



UNIVERSITY
OF WOLLONGONG
AUSTRALIA

University of Wollongong
Research Online

Faculty of Science, Medicine and Health - Papers:
Part B

Faculty of Science, Medicine and Health

2018

Serious Mental Illness, Neighborhood Disadvantage, and Type 2 Diabetes Risk: A Systematic Review of the Literature

Ramya Walsan

University of Wollongong, rw931@uowmail.edu.au

Andrew D. Bonney

University of Wollongong, abonney@uow.edu.au

Darren J. Mayne

University of Wollongong, Illawarra Shoalhaven Local Health District

Nagesh B. Pai

University of Wollongong, Illawarra Shoalhaven Local Health District, nagesh@uow.edu.au

Xiaoqi Feng

University of Wollongong, Illawarra Shoalhaven Local Health District, xfeng@uow.edu.au

See next page for additional authors

Publication Details

Walsan, R., Bonney, A., Mayne, D. J., Pai, N., Feng, X. & Toms, R. (2018). Serious Mental Illness, Neighborhood Disadvantage, and Type 2 Diabetes Risk: A Systematic Review of the Literature. *Journal of Primary Care and Community Health*, 9 1-7.

Research Online is the open access institutional repository for the University of Wollongong. For further information contact the UOW Library:
research-pubs@uow.edu.au

Serious Mental Illness, Neighborhood Disadvantage, and Type 2 Diabetes Risk: A Systematic Review of the Literature

Abstract

Aim of the Study: This review aims to systematically synthesize the body of literature examining the association between neighborhood socioeconomic disadvantage and serious mental illness (SMI)-type 2 diabetes (T2D) co-occurrence. **Methods:** We conducted an electronic search of four databases: PubMed, Scopus, Medline, and Web of Science. Studies were considered eligible if they were published in English, peer reviewed, quantitative, and focused on the association between neighborhood disadvantage and SMI-T2D comorbidity. Study conduct and reporting complied with PRISMA guidelines, and the protocol is made available at PROSPERO (CRD42017083483). **Results:** The one eligible study identified reported a higher burden of T2D in persons with SMI but provided only a tentative support for the association between neighborhood disadvantage and SMI-T2D co-occurrence. **Conclusion:** Research into neighborhood effects on SMI-T2D comorbidity is still in its infancy and the available evidence inconclusive. This points to an urgent need for attention to the knowledge gap in this important area of public health. Further research is needed to understand the health resource implications of the association between neighborhood deprivation and SMI-T2D comorbidity and the casual pathways linking them.

Keywords

systematic, risk:, diabetes, 2, serious, type, review, disadvantage, neighborhood, illness, mental, literature

Publication Details

Walsan, R., Bonney, A., Mayne, D. J., Pai, N., Feng, X. & Toms, R. (2018). Serious Mental Illness, Neighborhood Disadvantage, and Type 2 Diabetes Risk: A Systematic Review of the Literature. *Journal of Primary Care and Community Health*, 9 1-7.

Authors

Ramya Walsan, Andrew D. Bonney, Darren J. Mayne, Nagesh B. Pai, Xiaoqi Feng, and Renin Melkias Baby Selvi Toms

Serious Mental Illness, Neighborhood Disadvantage, and Type 2 Diabetes Risk: A Systematic Review of the Literature

Journal of Primary Care & Community Health

Volume 9: 1–7

© The Author(s) 2018

Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/2150132718802025

journals.sagepub.com/home/jpc



Ramya Walsan¹, Andrew Bonney^{1,2}, Darren J Mayne^{1,2,3},
Nagesh Pai^{1,2,4}, Xiaoqi Feng^{2,5}, and Renin Toms¹

Abstract

Aim of the Study: This review aims to systematically synthesize the body of literature examining the association between neighborhood socioeconomic disadvantage and serious mental illness (SMI)–type 2 diabetes (T2D) co-occurrence. **Methods:** We conducted an electronic search of four databases: PubMed, Scopus, Medline, and Web of Science. Studies were considered eligible if they were published in English, peer reviewed, quantitative, and focused on the association between neighborhood disadvantage and SMI-T2D comorbidity. Study conduct and reporting complied with PRISMA guidelines, and the protocol is made available at PROSPERO (CRD42017083483). **Results:** The one eligible study identified reported a higher burden of T2D in persons with SMI but provided only a tentative support for the association between neighborhood disadvantage and SMI-T2D co-occurrence. **Conclusion:** Research into neighborhood effects on SMI-T2D comorbidity is still in its infancy and the available evidence inconclusive. This points to an urgent need for attention to the knowledge gap in this important area of public health. Further research is needed to understand the health resource implications of the association between neighborhood deprivation and SMI-T2D comorbidity and the casual pathways linking them.

