Prevalence of Diabetes Mellitus and Risk Factors in South Western Sydney

WHERE ARE WE NOW?

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Statement of contribution:
Dr Uchechukwu L Osuagwu obtained the data, conceptualized the study, analysed and interpreted the data, and drafted the initial manuscript. Prof David Simmons conceptualized the study, contributed to drafting the initial manuscript, interpretation of data and provided critical revision of the manuscript. Prof Jeff Flack conceptualized the study, assisted in data collection and provided critical revision of the manuscript. Dr Milan Piya participated in data collection, analysis and interpretation of data, and critical revision of the manuscript. Dr Vincent Wong conceptualized the original study design, participated in data collection and critical revision of the initial manuscript. All authors read and approved the final manuscript as submitted.

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CONTENTS

ABSTRACT

Objective:

There is a substantial and growing burden from diabetes globally. South Western Sydney (SWS), New South Wales, with its ethnic and socioeconomic (SE) diversity, is a rapidly growing district with a population profile suggesting a high prevalence of diabetes. This monograph provides an overview of baseline diabetes epidemiology across South Western Sydney local government areas (SWSLGA).

Methods:

The prevalence of diabetes mellitus (DM) among SWS residents in March 2018 was investigated using population data from the Australian National Census, diabetes data from the National Diabetes Services Scheme (NDSS), and supplemented information for diabetes related factors from NSW Adult Health survey 2017. Prevalence of diabetes by type, gender, age group and socioeconomic (SE) factor in addition to the diabetes-related complications for each SWS local government area (LGA) was estimated.

Results:

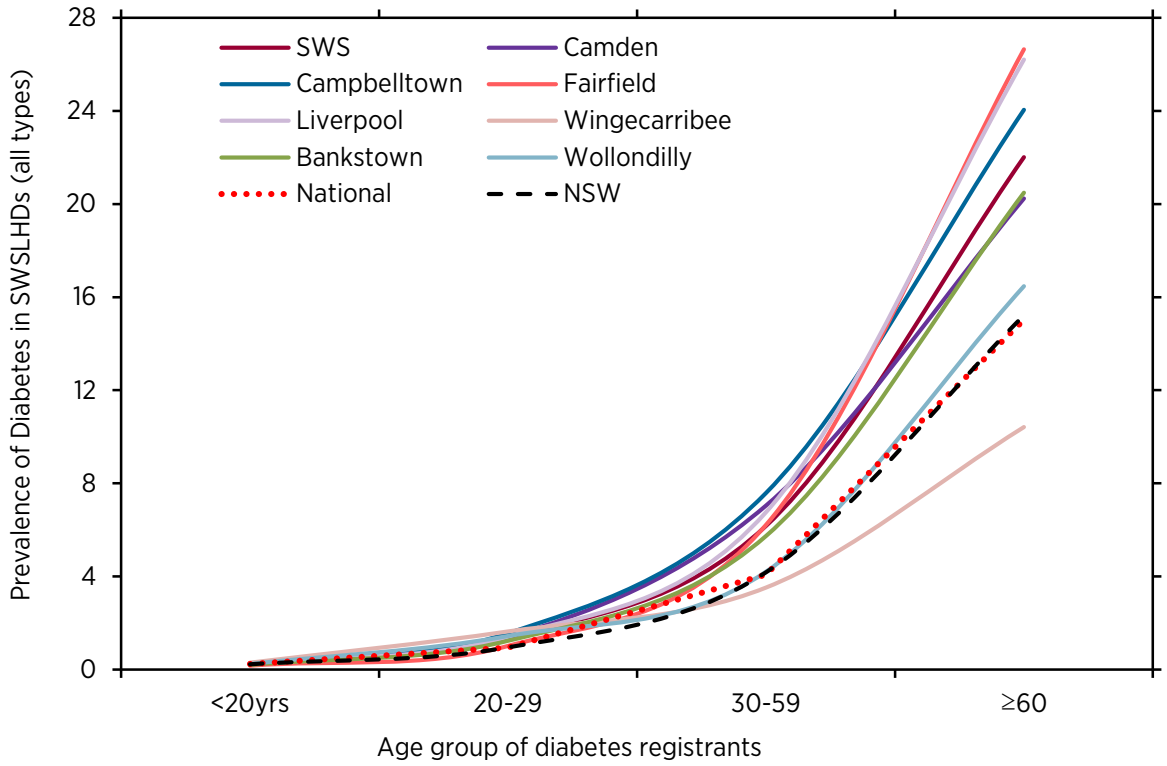
The prevalence of diabetes in SWS was 6.7% (64,389/960,552) affecting males (6.7%, 31,936) and females (6.7%, 32,448) equally. The rates in 4/7 LGA's were higher than the national rates and ranged from 6.5% in Bankstown (23,851) to 7.6% in Fairfield (16,389). The majority (87.2%, 55,936) had Type 2 diabetes (T2DM). Type 1 diabetes (T1DM), gestational diabetes (GDM), and other diabetes types made up 7.8%, 4.3% and 0.7% of the NDSS registrants, respectively. The T2DM proportions were higher than National proportions for T2DM in Fairfield (90.1% vs 87.2%) and for GDM in 6/7 LGAs (range 12.2% - 24.2% vs 12.7%). Camden, Wollondilly and Wingecarribee had higher than National proportions (9.3%) with T1DM. The diabetes risk factors of obesity (20.3 to 24.1%), in both men and women, overweight or obesity in females (44.6 to 52.1%) increased from 2011 - 16. Between 2011-16 adequate physical activity and consumption of vegetable increased 4.5% (from 47.7 to 52.2%) and 1.5% (3.9 to 5.4%) respectively, but adequate fruit consumption declined 0.8% (49.4 to 48.6%). Although the hospitalisation rate due to diabetes as a primary indication has remained stable over time across the district, it was disproportionately high in people with T1DM (affecting 8% of the diabetes population but accountable for 31% of hospitalisations with diabetes as a primary cause). The rates of potentially preventable hospitalisation for conditions related to diabetes increased linearly between 2013-16 (156 to 248 per 100,000 people) across SWSLHD. The rate of hospitalisation in Bankstown was double the NSW rate in 2015-16 (309 vs 149 per 100,000 people). The rate of diabetes-related lower knee amputations were higher in SWSLGAs compared to the National rates (164 versus 146 amputations per 100,000 people). In 2016,

