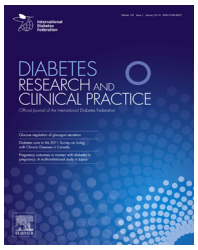
Contents available at ScienceDirect

Diabetes Research and Clinical Practice

journal homepage: www.elsevier.com/locate/diabres

International Diabetes Federation



Residential distance from major urban areas, diabetes and cardiovascular mortality in Australia

D.J. Magliano [a,b,*], K. Cohen [a], J.L. Harding [a,b], J.E. Shaw [a,b]

[a] Department of Clinical Diabetes and Epidemiology, Baker IDI Heart and Diabetes Institute, Melbourne, Australia
[b] Department of Epidemiology and Preventive Medicine, Monash University, Melbourne Australia

ARTICLE INFO

Article history:
Received 20 November 2014
Received in revised form
7 March 2015
Accepted 3 May 2015
Available online 15 May 2015

Keywords:
Mortality
Diabetes
Cardiovascular disease
Stroke
Socio-economic status
Remoteness
Residential location

ABSTRACT

Background: Living outside major urban centres is associated with increased mortality in the general population but whether having diabetes further impacts on the effects of living outside major urban centres is not known. This study explores the impact of residential location and diabetes on all-cause, ischemic heart disease (IHD) and stroke mortality in Australia.

Methods: We included 1,101,053 individuals (all ages) with diabetes on the national diabetes register, between 2000 and 2010. Vital statistics were collected by linkage to the death registry. The Accessibility/Remoteness Index of Australia (ARIA+) was used to categorize residences into major urban, inner regional, outer regional and remote areas, according to distance from major service centres. Standardised mortality ratios (SMRs) by ARIA+ are reported.

Results: During follow-up (median 6.7 years), there were 187,761 deaths (46,244 and 12,786 IHD and stroke deaths, respectively). Age-standardized all-cause, stroke and IHD mortality rates increased across ARIA+ categories in diabetes and in the general population. For all outcomes, similar patterns were observed in both sexes and diabetes type, although the rates were higher in males. For all-cause (both sexes, type 1 diabetes (T1DM) and type 2 diabetes (T2DM)), IHD mortality (T2DM only) and stroke mortality (T2DM only), SMRs varied across ARIA+ categories, showing a shallow U-shaped relationship, in which the lowest SMR was in the inner regional or outer regional areas, and the highest SMR in the major urban or remote areas.

Conclusion: The effect of diabetes on mortality varied only modestly by location, and the impact of diabetes was greatest in the major urban and remote areas, and least in the inner and outer regional areas.

1. Introduction

Studies have shown that living outside major urban centres is associated with increased mortality in the general population [1]. However, there are no studies examining this among people with diabetes, or whether having diabetes further impacts on the effects of living outside major urban centres. While the literature exploring residential distance to major urban centres and diabetes mortality is rare, similar studies

* *Corresponding author at:* 99 Commercial Road, Melbourne, Vic, 3004, Australia. Tel.: +61 3 8532 1826; fax: +61 3 8532 1100.
E-mail address: Dianna.magliano@bakeridi.edu.au (D.J. Magliano).

http://dx.doi.org/10.1016/j.diabres.2015.05.029
0168-8227/

have been performed using different markers of disadvantage. Chaturvedi et al. [2] showed, using two populations, that mortality increases with decreasing social class or disadvantage in diabetes. However, this analysis did not determine whether the pattern of mortality in diabetes was merely following the patterns observed in the general population or whether social class and diabetes status were interacting to influence mortality risk.

Two studies have compared mortality in diabetes to mortality in people without diabetes by area-based socioeconomic strata of disadvantage with contrasting results. The first, conducted in South Tees, UK, showed increasing mortality with increasing area-based deprivation in those with diabetes compared to those without diabetes [3]. However, the second, [4] which was conducted in Scotland, showed that the relative risks (RR) associated with diabetes for all-cause and IHD mortality were lower among the more deprived populations compared to less deprived populations. Further, we cannot assume that area-based markers of disadvantage or social class will have similar effects on diabetes mortality compared to residential distance from a major urban area.

