

**THEORETICAL EXPLANATIONS AND  
EMPIRICAL EVIDENCE FOR THE  
RELATIONSHIP BETWEEN INCOME  
INEQUALITY AND POPULATION ORAL  
HEALTH**

by

**Ankur Kumar Singh**

(B.D.S, M.Sc. Dental Public Health)

Submitted for the degree of

Doctor of Philosophy (Ph.D.)

Adelaide Dental School

Supervised by:

**Professor Marco Aurélio de Anselmo Peres**  
Adelaide Dental School  
The University of Adelaide

**Doctor Jane Harford**  
Adelaide Dental School  
The University of Adelaide

2017

# Table of Contents

Abstract.....	v
Thesis Declaration .....	vii
Acknowledgments.....	ix
Notes .....	xi
1. Introduction .....	1
1.1 Rationale.....	2
1.2 Research approach and framework .....	4
1.3 Structure of the thesis .....	6
1.4 Research outputs from this thesis.....	8
References for Chapter 1 .....	9
2. Literature Review .....	11
2.1. Income inequality: a social and health concern .....	13
2.2. Income inequality and population health: Evolution of the idea and summary of findings.....	14
Evolution of the idea.....	14
Summary of findings .....	15
2.3. Theoretical explanations for association between income inequality and population health... ..	22
2.3.1. Socio-epidemiologic theories .....	23
2.3.2. Alternative explanations .....	27
2.4. Theoretical and methodological aspects critical to testing association between income inequality and health.....	30
Income inequality as a marker of social inequality .....	30
Neoliberalism as an umbrella framework.....	31
Measures of income inequality.....	34
Geographic level of aggregation.....	35
Role of residential segregation: structural pathway .....	36

Role of race, educational attainment and poverty .....	37
Clarifying slope and level effects of income inequality .....	38
Level of analytical unit and choice of statistical modelling .....	39
Inequality threshold, period effects and lag effects .....	40
2.5. Income inequality and oral health .....	40
2.6. Conclusions drawn from the chapter .....	44
References for Chapter 2 .....	46
3. The role of theories in explaining the association between social inequalities and population oral health: a scoping review protocol .....	57
3.1 Statement of Authorship .....	59
3.2 Rationale for the publication .....	61
PAPER 1 .....	63
3.3 Conclusions drawn from the chapter .....	77
References for Chapter 3 .....	78
4. Theoretical basis and explanation for the relationship between area-level social inequalities and population oral health outcomes – A scoping review .....	79
4.1 Statement of Authorship .....	81
4.2 Rationale for the publication .....	83
4.3 Methodology .....	85
PAPER 2 .....	87
4.4 Conclusions drawn from the chapter .....	101
References for Chapter 4 .....	103
4.5 Appendices for Paper 2 .....	104
5. Investigating societal determinants of oral health: opportunities and challenges in multilevel studies .....	131
5.1 Statement of Authorship .....	133
5.2 Rationale for the publication .....	135
PAPER 3 .....	139

5.3	Conclusions drawn from the chapter.....	176
	References for Chapter 5.....	177
6.	Area-level income inequality and oral health among Australian adults – A population-based multilevel study.....	179
6.1	Statement of Authorship.....	181
6.2	Rationale for the publication.....	183
6.3	Methodology.....	184
6.3.1	Data source and study population.....	184
6.3.2	Data request, cleaning and preparation.....	187
6.3.3	Study measures.....	189
6.3.4	Analytical approach.....	191
	PAPER 4.....	196
6.4	Conclusions drawn from the chapter.....	229
	References for Chapter 6.....	230
6.5	Appendices for Paper 4.....	233
7.	Thesis Conclusion.....	245
7.1	Summary of findings.....	246
	Summary of findings for research question (I): Which socio-epidemiologic theories can be used to explain the linkages between social inequalities and population oral health? .....	246
	Summary of findings for research question (II): Is area-level income inequality inversely associated with population oral health in the Australian context? .....	246
	Key insights on the findings.....	247
7.1.1	Strengths.....	251
7.1.2	Limitations.....	254
7.2	Implications for research and policy.....	257
	Research Implications.....	257
	Policy Implications.....	260

7.3 Conclusion.....	260
References for Chapter 7.....	261
Thesis Appendices .....	265

## Abstract

**Background:** Over 300 studies have examined the hypothesised negative impact of high income inequality on health outcomes. Oral health is integral to general health. Several studies have examined the association between income inequality and oral health outcomes. A gap exists in the understanding of the theoretical basis for the income inequality and oral health relationship. The literature on income inequality and oral health at the sub-national level is limited to the USA, Japan, and Brazil. Australian evidence on the association between income inequality and general health outcomes is limited and inconclusive, and there is none for oral health. To address these gaps, this thesis by publication answered the following two research questions:

**Research Question (I):** Which socio-epidemiologic theories can be used to explain the linkages between social inequalities and population oral health?

**Research Question (II):** Is area-level income inequality inversely associated with population oral health in the Australian context?

**Methods:** A scoping review identified different types of socio-epidemiologic theories used in the global literature on area-level social inequality and population oral health and analysed their extent of application. A population-based multilevel study used the data on oral health of 5,169 Australian dentate adults nested in 435 Local Government Areas (LGAs) from the 2013 National Dental Telephone Interview Survey (NDTIS-2013) to answer research question (II). Associations were tested between tertiles of LGA-level income inequality and oral health outcomes of inadequate dentition (presence of <21 teeth) and poor self-rated oral health after accounting for covariates. Additionally, the population-based study investigated variations in the tested associations according to tertiles of LGA-level mean household weekly

income, as well as, the variations in the household income-oral health gradients according to tertiles of LGA-level income inequality.