about 11% of all diabetes attributable deaths in NSW involved residents from SWS.

Conclusion:

The prevalence of diabetes in four of 7 SWS LGAs was higher than State and National rates affecting one in 8 persons and increasing with age. Fairfield, Campbelltown, Liverpool and Bankstown districts were most affected, with higher T2DM prevalence, while Liverpool, Camden and Campbelltown had about 1.5 times higher rates of GDM compared to the National rate. These findings, together with the increasing rates of diabetes, obesity and overweight and the high rate of complications including hospitalisation, amputations, mortality and pregnancy complications, underscore the urgent need for a district diabetes plan. This would require close working between primary and secondary care, and evidence based strategies to reduce the incidence of diabetes.

Prevalence of Diabetes as a function of age for each South Western Sydney Local Government Areas (SWSLGAs)



BACKGROUND

Over the past decade, diabetes has remained a significant and growing global public health issue, accounting for an estimated 1.5 million deaths and 925.8 disability-adjusted life years (DALYs) per 100,000 population in 2015 [1-3]. In Australia, the prevalence of diabetes has more than doubled over the past three decades [4] with an estimate of around 1.3 million people living with diabetes in 2016–2018 making up to approximately 5.1% of the national population [5]. A large proportion of this burden is experienced by older people [6, 7], Indigenous people [8] and those from culturally and linguistically diverse backgrounds [9]. It is predicted that more than one-third of young people will develop diabetes during their lifetime and that 14% of their remaining life will be spent living with diabetes [10].

Diabetes and its associated complications and comorbidities impose a substantial burden on healthcare expenditure [11, 12]. The International Diabetes Federation estimated the total global healthcare expenditure due to diabetes for adults to be around US$ 850 billion in 2017 [6] and about US$ 1.7 trillion global losses in GDP from 2011 to 2030 were attributed to direct and indirect costs of diabetes [13]. The burden of diabetes is expected to increase by about 7% in the next decade with a greater burden of cost borne by high-income countries such as Australia compared to low or middle-income countries [13].

The Australian National Diabetes Services Scheme (NDSS) is funded by the Federal Government and captures data for 80-90% of Australians with known diabetes [5]. In the last 12 months, the scheme has registered 108,811 new people with diabetes i.e. an equivalent of 293 new registrants each day, although the rate varies between local government areas (LGAs) [5]. The differences in prevalence of diabetes between LGAs are attributable to the large socio-cultural and SE differences that exist between ethnic groups [14, 15]. SWS is one of the most socially, economically, culturally and linguistically diverse areas in New South Wales. The district covers seven LGAs: Bankstown-Canterbury, Campbelltown, Camden, Fairfield, Liverpool, Wollondilly and Wingecarribee. The population of SWS is over 957,000 people which is projected to escalate to 1.26 million people by 2031, making it the largest and fastest growing district in metropolitan Sydney [16]. The district has been identified as an area with a significantly high burden of diabetes [17, 18].

Based on the increasing burden of disease associated with diabetes, as well as other closely related diseases such as hypertension, the 66th World Health Assembly endorsed the World Health Organisation Global Action Plan for the Prevention and Control of Non-Communicable Diseases (NCDs) 2013-2020 [19]. The main aim of this strategic plan is to galvanise a multi-sectoral collaboration and

cooperate at the national, regional and global levels to reduce the preventable and avoidable burden of morbidity, mortality and disability due to NCDs, including diabetes. Achieving reductions in diabetes and its complications in many developed and developing countries, including Australia requires high-quality research to promote and support community based diabetes prevention programs. The action also provides a roadmap and policy options to attain nine voluntary global targets, one of which is to halt the rise of diabetes and obesity [19].