It might be expected that as area-based deprivation increases or when residential distance from a large urban area increases, access to health care may decrease and this would increase mortality related to diseases such as diabetes. However, it is also possible that as an individual's overall risk of mortality increases, the impact of any single risk factor, such as diabetes, would decrease. The Scottish data lend support to the latter notion. Further support for this can be found in a recent review of the health disadvantage of rural populations across several. This review suggests that while rural location plays a major role in determining the nature and level of access to and provision of health services, it does not always translate into health disadvantage [5]. Few data exist describing the relationship between rurality or residential location from a major urban area and mortality in diabetes. Thus the excess risk of diabetes on mortality across area-based disadvantage, residential location to major urban area or rurality remains uncertain.

In Australia, regional and remote regions have higher mortality rates, higher rates of diabetes consultations and less access to medical specialists than in other areas of Australia. [1,6] Diabetes-related hospitalisation and mortality rates also have been found to rise with increasing remoteness of residence [7]. The aim of this study was to determine whether the impact of diabetes on all-cause mortality, IHD and stroke mortality differed according to residential distance from major urban areas.

2. Methods

2.1. Study population

The study population included from individuals registered with the *National Diabetes Service Scheme* (NDSS), an Australian Government initiative established in 1987 to deliver diabetes-related products at subsidised prices. Registration is completed by a medical practitioner or credentialed diabetes nurse educator. The NDSS captures 80–90% of all Australians with known diabetes [8].

2.2. Definition of diabetes

We included all individuals with type 1 diabetes (T1DM) or type 2 (T2DM) diabetes who were on the NDSS between 2000 and 2010. The year 2000 was chosen as the start date, as this was the time period that mortality data according to categories of the Accessibility/Remoteness Index of Australia (ARIA) was available. Diabetes type is classified by the health practitioner completing registration. However, for the current study, T1DM status was assigned to registrants who were recorded as T1DM on the NDSS registry, were registered <45 years of age and were taking insulin. Registration date was used as a proxy for diagnosis date as a large proportion of registrants (59.1% T1DM and 36.1% T2DM diabetes) were missing date of diagnosis, many of whom registered in the early years of the operation of the NDSS and had had diabetes for a number of years. We chose 45 years as the cut-off to minimize the number of people with T1DM diabetes that we would miss, without misclassifying significant numbers of people with T2DM as T1DM [9]. Additionally, registrants who were recorded as T2DM on the registry, were diagnosed before the age of 30 and taking insulin within 1 year of diagnosis date were reclassified as T1DM. All others were classified as T2DM

2.3. Accessibility/remoteness index of Australia (ARIA)

ARIA or ARIA+ (its successor) is a standard classification and index of remoteness in Australia [10]. It was developed by the Australian government in 1999. ARIA defines remoteness, or accessibility, providing a value for every location in Australia. The values are derived from measures of road distances between populated localities and Service Centres. These road distance measures are then used to generate a remoteness score for each of over 12,000 populated localities. ARIA+, which is used in these analyses is a continuously varying index with values ranging from 0 (high accessibility) to 15 (high remoteness), based on road distance measurements from each locality to the nearest service centres in each of five categories of service centre based on population size. Category A service centres have a population greater than 250,000, while category E service centres have populations under 5000. Using the index, all localities are then placed into one of five groups: major urban areas; inner regional areas; outer regional areas; remote; and very remote. For these analyses, remote and very remote categories were collapsed into one category, (3% of the population), and will be referred to as 'remote' hereafter. Further, for the outcome of stroke mortality, outer regional, remote and very remote areas were combined due to small sample sizes in these categories.

2.4. Mortality ascertainment

To ascertain vital status and underlying cause of death, diabetes registrants were matched to the National Death Index (NDI) using data up to and including 31 December 2010. Record linkage was performed by the Australian Institute of Health and Welfare (AIHW). The record linkage methodology used by