assist to distinguish the role of the surrounding school environment and the characteristics which give rise to differences in mobility and therefore exposure to environmental risk. For example, low household income and low car ownership has been shown to be associated with higher rates of active transport to school among children (Pont, Ziviani, Wadley, Bennett, & Abbott, 2009), which may increase their exposure, and risk to, the neighbourhood environment. Relational approaches to studying contextual effects

(Cummins et al., 2007) may also be particularly salient in the investigation of neighbourhood effects on adolescents, whereby ‘situational contingencies’ or interactions with others within a context may promote or inhibit a behaviour (Kwan, 2012).

It is believed that opportunities for neighbourhood interaction may set the necessary ecological preconditions for the development of collective efficacy (Browning et al., 2015). The sharing of routine activity locations or “eco-networks” within the neighbourhood may enable residents to establish effective monitoring of public space, resident familiarity, information exchange, trust, and reinforcement of norms (Browning et al., 2015). Technology may also enable social ties and a normative consensus of behaviour without requiring the physical connection of individuals. Sampson (2006) refers to ‘technology-mediated collected efficacy’ in a rapidly-changing communication environment, whereby norms and values may be communicated in the virtual world (e.g. through community social media). It is suggested that the increasing use of the internet by communities to communicate with one another, or “glocalisation” (Hampton, 2010), has many promises for the development of social connections and may mitigate area-level inequalities in collective efficacy. In New Zealand, the provision of free computers and internet access to disadvantaged communities has resulted in stronger social networks, civic engagement, volunteerism, and leadership mobilisation (Williams, 2013). However, it remains uncertain as to the type of ties which need to be connected, either physically or virtually, to control adolescent risky behaviour. Some suggest that parental neighbourhood ties are particularly important (Kubrin & Weitzer, 2003; Valdimarsdóttir & Bernburg, 2015), rather than ties among general residents which has been the dominant focus within research. Parents are believed to have a greater interest in adolescent delinquency, have more effective means of supervising and controlling adolescent behaviour and ties between parents may be more useful in building consensus regarding social norms (Bernburg & Thorlindsson, 2007; Valdimarsdóttir & Bernburg, 2015).

The effect of disadvantage on high typical quantities in young adolescents is aligned with previous studies in the New Zealand context (Huckle, Huakau, et al., 2008; Vinther-Larsen et al., 2013). The current study also found additional effects of disadvantage on binge drinking and current drinking. The vulnerability of young adolescents to the effects of disadvantage is of particular concern given the high risk of alcohol-related harm in this age group (National Health and Medical Research Council, 2009). It remains uncertain if this remaining direct effect is through a tension reduction (reviewed by Pohorecky (1990)) or self-medication mechanism (Khantzian, 1997), whereby alcohol consumption is used to alleviate stress and negative life events experienced in disadvantaged neighbourhoods. The role of culture or degree of fatalism regarding an inevitable level of at-risk behaviour in a community is also highlighted as mechanism of disadvantage which requires further study (Kubrin, 2009). Finally, the finding that the effects of disadvantage are also mediated by collective perceptions of physical disorder supports the beliefs of others (Sampson, 2012), and suggests an emergent property of disorder which should be considered in neighbourhood effects studies.

The finding that the densities of off-licences and club licences were associated with drinking supports previous research. In New Zealand, the overall density of alcohol outlets has been shown to be associated with high typical quantities consumed by adolescents (Huckle, Huakau, et al., 2008). In Australia, off-licence outlets and club licences were shown to have the strongest effects on the self-purchasing of alcohol by adolescents (Rowland et al., 2015). The significant harm posed by club licences to young adolescents requires further research, but may suggest a less vigilant approach to the sale of alcohol to minors. Future research is required in the New Zealand context to determine the mediators of these density effects.

The current study has a number of limitations which point to the need for future research. Although all models were adjusted for many variables which reflect neighbourhood composition (e.g. ethnicity and family-level SEP) there may be residual confounding if other

factors are involved in parents' selection into neighbourhoods. For example, the survey data did not permit the paths to be controlled for parents' choices of moving to a neighbourhood (which may be unrelated to SEP), parental mental health or psychosocial distress, or parental loss or separation which could confound the neighbourhood effect. Residual confounding at the neighbourhood-level may also be possible as the models were not adjusted for residential mobility, population density, adult to adolescent ratio, ethnic heterogeneity, or neighbourhood inequality which may be related to disadvantage and also affect the perceptions of trust and hence the building of collective efficacy (Bjornstrom, 2011). In addition, spatial lags for collective efficacy in the surrounding neighbourhoods, which may have a direct or indirect effect on behaviour (Sampson, 2012), could not be controlled. Importantly, caution needs to be taken given the low reliability of some of the neighbourhood-level exposures. There may also be residential selection bias if the neighbourhood had its impact on mental health and externalising behaviour earlier in the life course (Matjasko et al., 2010; Mrug & Windle, 2009; Odgers, Caspi, Russell, et al., 2012). However, in relation to alcohol use the impact of collective efficacy may be 'situational', relating to behaviours that occur in the community at the current point in time (Sampson, 2012). The cross-sectional study design also has serious implications for causal inference (Diez-Roux, 2007; Oakes, 2004), and precludes the ability to detect reciprocal or bi-directional mechanisms as shown by others in contextual studies (Trucco et al., 2014). The current study is also at risk of same source bias (Diez-Roux, 2007) if characteristics of the individual (e.g. drinking status, SEP, mental health) affected the self-reported qualities of the neighbourhood environment, leading to confounding of the neighbourhood effect. For example, a negative affect may increase the likelihood of a negative perception of the neighbourhood environment. Measurement error resulting from same source bias can inflate or deflate the observed neighbourhood effect, depending on the correlation between the characteristic of the individual and the self-reported measure (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Finally, the sample appeared to be over-

represented by disadvantaged students, limiting the applicability of the findings to the entire cohort of high school students. In addition, the findings may not extend to students who were truant on the day of survey completion, were home-schooled, in alternative education, dropped out of school, or resided in rural settings. These students may have different drinking patterns to the school-based sample included in the study (Clark et al., 2010).

In summary, the growing evidence of the importance of collective efficacy for a range of health and social outcomes highlights the need for future neighbourhood-level research to identify the key components of this theoretically salient exposure. Findings from this study suggest a tipping point for collective efficacy to exert its effects on young adolescents and highlight the importance of social control for older adolescents in the presence of social connections in disadvantaged communities. With the increasing capability to conduct multilevel path analyses it is important that future studies utilise these techniques so that indirect effects of distal exposures can be ascertained. Moderation studies will continue to be important to identify differential neighbourhood effects to inform the targeting of neighbourhood-level interventions.

Chapter 8 Discussion and implications for research and practice

Although adolescents are capable of articulating their preferences with regards to choice of neighbourhood, many families in Aotearoa New Zealand have limited opportunity to exercise control over this social determinant that may have profound effects on their health and well-being. The strong link between social determinants and health inequalities points to the importance of exploring the role of the neighbourhood on adolescent behaviour, so that inequalities can be mitigated early in the life course and a healthy, equal, and productive society can ensue. This final chapter provides an overview of the thesis, its strengths and limitations, and points to the next steps in the development of neighbourhood research and health promotion practice to address inequities in adolescent alcohol use and harm.

8.1 Overview of research

The objectives of this research enquiry were to:

- Systematically review the evidence from multilevel studies of neighbourhood effects on adolescent alcohol use (Chapter 2);
- Identify proximal risk and protective factors associated with typologies of drinking among New Zealand adolescent drinkers (Chapter 4);
- Examine the influence of neighbourhood socio-economic position in relation to changes in drinking (Chapter 5);
- Identify neighbourhood typologies associated with adolescent alcohol use (Chapter 6); and
- Explore the mediating and interacting pathways of neighbourhood effects on adolescent alcohol use (Chapter 7).

Findings from Chapter 2 highlighted the mixed findings in the multilevel evidence base regarding neighbourhood effects on adolescent alcohol use. Overall, studies assessing a range of exposures

found no association with measures of drinking. Results from subsequent chapters in this thesis may assist to explain the null findings to date, particularly with regards to the potential for neighbourhood effects to be moderated by age and a tipping point for collective. Chapter 2 also demonstrated that many studies controlled for potential mediators in the causal pathway, or what Sampson (2008) refers to as included variable bias, potentially masking the neighbourhood effect. As such, the findings from Chapter 7 which explicate some of the likely intervening variables on the neighbourhood effects pathway and their thresholds of effect, may assist future researchers in their conceptualisation of the mediator/confounder distinction within their multilevel neighbourhood studies.

Chapter 4 identified typologies of drinking among adolescent drinkers, reflecting a mostly-linear progression of typologies by level of drinking and harm. Of particular concern was the finding that almost one-third (32.4%) of drinkers exhibited high or very high-risk drinking patterns. Almost half (46.0%) of all drinkers typically consumed five or more standard drinks in a usual drinking occasion. Chapter 4 also signposted the proximate risk factors for adolescent alcohol use which may play a role as intermediary variables in the pathway of neighbourhood effects, including buying own alcohol, peer alcohol use, having a positive attitude to adolescent alcohol use, and social supply of alcohol (i.e. obtaining alcohol from friends and/or a non-parent adult).

Chapter 5 examined changes in adolescent alcohol use from 2007 to 2012 across demographic groups and socio-economic strata. Although significant reductions in the prevalence of drinking and frequency of drinking occasions were found, there was little change in the typical quantity of alcohol consumed among most demographic groups. Although young males (<16 years) showed promising signs of consuming lower typical quantities over time, the gradient of change was unequal across SEP strata. This finding supported Skog's belief that factors such as SEP and sex may provide barriers of mutual influence in relation to positive changes in drinking behaviour (Skog, 2001). Of concern, young females of low family and neighbourhood SEP showed shifts towards an increase in high quantities of alcohol typically consumed over time, adding weight to

the importance of examining changes that occur in both the overall shift and shape of the distribution curve (Benach et al., 2011) and pointing to the potential for the impact of neighbourhood disadvantage to vary by age. Furthermore, the findings of Chapter 5 signalled the importance of the socio-economic environment for risky drinking behaviours, but not for frequency of drinking occasions.

Chapter 6 sought to identify neighbourhood typologies associated with adolescent alcohol use. The important finding from this study was the demonstration that age moderated the effect of the neighbourhood environment. This supported the suggestion that the saliency of individual-level factors for adolescent drinking (e.g. age) reflects the wider and varied contexts of drinking, with factors such as age possibly operating differently across social contexts (Lo et al., 2013a). The latent class approach was also valuable in identifying which exposures assisted in distinguishing risky neighbourhoods for adolescent alcohol use, overcoming problems of traditional regression models which suffer from collinearity when multiple predictors are included. The findings of Chapter 6 pointed to the role of disadvantage, disorder, alcohol outlet density, and collective efficacy in drinking behaviours, lending initial support to an extension of the Social Disorganisation Theory (Shaw & McKay, 1942) beyond crime control (Pratt & Cullen, 2005).

Chapter 7 built upon the previous chapter by assisting to explicate the exposures which may have a direct or mediating effect on adolescent drinking. Neighbourhood disadvantage was found to increase collective perceptions of physical disorder which in turn reduced collective efficacy. Opposing effects of collective efficacy (or more likely social cohesion) on drinking were found for young and older adolescents living in neighbourhood disadvantage, whereby it exerted a protective effect on the young but a detrimental effect on older adolescents. The findings of opposing effects of disadvantage and low collective efficacy on older adolescents also assisted to explain the lack of effects of neighbourhood typologies in Chapter 6, as the two exposures may have cancelled each other out. A tipping point was also demonstrated for collective efficacy, showing salience for risky drinking but not current drinking. Alcohol outlet density was not

found to be implicated in the Social Disorganisation pathway, but rather showed direct relationships with adolescent drinking. The finding that the protective effect of collective efficacy on young adolescents did not operate through the proximal risk factors identified in Chapter 4 (i.e. social supply, peer alcohol use, buying alcohol, or having a positive attitude towards drinking) suggested that collective efficacy may be more of a general attribute which lowers the prevalence of risky drinking through neighbourhood supervision and regulation. Furthermore, the post hoc finding that collective efficacy exerted a stronger protective effect on young adolescent students who liked their neighbourhood supported prior research (Burchfield, 2009; Warner, 2014), and further assisted to explain why the multilevel studies of collective efficacy identified in Chapter 2 have shown mixed findings.

8.2 Strengths of research

The Youth 2000 series, comprising the national Youth'01, Youth'07 and Youth'12 surveys, provided one of the most comprehensive datasets to investigate neighbourhood effects on adolescent alcohol use within the New Zealand context. When compared to national surveys of adolescent health and wellbeing conducted in other Western countries, the Youth 2000 series is shown to include a broader range of adolescents across the various stages of development, having significant implications for exploring the differential saliency of risk and protective factors across development. The random sampling of schools and students, to yield a nationally-representative cohort for analysis, also strengthened the ability to generalise study findings. Furthermore, the large sample size in the surveys provided for sufficient variation in neighbourhood exposures, permitting the use of multilevel or hierarchical modelling and the statistical ability to undertake moderation analyses.

A further strength of this thesis is the use of person-centred and social/contextual approaches, which are recommended to more fully capture the complexity of adolescent drinking and related harm (Muthen & Muthen, 2000). This includes latent class analysis and multilevel modelling

(including path analysis) to explore drinking patterns and the role of the wider context (i.e. neighbourhood) in shaping adolescent drinking behaviours. Both the LCA of neighbourhood typologies (Chapter 6) and the multilevel path analysis of neighbourhood effects (Chapter 7) were among the first studies to adopt such methodological approaches to the examination of neighbourhood effects on adolescent alcohol use. The inclusion of moderation analyses strengthened the ability of the novel studies to identify subgroups of adolescents who may be more vulnerable to neighbourhood effects, rather than producing an overall effect which may mask health inequities. Finally, through exploring the effects of ‘place’ findings may have more applicability to the planning and development of health promotion programmes, given that geographic communities are often the focus or target for reducing alcohol-related harm.

Finally, this thesis embedded a strong theoretical foundation into the formulation of the research questions. In particular, the Ecological Systems Model (Bronfenbrenner, 1979) informed the importance of exploring the interactions which may occur within and across the varied contexts of an adolescent’s life. The adoption of the Social Development Model (Catalano & Hawkins, 1996) pointed to the need to take a developmental perspective to the research, recognising that the strength of risk and protective factors may vary across the stages of adolescence. Further, the underpinning of the multilevel studies (Chapters 6 and 7) with the Social Disorganisation Theory (Sampson et al., 1997; Shaw & McKay, 1942) pointed to exposures which may be implicated in adolescent drinking and their potential pathway of effects. This is in contrast to many of the multilevel studies found in the systematic review (Chapter 2) that were rarely grounded in a theoretical approach, despite the call for the rigour of social epidemiology to be improved by explicitly embedding the consideration of theory into research (Krieger, 2011).