Recently, South Western Sydney Local Health District (SWSLHD), and South Western Sydney Primary Health Network (SWSPHN), have commenced investing in a range of services and activities to better manage the workload and reduce the impact of diabetes across the district. Such collaborative investment warrants both project by project and service development by service development evaluation, but this is hampered by limited baseline data from which programs can be monitored, progress assessed and outcome measures benchmarked.

The objective of this study is to determine the prevalence of diabetes in the different districts of SWS, using the most recent and comprehensive databases by gender and age, and compare them with the national rates. In addition, we will examine the changes in prevalence of diabetes and its associated risk factors over a 6 year period in the context of the WHO 2013-2020 action plan [19]. This will provide baseline data for monitoring changes in diabetes, its risk factors and associated complications, and identify target areas for interventions, and evaluate the overall impact of interventional programs across the district. It will also enable development of tools for scenario testing and effectiveness testing in future projections.

DATA SOURCES AND METHODOLOGY

NDSS Database

De-identified data were obtained for SWS residents registered with NDSS on 24th April 2018. Extracted data included type of diabetes: type 1 diabetes mellitus (T1DM), type 2 diabetes mellitus (T2DM) and gestational diabetes (GDM), sociodemographic (gender, age, total number of persons living in the area) health status and diabetes related risk factors (e.g. ethnicity), Aboriginal and Torres Strait Islander status (not considered in this study due to limited data). The information was supplemented with data on risk factors obtained from the HealthStats NSWs 2017 data. Prevalence and factors associated with diabetes (all types) were analysed descriptively. GDM rates report the proportion of women, not the proportion of pregnancies.

The prevalence of T1DM, T2DM, and other types of diabetes, along with the Socio-Economic index derived using Socio-Economic Indexes for Areas (SEIFA) 2011 [20] were obtained from the NDSS database by gender and age groups. Prevalence of GDM was determined from the number of GDM registrants in the NDSS database over the number of births in SWSLHDs obtained from the Census of Population and Housing in 2016 [21]. The NDSS was established in 1987 and delivers diabetes-related products (such as syringes, pen needles and glucose test strips, pump reservoirs and infusion sets) at subsidised prices while providing information to people with diabetes. Registration of patients is free and to be completed by a medical practitioner or accredited diabetes educator. However, registration is mandatory for access to the subsidies provided. Together with information obtained from the Australian Bureau of Statistics (ABS) Census 2016, a diabetes map is produced to monitor the prevalence of diabetes in Australia.

The HealthStats NSW data are managed by the Centre for Epidemiology and Evidence and specific for the New South Wales (NSW) population. Data are collected from telephone interviews conducted annually between February and December each year and involves all residents living in private households. The survey samples approximately 1,000 persons in each of the health administrative areas (total sample of about 16,000 depending on the number of administrative areas) and the questions provided information on the health status of the population, health inequalities and the determinants of health, the major causes of disease and injury and current health challenges and trends in health and comparisons between age groups and geographic locations [17].

From 2011 the random digit dialling (RDD) landline sampling frame was developed and the survey included landline only users, mobile only users and landline and mobile users. Details of the methods for data collection and analysis are provided elsewhere [17].

To identify respondents with diabetes, the questions asked included: "Have you/has your child ever been told by a doctor or at a hospital that you have/he/she has diabetes?" "Have you had diabetes/high blood glucose apart from when you were pregnant?" "What type of diabetes were you told you/child had?" To enquire on smoking habits, the questions asked were: "Which of the following best describes your smoking status: smoke daily, smoke occasionally, do not smoke now but I used to, I have tried it a few times but never smoked regularly, or I have never smoked?" and the indicator included those who smoked daily or occasionally. For body mass index (BMI) estimates, the questions used to define the indicator were: "How tall are you without shoes?" and "How much do you weigh without clothes or shoes?" BMI was calculated as weight (kg)/ height $(m)^2$ and categorized into: underweight (BMI less than 18.5 kg/m^2), healthy weight (BMI from 18.5 to 24.9 kg/m^2), overweight (BMI from 25.0 to 29.9 kg/m^2) and obese (BMI of 30.0 kg/m^2 and over) for analysis. The indicator covering Overweight or Obesity includes those who are overweight or obese: that is, with a BMI of 25.0 kg/m^2 or higher: overweight (BMI from 25.0 to 29.9 kg/m^2) and obese (BMI of 30.0 kg/m^2 and over) [22].

