Integrating and Connecting Care
A. Ryan et al. (Eds.)

doi:10.3233/978-1-61499-783-2-126

A Spatial Dashboard for Alzheimer's Disease in New South Wales

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Abstract. This paper illustrates a proof of concept scenario for the application of comprehensive data visualisation methods in the rapidly changing aged care sector. The scenario we explored is population ageing and the dementias with an emphasis on the spatial effects of change over time at the Statistical Area 2 (SA2) level for the state of New South Wales. We did this using a combination of methods, culminating in the use of the Tableau software environment to explore the intersections of demography, epidemiology and their formal cost of care implications. In addition, we briefly illustrate how key infrastructure data can be included in the same data management context by showing how service providers can be integrated and mapped in conjunction with other analyses. This is an innovative and practical approach to some of the complex issues already faced in the health and aged care sectors which can only become more pronounced as population ageing progresses.

Keywords. Ageing, informatics, spatial, dashboard, visualisation

Introduction

Data visualisation is a growing aspect of information management across a wide variety of industries. This includes health and aged care where dashboards and related visual methods have been in use for some years to facilitate understanding of and responses to complex and dynamic problems [1]. The concept of using visual techniques to explore complex information has gradually developed to the point where current digital visualisation methods are expanding rapidly. One of the growing elements of such systems is the growing integration of spatial visualisation to support location-dependent data analyses and patient supports [2]. This includes geographic maps of counties and regions as well as map-like visuals such as heat maps. Traditional spatial methods, such as those seen in a geographic information system, and these newer data visualisation methods are converging

Population ageing and associated epidemiological patterns are highly variable in nature [3]. This includes differences at the geographic level and changes in prevalence rates over time [4]. Many Australian dementia studies are not yet large enough to produce localised variations in prevalence rates, meaning that population structure must be used as a proxy to support modelling variations in outcomes by location. We can however expect to see further changes in dementia patterns as population ageing progresses [5]. In this project, we look to the utility of data visualisation methods to enhance our understanding of these more localised effects and systemic responses.

1. Aim

The focus of this paper is on the use of data visualisation methods to support and extend the role of health informatics generally and to address specific, often complex, problems within contemporary health and social care systems. In part, this need for overlap is driven by changing demographics and shifting epidemiological patterns associated with a growth and diversification in care needs. This is especially apparent in the context of population ageing, which is an increasingly global phenomenon [6]. Here we look specifically at how visualisation, incorporating spatial visualisation, can support understanding of and responses to the growing health system complexity associated with population ageing and the dementias. The aim is to explore how the issues associated with the dementias can be better understood and responded to using visual data environments.

2. Methods

A variety of methods were utilised in this work. The three major applications used were: (1) a population epidemiology modelling engine in Excel (shown below); (2) mapping of results in the geographic information system package Maptitude and; (3) transfer of those results to the Tableau software package for audience engagement and visualisation purposes. The outcome is an annualised model of population ageing and Alzheimer's disease for New South Wales for the period 2012 to 2027. All data was provided at the SA2 (statistical area level 2) geography using Australian Bureau of Statistics (ABS) official Australian geographic system and population projections.

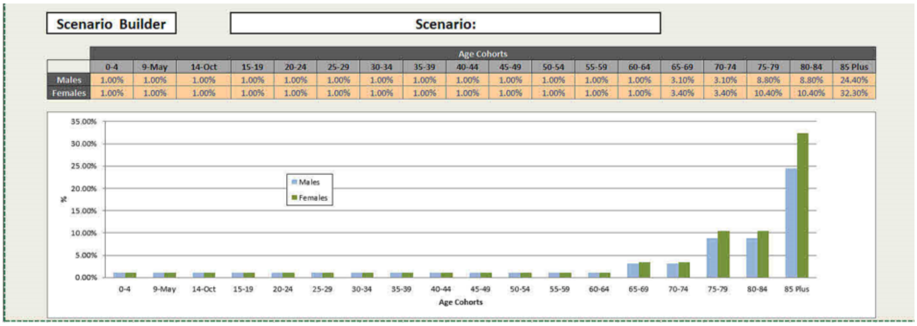

Figure 1. Scenario Builder in Excel for Modeling Dementia and Sub-Type Prevalence.

3. Results

The results presented here are a limited selection of outputs from the modelling processes utilised and the various technical instruments, including the Excel scenario-builder, the geographic information systems analysis and the export of the modelling outputs into the Tableau software environment. As such this is not a comprehensive data analysis exercise but a selective illustration of some of the capabilities of connecting the modelling, spatial analysis and data visualisation processes. As such this is a proof-of-concept piece and not a detailed research results paper.