Keywords

neighborhood disadvantage, socio economic disadvantage, serious mental illness, comorbidity, type 2 diabetes

Mental disorders that are severe in degree, persistent in duration and produce significant functional impairment are referred to as serious mental illness (SMI).¹ Individuals with SMI have higher risk of premature mortality and a reduced life expectancy of approximately 10 to 30 years compared with the general population.^{2–4} A large proportion of this excess mortality experienced by people with SMI is the consequence of cardiovascular diseases for which type 2 diabetes (T2D) is a major risk factor.^{4–6}

The prevalence of T2D in people with SMI is two to four times higher than the general population with estimates ranging from 1% to 68%.^{7–11} In those with SMI, a comorbid diabetes diagnosis not only confers a higher cardiovascular risk and increased mortality but is also associated with increased hospitalizations, greater number of emergency department visits, nonadherence to treatments, higher health care utilization costs and decreased quality of life.^{7,9,10,12–14} Studies have reported that people with both schizophrenia and type 2 diabetes have worse

cognitive deficit than schizophrenia without diabetes or diabetes alone, which can significantly impede their social rehabilitation and lead to poor clinical and functional outcomes.^{15,16}

¹School of Medicine, University of Wollongong, Wollongong, New South Wales, Australia

²Illawarra Health and Medical Research Institute, Wollongong Hospital, Wollongong, New South Wales, Australia

³Public Health Unit, Illawarra Shoalhaven Local Health District, Warrawong, Warrawong, New South Wales, Australia

⁴Mental Health Services, Illawarra Shoalhaven Local Health District, Wollongong, New South Wales, Australia

⁵Population Wellbeing and Environment Research Lab (Powerlab), School of Health and Society, University of Wollongong, New South Wales, Australia

Corresponding Author:

Ramya Walsan, School of Medicine, Faculty of Science, Medicine and Health, University of Wollongong, Northfields Avenue, Wollongong, New South Wales 2522, Australia.
Email: rw931@uowmail.edu.au



Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (<http://www.creativecommons.org/licenses/by-nc/4.0/>) which permits non-commercial use,

reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (<https://us.sagepub.com/en-us/nam/open-access-at-sage>).

Table 1. Search Terms and Subject Headings in PubMed Format (Modified in Other Search Engines).

Search	Query
#1	neighborhood [Title/Abstract] OR neighbourhood [Title/Abstract] OR “residence characteristics” [Title/Abstract] OR community [Title/Abstract] OR “small area” [Title/Abstract] OR context [Title/Abstract] OR geography [Title/Abstract]
#2	“serious mental illness” [Title/Abstract] OR psychosis [Title/Abstract] OR schizophrenia [Title/Abstract] OR “bipolar disorder” [Title/Abstract] OR “major depression” [Title/Abstract] OR “affective disorders” [Title/Abstract] OR “manic depression” [Title/Abstract]
#3	“type 2 diabetes” [Title/Abstract] OR “type 2 diabetes mellitus” [Title/Abstract] OR “non-insulin dependent diabetes mellitus” [Title/Abstract]
# Final Search	#1 AND #2 AND #3

Numerous studies have established that people who live in disadvantaged environments have worse mental and physical health outcomes than people living in more advantaged areas.¹⁷⁻²⁵ This phenomenon is commonly referred to as the social gradient of health²⁶ and is expected to be heightened for people with SMI because of their complex needs.²⁷ People with mental illness often live in disadvantaged neighborhoods.²⁸ Lack of adequate health care facilities, decreased access to healthy foods and an unsafe environment in these neighborhoods are often associated with adverse health outcomes such as sedentary life, unhealthy food, choices and obesity,²⁹⁻³³ which are the major risk factors for T2D.³⁴⁻³⁶ It is also proposed that the economic uncertainties associated with deprivation can induce chronic stress, which can result in altered immune system response and activate the hypothalamic-pituitary-adrenal axis leading to diabetes.^{10,37} An association between neighborhoods and comorbid diagnosis of SMI and T2D is highly plausible, given what is known about the underlying complex mechanisms that drive these two disorders.