For fruit consumption, the indicator included those who consumed 2 or more serves a day and for vegetables, the indicator included those males aged 16-18 years who consumed at least 5.5 serves of vegetables a day; males aged 19-50 years who consumed at least 6 or more serves a day; males aged 51-70 years who consumed at least 5.5 serves per day; and males aged over 70 years and all females aged 16 years and over who consumed at least 5 serves per day. To assist in monitoring the long-term risk of harm due to alcohol consumption, the 2009 National Health and Medical Research Council Guideline was used [23]. The indicator provided information on the proportion of adults who consumed more than 2 standard drinks on a day when they consume alcohol. For indicators of physical activity, the current guideline of 2014 [24] was used for all adults. Sufficient physical activity was defined as undertaking moderate intensity physical activity for a total of at least 150 minutes per week over 5 separate occasions while insufficient physical

activity included either those undertaking no moderate intensity physical activity or less than 150 minutes of moderate intensity physical activity per week or the moderate intensity physical activity was undertaken over fewer than 5 separate occasions per week. Other data extracted from the HealthStats NSW included hospitalisations and cardiovascular diseases.

The 2017 Public Health Information Development Unit (PHIDU) release of the Social Health Atlas of Australia includes data on a range of population characteristics, including demography, socioeconomic status, health status and risk factors, and use of health and welfare services. Data was provided by Local Government Area for same day dialysis and were age standardised.

For cataract surgery, data were obtained from The Australian Institute of Health and Welfare (AIHW) which provides health and welfare statistics for the Australian government as an Atlas. The Atlas shows rates of use of health care (hospitalisations, prescriptions, surgical procedures) in geographical local areas across Australia. The rate is age and sex standardised to allow comparisons between populations with different age and sex structures. All rates are based on the patient's place of residence, not the location of the hospital or health service. For pregnancy complications, data on malformations was extracted from a recent study [25] that reviewed hospital records (in electronic and paper formats) of ninety-nine pregnant women with pre-gestational diabetes (T1DM and T2DM) from the Macarthur Diabetes in Pregnancy Clinic (MDPC), SWS between 2010 and 2015. Data on women with GDM came from another review study [26] that involved hospital records of 827 pregnant women with GDM who attended the Diabetes Centre at Liverpool Hospital between 2007 and 2010. Details of the methods used in the analysis have been described in these studies [25, 26].

STATISTICAL ANALYSIS

The sample for the HealthStats NSW was weighted to adjust for differences in the probabilities of selection among survey respondents. Post-stratification weights were used to reduce the effect of differing non-response rates among males and females and different age groups on the survey estimates. These weights were adjusted for differences between the age and sex structure of the survey sample and were benchmarked to the estimated residential population using the latest available Australian Bureau of Statistics population estimates [27]. Adults were defined as persons aged 16 years and over. Data for the districts of Bankstown and Canterbury were combined following the merging of both districts in May 2016 [28].

RESULTS

Prevalence of diabetes in South Western Sydney

Of the 416,738 people living with diabetes in New South Wales (aged ≥ 9 year), a total of 64,389 (15.5%) were from SWS making up about 1/6th of the total NSW registrants. The prevalence rate of diabetes in SWS was 6.7% (n = 64,389) which was higher than the prevalence for other NSW districts (prevalence ranged from 3.5% – 6.3%), the State 5.3% (416,738/7,869,010) and National rates 5.1% (1273693/25,089,685). Although the prevalence of diabetes was higher for males than females at the State (5.5%, 215847 vs 5.1%, 200883) and National (5.3%, 666,091/12,489,063 vs 4.8%, 607,443) levels, the rates were similar between males and females in SWS (6.7% each; 31936 vs 32448).

The prevalence of diabetes was also similar between male and female registrants within the LGAs (p=0.22). Table 1 shows the prevalence of diabetes by district and gender with bolded figures for the districts with higher than National and state rates. The prevalence of diabetes was higher than National and State rates for four of seven LGAs with highest rates for Fairfield 7.6% and Campbelltown 7.2% districts where approximately one in 13 persons was living with known diabetes.

Table 1: Prevalence of diabetes mellitus in South Western Sydney by district and gender in people aged ≥ 9 years.

LGAs	NDSS Registrants (n)			Prevalence (%)		
	Female	Male	Persons	Female	Male	Persons
Bankstown	12,137	12,165	24,304	**6.6**	**6.6**	**6.6**
Camden	1,626	1,739	3,365	5.0	5.4	5.2
Campbelltown	6,132	5,882	12,015	**7.3**	**7.2**	**7.2**
Fairfield	8,479	7,908	16,389	**7.9**	**7.4**	**7.6**
Liverpool	7,204	6,972	14,179	**7.0**	**6.8**	**6.9**
Wingecarribee	1,144	1,330	2,473	4.4	5.4	4.9
Wollondilly	1,170	1,349	2,519	4.7	5.5	5.1

**LGA, Local Government Area; NDSS, National Diabetes Service Scheme. Values are bolded for prevalence higher than National and State rates.*

Prevalence of diabetes in South Western Sydney by age group

The age distribution of diabetes registrants in SWS and the national rates is presented in Figure 1. Analysis showed higher prevalence of diabetes among SWS registrants compared to national rates across the different ages (mean difference, 3.4%, 95%CI: 5.9 - 1.0%; p=0.012).