**Results:** The scoping review found that there was limited explicit use of socio-epidemiologic theories in the analytical frameworks of selected studies. The use of psychosocial theory was dominant among all the socio-epidemiologic theories proposed to explain the association between income inequality and oral health outcomes. The population-based study found no associations between LGA-level income inequality and poor self-rated oral health after adjusting for covariates. Contrary to the hypothesis, LGA-level income inequality was inversely associated with inadequate dentition (OR: 0.64; 95% CI: 0.48, 0.87) at the individual level. However, this association was limited to LGAs with high mean income. Individuals with lower household income had poorer oral health, but the household income and inadequate dentition gradients varied according to LGA-level income inequality.

**Conclusions:** There is a lack of theoretical basis for the association between area-level income inequality and oral health. Increased and explicit testing of theoretical pathways within the analytical framework of studies on income inequality and oral health outcomes is required. Findings from the Australian population-based study do not support the positive associations between area-level income inequality and worse oral health as reported from the USA, Japan and Brazil. These variations are likely due to the contextual differences between Australia, and these contexts including its social and geographic characteristics and consequent implications on distribution of oral health resources.

**Word count:** 498/500 words

## Thesis Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint award of this degree.

I give consent to this copy of my thesis when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the *Copyright Act 1968*.

The author acknowledges that copyright of published works contained within this thesis resides with the copyright holder(s) of those works.

I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library Search, and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

I acknowledge the support I have received for my research through the provision of an Australian Government Research Training Program Scholarship.

-----  
Ankur Kumar Singh





## Acknowledgments

I am very fortunate to have the opportunity to thank a few among many who have led me to this point in my life. Professor Marco Peres has helped me tremendously through my Ph.D. with his support and guidance. It is difficult to capture his huge contribution in my Ph.D. candidature in a few sentences. He is my role model for Ph.D. supervision who I wish to follow when I get the opportunity to supervise students during my academic career. Doctor Jane Harford has equally supported me in my Ph.D. journey and I am grateful to her for sharing her knowledge and skills during the supervision of this project. She enhanced my strengths, and guided me to overcome my weaknesses.

Professor Richard G Watt at the University College London has made an invaluable contribution to the start of my research career through his mentorship. I am grateful to him for continuing to do so even during my Ph.D. candidature. I am grateful to other senior academic researchers in the subject of social epidemiology and dentistry including Professor José Leopoldo Ferreira Antunes, Professor Juan Merlo, Associate Professor Loc G. Do, Professor Lisa Jamieson and Associate Professor Karen Peres who have shared their knowledge with me, helping me to overcome academic and professional challenges.

I am grateful to Doctor Yvonne Miels for editing this thesis. I am also thankful to the University of Adelaide for supporting this work through the provision of an Australian Government Research Training Program Scholarship.

I have been very fortunate to carry out Ph.D. in the Australian Research Centre for Population Oral Health (ARCPOH)'s collegial and supportive environment. I would like to thank my very talented friends at ARCPOH Claudia Lopez, Dandara G. Haag, Dominic Keuskamp, Fábio R. Leite, Gustavo G. Nascimento, Helena S. Schuch, Kamal B. Hanna, Nicole Muller, Ninuk Hariyani, Rahul Nair and Sofia Christofis (In Memoriam), who have

made a substantial contribution to this journey. Without their support, it would have been impossible to reach the other end. Equally, I would like to acknowledge the contribution of all ARCPOH staff and colleagues who have supported me through my candidature.

Finally, I would like to say thanks to my family members and friends who have tirelessly dealt with my happiness and disappointments during this journey and always encouraged me to go further. I am grateful to my parents Doctor T.N. Singh and Doctor Saroj Singh for believing in me, and Colonel Akhil Gupta and Mrs. Dolly Gupta for supporting me. My wife, Ph.D. colleague, and friend Doctor Adyya Gupta's support and contribution during this journey is hard to express. She is my pillar of strength and support, and with extreme responsibility she has steered me through this candidature. I dedicate this thesis to her and my mother for being the constant source of my strength and inspiration.

## Notes

### Referencing style:

This thesis has followed the Council of Scientific Editors (CSE) 8th Name-Year (Author-Year) style of referencing (<http://endnote.com/downloads/style/cse-style-manual-8th-ed-name-year>). Chapters 5 and 6 of this thesis includes papers that are currently under peer-review in the journals Community Dentistry and Oral Epidemiology and Plos One. For consistency, the two manuscripts (Papers 3 and 4) are formatted using the Council of Scientific Editors (CSE) 8th Name-Year in this thesis, but are submitted to the journals following their respective referencing styles.

- Journal: Community Dentistry and Oral Epidemiology: ([http://onlinelibrary.wiley.com/journal/10.1111/\(ISSN\)1600-0528/homepage/ForAuthors.html](http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1600-0528/homepage/ForAuthors.html))
- Journal: PLOS One (<http://journals.plos.org/plosone/s/submission-guidelines>)

### Appendices

Appendices submitted along with the publications to the journals are included at the end of Chapters 3 to 6. Appendices for the overall thesis are attached at the end of the thesis.