3.1. Estimating Dementia Prevalence in New South Wales

The table, Figure 2, below illustrates how the Excel modelling process produced outputs for the 2012-2027 modeling timeframe including total dementia estimates, using official Australian Institute of Health and Welfare estimations, and major sub-type estimates. These are total figures for the state but because the Excel modelling was linked to every SA2 in New South Wales, these total results were also output for each of those 536 SA2s. Ultimately, three specific prevalence scenarios were explored on the basis that changes are both highly probable in current prevalence rates and that such changes may affect different locations to a greater or lesser degree (e.g. SA2s with much higher or lower proportions of older people would face different outcomes and effects). These are not presented here due to space and complexity issues.

NSW Data	Total Dementia	Alzheimer's Disease	Vascular Dementia	Other Dementias
Year	**Total**	**Sub-Total**	**Sub-Total**	**Sub-Total**
2012	102935	76987	10399	15549
2013	105674	79014	10681	15979
2014	108586	81161	10984	16441
2015	111511	83316	11288	16907
2016	114385	85434	11587	17365
2017	117109	87437	11871	17802
2018	119865	89465	12158	18242
2019	122862	91671	12470	18721
2020	126136	94090	12809	19238
2021	129719	96735	13180	19804
2022	133944	99853	13618	20473
2023	138029	102871	14041	21117
2024	142113	105892	14462	21758
2025	146409	109075	14904	22430
2026	150877	112390	15363	23124
2027	155478	115808	15834	23837

Figure 2. Total State-Level Estimation of the Dementias 2012-2027.

3.2. The Localisation of Alzheimer's Disease

As noted above, the modelling process permits the exploration of scenarios for every SA2 in New South Wales. The output process means that each SA2, or combination of SA2s, can have its own local profile for the dementias in total or by sub-type. The chart below shows this process for the initial prevalence projection (no change to AIHW rates) for the Tweed Heads SA2. This is an area that is already experiencing growth in the older population and the modeling illustrates what is likely to happen under specified conditions for Alzheimer's disease from 2012 to 2027. An additional benefit of this approach is that not only does the process provide a prevalence estimate but an incidence estimation based on the change between one year and the next. This provides a highly localised picture of potential change and can be used by service providers to manage resources since they can anticipate when numbers will increase or decrease. The prevalence rates can be readily adjusted to accommodate (1) new research data or (2) changes in population data, such as those arising from the Census.

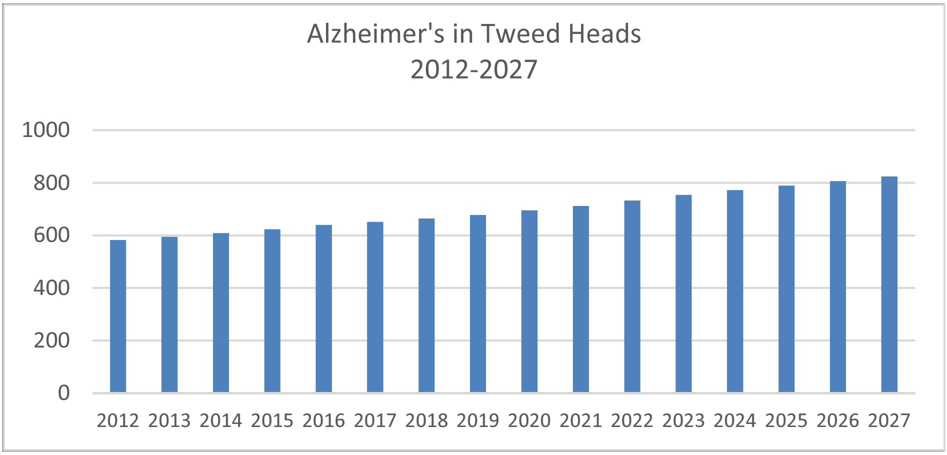

Figure 3. Alzheimer's Prevalence Projections 2012-2027.

3.3. Spatialising Data Visualisation

The second stage in the modelling process was to input this data into a geographic information package, which also allows secondary analysis of the included variables in order to identify specifically spatial patterns. This is illustrated below in Figure 4, for the broader Sydney metropolitan area, with the colors indicating the number range of likely Alzheimer's patients for 2027 and the number of SA2s in brackets with that range of patients – red being the highest. This helps visualise the data estimations tabled above.