8.3 Limitations of research

8.3.1 Causal inference from observational designs

The findings in this thesis must be considered in light of several limitations. Of foremost concern in epidemiological studies is the issue of causation. In the realm on neighbourhood effect studies, whereby the independent variable may be situated within a complex, socially segregated, and stratified environment (Sampson, 2008), much contention has focused on the ability of observational designs to contribute to causal knowledge (Diez Roux, 2004a, 2004b; Merlo & Chaix, 2006; Oakes, 2004). In the past, criticism has been directed to the social epidemiological literature for insightfully noting important issues, such as neighbourhood definitions and measurement error, but paying insufficient attention to causal inference (Oakes, 2004).

In relation to the descriptive, cross-sectional associations identified in this thesis, paramount consideration must be given when using the findings to answer the following causal questions (Subramanian, Glymour, & Kawachi, 2007): 1) “what would an adolescent’s likelihood of drinking be under alternative neighbourhood conditions?” or 2) “how would moving to a new neighbourhood affect an adolescent’s likelihood of drinking?” As Diez-Roux (2007) points out, the causal question may not relate to the literal effect of neighbourhood disadvantage per se, but also the causal effect of the physical environment and social processes which neighbourhood disadvantage is often a proxy for. In the absence of randomised controlled trials to answer these questions in the New Zealand context, reliance on observational data is required.

However, the major concern regarding causal inference from observational designs is the non-random nature of neighbourhood allocation or selection. Whereas selection into trials is conducted under random sampling procedures, reducing selection bias, a myriad of reasons may relate to neighbourhood choice. Both chance and choice can determine residential location, resulting from factors such as financial means, lifestyle preferences, availability of neighbourhood resources and services, housing quality, presence of social connections, and

neighbourhood reputation (De Koninck & Pampalon, 2007). In Auckland, New Zealand, neighbourhood identity was found to be a key motivator for house purchases (Levy & Lee, 2011). A longitudinal study of New Zealand parents (Morton et al., 2014) found that the main reasons for moving neighbourhood after childbirth related to safety, affordable housing, and nearby location of family, friends and work. Others have also shown that residential moving decisions to be not all socio-economically related, with one in five respondents in a large neighbourhood study in the United States reporting that concerns about child development, such as attendance at good schools, played a role in residential mobility (Billy, 2001). As such, the large number of reasons that families may choose to move into a particular neighbourhood has the potential to confound the neighbourhood effect if the reasons are also associated with adolescent alcohol use. For example, more motivated parents may choose to live in disadvantaged neighbourhoods to conserve funds for children's schooling and social and recreational activities which could affect an adolescent's drinking status or pattern (Duncan & Raudenbush, 2001).

Within this thesis, the potential for the contextual effects of neighbourhood disadvantage on drinking to be due to residual differences between adolescents living in different neighbourhoods warrants attention. Omitted variable bias may be present if reasons beyond socio-economic position influenced both neighbourhood selection and the drinking outcomes under study. However, the unmeasured variables would have to be shared by adolescents within a given neighbourhood (Diez Roux, 2004a). Furthermore, residual confounding may be present if the family-level socio-economic control variables included in the models omitted other important indicators of socio-economic position which are related to neighbourhood choice (e.g. single-headed families) and adolescent alcohol use.

On the other hand, the Introduction chapter detailed studies which found neighbourhood selection to fall powerfully across socio-economic lines (Harding, 2003; Odgers, Caspi, Russell, et al., 2012; Sampson, 2008). Using a robust counterfactual approach to investigate the effects of neighbourhood disadvantage on dropping out of high school and teenage pregnancy Harding

(2003) revealed that sensitivity analyses showed that factors such as parental involvement or commitment to their children would have had to have been just as powerful as the SEP covariates to wipe out the neighbourhood effect. The applicability of these findings to the New Zealand context may be questioned, as different ethnic groups have been shown to sort themselves into neighbourhoods using different criteria. High income Asian residents in New Zealand have been shown to generally sort themselves into high income neighbourhoods, whilst Māori and Pacific peoples tend to co-locate near others of the same ethnicity regardless of personal income (Maré, Pinkerton, Poot, & Coleman, 2012). It has been further argued that the dichotomy between compositional and contextual effects within neighbourhood studies in the New Zealand context does not sufficiently consider the dynamic relationship for Māori, who may be driven to choose a particular neighbourhood based on their relationships with the land (Becares et al., 2013). Future studies which collect data on the reasons for neighbourhood choice from the parents or guardians of adolescents in New Zealand will be required to inform the control of selection bias within neighbourhood studies.

Causal inference may also be compromised in this thesis as a result of the unreliability in the extrapolation of neighbourhood effects. It is suggested that it is only possible to estimate a neighbourhood effect conditional on a covariate (e.g. family SEP) if the distribution of the covariate overlaps across neighbourhoods (Subramanian et al., 2007). That is, the prevalence of students of low family SEP in poor neighbourhoods needs to overlap with the prevalence found in more advantaged neighbourhoods. If the distribution of SEP (or other covariates) is different, then the estimation of the neighbourhood effect conditional on SEP may be unreliable. The amount of overlap is considered a matter of judgement but should be investigated prior to analysis (Diez-Roux, 2007). Analysing data from the Youth'07 and '12 surveys found that only 10% of students living in the lowest tertile of neighbourhood disadvantage reported low family SEP, in contrast to 52% living in the highest tertile of disadvantage. As such, extrapolation of the conditional neighbourhood effect estimates may be compromised. Utilising instrumental

variables or propensity score matching has been suggested to attempt to overcome this problem (Diez-Roux, 2007), although the latter is likely to present problems finding a suitable match to study neighbourhood effects, particularly for those who have high probabilities of living in poor neighbourhoods (Harding, 2003). This is demonstrated below, wherein the Census 2013 found that very few people of Pacific Island ethnicity lived in the upper deciles of mesh-block socio-economic advantage (Peter Crampton, personal communication).

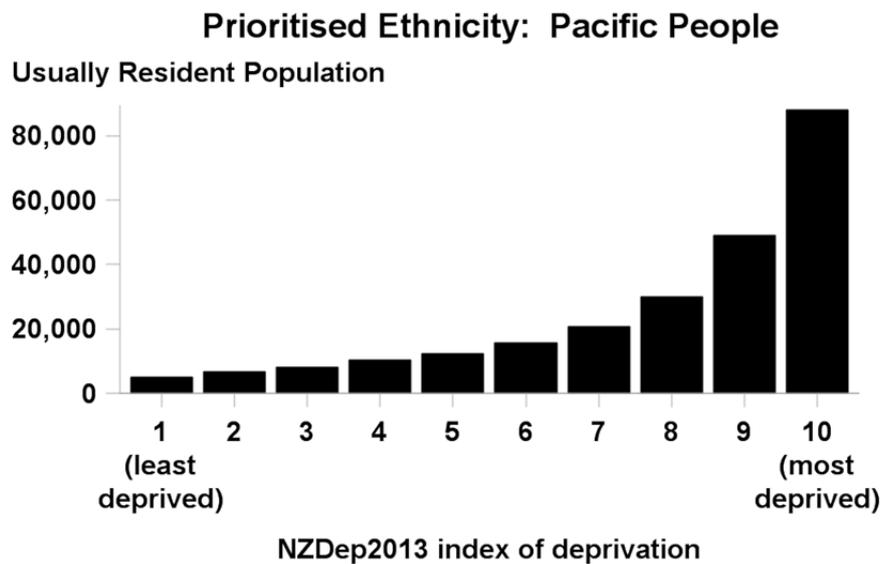


Figure 8-1. Distribution of Pacific people across socio-economic deprivation deciles
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Another source of bias influencing causal inference in this thesis relates to the stability of the neighbourhood exposure. Causal frameworks require that the treatment (i.e. moving from one neighbourhood to another) does not affect the exposures of the other units; referred to as the stable unit treatment assumption, or SUTVA (Rubin, 1978). Oakes (2004) believes that this is violated in most cases within neighbourhood effects studies whereby the hypothetical relocation of families from poor to wealthier neighbourhoods changes the overall wealth of neighbourhoods. Further, studies in the US have shown that residents are sensitive to new entrants to their neighbourhood environment, with Whites leaving neighbourhoods when the concentration of minority populations increases (known as ‘White flight’), even if it does so only in the surrounding neighbourhoods (Crowder & South, 2008; Pais, South, & Crowder, 2009; Sampson,

2008). This can greatly affect the economic trajectory of the neighbourhood (Sampson, 2012), further violating SUTVA assumptions.

In summary, observational study designs will continue to have their place in the understanding of neighbourhood effects (Diez Roux, 2004a; Merlo & Chaix, 2006; Subramanian et al., 2007). Diez-Roux (2007) suggests that although the observed crude associations found in multilevel observational studies of neighbourhood effects cannot be considered as valid and definite measures of causal effects, they assist in painting a picture when taken together with evidence drawn from more-focused observational designs, community trials, natural experiments, and qualitative studies. Accordingly, the multiple sources of bias inherent in the cross-sectional studies in this thesis, which compromise causal inference, may support the suggestion by Oakes (2004) that this type of research has assisted towards the development of theory and preliminary testing of neighbourhood effects. The next section details the specific methodological limitations that relate to the research studies included in this thesis.

8.3.2 Specific methodological limitations

In addition to the likelihood that the associations reported in observational designs do not represent generalisable causal parameters (Diez Roux, 2004a) a number of specific methodological limitations may also thwart the applicability of the thesis findings. These have been described below in relation to those pertaining to the outcome assessment and collection of neighbourhood exposures.

a) Limitations pertaining to the outcome

The studies comprised in this thesis relied on alcohol drinking behaviours and harm which were self-reported. As described in the Introduction chapter, self-reports of drinking by adults and adolescents can show adequate reliability and validity for most alcohol-related research purposes (Brener et al., 2003; Campanelli et al., 1987; Del Boca & Darkes, 2003; Lintonen et al., 2004). The use of computer-assisted surveys which were conducted in the school setting may have

assisted to reassure students of their anonymity, resulting in an increase in the veracity of the self-reported drinking behaviours (Kann et al., 2002; Wright et al., 1998). However, it remains unknown if factors which affect the veracity of self-report (Del Boca & Darkes, 2003), such as demographic characteristics (e.g., age, gender, ethnicity, religious preference) and values and beliefs (e.g., perceived norms regarding drinking), have become more or less important over time. For example, if social desirability changes differentially across demographic subgroups over time, as has occurred in young females previously (Keyes et al., 2008), this may have important implications for exploring trends in alcohol use.

The response rate may have significant implications on the inferences which can be drawn from the studies included in this thesis. The response rate of 68% in 2012 resulted in a sample that was under-represented by older adolescents. The school-based setting of the survey also excluded older adolescents who had legally left school once they reached the age of 15 years. As such, caution should be taken in the application of results pertaining to older adolescents. In relation to non-response, studies of non-response bias in alcohol surveys suggest higher alcohol risk-taking behaviour in adolescent (Mattila, Parkkari, & Rimpelä, 2007) and university aged non-responders (Kypri, Samaranayaka, Connor, Langlely, & Maclennan, 2011). In addition, the generalisability of results is further limited to students enrolled in high school who attended the day of the survey, omitting adolescents who were truant or in Alternative Education. The latter have been shown to have a very high prevalence of risky drinking patterns (Clark et al., 2010). The omitted school students in the survey may not only differ in relation to drinking patterns but also in exposure to harmful neighbourhood environments, suggesting that the students included in the Youth surveys may present a slightly positive view of the health of adolescents in schools (Clark, Fleming, Bullen, Denny, et al., 2013).

The focus on risky neighbourhoods in this thesis deserves mention. In relation to adolescent development, the importance of strength-based models has been highlighted, such the Pluralistic Neighbourhood Theory (Aber & Nieto, 2000), which suggests that neighbourhood strengths can

co-exist with sub-optimal characteristics to nurture and sustain positive youth development. This is in contrast to deficit-based models which continue to pervade the literature (Witherspoon & Ennett, 2011). Although studies in this thesis centred on the deficits of neighbourhoods in relation to socio-economic resources, they also sought to examine the buffering effects of social cohesion and membership in community organisations which may alleviate the effects of a harsh environment.

The framing of adolescent drinking as problem behaviour also warrants discussion. Qualitative studies of adolescents and young adults in New Zealand demonstrate that young people do not necessarily perceive their alcohol drinking as an anti-social behaviour. Rather, discourses of young people were found to relate to the friendship connections established through drinking and the caring and protection of friends which occurs in drinking events (Chainey & Stephens, 2014; Niland, Lyons, Goodwin, & Hutton, 2013). Although young people acknowledged the potential harms of their behaviour, these were perceived to be outweighed by the good outcomes which ensue from drinking. This is consistent with the literature which points to belonging as an important strength in positive youth development, particularly in stressed environments (Cuervo & Wyn, 2014). Future neighbourhood studies could benefit from adopting a strengths-based approach, by reframing research questions from focusing on risky or problem behaviours to those which emphasise positive or healthy youth development (Blum, 1998; Catalano, Berglund, Ryan, Lonczak, & Hawkins, 2004; Ungar, Ghazinour, & Richter, 2013). This means identifying neighbourhood exposures which promote social, emotional, cognitive and behavioural competence, foster self-determination and resilience, promote a positive identity, and develop self-efficacy (Catalano et al., 2004). In addition, research is required to explore parents' perceptions of drinking and whether they differentially perceive adolescent drinking as a risky behaviour or pro-social behaviour depending on the age of the adolescent. Such information would greatly inform the examination of the effects of collective efficacy on different age groups.

Finally, the categorisation of ethnicity in the analytical models with drinking is likely to have masked the complexity and heterogeneity of culture, lifestyle, and language among the adolescents included in the study (Teevale et al., 2012). Grouping ethnicity into four collectives precluded the ability in the models to determine the underlying causes of ethnic inequalities in alcohol-related harm (Didham & Callister, 2012). For example, the populations of Pacific people in New Zealand are diverse and have different attitudes and norms to drinking (Teevale et al., 2012). The ‘Asian’ concept is also problematic, attempting to agglomerate a range of peoples into a single entity (Rasanathan, Craig, & Perkins, 2004). This has similar implications for the Māori and European/other ethnic groups which were treated as unitary in the thesis studies. Furthermore, the attempt to homogenise age into two groups in the thesis also presents limitations, given that there is rarely uniformity in the characteristics of adolescents across a wide age band.

b) Limitations pertaining to neighbourhood exposures

Determination of spatial scale is paramount in neighbourhood research (Diez-Roux, 2007). In this thesis, misclassification of ‘neighbourhood’ may have resulted in the attenuation of effects of neighbourhood exposures if the use of statistical area unit boundaries did not align with the adolescent’s perceived neighbourhood for which they self-reported its features. The use of administrative boundaries to demarcate the ‘neighbourhood’ is at risk of the “Modifiable Areal Unit Problem” (Openshaw, 1984) and the “Uncertain Geographic Context Problem” (Kwan, 2012). With regards to the former, it is unknown how alternative aggregations of meshblocks (to construct area units) may have altered findings. In addition, a dearth of evidence was available to guide decisions regarding the appropriate spatial scale to measure the effects of the neighbourhood exposures. One study suggests that the effects of collective efficacy are greater at smaller, than larger units, representing the level at which social mechanisms occur and take effect (Gerell, 2015). Therefore, sensitivity analyses are of paramount importance to understand the consequences of different methods to create neighbourhood boundaries.