Fig. 1 Age-specific prevalence of diabetes in SWS versus National rates based on NDSS registrants which included 64389 vs 1277513 persons, respectively.

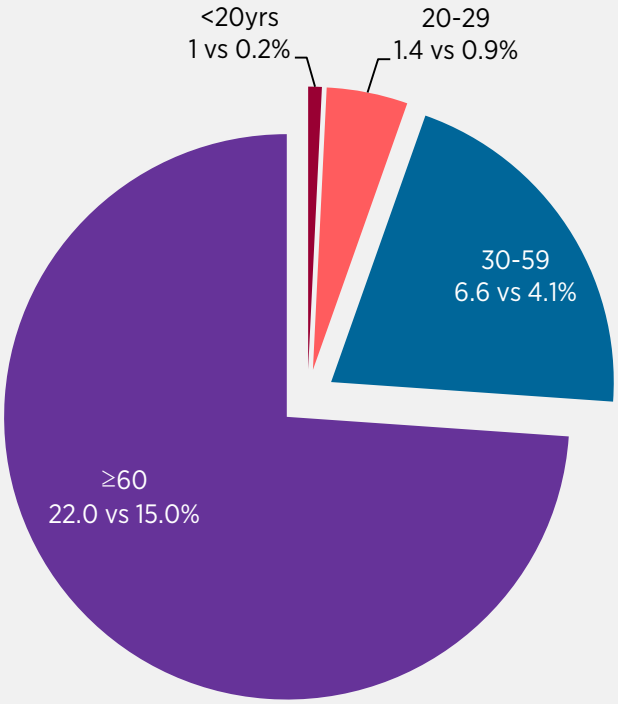
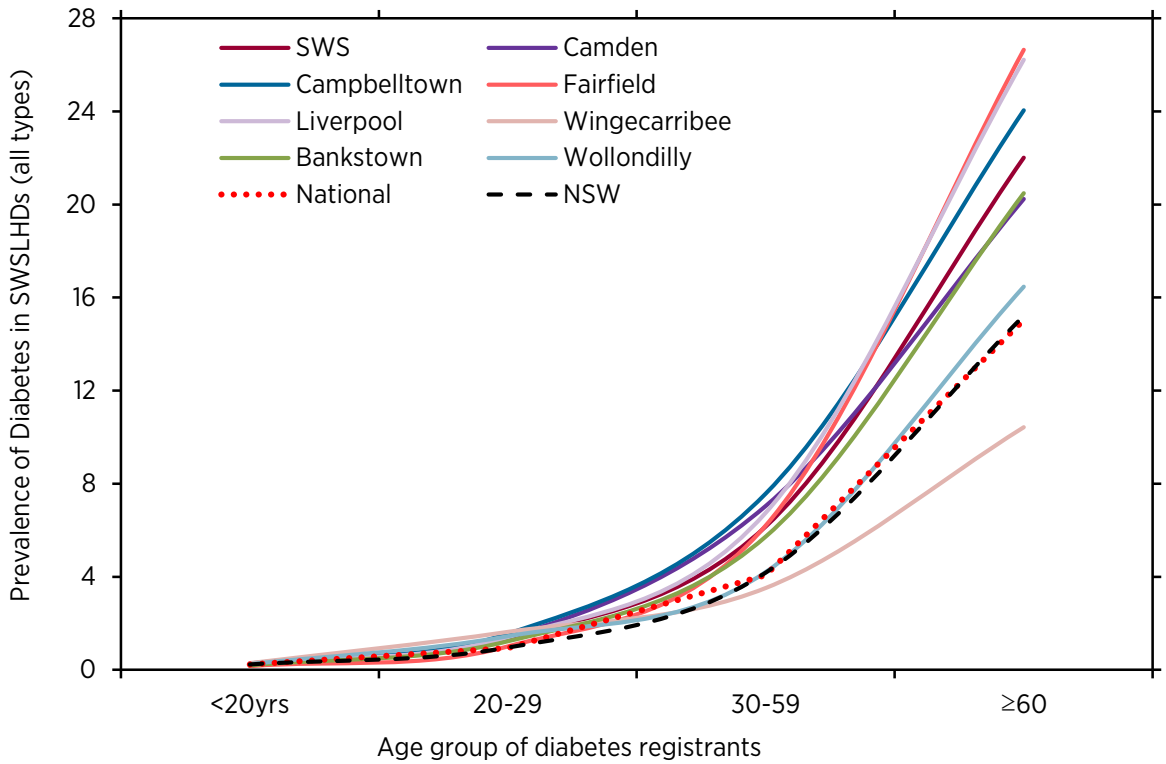


Figure 2 is a plot of the age groups as a function of the prevalence of diabetes by LGAs. The LGAs have been shown in solid lines while dotted black and red lines are for the state of New South Wales and National rates, respectively. Overall (Figure 1), 630 persons (1.0%) with diabetes in SWS were aged 19 years or under while the majority (39200, 22.0%) were aged 60 years and over.