Neighborhood disadvantage has been associated with SMI and T2D.^{22-25,38,39} However, only a few studies have examined the associations between neighborhood disadvantage and chronic disease comorbidities.^{40,41} There is increasing interest in recent years to address diseases that occur concurrently rather than as separate conditions; that is, are comorbid. Moreover, “syndemics,” which is gaining broad recognition in public health literature, also calls for a holistic approach that considers the biological and social interactions of two or more synergistic diseases rather than treating them as separate entities independent of the social context in which they are found.⁴²

Given the importance and the degree of public health burden imposed by SMI-T2D comorbidity and the plausibility of an association with neighborhood deprivation, it is imperative to understand the evidence available on the association between neighborhood socioeconomic disadvantage and SMI-T2D comorbidity. Understanding these relationships would be useful in developing evidence based holistic interventions, health care policies and would even

help us in designing healthier life spaces. Accordingly, this review aims to synthesize the body of literature examining the association between neighborhood socioeconomic disadvantage and SMI-T2D comorbidity.

Methods

Design

This systematic review followed the Preferred Reporting Items for Systematic review and meta-analysis (PRISMA) format. Research question, inclusion and exclusion criteria and search strategy were developed before the review process based on the PICO (Population, Indicator, Comparison and Outcome) approach. The protocol for this systematic review was registered on PROSPERO (CRD42017083483) and can be accessed at https://www.crd.york.ac.uk/PROSPERO/display_record.php?RecordID=83483.

Search Strategy

Relevant literature was identified through a systematic search of four databases: PubMed, Scopus, Medline, and Web of Science. These databases were selected due to their relative strengths and coverage in medical and social sciences. An initial text search was carried out on PubMed to identify all the possible synonyms of the main concepts and keywords included in the study.

The search strategy consisted of three themes: neighborhoods (neighborhoods, neighbourhoods, residence characteristics, community, small area, context or geography); type 2 diabetes (type 2 diabetes, type 2 diabetes mellitus, non-insulin dependent diabetes mellitus); and serious mental illness (serious mental illness, psychosis, schizophrenia, bipolar disorder, major depression, affective disorders, psychotic disorders) (see Table 1). The reference lists of retrieved articles were hand searched to identify relevant articles that may have been missed in the electronic search. No geographic, date, or study design restrictions were imposed.