The use of a static neighbourhood model also presents the “Uncertain Geographic Context Problem” as the administrative area unit may have been unable to capture the complexity of each adolescent’s activity path and social networks, which may occur across many area units and not necessarily among those which are contiguous. Among adolescents, studies have demonstrated significant variation in activity spaces and perceived neighbourhood boundaries. For example, Byrnes et al. (2015) used GPS technology to discover that adolescent activity intersected with 24.3 census tracts (1,200-8,000 residents), exposing adolescents to nine times the number of alcohol outlets than their residential census tract. Similar levels of exposure to alcohol outlets has been found by others using hand-drawn neighbourhood approaches (Basta et al., 2010). Furthermore, perceptions of neighbourhood size have been shown to be determined by characteristics such as ethnic composition, socioeconomic position, physical and institutional characteristics, perceived levels of crime, and symbolic neighbourhood identities (Campbell, Henly, Elliott, & Irwin, 2009), requiring such information to be incorporated into neighbourhood-based models (Lee, 2001).

Missing data may have significant implications on the inferences which can be drawn from the findings in this thesis. The Youth 2000 series was not designed primarily as a neighbourhood-based study, where the number of neighbourhoods and individuals per neighbourhood required for multilevel modelling and moderation analyses is taken into account to determine the overall sampling frame. Oakes (2004) refers to the use of data dredging in observational studies as ‘file-cabinet’ analyses. To obtain adequately-reliable aggregated neighbourhood measures over 40% of the total sample was excluded. As described within Chapters 6 and 7, the included sample was found to represent a more disadvantaged end of the spectrum, limiting the generalisability of findings. A loss of power would also have resulted for the analysis. In addition, the use of the Youth’12 survey data precluded the calculation and inclusion of spatial lags for the self-reported neighbourhood exposures (e.g. social cohesion, disorder, etc.), as not all neighbourhoods were sampled in the national survey. Accounting for spatial dependence is important in neighbourhood

effects studies, as it allows for auto-correlation of neighbourhood exposures and/or outcomes to be controlled and permits the testing of positive or negative spill-over effects from surrounding areas. As documented previously, features of neighbourhoods including collective efficacy (Sampson, 2012), affluence (Inagami, Cohen, & Finch, 2007; Maimon & Browning, 2010) and comparable levels of immigrant concentration (Jackson et al., 2015), can buffer the effects of risky neighbourhoods, whilst nearby disadvantage may have social multiplier effects (Morenoff, Sampson, & Raudenbush, 2001). It is suggested that multilevel studies which do not take into account spatial dependence may overestimate the size of neighbourhood effects (Chaix et al., 2005). Unfortunately, incorporation of spatial dependence in this thesis was limited to outlet density and economic disadvantage indicators, omitting important social processes in nearby neighbourhoods which may also shape adolescent behaviour.

A further limitation of this research was the low reliability of the aggregated collective efficacy measure within area units/neighbourhoods. The results of the sensitivity analysis in Chapter 7 showed that the collective efficacy measure was unlikely to have tapped into the emergent component of informal social control. Other studies have documented positive associations between social cohesion and adult alcohol use (Kuipers, van Poppel, van den Brink, Wingen, & Kunst, 2012; Moos, Brennan, Schutte, & Moos, 2010), with the authors suggesting that the social support component of social cohesion may have the ability to reduce alcohol use but the sociability component may lead to increased alcohol use. Future neighbourhood studies of New Zealand adolescents would benefit from utilising the collective efficacy scale developed by Sampson et al. (1997) (Table 1-3) and exploring the differences in effects when the social cohesion and informal social control components are tested separately (Gau, 2014). In addition, the finding that the impact of collective efficacy was dependent on an adolescent's stage of development highlights that there may be utility in aggregating collective efficacy scales independently for younger and older adolescents, especially as the two age groups may have very

different intensities of exposure to the immediate environment. Such an approach will no doubt have serious implications for overall sample size requirements in neighbourhood studies.

The use of cross-sectional data in this thesis precluded the important investigation of reciprocal relationships which may occur between exposures, and/or between drinking outcomes and neighbourhood exposures. The relationship between collective efficacy and disorder is considered reciprocal (Sampson, 2012), whereby disorder may prevent residents from interacting with their neighbours and low levels of collective efficacy may result in inaction towards addressing a disordered environment. Sampson (2013) suggests that disorder may be more likely to be a mediator of collective efficacy on health and social outcomes, although that was not supported in the path modelling undertaken in Chapter 7. Only longitudinal studies can assist in determining the temporality of these relationships.

The cross-sectional design was also unable to rule out neighbourhood effects which may have begun earlier in the life course of the adolescent or are the result of a cumulative exposure to disadvantage (Wodtke et al., 2011). As residents of disadvantaged neighbourhoods in New Zealand tend to remain or move with the same levels of deprivation (Morrison & Nissen, 2010), it could be argued that the findings in this thesis result from the exposure of disadvantage in earlier years or cumulative impact over time. For example, Sampson et al. (2008) have demonstrated a time lag for cognitive ability in disadvantaged neighbourhoods, whereby living in a disadvantaged neighbourhood in early childhood reduced verbal ability in later years, equating to missing a year or more of school education. In another longitudinal study, parenting practices were found to mediate the effects of neighbourhood disadvantage on antisocial behaviour of children as young as 5 years old (Odgers, Caspi, Russell, et al., 2012). Such effects would no doubt have long-term sequelae into adolescence and subsequent drinking behaviours, having important implications for the use of cross-sectional studies which assume there is no time lag between exposure and outcome. However, as described throughout this thesis, the impact of collective efficacy on young people is believed to be affected more by the contemporaneous

(situational) neighbourhood rather than developmental effects resulting from past circumstances (Sampson, 2012).

Finally, residual confounding of the neighbourhood effect might also be present due to omitted neighbourhood variables, such as ethnic heterogeneity, immigrant concentration, population density, and residential instability, which were not controlled in the analyses. These factors may also be present in disadvantaged communities, affect adolescent drinking, and reduce the ability of neighbours to communicate and discover shared values, giving rise to difficulties in forming social ties and informal social control (Valdimarsdóttir & Bernburg, 2015).

8.4 Implications for research

Neighbourhood-level determinants of health, beyond access to healthcare services and unhealthy retail environments, have rarely been the focus of empirical research or intervention in the New Zealand context (Stevenson, Pearce, Blakely, Ivory, & Witten, 2009). This thesis adds to the growing evidence base of neighbourhood-effects, and with some caution taken, suggests that neighbourhoods do matter for adolescent alcohol use and harm. The following subsections provide future directions of neighbourhood research to better understand and more adequately capture the complex role of the neighbourhood in adolescent drinking behaviour.

8.4.1 Measures or typologies of alcohol use

Chapter 4 demonstrated that adolescent drinking patterns could be mostly described by a linear progression within consumption measures (e.g. binge drinking, typical quantity, drinking frequency) from 'low-risk' to very-high risk. Since the publication of Chapter 4 in December 2013 (Jackson, Denny, Sheridan, et al., 2014) a narrative review of drinking typologies in young people aged 12-24 years has been conducted, identifying a total of 13 studies (Davoren et al., 2015). Of these, the study by the candidate et al. received the highest score for methodological quality. Findings across studies conducted in a number of countries showed similar typologies, represented by six main types of alcohol consumer: abstainers, light drinkers, social drinkers,

hedonistic drinkers, heavy alcohol consumers and problem alcohol users. The choice in some studies in the narrative review to combine reasons for drinking with drinking consumption measures to assess typologies is useful, and could be applied to the Youth 2000 series survey data to further identify any nuanced subgroups within the drinking typologies. Further research is also required to identify effective strategies to prevent transition from one drinking typology to another. For example, Davoren et al. (2015) recommend that the development of typology-based screening tools may assist practitioners to develop and implement tailored preventative interventions. In addition, the low-risk drinking typology identified in this thesis warrants further qualitative and quantitative investigation, as it is this group who is considered to look out for others in drinking occasions and have influence or sway over the behaviour of more heavy drinkers (VicHealth, 2013). As such, this group may play a key role in changing the adolescent drinking culture in New Zealand.

The mostly-linear drinking typologies also suggests that the continuation of single dimensions of alcohol consumption (e.g. high typical quantities, binge drinking) is likely to be appropriate in the study of neighbourhood effects. The finding that collective efficacy had a tipping point for young adolescent drinking, or threshold for the community process to set in, suggests that the inclusion of high-risk drinking behaviours will continue to be imperative in the study of neighbourhood effects. Researchers may also look to efforts to strengthen the approximation of alcohol consumed in population surveys, by including the use of beverage-specific and location-specific questions which have been found in New Zealand to account for the majority of taxable alcohol available for consumption (Casswell et al., 2002). Finally, as detailed in Chapter 4, further study is required to examine why one drinking typology experienced higher levels of alcohol-related harm despite reporting lower levels of alcohol use.

8.4.2 Neighbourhood-based designs and the operationalisation of ‘neighbourhood’

As outlined previously, neighbourhood-based observational studies and randomised controlled trials are best suited to the study of neighbourhood effects. Studies which consider neighbourhood effects from the outset are more likely to conduct sampling procedures which result in adequate sample sizes for multilevel analysis and sufficient numbers of residents per neighbourhood to enhance the reliability of aggregated neighbourhood measures. Sampling strategies can also be planned to ensure there is sufficient variability in the neighbourhood exposure(s) or interest and that data is collected from contiguous neighbourhoods to incorporate spatial dependence into the analysis. It is generally recommended that if observational designs are used, that they should be designed from the outset to approximate randomised controlled trials (Rubin, 2008). Within the umbrella of observational designs, longitudinal studies will continue to be paramount to the examination of selection bias (i.e. movers and stayers), reciprocal effects, and temporality with regards to the impact of exposures across the life course. In relation to mediation analyses, longitudinal studies will be imperative to determine the sequencing of exposures.

As described within the Introduction (Chapter 1) randomised controlled trials have their place in causal inference, but suffer their own limitations in the study of neighbourhood effects. In common with observational designs, the principle of SUTVA is often found to be violated (Oakes, 2004). In addition, the experience of Moving to Opportunity showed that inferring neighbourhood effects was difficult when the intervention was allocated at the family-level, and that despite being offered the opportunity to move many did not take up the offer. If they did, many moved only a short distance from their original neighbourhood and eventually returned to live in neighbourhoods characterised by disadvantage (Sampson, 2008).

As described by Merlo and Chaix (2006) the significant costs, practicability, and difficulty attributing the effects of single exposures within a multi-component intervention would hinder

the utility of community trials. The role of the historical, social, and cultural backgrounds of neighbourhoods also presents challenges in identifying a suitable comparison or control neighbourhood to study behaviour. Further, Sampson (2012) suggests that trials may be hampered by an enduring cycle of disadvantage and neighbourhood stigma, which is unlikely to change as a result of short-term efforts.

Exploiting the opportunities provided by "natural experiments" is thought to have an important role in examining the determinants of health inequalities (Petticrew et al., 2005). For example, 'Enable London' is a longitudinal study designed to examine the effects of housing provision in the former Athlete's Village of the London 2012 Olympic Games (Owen et al., 2014). Aspects of the built environment will be studied for their effects on physical activity patterns. Finally, the value of qualitative research to inform the evidence base cannot be underestimated. For example, ethnographic research has the potential to provide an extremely rich account of neighbourhood conditions as experienced by residents, as well as an insight into their social interactions and social control (Kubrin & Weitzer, 2003).

Operationalisation of 'neighbourhood'

Growing criticism regarding the use of static and discrete spatial units to operationalise neighbourhoods has challenged researchers to develop more innovative approaches which capture the complexity and heterogeneity of human activity and exposure to risk and protective factors (Matthews & Yang, 2013). Next-generation measures and methods are called for to account for spatial polygamy, where individuals may belong and be exposed to a number of nested and non-nested localities, cutting across different social, geographic, real, virtual, past and present contexts (Matthews, 2011). From the outset, researchers should consider and plan to spend as much time determining the appropriate 'neighbourhood' for their particular exposure as collecting the data for their study (Chaix, Merlo, Evans, Leal, & Havard, 2009). As documented previously, different contextual exposures will often need to be assessed using different spatial

scales even when measuring the same health or behavioural outcome (Owen et al., 2015). The systematic review (Chapter 2) highlighted the variety of spatial scales used to categorise neighbourhoods, often with little (or no) explanation of the theory or mechanisms which determined the selected spatial scale to examine the neighbourhood effect.

There is general agreement that a combination of both qualitative and quantitative investigations will be needed to capture the complexity of space (Chaix et al., 2009; Owen et al., 2015), although within the former approach caution needs to be taken given the likelihood that it may be difficult to gain consensus and respondents may restrict their definition of neighbourhood to exclude particular areas (e.g. deprived) of close proximity which they do not wish to include in their perceived neighbourhood (Chaix et al., 2009; Owen et al., 2015). In the construction of 'neighbourhood' researchers are encouraged to go beyond administrative boundaries and extend their conceptualisation to include features of the built environment, collective representations, population characteristics, and historical or social processes (Chaix et al., 2009). The use of circular buffers around neighbourhoods has also been criticised for failing to consider the streetscape (e.g. the closest major road, shops, or transportation station) which significantly determines or distorts the direction of local exposures (Chaix et al., 2009; Owen et al., 2015).

Novel approaches have emerged to conceptualise space in the study of neighbourhood effects. Chaix et al. (2005) created fuzzy delimitations of neighbourhood boundaries using the centroid of a resident's municipality to create a weighted street network buffer. For example, positioning points on every kilometre in France were attributed socioeconomic characteristics based on the municipality in which it was located. A contextual measure of socio-economic position for each person was then computed using the weighted average of the socio-economic values for all points which surrounded the individual. In Auckland, New Zealand, Zhao and Exeter (2016) created two additional geographical zones (lower and upper zones) to complement the use of meshblocks and area units for social epidemiological investigation of area effects. To develop meaningful zones the authors considered features including geographic contiguity, population equality, existing

administrative boundaries, physical and social environment features, compactness, and internal homogeneity. Such an approach highlights what can be achieved within the study of a city, but applying such methods at a national level would likely be cumbersome.