Age had a significant effect ($p<0.042$) on the prevalence of diabetes across the district, increasing very rapidly from the age of 30yrs and more in Fairfield and Liverpool but less in Wingecarribee (Figure 2). Compared to State and National rates, the prevalence of diabetes in all SWS LGAs (except for Bankstown) changed more quickly with age, with more rapid changes in Campbelltown, Fairfield, Camden and Liverpool LGAs. However, the differences were not statistically significant ($p>0.05$, for all paired comparisons).

Fig. 2 Prevalence of Diabetes as a function of age for each South Western Sydney Local Government Areas (SWSLGAs). Dotted lines are for State (black) and National (red) rates.



Prevalence of diabetes in South Western Sydney by type

There was a significant difference between diabetes types across the districts ($p<0.0001$) with the majority of the people living with T2DM (87.2%, 56125) and lesser numbers diagnosed with GDM (18.0%, 2771), T1DM (7.8%, 5051), and other types of DM (0.7%, 443). Overall, the rate of GDM in SWS (17.9%, 2771) and for all LGAs (see Table 2) was higher than the national rate (12.7%, 39,490) except in Camden which had lower rates compared to State and National, respectively. The breakdown of the proportion of diabetes by type shown in Table 2 reveal that proportionally, Camden, Wollondilly and Wingecarribee, had higher than National proportions (9.3%) of T1DM while Fairfield had a higher rate of T2DM than National rates (90% vs 86.9%).

Table 2. Proportion of Diabetes by type for each South Western Sydney Local Health District

SWSLGA	Total Population	All DM	No DM	T2DM *n* (%)	T1DM *n* (%)	GDM^ *n* (%)	Others# *n* (%)
Bankstown	365,116	13,443	351,673	21,183 (87.2)	1,900 (7.8)	1,090 (**20.5**)	133 (0.5)
Camden	64,990	3,328	61,662	2,772 (83.3)	373 (**11.2**)	155 (12.2)	28 (0.8)
Campbelltown	166,778	11,927	154,851	10,278 (86.2)	1,011 (8.5)	551 (**24.2**)	87 (0.7)
Fairfield	214,745	16,329	198,416	14,712 (**90.1**)	1,049 (6.4)	471 (**19.2**)	97 (0.6)
Liverpool	205,602	14,111	191,491	12,226 (86.6)	1,077 (7.6)	707 (**22.2**)	101 (0.7)
Wingecarribee	50,782	2,480	48,302	2,111 (85.1)	250 (**10.1**)	94 (**22.6**)	25 (1.0)
Wollondilly	49,331	2,519	46,826	2,101 (83.9)	277 (**11.1**)	101 (**18.8**)	26 (1.0)

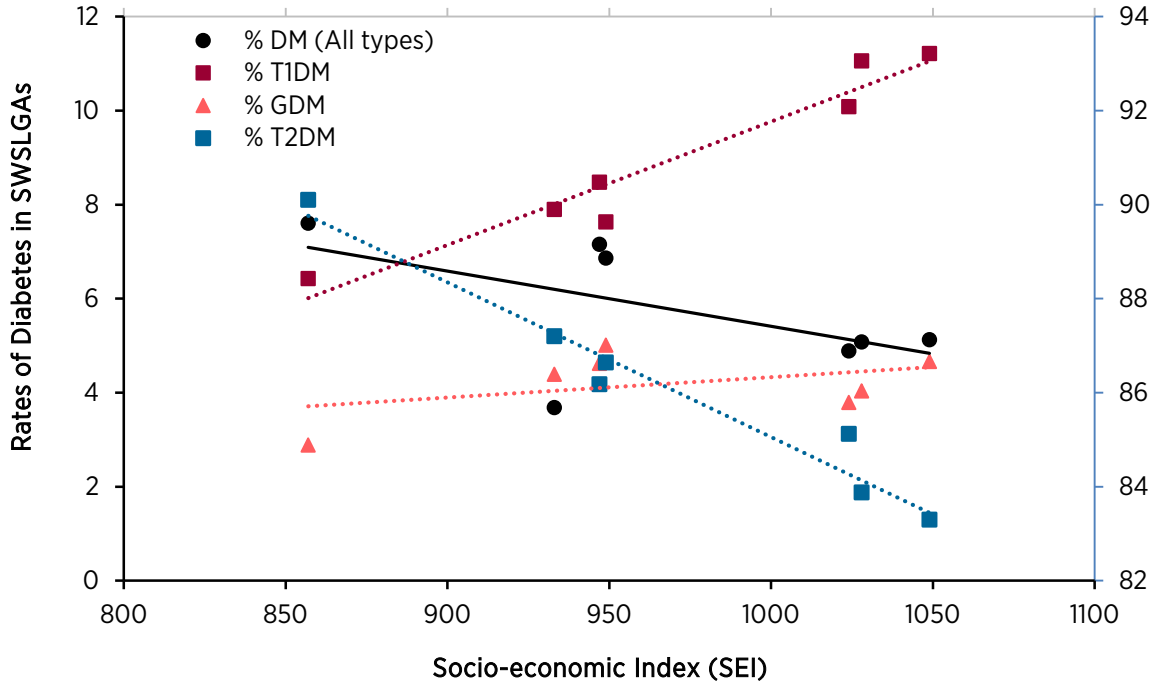
Abbreviations: SWSLGAs, South Western Sydney Local Government Areas; DM, Diabetes mellitus; T2DM, Type 2 Diabetes Mellitus; T1DM, Type 1 Diabetes Mellitus; GDM, Gestational Diabetes Mellitus. ^GDM rates use births as the denominator. # other types of diabetes which were not listed. *Those with higher than national rates have been **bolded***