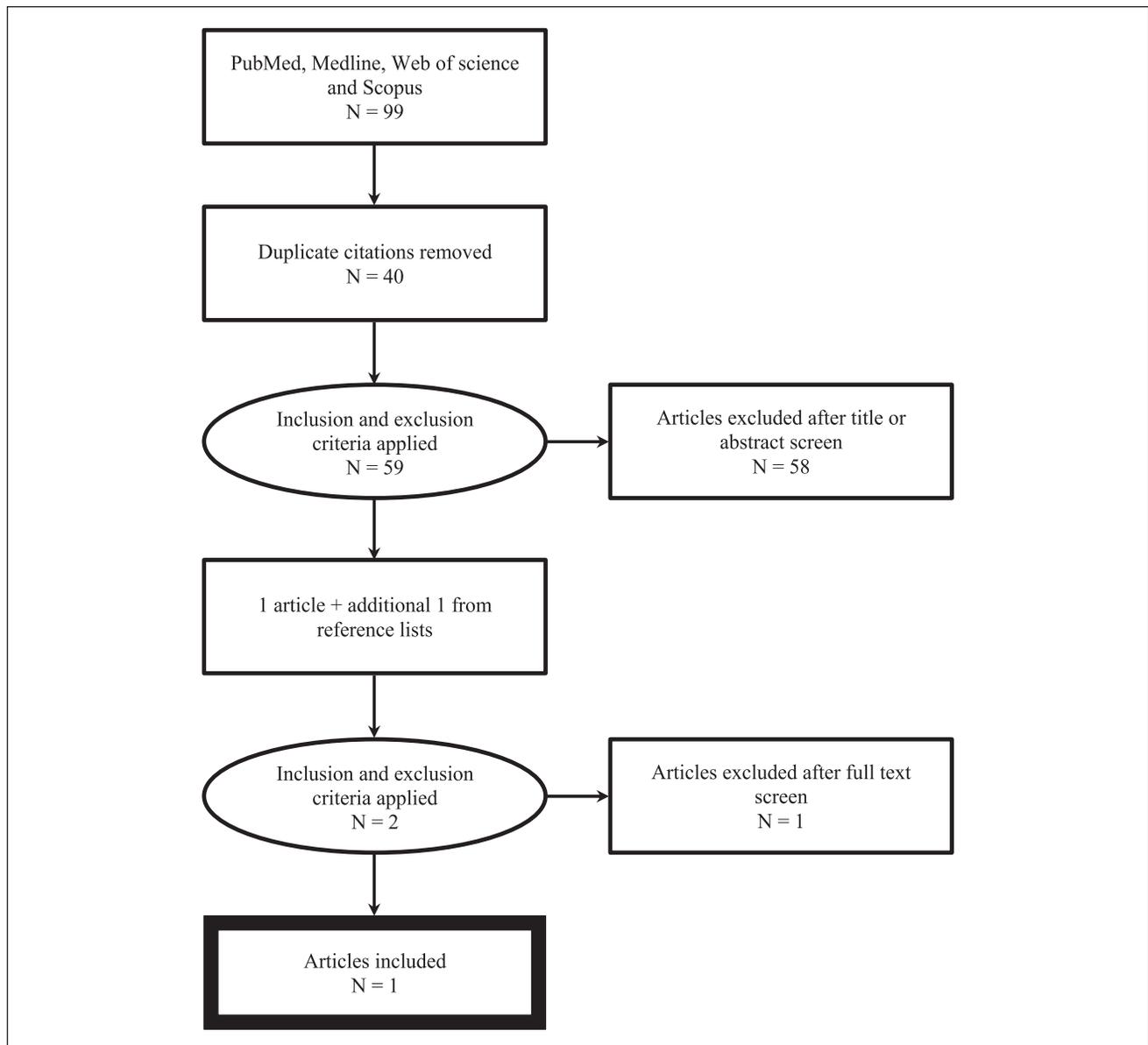


Figure 1. Flowchart of literature search process and the results.

Study Selection

Journal articles that met the following criteria were included in the study: published in English, peer reviewed, quantitative and focusing on the neighborhood disadvantage and SMI-T2D comorbidity. Studies reporting SMI and T2D independently and not as comorbid conditions were excluded from the review. Similarly, studies pertaining to neighborhood features other than disadvantage were also not included.

A 3-step study selection process was employed. In the first step, articles were screened and duplicates were removed. In the second step, the titles and abstracts of remaining articles were reviewed for their eligibility for

inclusion. In the third step, eligible articles identified were examined in full for their inclusion in the review. Two reviewers (RW and RT) independently performed all three stages. Study selection procedures are summarized in Figure 1.

Data Extraction

Information extracted from the eligible studies included the following: author, publication date, country of data origin, study population, study design, measures of neighborhood disadvantage, measures of T2D, method of analysis and major findings.

Table 2. Summary of Studies on Neighborhood Disadvantage and Serious Mental Illness–Type 2 Diabetes (SMI-T2D) Comorbidity.

Number	1
Study	Mezuk et al ⁴³ (2013)
Country	Sweden
Sample	336 340 adults
Study design	Longitudinal
SMI measure	Clinically diagnosed major depression from primary care, inpatient, or outpatient registries from January 2001 to December 2007
Neighborhood disadvantage measure	Computed composite index based on education status, income, unemployment, and social welfare assistance
T2D measure	Clinically diagnosed T2D from primary care, inpatient, or outpatient registries, or the use of antidiabetic medications as recorded in primary care/national prescription registries
Method of analysis	Multilevel analysis
Findings	Depression was significantly associated with T2D risk (odds ratio [OR] 1.10, 95% confidence interval [CI] 1.06-1.14). Similar relationship was observed for neighborhood disadvantage (OR high vs low 1.66, 95% CI 1.22-1.34). However, the interaction term between depression and disadvantage was found to be nonsignificant (intraclass correlation 0.013)

Data Analysis

As the focus of this review was to describe the association between neighborhood disadvantage and SMI-T2D comorbidity, the data analysis concentrated on this association. Meta-analysis was thought to be inappropriate because of the heterogeneity expected between the study populations, design and neighborhood measures. Hence, a descriptive review was conducted.