It is envisaged that future neighbourhood designs will necessarily incorporate spatial dependence into the modelling of neighbourhood effects. As described earlier in this chapter, multilevel models which do not take into account a continuous notion of space have been criticised for their likelihood of overestimating neighbourhood effects (Chaix et al., 2005). It has been postulated that the impact of living in a deprived neighbourhood positioned within in a wider affluent or disadvantaged area is likely to be different (Chaix et al., 2005). Recommended improvements in multilevel modelling point to the need to consider the nested nature of neighbourhoods within larger macro units, whereby local policies also have an impact on neighbourhood exposures and behaviour (Owen et al., 2015; Shankardass & Dunn, 2012). For all these reasons, multilevel modelling approaches have been shown to have limitations in the primacy of study of neighbourhood effects (Shankardass & Dunn, 2012) and proposed that they may be best suited to a defined context that is not strictly geographical, for example schools and workplaces (Chaix et al., 2005).

Overall, many positive shifts are occurring in neighbourhood research to improve the rigour of the field. Researchers are continually seeking to create more meaningful definitions of neighbourhoods in partnership with residents, there appears to be a growing interest in the qualitative and quantitative exploration of mechanisms of neighbourhood effects and the spatial scale at which they operate, and studies are increasingly acknowledging the wider environment which shapes the physical and social characteristics of the neighbourhood. All these point in the right direction for high-quality and meaningful neighbourhood research.

8.4.3 Collection of neighbourhood exposures

Advances are also occurring in the methods used to collect data on neighbourhood exposures. Although the majority of studies have utilised population surveys for data collection, approaches such as systematic social observation (SSO), whereby a researcher drives or walks down street segments to report on visual observations of the landscape, have also been used to audit the neighbourhood landscape. The PHDCN study pioneered such an approach using sports utility vehicles, although the resource-intensive and costly nature of SSO meant that only a selection of neighbourhoods could be sampled (Sampson & Raudenbush, 1999). Within the New Zealand context, Photovoice has been used in case studies to document the neighbourhood environment (Jensen et al., 2006).

Growth in internet capabilities may hold great promise for collecting data on the physical neighbourhood environment at low cost. For example, Google Street View provides 360° horizontal panoramic views of neighbourhoods across seven continents, free of charge (Google, 2016). Access to such data has prompted many neighbourhood researchers to compare “virtual” data with that collected in person. Using field work (such as the PHCDN SSO) as a comparison, concordance with Google Street View has been found for neighbourhood indicators including recreational facilities, the local food environment, general land use (Clarke, Ailshire, Melendez, Bader, & Morenoff, 2010), pedestrian safety, traffic and parking, and active travel infrastructure (Rundle, Bader, Richards, Neckerman, & Teitler, 2011). Contrasting findings are evident for physical disorder, with Rundle et al. (2011) finding low levels of concordance, suggesting that this was due to the temporal variability of items such as rubbish. Conversely, Odgers, Caspi, Bates, Sampson, and Moffitt (2012) found high levels of concordance for physical disorder, likely to be result from the field work and virtual observations occurring within the same time period. The possibility of bias in the virtual counting of items relating to physical disorder across neighbourhoods has been noted, resulting from differential use (e.g. by socio-economic group) of Google’s policy to request the removal or blurring of images that depict features of a resident’s

property. The usefulness of internet capabilities for examining neighbourhood social processes remains unexplored.

The recommendation for more space-time neighbourhood research (Auchincloss et al., 2012) which takes into account the “Uncertain Geographic Context Problem” (Kwan, 2012) has resulted in the utilisation of mobile-phone GPS-based data collection strategies to examine real-time spatial exposures (Browning and Soller, 2014; Palmer, 2013; Wiehe et al., 2008). The richness of this type of data on human mobility, when combined with data on social networks (which may be gathered through online communications such as Facebook), has the potential to provide a more nuanced investigation into the impact of time spent across a range of structured and unstructured settings, such as institutions, homes, and parks (Browning et al., 2015). Simulation models which create artificial populations in space and examine bidirectional relationships have also been signalled (Auchincloss et al., 2012).

8.4.4 Disentangling the mechanisms of effects

Evidence documenting the paths which give rise to neighbourhood collective efficacy and the mechanisms in which it exerts its effects is scarce. In relation to socio-economic disadvantage, it remains unknown the precise mechanism or particular features of disadvantage which lead directly to young adolescent drinking and to reduced collective efficacy (as demonstrated in Chapters 6 and 7). As Shankardass and Dunn (2012) have argued, utilising a range of census-based measures to approximate disadvantage results in speculation regarding the meaning or etiological pathway of each indicator of disadvantage on health outcomes and the development of collective efficacy. It has been argued (Wilkinson, 1997; Wilkinson & Pickett, 2006) that the concentration of disadvantage at the neighbourhood-level simply reflects the pattern of societal inequality, which has a psychosocial pathway to reducing social cohesion and affecting health and behavioural outcomes. The salience of the objective versus subjective perceptions of societal inequalities to health is uncertain (Muntaner & Lynch, 1999). Others dispute the domination of

the inequality pathway (Coburn, 2000; Lynch, Due, Muntaner, & Smith, 2000; Muntaner & Lynch, 1999), with evidence suggesting that it is absolute income that matters most to health (Lynch et al., 2000). It is recommended that considering health to be a result of both psychosocial *and* material circumstances can assist to draw attention to the material differences between neighbourhoods which may also give rise to health inequalities (Lynch et al., 2000).

The findings in this thesis of a direct and indirect effect of concentrated disadvantage and disorder on young adolescent drinking could provide support to the role of both material and psychosocial pathways on health behaviour. It is also argued that neo-liberalism may have direct effects on reducing social cohesion (Coburn, 2000), although this has been mostly expressed or referred to at the societal level. The ideology of neo-liberalism, as one which views society as composed of autonomous individuals who are largely materially motivated and valued according to their contribution to the market, is believed to lead to social fragmentation, scepticism, distrust to one another, and individual blame (Coburn, 2000). Other contributing features of neo-liberalism to lowered cohesion may include the undermining of labour unions, privatisation of publicly-owned assets, and exploitation in the labour markets, through gender pay inequality and negative stereotypes regarding the value of the manual or working class (Muntaner & Lynch, 1999). Understanding the importance of relative inequalities in society versus absolute neighbourhood income, and the larger role of neo-liberalism, has important implications for the development of effective advocacy and public policy efforts to enable healthy outcomes across neighbourhoods.

As demonstrated throughout this thesis, studies have shown collective efficacy to have wide reach into a range of adolescent health and social outcomes. The demonstration of universal protective effects has wide implications for shifting the paradigm of neighbourhood research, from being mostly deficit-based towards being more resiliency-focused, addressing or mitigating some of the concerns of others (Forrest & Kearns, 2001; Tuck, 2009). However, as most of the studies examining collective efficacy have been conducted in the United States, further research

will be required to determine its role in other social contexts, particularly welfare states, where the effects of disadvantage may be less tenacious and the norms regarding social control may be different (Sampson, 2006). The only study conducted in neo-liberal context similar to that of New Zealand, was in Brisbane, Australia, which found an association between collective efficacy and adult crime (Mazerolle, Wickes, & McBroom, 2010).

Browning et al. (2015) suggest that eco-networks, where neighbours jointly engage in space during their routine activities, may play a pivotal role in collective efficacy and strengthening adolescents' sense of security and predictability of the local context. These 'eco-networks' are believed to influence a number of positive mechanisms, including effective monitoring of public space, establishing familiarity between adolescents and adults, providing for casual information exchange, developing trust, and reinforcing place-based behavioural norms (Browning et al., 2015). Neighbourhood social cohesion has been found to be a necessary prerequisite to resident's responding positively to these types of social control methods (Warner, 2014), which aligns with Gau's (2014) belief that the components of collective efficacy are best tested separately. Further research will be necessary to explore the importance of different types of ties found in eco-networks which give rise to social cohesion and informal control for adolescent behaviour. For example, parental ties may be more important than residential ties in the development of social cohesion and informal social control (Coleman, 1988; Valdimarsdóttir & Bernburg, 2015).

In addition, further research and intervention is required to understand the importance and pathways of the informal social control mechanisms which arise in socially cohesive neighbourhoods (Leslie et al., 2015). Browning et al. (2015) consider that there is a pro-social element to eco-networks through their potential to draw adolescents into other pro-social institutions, such as family life, education, and employment. The authors also point to the social costs for adolescents in disrupting conventional goals which are established through strong eco-networks. Research could also investigate the role of other forms of social control, from informal methods such as raising eyebrows to more formal mechanisms including direct criticism,

intervening, or calling the Police. Each is considered qualitatively different and may occur privately, within broader interpersonal networks, or may involve third-parties (Warner, 2007). It is also considered that each social control mechanism may be behaviour-specific (Erickson et al., 2012). In the absence of intervention studies, qualitative research to understand the forms of social control which have salience for New Zealand adolescents will be imperative.

Sampson (2012) has also pointed to the role of established community institutions and organisations in the development of neighbourhood collective efficacy, which can be appropriated to take action to achieve collective goals. He suggests that the density of non-profit organisations, and especially resident's perceptions of their level of action, can have a powerful impact on shared expectations and trust, particularly within highly segregated Black communities (Sampson, 2013). Community organisations are perceived to be strategic points for policy intervention and can serve as a counterweight to economic disadvantage (Sampson, 2012). The applicability of these findings to the New Zealand context, which has a strong history and contribution of the non-governmental sector to health and social well-being (Harrison, 2010), is unknown and should be the focus for future research. Furthermore, it is uncertain whether the absence of large private philanthropy for non-profit funding in New Zealand (in contrast to the United States) and consequently closer relationships with Government funding bodies (Tennant, O'Brien, & Sanders, 2008) has differential impact on the ability of community organisations to influence collective efficacy.

Future research should also seek to address criticisms relating to the utility of average levels of neighbourhood exposures in the study of contextual effects. Assumptions that neighbourhoods are internally homogenous entities, where structural disadvantage and collective efficacy is evenly distributed, are suggested to mask observations which are to the contrary (Lee, 2001). As Lee (2001) notes:

equally high mean scores on collective efficacy in two neighbourhoods could be produced by very different distributions of survey responses, which in turn could have different consequences for the outcome of interest. To bring the matter closer to home, would you prefer to live in an area where efficacy is uniformly average, or in one where the average level results from extremely high and low pockets? I know how I would answer this question (p. 36).

Thus, Lee (2001) recommends that the use of means and percentages in neighbourhood research is supplemented with measures of dispersion. Finally, attention should be directed to address the paucity of research on the importance of relative position and neighbourhood inequality on perceptions of trust and development of collective efficacy (Bjornstrom, 2011).

8.5 Implications for health promotion practice

Health equity is considered a marker of the progress of society and a goal that should be the focus across all government sectors (Commission on the Social Determinants of Health, 2008). The findings in this thesis of a spatial pattern of socio-economic inequalities, or inscription of class in the geographical landscape (Florida, Matheson, Adler, & Brydges, 2014), presents challenges for health promotion practitioners committed to achieving social justice.

The health sector is considered the defender of health, an advocate for health equity, and negotiator for broader societal goals (Commission on the Social Determinants of Health, 2008). Consequently, differences in adolescent drinking by level of neighbourhood disadvantage, disorder, and collective efficacy requires health promotion practice to 'swim upstream' (Kiran & Pinto, 2016) to address the root causes of inequity. Health promotion efforts will be required which work towards reducing the inequities in the spatial concentration of socio-economic disadvantage in neighbourhoods, particularly in urban and semi-urban areas. This presents two options to health promoters: 1) to seek strategies which increase the absolute level of income in disadvantaged neighbourhoods, or 2) to identify ways to increase the socio-economic mix within

all neighbourhoods. From a social justice perspective both strategies have their place, although the former is likely to enable long-term health gains in families and future generations. It is also likely that the second option may present challenges or controversy when seeking to enable disadvantaged families to move to more affluent neighbourhoods, or encouraging less disadvantaged families to move to poor neighbourhoods. The strong ties that Māori have with land (Becares et al., 2013) must also be strongly considered in decision-making concerning policies relating to neighbourhood mobility, particularly in light that ethnic density in neighbourhoods is protective of Māori health (Becares et al., 2013). Whilst long-term efforts to reduce disadvantage are implemented action can be directed towards enabling environments which enhance neighbourhood social connections and collective efficacy. Using the five cornerstones of the Ottawa Charter (World Health Organization, 1986), which is one the foundations for health promotion practice in Aotearoa New Zealand alongside Te Tiriti o Waitangi, recommendations for addressing the upstream, neighbourhood-level determinants of adolescent alcohol use are made. It is acknowledged that the studies which comprise this thesis constitute insufficient evidence on their own to affect policy and practice, but signal a direction that health promotion could take in light of the findings and future neighbourhood research.

8.5.1 Build healthy public policy

Health promotion is inherently a political activity (Raphael, 2013b). The theme of the most recent Global Conference on Health Promotion entitled “Health in All Policies” sought to identify opportunities to implement health promotion action on the social determinants of health. The conference statement drew attention to the need for health considerations to be systematically and transparently taken into account in policy-making processes (World Health Organization, 2013). The enduring spatial concentration of economic disadvantage within and across neighbourhoods in New Zealand is seen to be sensitive to the broader pattern of societal inequality (Wilkinson, 1997; Wilkinson & Pickett, 2006), which is further determined by social, economic and planning policies (Commission on the Social Determinants of Health, 2008; Sampson, 2012; Voigtländer,

Razum, & Berger, 2013). Spatial sorting also seen to play a role in a society's cycle of continuity in inequality (Wilkinson, Pickett, & Chafer, 2011). To achieve change, the dominant policy approach of individualism will need to be shifted to one which is more holistic, and considers the neighbourhood as the unit for both policy action and evaluation (Sampson, 2012).

As detailed in the previous section, it is important to consider both the material and psychosocial effects of neighbourhood disadvantage on adolescent risky drinking. Chapter 7 showed that there were both direct and indirect effects of disadvantage and disorder on high typical-quantities and current drinking. The direct effect may point to the need for advocacy strategies which seek to raise absolute income in disadvantaged neighbourhoods or increase the socio-economic mix of neighbourhoods. Alternatively, adopting a perspective that concentration of disadvantage merely reflects societal inequality may influence the desire to advocate for policies which seek to redistribute income across the social gradient. Ideally, proportionate universalism should be recommended, whereby actions taken are universal, but "with a scale and intensity that is proportionate to the level of disadvantage" (Marmot et al., 2010, p.15).