RISK FACTORS FOR DIABETES IN SOUTH WESTERN SYDNEY

Socioeconomic status

The SEIFA index used by the NDSS was based on calculations from ABS which used the SEIFA of 2011 [20]. It displayed an index score, with a central tendency of 1000, with higher index scores indicative of areas of relatively higher socioeconomic advantage. As at 2011, the socioeconomic index (SEI) for SWS overall was 939 and for the LGAs were: Camden 1049, Wingecarribee 1028, Wollondilly 1024, Liverpool 949, Campbelltown 947, Bankstown 933, and Fairfield 857. The SEI was linearly related to the prevalence of diabetes across the district for all types (adjusted R = -0.55, $P < 0.0001$), T1DM (R = 0.97, $P < 0.0001$) and T2DM (R = -0.98, $P < 0.0001$) but not with GDM (R = 0.43, $P = 0.17$). The SWS LGAs with higher socioeconomic advantage had much lower prevalence of T2DM but had higher prevalence of T1DM (see Fig.3) after adjustment for age.

Fig. 3 Socioeconomic advantage (SEI: 1000=reference) as a function of diabetes type in South Western Sydney Local Government Area (SWSLGA).



Solid line is for all types of diabetes, dotted lines are for the different types of diabetes in colours. Secondary vertical axis is for type 2 diabetes mellitus T2DM; Higher index scores show areas of higher socioeconomic advantage. Value for other types of diabetes were not included due to very low prevalence. Results were not adjusted for ethnicity.

Ethnicity

Ethnicity had a significant effect on the distribution of diabetes in SWS. In general, we found that when diabetes registrants were classified by country of birth (overseas vs Australian born), the percentage distribution of diabetes by type respectively was as follows: 4.4 vs 7.8% for GDM, 2.5 vs 7.0% for T1DM and 93.1 vs 85.2% for T2DM. There was a significant association between diabetes and registrants' place of birth (overseas-born vs Australia-born) for T1DM ($p<0.001$) only. Significant interactions were found between district and registrants' country of birth ($p<0.001$) and the proportions of overseas (vs Australian) born by district for all people with diabetes were: Fairfield (84%), Liverpool (74%), Bankstown (78%), Campbelltown (62%), Wollondilly (45%) and Wingecarribee (29%). Compared to Australian born residents, the proportion of overseas-born registrants with T2DM who lived in Fairfield (84.9%), Bankstown (79.7%) and Liverpool (75.9%) were significantly higher ($p<0.05$, for all comparisons).

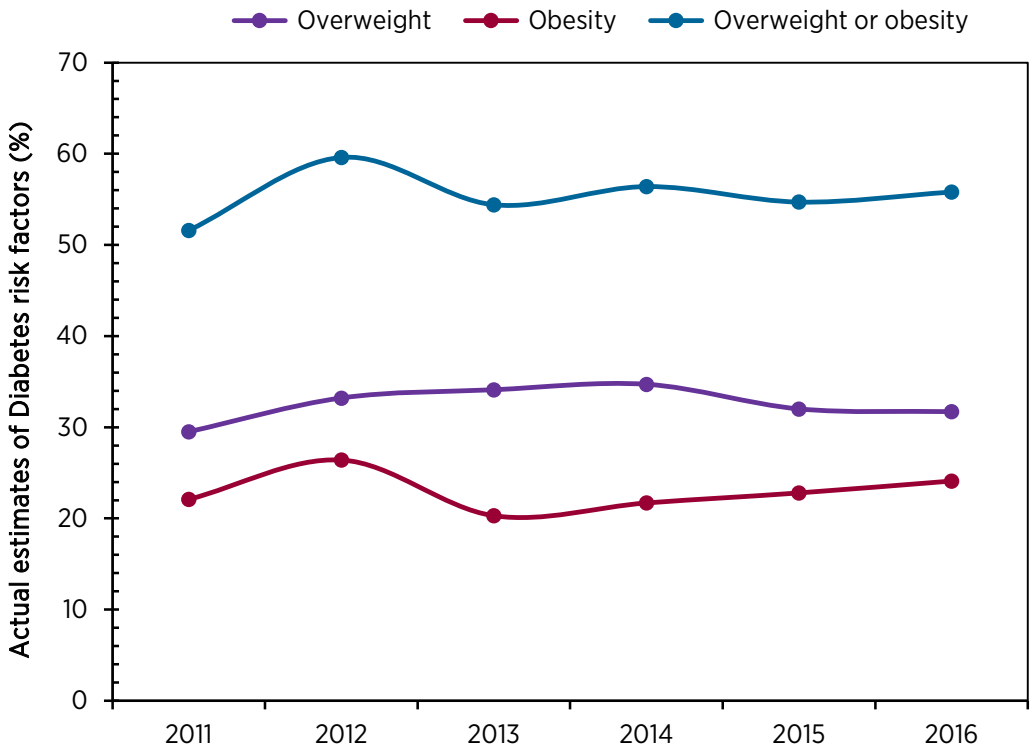
In Wingecarribee and Wollondilly LGAs, the rate of T1DM (13.0/87.0% and 22.1/77.9%, $p<0.05$ for both comparisons) was significantly lower among the overseas-born registrants than Australian born registrants. Similar lower proportions of T2DM (31.2/68.8%) and GDM (15.3/84.7%) were found among the overseas-born registrants compared to the Australian born registrants in Wingecarribee but the difference did not reach significance ($p>0.05$, for both comparisons). There was also no significant effect of ethnicity on GDM rates across the district.