Results

The literature search retrieved a total of 99 potentially relevant records. After excluding 40 duplicates, the remaining 59 articles were screened for their broad eligibility, and a further 58 ineligible articles were excluded. The one remaining article and the additional one retrieved from reference lists were reviewed in full. One article was excluded after full text review leaving one eligible study for inclusion in the review. Study selection outcomes at each stage of the review are summarized in Figure 1.

The one study meeting the selection criteria examined the association between neighborhood disadvantage, major depression and T2D risk among 336 340 adults from Sweden (Table 2). The study relied on identified incident diabetes in those individuals with clinically diagnosed major depression and had a follow-up period of seven years. The measure of neighborhood disadvantage used in the study was a computed index based on four variables: income, education, unemployment and social service assistance. Multilevel logistic regression models were used to assess the relationship between disadvantage and comorbidity.

After accounting for demographic and individual characteristics, such as age, gender, family income, educational attainment and immigration status, the interaction between neighborhood disadvantage and comorbidity risk was

found to be nonsignificant ($\beta = 0.01$, 95% confidence interval [CI] -0.06 to 0.06 , $P = .573$) indicating that the association between major depression and T2D is similar across different levels of neighborhood disadvantage. Although there was no evidence of synergistic interaction, the attributable risk of T2D due to depression ($\text{Diabetes incidence}_{\text{depression}} - \text{Diabetes incidence}_{\text{without depression}}$) was increased in high deprivation areas (16.4) compared with lower deprivation areas (8.2). The study also highlighted that the individual socioeconomic indicators were not strongly related to T2D risk after controlling for neighborhood factors, indicating the role that contextual factors may play in the development of comorbid association.

Discussion

Our review indicates a paucity of evidence in the research literature investigating the associations between socioeconomic disadvantage and comorbidity of SMI and T2D despite the plausibility of such an association and its implications for health. The only research available reports a nonsignificant association between socioeconomic disadvantage and SMI-T2D cooccurrence.⁴³ However, the above study focused entirely on major depression, which is often claimed to be under-detected especially in the primary care settings,⁴⁴ and did not take into account other forms of SMI such as schizophrenia or bipolar disorder. The study, however, provides indicative evidence of higher attributable risk of T2D in disadvantaged neighborhoods, signaling the focus needed on high deprivation areas in order to reduce the risk of T2D in SMI patients. Furthermore, the study provides an impetus to explore potential neighborhood contextual pathways linking neighborhood deprivation with SMI-T2D comorbidity.

Previous research examining the association between neighborhood disadvantage and T2D risk as an independent condition has established a consistent positive association,

whereby increased neighborhood deprivation is associated with increased T2D risk.⁴⁵⁻⁴⁷ Research has also shown that multimorbidity is common among populations living in deprived neighborhoods.⁴⁰ Although this large cohort study provides only a tentative support for the association between neighborhood socioeconomic disadvantage and SMI-T2D comorbidity, it is consistent with observations showing a high burden of T2D in persons with SMI. More research is needed under different settings and including different forms of SMI to confirm the above results.

Another limitation in the evidence base is that the available study focused mainly on the social aspect of neighborhood disadvantage and used a computed index of disadvantage based on income, education, unemployment and social service assistance and did not focus on the contextual factors of the neighborhoods which might play a significant role. For example, deprived neighborhoods often lack access to fresh produce, and may be dominated by fast food and convenience stores, making the latter the easily available food option.¹⁸ Similarly, deprived neighborhoods might lack an environment conducive to physical activity.¹³ The presence of such unobserved moderating or mediating factors might have also contributed to the nonsignificant association between the 2 in the above study.