In Auckland, New Zealand, it is suggested the economic segregation has been heavily influenced by housing policies (Morrison, 2015a). Auckland now contains over half of all affluent area units in the country, despite representing only one-third of the total population (Morrison, 2015a). Zoning policies, the purview of both local and central government in New Zealand, can significantly impact economic segregation. Regulations such as density restrictions, land supply and building codes are believed to lead to economic segregation by forcing socio-economically disadvantaged households to the suburban limits (Lens & Monkkonen, 2016). Policies which impact on urban sprawl have also been found to hinder resident's social mobility to improve their life chances (Ewing, Hamidi, Grace, & Wei, 2016). In relation to policies on neighbourhood regeneration, it is suggested that unless approaches address the stigmatisation of neighbourhoods, regeneration initiatives will be unlikely to succeed in the longer term (Dean & Hastings, 2000).

Policies can also shape the potential for neighbourhood social interaction (Sampson, 2003), which although may mitigate the effects of neighbourhood disadvantage should not be considered to replace efforts to reduce income inequality. Local government's role in developing neighbourhood structures, such as meeting places, parks, and playgrounds, have important implications for the walkability and social interaction within neighbourhoods (Browning et al., 2015; Witten, McCreanor, & Kearns, 2003). The use of mixed density and pedestrian-oriented neighbourhoods also have a role in walkability and use of public transport (Stock, 2013), leading to greater familiarity with neighbours and social engagement (Leyden, 2003). Finally, policies which limit sprawl may also impact positively on social connections (Frumkin, Frank, & Jackson, 2004) and civic engagement (Williamson, 2002).

The disproportionate number of Māori and Pacific students found to reside in neighbourhoods associated with inequities in alcohol use and harm may reflect the longer-term political history of policy making in New Zealand. The history of colonisation, disruption or severance of ties to land, interpersonal and institutional racism, and inequality in social participation and power are believed to be the dominant forces of disadvantage and health inequalities for indigenous populations (Durie, 1998; Indigenous Health Group, 2007). The enactment of policies which address economic redistribution, reduce discrimination and enable autonomy are considered essential to uphold the rights of indigenous people and enable self-determination (Indigenous Health Group, 2007).

The importance of policy levers to affect structural change and reduce inequalities presents many opportunities to a health promotion workforce committed to social justice. Although many of the broader political determinants are not within the control of health promoters, they are certainly within their influence. Health promoters can utilise their skills to engage with other sectors and take a leadership role in advocacy for healthy public policies which address economic and ethnic inequalities and seek to build healthy, connected communities (Frohlich & Potvin, 2008). Health promotion advocacy may take many forms, from awareness raising activities, establishment of

community coalitions, formal policy submissions, to community empowerment of disadvantaged communities (Carlisle, 2000). Health promoters also need to be acutely aware of the importance of the political economy of health in seeking to redress the causes of inequities i.e. how New Zealand's liberal welfare state is juxtaposed with a strong and influential business sector and a government interested in deregulation and weakening of the long-entrenched welfare state (Raphael, 2013b). It is believed that inequality in New Zealand has grown as a consequence of the decentralisation of government, resulting from neighbourhoods and communities differing in their ability to represent and respond to their own needs (Craig, 2004). The shifting of accountability and responsibility to communities without adequate resourcing and capacity is suggested to lead to a situation whereby those with power and resources are more likely to be politically active so that they can achieve self-interested goals (Craig, 2004).

Health promoters need to be involved from the outset in policy development processes to ensure that the impact of policies on health equity is considered. One strategy to enable this may involve the physical co-location of health promoters within departments of local government; a strategy which has been used in the United Kingdom and in Christchurch, New Zealand (Blackwell, Macmillan, & Tenbenschel, 2011). In addition, Health Impact Assessment (Public Health Advisory Committee, 2005), Whanāu Ora Health Impact Assessment (Ministry of Health, 2007), and the Health Equity Assessment Tool (Signal, Martin, Cram, & Robson, 2008) will continue to be important tools for health promoters to assess the potential benefits and harms to health which may arise from draft policies. For example, Health Impact and Whanāu Ora Assessment were utilised in Wiri, Auckland, to evaluate the impact of the Spatial Structure Plan on the health and wellbeing of its residents (Field, 2010). Effective implementation of such strategies will require a broad competency base for the health promotion workforce (discussed later). In addition, permission within health promotion funding contracts to be involved in Health Impact Assessment is imperative if the wider determinants of health are to be addressed.

Finally, in relation to policy and political power, leadership ties amongst the elite have been shown to be important in the development of collective efficacy (Sampson, 2012; Sampson & Graif, 2009). Connected leaders within a neighbourhood are believed to be capable of mobilising action to access resources from within and outside their neighbourhood to achieve desired policy outcomes. One could consider this exposure as a type of bridging tie at the macro level, which is independent of the economic status of the neighbourhood (Sampson & Graif, 2009). Research is required to determine the applicability of these findings to the New Zealand context, but points to health promoters having a key role in facilitating the stability of, and connection between, local leaders in the neighbourhood or wider community.

8.5.2 Creating supportive environments

Many strategies are available to health promoters to create supportive environments which enhance social connections between neighbours, reduce neighbourhood stereotypes, and promote a positive climate for action on the social determinants of health. Health promoters should continually evaluate their practice in this area to identify measureable progress towards equity in health outcomes.

The role of technology is continuing to change the face of communication and social ties within neighbourhoods, as communities become more ‘wired’ through the use of the internet (Forrest & Kearns, 2001). Known as “technology-mediated collective efficacy” (Sampson, 2006) or “glocalisation” (Hampton, 2010), online communication in the United States has been found to hold many promises for the development of social connections and collective action, particularly in disadvantaged communities (Gad, Ramakrishnan, Hampton, & Kavanaugh, 2012; Hampton, 2010). The potential for disadvantaged communities to particularly benefit has important implications for mitigating neighbourhood-level inequalities in collective efficacy. Cross-cultural application of this finding to the New Zealand context remains to be empirically tested, but promising results have emerged from a case study (Williams, 2013) of the free ‘Computers in

Homes' scheme established in New Zealand in 2000 to provide a computer (with internet access) to disadvantaged homes. Similar to the findings reported in the United States, outcomes including stronger social networks, civic engagement, volunteerism, and leadership mobilisation have been documented. Consequently, a role for health promoters may be to advocate for reductions in the digital divide by level of income in New Zealand (Statistics New Zealand, 2015a) and facilitate access to the internet where possible. Like any technology, health promoters also need to be cognisant of the many harmful sides of internet use. Within their community-based programmes health promoters should also seek opportunities to incorporate strategies (virtual and/or real) which enhance day-to-day connections between neighbours.

Creating supportive environments which address neighbourhood reputation should also be part of the role of the community-based health promoter. Reputations and stereotypes are often developed and obtained from a number of sources, including direct observation, dissemination from other neighbours, and via reports and depictions from the media (Matsueda & Drakulich, 2015). It is suggested that the hegemony of the mainstream media in characterising neighbourhoods forms a key part of the overall development of a neighbourhood's identity and meaning (Martin, 2000). Such stereotypes are contested by local media and actors, who demand their own voice and identity (Martin, 2000). Similar to experiences in other countries, disadvantaged neighbourhoods in New Zealand are often lumped together and characterised as if they are one homogeneous and singular identity. Deficiency-oriented headlines are widespread. For example, a former Mayor of Manukau City (a large area in Auckland which experiences high levels of deprivation) and others have called for discontinuation of offensive stereotypes and the use of "South Auckland" as a term of generic contempt (Manukau City Council, 2000; Ringer, 2008). Health promoters should direct their attention to the role of the media in stereotyping communities, working proactively with them surrounding the provision of balanced stories as well as being vigilant for the use of stories which reinforce negative stereotypes.

Finally, the World Health Organisation European Healthy Cities approach provides an evidence-based argument for focusing attention towards addressing health inequities at the city-level. The Healthy Cities approach emphasises equity, inter-sectoral collaboration, local action and participatory decision-making to address the social determinants of health (Goldstein, 2000). Across the large number of participating towns and cities in Europe supportive environments have been enabled in relation to policy making (including urban planning (de Leeuw, Green, Spanswick, & Palmer, 2015)) and community empowerment and participation in decision making (Dooris & Heritage, 2013). Health promotion practice in New Zealand could look to adopt such evidence-based approaches or strengthen them where they exist.

8.5.3 Strengthening community action

This cornerstone is characterised by neighbourhood empowerment to enable self-determination in the setting of priorities, decision-making, and implementation of strategies to increase well-being (World Health Organization, 1986). However, community action programmes in New Zealand are often more prescribed by the funding agency, directed to achieving specific government priorities or outcomes rather than a wider and more long-term general goal of empowering communities (Casswell, 2001). Often place-based and targeting high-needs communities programmes are usually found to prioritise the reduction of individual risk factors or more proximal environmental determinants of behaviour (Baum & Fisher, 2011; Signal & Ratima, 2015). Examples of community action in relation to alcohol-related harm include mobilisation of communities surrounding the objection to individual liquor licence applications, providing input into national and local alcohol policy development (via formal submissions), and implementing programmes to reduce social supply of alcohol to minors. Criticism has been directed to community action strategies (and research) which target marginalised settings and adversely position the blame on the setting itself. It is suggested that such approaches result in a default to ‘community responsibility’ (Muntaner & Lynch, 1999) or ‘damage-centred research’ (Tuck, 2009), which is inherently disempowering and diverts attention away from the absence of

genuine broader changes in the social determinants which account for the setting's marginalisation in the first instance (McLaren, McIntyre, & Kirkpatrick, 2010; Muntaner & Lynch, 1999; Shareck et al., 2013; Tuck, 2009).

In New Zealand, the national 'Community Action on Youth and Drugs' (CAYAD) initiative does include funding provisions to address the more distal determinants of health and inequity. Adopting a youth development approach, CAYAD is funded to increase community capacity to support young people in education, employment and recreation, albeit with reference to the specific goal of reducing alcohol and drug-related harm (Ministry of Health, 2009b). Evaluation of these types of programmes could determine if such approaches have positive flow-on effects of empowering communities to address much larger structural issues, such as the concentration of economic disadvantage. Other examples of long-term community action programmes that have specific attention to the neighbourhood-level determinants (e.g. disadvantage) or broader social issues which impact on alcohol-related harm are rare in New Zealand. The growing evidence of the importance of neighbourhood-level processes (e.g. social cohesion) for effective social control of behaviour (Burchfield, 2009; Warner, 2014) has important implications for the on-going development of community action programmes, particularly those which seek to increase social control mechanisms to reduce the social supply of alcohol to minors or change social norms.

Community action, as it is described in the Ottawa Charter, has traditionally been situated within the discipline of community development or within Maori health promotion programmes which generally prioritise the collective needs over the interests of the individual (Signal & Ratima, 2015). Examples of long-term community development programmes in New Zealand include the Ranui Action Project (Adams, Witten, & Conway, 2009) and the "Know your neighbours" initiative in the North Shore of Auckland (Metzger, Myers, & Woodley, 2012) which have been found to result in positive outcomes in relation to neighbourhood social connections. Health promoters have a role in supporting community development programmes, such as those

described above, to increase community capacity to take local action and build cohesive communities.

Despite health promotion programmes being typically short in duration and funded to address priorities which are usually pre-determined by funding agencies, there is potential within the field to increase youth participation to address the social determinants of health. This is aligned with the belief that adolescents should be viewed as resources and not considered as “problems”; a more common reflection found within mainstream media (Checkoway & Gutiérrez, 2006). Engaging young people in decisions which affect their lives, through the formation of groups or organisations which create social and political action, has been used to address a number of key social determinants (Checkoway & Gutiérrez, 2006; Tsui, Bylander, Cho, Maybank, & Freudenberg, 2012). Such efforts by young people can also catalyse attention and action by the wider community to influence the social determinants of their health and wellbeing (Tsui et al., 2012).

8.5.4 Developing personal skills

Population-based prevention strategies which target individuals to change their behaviour, or require agency from individuals, have been criticised for having the potential to worsen health inequalities due to variation in uptake (McLaren et al., 2010). In contrast, population strategies which are more structural in nature and target the conditions underlying the occurrence of behaviours are recommended.

For this reason, health promoters may be better placed to focus their attention on targeting disadvantage and collective efficacy through building healthy public policy and creating supportive environments. Any development of personal skills could be directed to the health promotion workforce, to increase their knowledge, skills, and abilities to participate and partner across various non-health sectors in the policy making processes which impact on the social determinants of health (Barry, Battel-Kirk, & Dempsey, 2013). In addition, the development of

lifeskills (e.g., coping, decision making, impulse control, refusal/resistance) and advocacy skills for adolescents living in disadvantaged neighbourhoods may contribute to positive youth development (Catalano et al., 2004) and engagement in social and political efforts to reduce health inequities.

The inter-sectoral nature of health promotion practice ideally places practitioners to alter the wider discourse surrounding action on inequalities. Health promoters should be challenged to address New Zealand's low level of support for Government intervention to reduce inequalities (Morrison, 2015b), by increasing population awareness of the structural causes of ill health (Canadian Council on Social Determinants of Health, 2013). To do this, health promoters need to be cognisant of the way in which they frame their messages around the social determinants of health, and should consult a number of excellent manuals to assist them in developing their skills for effective communication on this topic to audiences with varying ideologies (Canadian Council on Social Determinants of Health, 2013; Crompton, 2010; Robert Wood Joseph Foundation, 2010).

8.5.5 Reorienting health services

This final cornerstone describes the need for health services to take action beyond its responsibility for the provision of clinical and curative services to achieve health equity. Advocacy in this area is considered to “be a logical extension of a healing, compassionate profession” (Kiran & Pinto, 2016, p. 3). It is recommended that the health sector listens more closely to its patients, co-designs its services to meet the social and health needs of its population, and gives stronger attention to prevention and professional education so that channels between health and other sectors can be opened (Kiran & Pinto, 2016; World Health Organization, 1986).

Many have lamented the slow progress in this domain in relation to health systems (including health promotion) strengthening its role in addressing the social determinants of health (Baum & Fisher, 2011; Baum, Bégin, Houweling, & Taylor, 2009; Kiran & Pinto, 2016; Ziglio, Simpson,

& Tsouros, 2011). Medical education is seen as one of the first steps which should be taken towards creating a health workforce which understands the social determinants, the need for inter-disciplinarity, and is confident and capable of advocating for and enabling structural change (Baum et al., 2009; Chokshi, 2010; Ziglio et al., 2011). Health practitioners have been shown to be quick to list the ways in which they improve equity of access, but less so in pointing to examples of taking action or advocating on the broader social determinants of health (Freeman et al., 2011). In New Zealand, holistic approaches to training youth health physicians who work in secondary school health services have been shown to be associated with lower levels of binge drinking among students in the schools that receive their services (Denny et al., 2014). Baum et al. (2009) believe that a central element in medical training should also be targeted to how health professionals can work with and upskill their counterparts from other sectors to achieve health equity. Utilising a critical pedagogical approach to enhance social accountability in medical education, students can be encouraged to examine inequity and their role in it (Ross, 2015). Currently, the World Health Organisation is preparing a resource that will enable transformation of health workforce education and training to address the social determinants of health (World Health Organization, 2014).