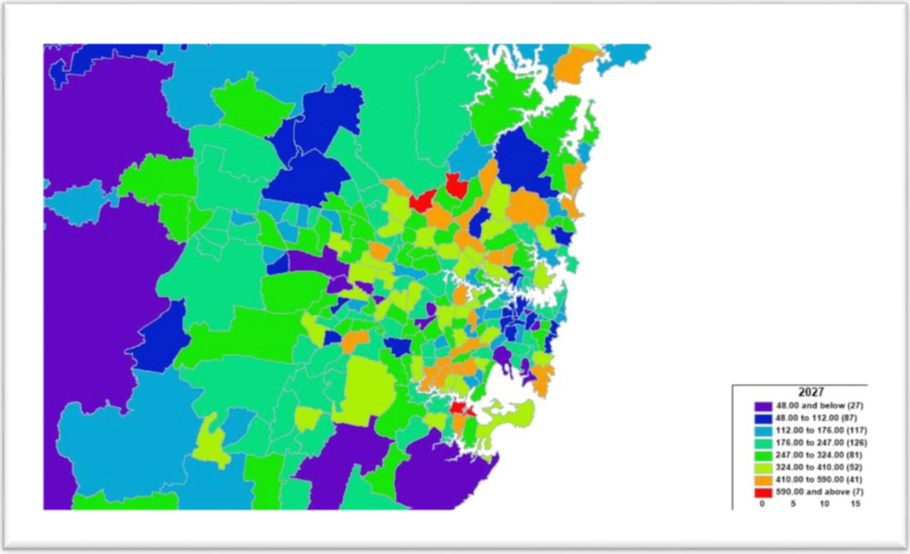

Figure 4. Alzheimer's Patient Estimates by SA2 for Sydney Metropolitan – Scenario 1 (no change).

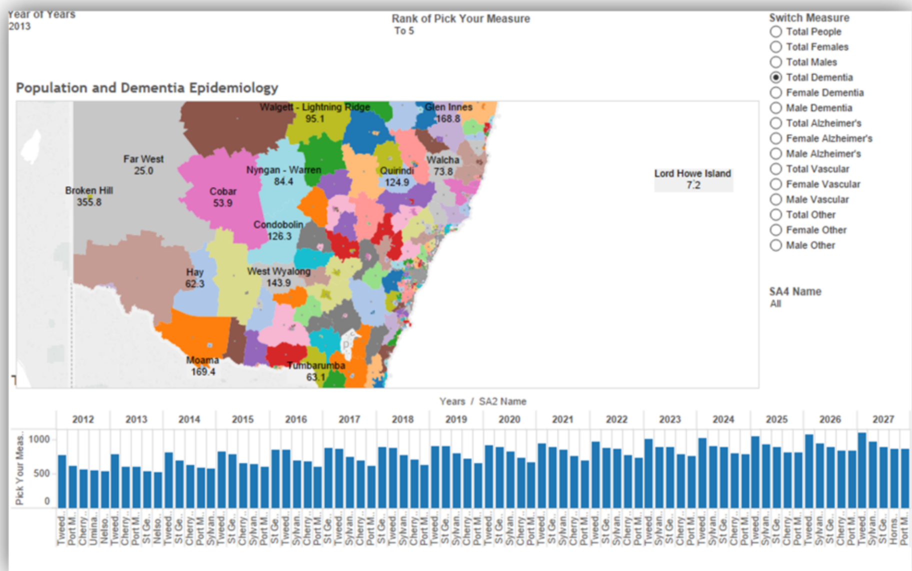

Figure 5. Dashboarding Ageing Demography and Dementia Estimates.

3.4. Export to a Data Visualisation Environment

Figure 5 above shows a dashboard visualisation produced by the transfer of the modelled data for Alzheimer's disease in New South Wales. Tableau can accommodate non-contiguous geographies so Lord Howe Island is also included in this visualisation. The actual results shown are for total dementia for all SA2 across the state from 2012 to 2027. The map illustrates this data while the chart below shows the 2012-2027 annual estimates for top five SA2s in terms of highest estimated number of people with a dementia. This selection can be further modified by using the menus on the top and at the right-hand side of the dashboard.

These examples illustrate how a variety of elements crucial to aged care service provision now and into the future can be visualised in a highly accessible visual format. The combination of temporality, geography and key data variables (population, epidemiology, cost) makes for a very flexible data environment. Our proposal is that this type of work has a great deal to offer the health, disability and aged care sectors moving forward. This is especially so because rapid change is integral to these sectors, and data visualisation methods support improved understanding of data rich environments experiencing dynamic complexity.

4. Limitations

This is a generalised model of the potential trajectory of the dementias and a finite selection of related consequences for the period 2012-2027. Clearly additional data sources from service providers, the healthcare and aged care systems or the 2016 Census results could be used to modify this modelling and its outputs. One key contention of this exercise is that these limitations are more readily addressed and updated in a flexible, visual environment such as this. Changes in population composition, dementia prevalence or per capita costs of care can be expanded and improved moving forwards. Changes in the supply of service providers by type, service range or places can also be integrated into this type of visual environment.

5. Conclusion

Potential users of this type of strategy and modeling approach could replicate similar work to combine with their own internal systems data, such as client profile or composition data (e.g. high care versus low care clients, or specific service utilisation). This could inform, for example, planning acquisitions for new service locations or expanding or contracting specific service types, as local needs change over time. Knowing where specific older cohorts are located and how their probable health and care needs will be exhibited spatially provides support for a variety of decision-making processes. The addition of service provider data would not only permit the analysis of likely future scenarios but also inform questions about the available capacity to meet emerging demand or the need for new or enhanced service types or providers in specific areas. Using data visualisation techniques, these types of issues can be explored by a broad audience of users including direct care providers, service planners and management making for a more informed and responsive information environment.

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