The lack of a conclusive evidence base makes it difficult to make firm policy recommendations based on our review. Further research is needed to capture the completeness of association between neighborhood deprivation and SMI-T2D comorbidity and the causal pathways linking them. Future research should also focus more on the modifiable contextual or physical aspects of the area that could potentially mediate or moderate the association between deprivation and T2D-SMI comorbidity. Sound knowledge of the factors that are modifiable by interventions will turn out to be more useful and informative for developing policy solutions and interventions.

Conclusions

Research into neighborhood effects on SMI-T2D comorbidity is still in its infancy, and the available evidence inconclusive. This points to an urgent need for attention to the knowledge gap in this important area of population health. Further research is needed to understand the health resource implications of the association between neighborhood deprivation and SMI-T2D comorbidity and the casual pathways linking them. Multilevel study designs can generate more evidence in this direction as it can be useful in analyzing the moderating and mediating processes between neighborhood and individual level variables. Identifying the relationship and connecting processes will help policy makers to develop efficient intervention strategies to curb the syndemics of SMI and T2D.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research was conducted with the support of Australian Government Research Training program scholarship and Illawarra Shoalhaven Local Health District–University of Wollongong combined scholarship.

References

1. World Health Organization. ICD-10 Version: 2010. <http://apps.who.int/classifications/icd10/browse/2010/en>. Accessed September 4, 2018.
2. Chang CK, Hayes RD, Perera G, et al. Life expectancy at birth for people with serious mental illness and other major disorders from a secondary mental health care case register in London. *PLoS One*. 2011;6:e19590.
3. Lawrence D, Hancock KJ, Kisely S. The gap in life expectancy from preventable physical illness in psychiatric patients in Western Australia: retrospective analysis of population based registers. *BMJ*. 2013;346:f2539.
4. Brown S, Kim M, Mitchell C, Inskip H. Twenty-five year mortality of a community cohort with schizophrenia. *Br J Psychiatry*. 2010;196:116-121.
5. Hennekens CH. Increasing global burden of cardiovascular disease in general populations and patients with schizophrenia. *J Clin Psychiatry*. 2007;68(suppl 4):4-7.
6. Royal Australian & New Zealand College of Psychiatrists. Keeping body and mind together. Improving the physical health and life expectancy of people with serious mental illness. <https://www.ranzcp.org/Files/Publications/RANZCP-Keeping-body-and-mind-together.aspx>. Published 2015. Accessed September 4, 2018.
7. Holt RIG, Mitchell AJ. Diabetes mellitus and severe mental illness: mechanisms and clinical implications. *Nat Rev Endocrinol*. 2015;11:79-89.
8. Wändell P, Ljunggren G, Wahlström L, Carlsson AC. Diabetes and psychiatric illness in the total population of Stockholm. *J Psychosom Res*. 2014;77:169-173.
9. De Hert M, Correll CU, Bobes J, et al. Physical illness in patients with severe mental disorders. I. Prevalence, impact of medications and disparities in health care. *World Psychiatry*. 2011;10:52-77.
10. Ward M, Druss B. The epidemiology of diabetes in psychotic disorders. *Lancet Psychiatry*. 2015;2:431-451.
11. Tirupati S, Chua LE. Obesity and metabolic syndrome in a psychiatric rehabilitation service. *Aust N Z J Psychiatry*. 2007;41:606-610.
12. Egede LE, Gebregziabher M, Zhao Y, et al. Impact of mental health visits on healthcare cost in patients with diabetes and comorbid mental health disorders. *PLoS One*. 2014;9:e103804.
13. Šprah L, Dernovšek MZ, Wahlbeck K, Haaramo P. Psychiatric readmissions and their association with physical comorbidity: a systematic literature review. *BMC Psychiatry*. 2017;17:2.