Beyond medical education and inter-sectoral collaboration health services can also take a leadership role in improving equity. Health sector policy statements and strategies which are explicit about health equity are needed to lead the transformation of the health sector towards addressing both the social and health concerns of its patients (Baum et al., 2009; Freeman et al., 2011). Although the New Zealand Health Strategy (Ministry of Health, 2016) acknowledges the wider factors which contribute to health and consequently the need for inter-sectoral action, there remains a lack of explicit and measurable strategies which will advance the social determinants agenda. District Health Board Annual Plans could also go much further in supporting an evolving role in this area. To do this, health services are recommended to develop process maps and cause and effect diagrams in their plans, so that the social determinants of health are explicitly

addressed (Kiran & Pinto, 2016). In addition, although the development of national preventive taskforces and health initiatives could be considered positive moves towards a health equity agenda, experience in Australia has shown that these initiatives have fallen short of expectations in addressing the social determinants, by focusing on predominantly individual behaviourist or proximal environmental strategies to the detriment of seeking to address the wider structural factors that drive behaviours (Baum & Fisher, 2011).

Finally, reorienting health services also directs attention to health research. Although there are many complexities and challenges to developing the evidence on the social determinants and neighbourhood effects (Kelly, Morgan, Bonnefoy, Butt, & Bergman, 2007) it is recommended that countries develop a specified, funded programme of primary research and evaluation of interventions on the impact of the social determinants of health (Baum et al., 2009). Of relevance, to further improve the understanding of the complex causal processes of the social determinants of health more publishers of socio-epidemiological research could move towards permitting longer articles which provide for a richer explanation of mechanisms of neighbourhood effects (Shankardass & Dunn, 2012).

Conclusion

This thesis aimed to understand the role of the neighbourhood in adolescent drinking in Aotearoa New Zealand. Despite the significant challenges with causal inference, the findings show that alcohol consumption does not occur in a vacuum, dispelling Margaret Thatcher's argument of there being only individuals and "no such thing as society" (Margaret Thatcher Foundation, 2016, para. 162). In contrast, the neighbourhood has been shown to constitute more than the sum of individuals, exposing adolescents to environments and emergent social processes which shape their behaviour. And that even within an ever-increasing global world, the relevance of the neighbourhood and everyday life in its boundaries cannot be underestimated (Forrest & Kearns, 2001).

The significant moderation effects found in the research underscore the importance of adopting a developmental approach to identifying neighbourhood effects in adolescents and suggest a tipping point (i.e. risky drinking) for neighbourhood social processes to take effect. Socio-economic disadvantage, collective perceptions of disorder, and collective efficacy/social cohesion were salient for adolescent drinking, aligned with the Social Disorganisation Theory which has its origins in predicting neighbourhood variation in crime. Although interest in the role of the Social Disorganisation Theory in adolescent alcohol use is growing, it has predominantly emerged from one of the most racially and economically segregated cities in America (i.e. Chicago). The findings from this thesis add some weight to its role in other geographical contexts, although the use of a static model to capture an environment which can be extremely fluid and inter-related across space points to the need for future neighbourhood research to more-adequately capture an adolescent's exposure to neighbourhood features as they go about their day-to-day life.

If it is accepted that health is a human right and that equity in health is as an expression of social justice it becomes ethically imperative that action be taken to further understand the causal pathways of disadvantage and disorder so that interventions can tackle these exposures at their root source. Adopting a political economy of health approach will be vital in this regard. This thesis has shown that population health approaches to reduce harm should not be judged alone on their ability to shift the overall distribution curve. Instead, increasing attention to the changes in the shape of the curve will be required. Implications from this thesis suggest that health promotion in New Zealand could look to re-orient its own practice by giving increased attention and action towards addressing the social determinants of health, particularly neighbourhood disadvantage. A statement from Nancy Edwards, Scientific Director of the Canadian Institutes of Health Research Institute of Population and Public Health, provides the most apt closing: "No matter how sophisticated our population health interventions, they won't adequately address inequities if we exclusively focus on proximal determinants and tinker at the edges of structural disadvantage" (2011, p. 51).

Appendix 1. PRISMA checklist

Section/topic	#	Checklist item	Completed
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	✓
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	✓
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	✓
Objectives	4	Provide an explicit statement of research questions with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	✓
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	✓
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	✓
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	✓ Medline
Study selection	9	State the process for selecting studies (i.e., screening, eligibility), and, if applicable, included in the meta-analysis).	✓
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	✓
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and assumptions and simplifications made.	✓

Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	✓
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	✓
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	✓
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting)	✓
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses).	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	✓
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, follow-up), providing citations.	✓
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	✓
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	✓
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarise the main findings including the strength of evidence for each main outcome; consider relevance to key groups.	✓
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	✓
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	✓
FUNDING			
Funding	27	Describe sources and role of funding for the systematic review and other support (e.g., supply of data).	✓

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

Appendix 2. Medline search strategy: details and results

Search History (31)					View Saved	
<input type="checkbox"/>	# ▲	Searches	Results	Type	Actions	Annotations
<input type="checkbox"/>	1	young adult\$.mp.	607730	Advanced	Display Results More	Contract
<input type="checkbox"/>	2	adolescen\$.mp.	1842173	Advanced	Display Results More	
<input type="checkbox"/>	3	youth\$.mp.	60610	Advanced	Display Results More	
<input type="checkbox"/>	4	young person\$.mp.	2963	Advanced	Display Results More	
<input type="checkbox"/>	5	young people\$.mp.	21347	Advanced	Display Results More	
<input type="checkbox"/>	6	teen\$.mp.	25881	Advanced	Display Results More	
<input type="checkbox"/>	7	Adolescent/	1786815	Advanced	Display Results More	
<input type="checkbox"/>	8	Young Adult/	551763	Advanced	Display Results More	
<input type="checkbox"/>	9	alcohol\$.mp.	358757	Advanced	Display Results More	
<input type="checkbox"/>	10	intoxicat\$.mp.	51672	Advanced	Display Results More	
<input type="checkbox"/>	11	liquor\$.mp.	9090	Advanced	Display Results More	
<input type="checkbox"/>	12	beer\$.mp.	9346	Advanced	Display Results More	
<input type="checkbox"/>	13	wine\$.mp.	17641	Advanced	Display Results More	
<input type="checkbox"/>	14	binge\$.mp.	10926	Advanced	Display Results More	
<input type="checkbox"/>	15	drunk\$.mp.	3960	Advanced	Display Results More	
<input type="checkbox"/>	16	Alcohol Drinking/	58709	Advanced	Display Results More	
<input type="checkbox"/>	17	Alcoholic Intoxication/	11784	Advanced	Display Results More	
<input type="checkbox"/>	18	Alcohol-Induced Disorders/	243	Advanced	Display Results More	
<input type="checkbox"/>	19	neighbourhood\$.mp.	5470	Advanced	Display Results More	
<input type="checkbox"/>	20	neighborhood\$.mp.	18193	Advanced	Display Results More	
<input type="checkbox"/>	21	communit\$.mp.	486633	Advanced	Display Results More	
<input type="checkbox"/>	22	(social capital or collective efficacy or informal social control).mp.	2852	Advanced	Display Results More	
<input type="checkbox"/>	23	Residence Characteristics/	27461	Advanced	Display Results More	
<input type="checkbox"/>	24	residence\$.mp.	64344	Advanced	Display Results More	
<input type="checkbox"/>	25	Social Environment/	40152	Advanced	Display Results More	
<input type="checkbox"/>	26	(place or norm or norms or area-level or geograph\$.mp.	408783	Advanced	Display Results More	
<input type="checkbox"/>	27	(depriv\$ or poverty or economic or socioeconomic or income).mp.	499937	Advanced	Display Results More	
<input type="checkbox"/>	28	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8	2152050	Advanced	Display Results More	
<input type="checkbox"/>	29	9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18	426745	Advanced	Display Results More	
<input type="checkbox"/>	30	19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27	1351017	Advanced	Display Results More	
<input type="checkbox"/>	31	28 and 29 and 30	15711	Advanced	Display Results More	

Appendix 3. Details of included studies

* Population size obtained from the US Census Bureau

Authors, year, country	Sample (overall, n, age)	Number, type and size of neighbourhood	Area-level exposure	Outcome	Results	p value	Control variables	Mediation model	Moderation analysis
Neighbourhood disadvantage or income									
Aslund et al, 2013, Sweden	Mixed 7757, 13-18yrs	31 housing areas (size unknown) # respondents/ neighbourhood: range 64-666	Median income of housing area	High alcohol consumption (highest quartile of modified AUDIT-C)	OR 1.00 (0.99-1.01)	NS	Age, grade, subjective SES, individual-level social capital, individual level social trust, living conditions, parental unemployment, ethnicity	Not explored	Not explored
Bernburg et al, 2009, Iceland	Mixed 5491, 15-16yrs	83 school districts, population range 719-15,926 (mean 3226) # respondents/ neighbourhood: mean = 71 (range 21-286)	Median neighbourhood household income, immigrant population, single parent households	Drunkenness (at least once) in past 30 days	b=0.12	p<0.05	Weak social ties to parents, coercive family interaction, gender, household poverty, residential mobility, two-parent households, immigrant status.	b=0.04 NS Controlling for community-level weak social ties to parents and coercive family interaction	Not explored
Brenner et al, 2011, United States	Low grade point average, high ethnic minority 711, π age at baseline 14.5 yrs	143 Census blocks (600-3000*) # respondents/ neighbourhood: Not stated	Families with annual incomes less than \$15,000, families on public assistance, single-headed families with child <18yrs, families where adult is unemployed, head of household education <high school	Scale comprising frequency of alcohol consumption in past month, frequency of binge drinking past 2 weeks and drinking enough to feel high	b=0.03	NS	Gender, age, ethnicity, family SES, maternal education, caregiver alcohol and drug use, peer alcohol and drug use, mothers support, peer support, school and church activities	Interpersonal factors did not mediate the relationship between disadvantage and alcohol use (data not reported)	Not explored
Breslin and	Mixed	136 health	% respondents	Frequency of binge	b=-0.129	NS	Age, gender, family	Not explored	Community

Adlaf, 2005, Canada	8,080, 15-19yrs	regions (size unknown) # respondents/ neighbourhood: mean = 59 (SD31)	defined as low income (from household income)	drinking in the past year			SES, work hours		disadvantage did not moderate association between longer work hours and alcohol use.
De Haan et al (2010) US	Rural, young 1424, 11-15yrs, mean age 12.5yrs	22 rural communities surrounding schools (range 319-2485 population) # respondents/ neighbourhood: Not stated	Town-level child poverty rate, town-level adult poverty rate, % of adults with less than high school education, % of population White, unemployment rate, % female headed households	Lifetime use of alcohol Past month alcohol use	OR 1.04 (0.92-1.17) Disadvantage quadratic (middle vs. low and high) OR 1.00 (0.96-1.04)	NS NS	Individual level community support, perceived peer drinking, perceived economic strain, parental relationships, community-level collective efficacy, adult community support	Not explored	Past month use was higher for individuals who reported low levels of economic strain living in areas of high disadvantage.
Ennett et al, 2008, US	Mixed 6544, 11-17yrs	158 Census blocks (600-3000*) # respondents/ neighbourhood: Not stated	6 items relating to perceived neighbourhood physical and social disorder (assessed by parents) and 5 Census measures (e.g. % below poverty line, % of households without a high school degree)	Problematic levels and negative consequences of drinking	b=0.00	NS	Gender, age, ethnicity, family structure, parental education, high school enrolment, and family, peer and school context variables	Not explored	No significant interactions between neighbourhood level variables; alcohol use in the community, neighbourhood bonding, neighbourhood social control, and disadvantage.
Fagan et al, 2013 US	Mostly ethnic minority 1856, 8-17yrs (mean 12)	79 neighbourhood clusters (combination of census tracts) (approx. 8000) # respondents/ neighbourhood: Not stated	Census measures of % residents below poverty line, receiving public assistance, unemployed, living in female household	Drinking in past year Binge drinking in past 30 days	b= 0.001 b= -0.039	NS NS	Age, gender, ethnicity, household salary, peer and parent drug use, prior drug use, parental warmth	Not explored	Not explored
Huckle et al, 2008, New	Mixed 1179,	Census Area Unit (~2000) – 310	Nine census variables; income, employment,	Typical occasion quantity Annual frequency of	b=0.002 b=0.001 b=0.001	p<0.05 NS NS	Age, gender, ethnicity, young person's income,	Not explored	Not explored

Zealand	12-17yrs	# respondents/ neighbourhood: mean 3.8	communication, transport, support, qualifications, living space, owning a home	use Frequency of drunkenness			social supply of alcohol, exposure to alcohol advertising, own purchase of alcohol		
Kulis et al, 2007, US	Ethnic minority 3570, 11-17yrs (mostly 12-13)	35 school catchments (unknown) # respondents/ neighbourhood: Not stated	% families with incomes below poverty line % families headed by a single mother	Past month alcohol use	Poverty: b= -0.034 Single mother: b= 0.015	NS NS	Age, free school lunch, gender, ethnicity, acculturation, academic performance	Not explored	Neighbourhood effects were not moderated by ethnicity.
Lo et al, 2006, US	Mixed 73782, 6th to 12th grade	67 counties (size unknown) # respondents/ neighbourhood: Not stated	% Black, % population 16- 19yrs, median household income, use of temporary assistance, food stamp recipients, unemployment rate, single-headed families	Lifetime alcohol use Alcohol use past 30 days	b=-0.0045 b=-0.0010	p<0.05 NS	Grade, gender, religious attendance, self (morals), protective role of family, peer drug use, school and community protection	Not explored	Lifetime alcohol use: Disadvantage strengthens the protective effect of religious attendance and personal morals but reduces the protective effect of the family. Alcohol use in past 30 days: The negative effect of grade and drug using peers is stronger in areas with more disadvantage. The protective effect of religion and personal morals is stronger in areas with less disadvantage.