14. Kurdyak P, Vigod S, Duchon R, Jacob B, Stukel T, Kiran T. Diabetes quality of care and outcomes: comparison of individuals with and without schizophrenia. *Gen Hosp Psychiatry*. 2017;46:7-13.
15. Zhang BH, Ham M, Zhang XY, et al. Gender differences in cognitive deficits in schizophrenia with and without diabetes. *Compr Psychiatry*. 2015;63:1-9.
16. Han M, Huang XF, Chen DC, Xiu M, Kosten TR, Zhang XY. Diabetes and cognitive deficits in chronic schizophrenia: a case-control study. *PLoS One*. 2013;8:e66299.
17. Morenoff JD, Lynch JW. What makes a place healthy? Neighborhood influences on racial/ethnic disparities in health over the life course. In Anderson NB, Bulatao RA, Cohen B, eds. *Critical Perspectives on Racial and Ethnic Differences in Health in Late Life*. Washington, DC: National Academic Press; 2004:406-449.
18. Roux AVD, Mair C. Neighborhoods and health. *Ann N Y Acad Sci*. 2010;1186:125-145.
19. Roux AVD. Neighborhoods and health: where are we and where do we go from here? *Rev Epidemiol Sante Publique*. 2007;55:13-21.
20. Dauncey K, Giggs J, Baker K, Harrison G. Schizophrenia in Nottingham: lifelong residential mobility of a cohort. *Br J Psychiatry*. 1993;163:613-619.
21. Kirkbride JB, Boydell J, Ploubidis GB, et al. Testing the association between the incidence of schizophrenia and social capital in an urban area. *Psychol Med*. 2008;38:1083-1094.
22. Kirkbride JB, Jones PB, Ullrich S, Coid JW. Social deprivation, inequality, and the neighborhood-level incidence of psychotic syndromes in East London. *Schizophr Bull*. 2014;40:169-180.
23. Galea S, Ahern J, Nandi A, Tracy M, Beard J, Vlahov D. Urban neighborhood poverty and the incidence of depression in a population-based cohort study. *Ann Epidemiol*. 2007;17:171-179.
24. Cox M, Boyle PJ, Davey PG, Feng Z, Morris AD. Locality deprivation and Type 2 diabetes incidence: a local test of relative inequalities. *Soc Sci Med*. 2007;65:1953-1964.
25. Cubbin C, Sundquist K, Ahlén H, Johansson SE, Winkleby MA, Sundquist J. Neighborhood deprivation and cardiovascular disease risk factors: protective and harmful effects. *Scand J Public Health*. 2006;34:228-237.
26. Marmot M. Social determinants of health inequalities. *Lancet*. 2005;365:1099-1104.
27. Lawrence D, Kisely S. Review: inequalities in health-care provision for people with severe mental illness. *J Psychopharmacol*. 2010;24(4 suppl):61-68.
28. Almog M, Curtis S, Copeland A, Congdon P. Geographical variation in acute psychiatric admissions within New York City 1990-2000: growing inequalities in service use? *Soc Sci Med*. 2004;59:361-376.
29. Stimpson JP, Ju H, Raji MA, Eschbach K. Neighborhood deprivation and health risk behaviors in NHANES III. *Am J Health Behav*. 2007;31:215-222.
30. Bonney A, Mayne DJ, Jones BD, et al. Area-level socioeconomic gradients in overweight and obesity in a community-derived cohort of health service users—a cross-sectional study. *PLoS One*. 2015;10:e0137261.
31. Astell-Burt T, Feng X, Kolt GS. Identification of the impact of crime on physical activity depends upon neighbourhood scale: multilevel evidence from 203,883 Australians. *Health Place*. 2015;31:120-123.
32. Morland K, Wing S, Roux DA, Poole C. Neighborhood characteristics associated with the location of food stores and food service places. *Am J Prev Med*. 2002;22:23-29.
33. Algren MH, Bak CK, Berg-Beckhoff G, Andersen PT. Health-risk behaviour in deprived neighbourhoods compared with non-deprived neighbourhoods: a systematic literature review of quantitative observational studies. *PLoS One*. 2015;10:e0139297.
34. Auchincloss AH, Roux AVD, Mujahid MS, Shen M, Bertoni AG, Carnethon MR. Neighborhood resources for physical activity and healthy foods and incidence of type 2 diabetes mellitus: the multi-ethnic study of atherosclerosis. *Arch Intern Med*. 2009;169:1698-1704.
35. Astell-Burt T, Feng X. Geographic inequity in healthy food environment and type 2 diabetes: can we please turn off the tap? *Med J Aust*. 2015;203:246-248.e1.
36. Golay A, Ybarra J. Link between obesity and type 2 diabetes. *Best Pract Res Clin Endocrinol Metab*. 2005;19:649-663.
37. Pickering T. Cardiovascular pathways: socioeconomic status and stress effects on hypertension and cardiovascular function. *Ann N Y Acad Sci*. 1999;896:262-277.
38. Bonney AD, Mayne DJ, Jones BD, et al. Area level socioeconomic disadvantage and diabetes control in the SIMLR Study cohort: Implications for health service planning. *PLoS One*. 2015;10:e0137261.
39. Astell-Burt T, Feng X, Kolt GS, McLean M, Maberly G. Understanding geographical inequities in diabetes: multilevel evidence from 114 755 adults in Sydney, Australia. *Diabetes Res Clin Pract*. 2014;106:e68-e73.
40. Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. *Lancet*. 2012;380:37-43.
41. Rachele JN, Giles-Corti B, Turrell G. Neighbourhood disadvantage and self-reported type 2 diabetes, heart disease and comorbidity: a cross-sectional multilevel study. *Ann Epidemiol*. 2016;26:146-150.
42. Mendenhall E. Syndemics: a new path for global health research. *Lancet*. 2017;389:889-891.
43. Mezuk B, Chaikiat Å, Li X, Sundquist J, Kendler KS, Sundquist K. Depression, neighborhood deprivation and risk of type 2 diabetes. *Health Place*. 2013;23:63-69.
44. Harman JS, Veazie PJ, Lyness JM. Primary care physician office visits for depression by older Americans. *J Gen Intern Med*. 2006;21:926-930.
45. Ludwig J, Sanbonmatsu L, Gennetian L, et al. Neighborhoods, obesity, and diabetes—a randomized social experiment. *N Engl J Med*. 2011;365:1509-1519.
46. Bocquier A, Cortaredona S, Nauleau S, Jardin M, Verger P. Prevalence of treated diabetes: geographical variations at the small-area level and their association with area-level characteristics. A multilevel analysis in Southeastern France. *Diabetes Metab*. 2011;37:39-46.
47. Bonney AD, Mayne DJ, Caputi P, Weston KM. Area level socioeconomic disadvantage and diabetes control in the SIMLR Study cohort: implications for health service planning. <https://ro.uow.edu.au/ihmri/530/>. Accessed September 4, 2018.