Maimon et al, 2012, US	Mixed 1135, 8-16yrs	76 neighbourhood clusters (1-3 census tracts) (~8000) # respondents/ neighbourhood: Not stated	% residents below the poverty line, receiving public assistance, unemployed, households headed by a female	Use in past 30 days	Negative and significant	p<0.05	Gender, age, family SES, ethnicity, family size, two- parent households, parental supervision, family attachment, impulsivity, unstructured socialising, deviant peers, prior delinquency, alcohol use at wave 1	Not explored	Not explored
Snedker et al, 2008, US	High-risk of dropping out 1721, 13-21yrs (mean 15.6)	111 Census tracts (1200-6000*) # respondents/ neighbourhood: >5	% residents below poverty line, % female headed households, % residents receiving public assistance, % residents aged 16yrs and older that are unemployed.	Alcohol use past month	b=-0.035	p<0.01	Ethnicity, age, sex, high risk of school drop-out, high school change, family structure, parent's educational attainment, personal control, family support, deviant peer bonding, distance to nearest outlet.	Not explored	The influence of deviant peers is stronger for adolescents living in areas of low disadvantage. No interaction between disadvantage and family functioning.
Snedker et al, 2009, US	High-risk of dropping out 2006, 13-21yrs (mean 15.68)	131 Census tract (1200-6000*) # respondents/ neighbourhood: >5	% residents below poverty line, % female headed households, % residents receiving public assistance, % residents aged 16yrs and older that are unemployed.	Alcohol use past month	b=-0.015	p<0.05	Ethnicity, age, gender, high risk of drop-out, high school change, family structure, parent's educational attainment, personal control, family support, deviant peer bonding	Not explored	The influence of deviant peers is stronger for adolescents living in areas of low disadvantage. Disadvantage did not moderate the association between family support or personal agency and coping skills and alcohol use.
Vinther-Larsen et al, 2013 New Zealand	Mixed 1144, 12-19yrs	Census Area Units (median size 2000) – number unknown	% receiving welfare, low income, home ownership, family structure,	Typical occasion quantity	j-shaped curve – negative relationship low deprivation, positive association with high deprivation	p<0.05	Age, sex, ethnicity, individual, occupation of main earner in household	Not explored	Not explored

		# respondents/ neighbourhood: Not stated	employment, educational qualifications, overcrowded living spaces, access to telephone, transport	Alcohol use past year	b =0.0253	NS			
Yabiku et al, 2007, US	Low socio- economic	35 school enrolment areas/census tract of school (size unknown)	% in poverty % less than high school education	Amount consumed past 30 days	b=0.00 b=0.14	NS NS	Ethnicity, gender, free/reduced lunch, grades	Not explored	For non- American Indian students, poverty and low high school education levels increased alcohol use (and decreased it for American Indian students).
		4137, 11-13yrs							
		# respondents/ neighbourhood: Not stated							
Neighbourhood disorder									
Fagan et al, 2007	Mixed	41 communities (range 1,578 - 106,221 (mean 18,275)	Aggregate of perceptions of presence of crime/drug selling, fights, empty and abandoned buildings, graffiti		6 th to 8 th grade:		Age, sex, ethnicity	Not explored	Not explored
US	>69,000 in grades 6, 8 and 10			Lifetime use	b=0.14	NS			
		# respondents/ neighbourhood:		Past month use	b=0.10	NS			
		Average 2126 (range 201- 12350)		Binge drinking	b=0.14	NS			
					8 th to 10 th grade:				
				Lifetime use	b=0.12	NS			
				Past month use	b=0.08	NS			
				Binge drinking	b=0.03	NS			
Kulis et al, 2007, US	Ethnic minority	35 school catchments (unknown)	Violent crime rate	Past month alcohol use	b= 0.036	NS	Age, free school lunch, gender, ethnicity, acculturation, academic performance	Not explored	Violent crime was associated with higher alcohol use in English dominant students with Mexican heritage.
		3570, 11-17yrs							
		# respondents/ neighbourhood: Not stated							

Snedker et al, 2008, US	High-risk of dropping out	111 Census tracts (1200-6000*) # respondents/ neighbourhood: 1721, 13-21yrs (mean 15.6) >5	Crime rate	Alcohol use past month	b=0.0001	NS	Ethnicity, age, sex, high risk of school drop-out, high school change, family structure, parent's educational attainment, personal control, family support, deviant peer bonding, distance to nearest outlet.	Not explored	The protective effect of family support is stronger for adolescents living in areas with high crime rates. No interaction between the crime rate and effects of deviant peers.
Steen, 2010, US	Mixed	60 counties (size unknown) 50,529, 6th to 12th grade # respondents/ neighbourhood: Not stated	Aggregated adolescent perceptions of large number of abandoned buildings	Ever use of alcohol	b=0.02	p<0.05	Individual level: attitude to alcohol (perception of risk, immorality of use), perceptions of parental and neighbour approval, perceptions of ease of access to alcohol	Not explored	Not explored
Yabiku et al, 2007, US	Low socio-economic	35 school enrolment area/census tract of school (size unknown) 4137, 11-13yrs # respondents/ neighbourhood: Not stated	Crime rate	Amount consumed past 30 days	b=0.05	p<0.05	Ethnicity, gender, free/reduced lunch, grades	Not explored	No significant interaction between ethnicity, crime levels and alcohol use.
Enforcement of liquor laws									
Dent et al, 2005, US	Mixed	93 school catchment communities 3318, 16-17yrs Current # respondents/	1 item: "If a kid drank some beer, wine, or hard liquor in your neighbourhood, would he or she be caught by the	Alcohol use past 30 days Binge drinking	b=-0.040 b=-0.035	p<0.05 NS	Individual-level commercial and social sources of alcohol supply	Not explored	High levels of enforcement was associated with fewer young people acquiring alcohol from friends under the legal age and

	drinkers	neighbourhood: ~156	Police?"						more from their home. No cross-level interaction between community-level commercial access of alcohol and enforcement.
Fagan et al, 2007	Mixed	41 communities (range 1,578 - 106,221 (mean 18,275)	Aggregate of adolescent perception of being caught using alcohol and/or drugs	Lifetime use	6 th to 8 th grade: b=0.16	NS	Age, sex, ethnicity	Not explored	Not explored
US	>69,000 in grades 6, 8 and 10	# respondents/ neighbourhood: Average 2126 (range 201-12350)		Past month use	b=0.18	NS			
				Binge drinking	b=0.18	NS			
				Lifetime use	8 th to 10 th grade: b=0.26	p<0.05			
				Past month use	b=0.25	p<0.05			
				Binge drinking	b=0.23	p<0.05			
Paschall et al (2013),	Mixed	50 cities (range 50-500,000)	Per capita enforcement funding (only 15 cities had received any funding)	Past year drinking	At 1yr: b=-0.11	p<0.05	Age, gender, ethnicity, perceptions of availability of alcohol, perceptions of enforcement of liquor laws, perceptions of acceptability of underage alcohol use	Past year:	At 2 year follow-up no significant interactions were found between changes in alcohol use and level of funding for enforcement.
Paschall et al (2012)	1236-1478, 13-18yrs	# respondents/ neighbourhood: 1yr follow up: 15-44 (mean 30) 2yr follow up: 20-47 (mean 26)		Heavy drinking	At 2yrs: b=-0.085	p<0.05		At 1yr: b=-0.07 NS At 2yrs: b=-0.052 p<0.05	
US					At 1yr: b=NS	NS		Controlling for perceived alcohol availability, enforcement and acceptability of alcohol use	
					At 2yrs: b=-.002	NS			

Residential mobility									
Bernburg et al, 2009, Iceland	Mixed	83 school-districts, range 719-15,926 (mean 3226)	% parents that were not in the neighbourhood 5 years previously	Drunkenness (at least once) in past 30 days	b=-0.13	NS	Weak social ties to parents, coercive family interaction, gender, household poverty, residential mobility, two-parent households, immigrant status, , moved last 12 months, peer substance use, status (if alcohol is perceived to give respect), membership (wanting to belong)	Not explored	Not explored
	5491, 15-16yrs	# respondents/ neighbourhood: Mean = 71 (range 21-286)							
Fagan et al, 2007	Mixed	41 communities (range 1,578 - 106,221 (mean 18,275)	Aggregate of changing homes and schools	Lifetime use	6 th to 8 th grade:		Age, sex, ethnicity	Not explored	Not explored
US	>69,000 in grades 6, 8 and 10	# respondents/ neighbourhood: Average 2126 (range 201-12350)		Past month use	b=0.07	NS			
				Binge drinking	b=0.02	NS			
					b=0.04	NS			
					8 th to 10 th grade:				
				Lifetime use	b=-0.04	NS			
				Past month use	b=-0.09	NS			
				Binge drinking	b=-0.08	NS			
Kulis et al, 2007, US	Ethnic minority	35 school catchments (unknown)	% residents moved past 5 years	Past month alcohol use	b= 0.011	NS	Age, free school lunch, gender, ethnicity, acculturation, academic performance	Not explored	Residential instability protected bilingual students from alcohol use in comparison to other Mexican heritage students.
	3570, 11-17yrs (mostly 12-13)	# respondents/ neighbourhood:			No difference in effect between Spanish dominant, bilingual, English dominant and White				

			Not stated	adolescents.					
Maimon et al, 2012, US	Mixed 1135, 8-16yrs	76 neighbourhood clusters (1-3 census tracts) (~8000) # respondents/ neighbourhood: Not stated	% residents living in the same house 5 years previously	Use in past 30 days	b=-0.124	NS	Gender, age, family SES, ethnicity, family size, two-parent households, parental supervision, family attachment, impulsivity, unstructured socialising, deviant peers, prior delinquency, alcohol use at wave 1	Not explored	Not explored
Snedker et al, 2009, US	High-risk of dropping out 2006, 13-21yrs (mean 15.68)	131 Census tracts (1200-6000*) # respondents/ neighbourhood: >5	% different address five years previously, % non-owner occupied houses	Alcohol use past month	b=-0.002	NS	Ethnicity, age, gender, high risk of drop-out, high school change, family structure, parent's educational attainment, personal control, family support, deviant peer bonding	Not explored	No interaction between residential mobility and deviant peers, family support or personal agency and coping skills.
Employment and job availability									
Breslin and Adlaf, 2005, Canada	Mixed 8080, 15-19yrs	136 health regions # respondents/ neighbourhood: Average 59 (SD31)	Aggregate of weeks in past year looking for a job	Frequency of binge drinking in the past year	b=0.006	NS	Age, gender, family SES, work hours	Not explored	Community job availability did not moderate the association between longer work hours and alcohol use.
Svensson et al, 2010	Mixed	14 Municipalities (size unknown) # respondents/	Unemployment rate	Annual use Binge drinking	OR 0.96 (0.93-1.00) OR 0.94 (0.90-0.98)	p<0.05 p<0.01	Gender, time of survey	Not explored	Not explored

Sweden	15206, 15-16yrs	neighbourhood: Not stated							
Yabiku et al, 2007, US	Low socio-economic 4137 , 11-13yrs	35 school enrolment areas/census tract of school (size unknown) # respondents/ neighbourhood: Not stated	% unemployed	Amount consumed past 30 days	b=0.23	NS	Ethnicity, gender, free/reduced lunch, grades	Not explored	For non-American Indian students, unemployment increased alcohol use (and decreased it for American Indian students).

Neighbourhood attitudes to drinking

De Haan and Boljevac, 2010, US	Rural, Young 11-15yrs (mean 12.5)	22 rural communities surrounding schools (range 319-2485 population) # respondents/ neighbourhood: Not stated	Aggregated adult perceptions of community intolerance to adolescent alcohol use	Lifetime use of alcohol Past month alcohol use	OR 1.02 (0.95-1.11) OR 0.69 (0.56-0.86)	NS p<0.01	Adolescent perception of community support, controls against drinking, perceived peer drinking	Not explored	Adult perceived community intolerance did not moderate the association between adolescent perceptions of community intolerance and alcohol use.
Fagan et al, 2007 US	Mixed >69,000 in grades 6, 8 and 10	41 communities (range 1,578 - 106,221 (mean 18,275) # respondents/ neighbourhood: Average 2126 (range 201-12350)	Aggregate of adolescent perceptions of community norms favourable to drug and alcohol use	Lifetime use Past month use Binge drinking Lifetime use Past month use	6 th to 8 th grade: b=0.18 b=0.12 b=0.12 8 th to 10 th grade: b=0.23 b=0.12	NS NS NS p<0.05 NS	Age, sex, ethnicity	Not explored	Not explored

				Binge drinking	b=0.08	NS			
Musick et al, 2008, US	Mixed	65 census tracts (~5600)	Aggregated adult disapproval of adult drinking behaviour	Frequency of alcohol use	b=-0.24	NS	Number of children in household, mother's education, family income, grade, gender, foreign born, ethnicity, mother's alcohol use, mother's disapproval of alcohol use	Not explored	Community alcohol norms did not moderate the association between child social control and drinking.
	838, 12-17yrs	# respondents/ neighbourhood: 15 (range 5-25) Parents 40 (range 27-57)							

Neighbourhood-level disrupted family processes

Bernburg et al, 2009, Iceland	Mixed	83 school-districts, population range 719-15,926 (mean 3226)	Weak social ties (6 items): how difficult or easy it is to receive different types of support from parents	Drunkenness (at least once) in past 30 days	Weak social ties b=0.90 Coercive family interaction b=1.58	p<0.01 p<0.01	Weak social ties to parents, coercive family interaction, gender, household poverty, residential mobility, two-parent households, immigrant status, , moved last 12 months, peer substance use, status (if alcohol is perceived to give respect), membership (wanting to belong)	Controlling for association with deviant peers Weak social ties b=0.45 NS Coercive family interaction b=0.04 NS	Not explored
	5491, 15-16yrs	# respondents/ neighbourhood: Mean = 71 (range 21-286)	Coercive family interaction (2 items): Verbal fighting and physical coercion						

Neighbourhood-level social capital

Aslund et al, 2013, Sweden	Mixed	31 housing areas (size unknown)	Adolescent perceived social capital (index measure)	High alcohol consumption (highest quartile of modified AUDIT-C)	OR 1.00 (0.99-1.02)	NS	Gender, grade, subjective SES, individual-level social capital, individual level social trust, living conditions, parental unemployment,	Not explored	Not explored
	7757, 13-18yrs	# respondents/ neighbourhood:							

range 64-666					ethnicity				
De Haan et al (2010)	Rural, young	22 rural communities surrounding schools (range 319-2485 population)	Aggregated adult perceptions of neighbourhood support	Lifetime use of alcohol	OR 0.97 (0.80-1.16)	NS	Individual level community support, perceived peer drinking, perceived economic strain, parental relationships, community-level collective efficacy, adult community support	Not explored	Not explored
US	1424, 11-15yrs, mean age 12.5yrs	# respondents/ neighbourhood: Not stated		Past month alcohol use	OR 0.91 (0.78-1.05)	NS			
Ennett et al, 2008,	Mixed	158 Census blocks (600-3000)	Aggregated parents perceptions of neighbourhood bonding and trust among neighbours – 3 items	Problematic levels and negative consequences of drinking	b=-0.03	NS	Gender, age, ethnicity, family structure, parental education, high school enrolment, and family, peer and school context variables	Not explored	No significant interactions between neighbourhood level variables; alcohol use in the community, neighbourhood bonding, neighbourhood social control, and disadvantage.
US	6544, 11-17yrs	# respondents/ neighbourhood: Not stated							
Fagan et al, 2007	Mixed	41 communities (range 1,578 - 106,221 (mean 18,275)	Aggregate of adolescent perceived neighbourhood attachment - e.g. miss neighbourhood if move, like my neighbourhood, like to get out of neighbourhood)		6 th to 8 th grade:		Age, sex, ethnicity	Not explored	Not explored
US	>69,000 in grades 6, 8 and 10	# respondents/ neighbourhood: Average 2126 (range 201-12350)		Lifetime use	b=0.24	p<0.05			
				Past month use	b=0.24	p<0.05			
				Binge drinking	b=0.27	p<0.05			
					8 th to 10 th grade:				
				Lifetime use	b=0.22	NS			
				Past month use	b=0.18	NS			

				Binge drinking	b=0.18	NS			
Steen, 2010, US	Mixed	60 counties (size unknown)	Aggregated adolescent perceptions of having neighbours to talk to	Ever use of alcohol	b=0.02	p<0.01	Individual level: attitude to alcohol (perception of risk, immorality of use), perceptions of parental and neighbour approval, perceptions of ease of access to alcohol	Not explored	Not explored
	50529, 6th to 12th grade	# respondents/ neighbourhood: Not stated							

Neighbourhood-level prosocial rewards

Fagan et al, 2007	Mixed	41 communities (range 1,578 - 106,221 (mean 18,275)	Aggregate of adolescent's perceptions of encouraging and noticing adolescents doing a good job		6 th to 8 th grade:		Age, sex, ethnicity	Not explored	Not explored
US	>69,000 in grades 6, 8 and 10	# respondents/ neighbourhood: Average 2126 (range 201-12350)		Lifetime use	b=-0.14	NS			
				Past month use	b=-0.22	p<0.05			
				Binge drinking	b=-0.23	p<0.05			
					8 th to 10 th grade:				
				Lifetime use	b=-0.27	p<0.05			
				Past month use	b=-0.29	p<0.05			
				Binge drinking	b=-0.31	p<0.05			

Neighbourhood-level alcohol use

Bendtsen et al (2013), Denmark	Mixed	38 municipalities (size unknown)	Community-level alcohol use in adults (weekly consumption)	Frequency of drunkenness (30 days)	High use OR 1.95 (1.19-3.22)	p<0.05	Gender, age, family structure, migration status, parental drinking, youth friendly environment at school, alcohol education, exposure to alcohol outlets	Frequency of drunkenness	Not explored
	2911, ~13-16yrs	# respondents/ neighbourhood: Not stated			Med use OR 1.47 (0.94-2.14)	p<0.05		High use OR 1.94 (1.21-3.11) p<0.05	
				Frequency of binge drinking (30 days)	High use OR 1.90 (1.21-2.98)	p<0.05		Med use OR 1.46 (0.96-2.22) p<0.05	

									Controlling for parental alcohol use
Breslin and Adlaf, 2005, Canada	Mixed	136 health regions # respondents/ neighbourhood: Average 59 (SD31)	Aggregate of teenage drinking	Frequency of binge drinking in the past year	b=1.641 (0.262)	p<0.05	Age, gender, family SES, work hours	Not explored	Longer working hours was more strongly associated with heavy drinking in communities with low levels of alcohol use.
De Haan and Boljevac, 2010, US	Rural, Young 11-15yrs (mean 12.5)	22 rural communities surrounding schools (range 319-2485 population) # respondents/ neighbourhood: Not stated	Aggregated adult perception of community level of drinking Aggregated adolescent perception of community level of drinking	Lifetime use of alcohol Past month alcohol use Lifetime use of alcohol Past month alcohol use	OR 1.38 (1.03-1.84) OR 0.50 (0.23-1.09) OR 0.48 (0.06-4.01) OR 0.38 (0.21-0.69)	p<0.05 NS p<0.01 NS	Adolescent perception of community support, controls against drinking, perceived peer drinking	Not explored	Lifetime use: Effects of adult perceptions of prevalence only significant in communities with lower levels of peer prevalence. As peer prevalence increased, the effects of a high adult prevalence disappeared. At lower levels of peer prevalence adult perceived drinking levels were not significant.
Ennett et al, 2008, US	Mixed	158 Census blocks (600-3000*) 6544, 11-17yrs	Aggregated adolescent alcohol use	Problematic levels and negative consequences of drinking	b=0.67	p<0.01	Gender, age, ethnicity, family structure, parental education, high school enrolment, and family, peer and	Not explored	No significant interactions between neighbourhood level variables; alcohol use in

		# respondents/ neighbourhood: Not stated					school context variables		the community, neighbourhood bonding, neighbourhood social control, and disadvantage.
Musick et al, 2008, US	Mixed 838, 12-17yrs	65 census tracts (~5600) # respondents/ neighbourhood: 15 (range 5-25) Parents 40 (range 27-57)	Aggregated adult alcohol use	Frequency of alcohol use	b=-0.03	NS	Number of children in household, mother's education, family income, grade, gender, foreign born, ethnicity, mother's alcohol use, mother's disapproval of alcohol use	Not explored	Not explored
Paschall et al (2012), Paschall et al (2013), US	Mixed 1236- 1478, 13- 17yrs (mean 14.7)	50 cities (range 50-500,000, mean 106,588) # respondents/ neighbourhood: 20-47 (mean 30)	Aggregated adult alcohol use in past 4 weeks	Past year drinking Binge drinking	At 1y: b=0.55 At 2y: b=-0.110 At 1y: b=0.32 At 2y: b=-0.026	p<0.05 NS p<0.05 NS	Age, gender, ethnicity, perceptions of availability of alcohol, perceptions of enforcement of liquor laws, perceptions of acceptability of underage alcohol use	At one year: Past year: b=0.29 Binge: b=0.21 Controlling for perceptions of acceptability, availability and enforcement	Significant interaction between changes in alcohol use at 2 years and adult alcohol use – greater increases in alcohol use for adolescents living in communities with higher levels of adult alcohol use
Collective efficacy and informal social control									
De Haan et al (2010) US	Rural, young 1424, 11-15yrs,	22 rural communities surrounding schools (range 319-2485)	10-item tool collective efficacy (Sampson et al, 1999)	Lifetime use of alcohol Past month alcohol	OR 1.72 (0.21-13.86) OR 0.34 (0.07-1.53)	NS NS	Individual level community support, perceived peer drinking, perceived economic strain,	Not explored	Not explored

	mean age 12.5yrs	population) # respondents/ neighbourhood: Not stated		use			parental relationships, community-level collective efficacy, adult community support		
Ennett et al, 2008, US	Mixed 6544, 11-17yrs	158 Census blocks (600- 3000*) # respondents/ neighbourhood: Not stated	Aggregated neighbourhood informal control (Sampson et al, 1997) – 6 items	Problematic levels and negative consequences of drinking	b=0.02	NS	Gender, age, ethnicity, family structure, parental education, high school enrolment, and family, peer and school context variables	Not explored	No significant interactions between neighbourhood level variables; alcohol use in the community, neighbourhood bonding, neighbourhood social control, and disadvantage.
Maimon et al, 2012, US	Mixed 1135, 8-16yrs	76 neighbourhood clusters (1-3 census tracts) (~8000) # respondents/ neighbourhood: Not stated	Aggregated adult perceptions of social cohesion and informal social control (Sampson et al, 1997)	Use in past 30 days	b=0.050	NS	Gender, age, family SES, ethnicity, family size, two- parent households, parental supervision, family attachment, impulsivity, unstructured socialising, deviant peers, prior delinquency, alcohol use at wave 1	Not explored	A high prevalence of alcohol outlets significantly increases the prevalence of alcohol use in low collective efficacy neighbourhoods.

Appendix 4. Summary of quality assessment for included studies

1) Neighbourhood disadvantage or income

Paper	Selection bias	Study design	Controlling for confounders	Data collection - exposures	Withdrawals and drop outs	GLOBAL RATING
Aslund et al (2013)	Moderate	Weak	Moderate	Strong	N/A	Moderate
Bernburg et al (2009)	Strong	Weak	Strong	Strong	N/A	Moderate
Brenner et al (2011)	Weak	Moderate	Strong	Strong	Strong	Moderate
Breslin and Adlaf (2005)	Strong	Weak	Moderate	Moderate	N/A	Moderate
De Haan et al (2010)	Weak	Weak	Moderate	Strong	N/A	Weak
Ennett et al (2008)	Moderate	Weak	Strong	Strong	N/A	Moderate
Fagan et al (2013)	Weak	Moderate	Strong	Strong	Moderate	Moderate
Huckle et al, 2013	Moderate	Weak	Moderate	Strong	N/A	Moderate
Kulis et al (2007)	Weak	Weak	Moderate	Strong	N/A	Weak
Lo et al (2006)	Moderate	Weak	Weak	Strong	N/A	Weak
Maimon et al (2012)	Moderate	Moderate	Strong	Strong	Strong	Strong
Snedker et al (2008)	Weak	Weak	Strong	Strong	N/A	Weak
Snedker and Herting (2009)	Weak	Weak	Strong	Strong	N/A	Weak
Vinther-Larsen et al (2013)	Moderate	Weak	Moderate	Strong	N/A	Moderate
Yabiku et al (2007)	Weak	Weak	Moderate	Strong	N/A	Weak

2) Neighbourhood disorder or perceptions of neighbourhood problems / crime

Paper	Selection bias	Study design	Controlling for confounders	Data collection - exposures	Withdrawals and drop-outs	GLOBAL RATING
Fagan et al (2007)	Weak	Weak	Weak	Moderate	N/A	Weak
Kulis et al (2007)	Weak	Weak	Moderate	Strong	N/A	Weak
Snedker et al (2008)	Weak	Weak	Strong	Strong	N/A	Weak
Steen (2010)	Moderate	Weak	Weak	Moderate	N/A	Weak
Yabiku et al (2007)	Weak	Weak	Moderate	Strong	N/A	Weak

3) Enforcement of liquor laws in the neighbourhood

Paper	Selection bias	Study design	Controlling for confounders	Data collection - exposures	Withdrawals and drop-outs	GLOBAL RATING
Dent et al (2005)	Moderate	Weak	Weak	Weak	N/A	Weak
Fagan et al (2007)	Weak	Weak	Weak	Moderate	N/A	Weak
Paschall et al (2012, 2013)	Weak	Moderate	Weak	Strong	Moderate	Weak

4) Residential mobility

Paper	Selection bias	Study design	Controlling for confounders	Data collection - exposures	Withdrawals and drop-outs	GLOBAL RATING
Bernburg et al (2009)	Strong	Weak	Strong	Strong	N/A	Moderate
Fagan et al (2007)	Weak	Weak	Weak	Moderate	N/A	Weak
Kulis et al (2007)	Weak	Weak	Moderate	Strong	N/A	Weak
Maimon et al (2012)	Moderate	Moderate	Strong	Strong	Strong	Strong
Snedker & Herting (2009)	Weak	Weak	Strong	Strong	N/A	Weak

5) Employment of job availability

Paper	Selection bias	Study design	Controlling for confounders	Data collection - exposures	Withdrawals and drop-outs	GLOBAL RATING
Breslin and Adlaf (2005)	Strong	Weak	Moderate	Moderate	N/A	Moderate
Svensson & Hagquist (2010)	Moderate	Weak	Weak	Strong	N/A	Weak
Yabiku et al (2007)	Weak	Weak	Moderate	Strong	N/A	Weak

6) Neighbourhood attitudes to drinking

Paper	Selection bias	Study design	Controlling for confounders	Data collection - exposures	Withdrawals and drop-outs	GLOBAL RATING
De Haan and Boljevac (2010)	Weak	Weak	Weak	Moderate	N/A	Weak
Fagan et al (2007)	Weak	Weak	Weak	Moderate	N/A	Weak
Musick et al (2008)	Strong	Weak	Strong	Moderate	N/A	Moderate

7) Neighbourhood-level disrupted family processes

Paper	Selection bias	Study design	Controlling for confounders	Data collection - exposures	Withdrawals and drop-outs	GLOBAL RATING
Bernburg et al (2009)	Strong	Weak	Strong	Moderate	N/A	Moderate

8) Neighbourhood-level social capital

Paper	Selection bias	Study design	Controlling for confounders	Data collection - exposures	Withdrawals and drop-outs	GLOBAL RATING
Aslund et al (2013)	Moderate	Weak	Moderate	Moderate	N/A	Moderate
De Haan et al (2010)	Weak	Weak	Moderate	Strong	N/A	Weak
Ennett et al (2008)	Moderate	Weak	Strong	Strong	N/A	Moderate
Fagan et al (2007)	Weak	Weak	Weak	Moderate	N/A	Weak
Steen (2010)	Moderate	Weak	Weak	Moderate	N/A	Weak

9) Neighbourhood-level pro-social rewards

Paper	Selection bias	Study design	Controlling for confounders	Data collection - exposures	Withdrawals and drop-outs	GLOBAL RATING
Fagan et al (2007)	Weak	Weak	Weak	Moderate	N/A	Weak

10) Neighbourhood-level alcohol use

Paper	Selection bias	Study design	Controlling for confounders	Data collection - exposures	Withdrawals and drop-outs	GLOBAL RATING
Bendtsen et al (2013)	Moderate	Weak	Strong	Strong	N/A	Moderate
Breslin and Adlaf (2005)	Strong	Weak	Moderate	Moderate	N/A	Moderate
De Haan and Boljevac (2010)	Weak	Weak	Weak	Moderate	N/A	Weak
Ennett et al (2008)	Moderate	Weak	Strong	Strong	N/A	Moderate
Musick et al (2008)	Strong	Weak	Strong	Moderate	N/A	Moderate
Paschall et al (2012, 2013)	Weak	Moderate	Weak	Moderate	Moderate	Weak

11) Collective efficacy and informal social control

Paper	Selection bias	Study design	Controlling for confounders	Data collection - exposures	Withdrawals and drop-outs	GLOBAL RATING
De Haan et al (2010)	Weak	Weak	Moderate	Strong	N/A	Weak
Ennett et al (2008)	Moderate	Weak	Strong	Strong	N/A	Moderate
Maimon et al (2012)	Moderate	Moderate	Strong	Strong	Strong	Strong

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