Author Biographies

Ramya Walsan is a PhD candidate at the School of Medicine, University of Wollongong. Her research proposes to quantify the co-occurrence of Serious mental illness – Type 2 diabetes in Illawarra Shoalhaven and to determine its association with neighbourhood factors such as socioeconomic disadvantage.

Andrew Bonney is a general practitioner and Roberta Williams Chair of General Practice at the school of Medicine, University of Wollongong. He is a nationally recognised expert in practice based research with a focus on improving quality and equity in primary care delivery. He's an associate editor for the Australian Journal of Rural Health, Director of Illawarra and Southern Practice Research Network (ISPRN) and Co Director of the Health Impacts Research Cluster (HIRC) within the faculty of Science, Medicine and Health.

Darren J Mayne is a public health epidemiologist with the Illawarra Shoalhaven Local Health District, an honorary fellow at University of Wollongong School of Medicine, and an affiliate researcher with the Illawarra Health and Medical Research Institute. His principal interest is the application of information

science methods and spatial statistics to primary, public and population health practice and research.

Nagesh Pai is a professor of Psychaitry at the School of Medicine, University of Wollongong and a senior clinical academic in Psychiatry at the Illawarra Shoalhaven Local Health District (ISLHD). He is an active academic and has been on the RANZCP examinations committee and is a substantial comaparabililty assessor for International Medical graduates in Psychiatry.

Xiaoqi Feng is an associate professor of Epidemiology at University of Wollongong and the co-Director of Population Wellbeing and Environment Research Lab. Dr Feng's teaching and research is multidisciplinary and policy driven, leveraging synergies between public health, geography and economics to enhance understandings of health and wellbeing.

Renin Toms is a PhD candidate at the School of Medicine, University of Wollongong. Her research focuses on epidemiology of chronic disease parameters at regional level, in view of developing a geo enabled visual mapping system to facilitate regional planning activities.