The registrants were further classified into predominantly English speaking countries, those from Culturally and Linguistically Diverse Group (CALD) and the Australian born registrants [29]. This was based on the main language other than English which was spoken at home. The results revealed that the proportion of diabetes was lower among registrants from predominantly English speaking countries compared to those from the CALD group (mean difference 30%, 95% CI 7.6-53%; P =0.017) and the Australian born registrants (22%, 13-31.3%; $p=0.001$).

Overweight and obesity

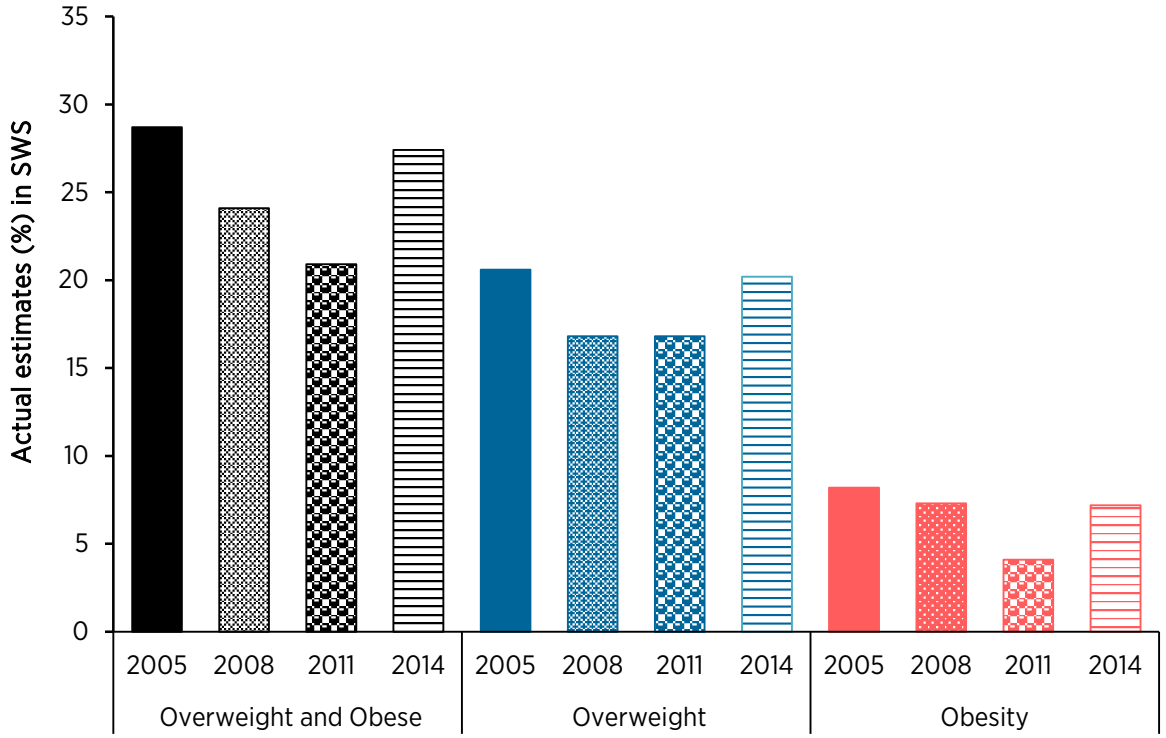
Figure 4 shows the mean estimates for the diabetes risk factors obesity, overweight, and obesity/overweight for respondents from SWS aged 16 years and over who participated in the 2011 – 2016 Adult Health surveys. In 2014-16, about one in two adults (55.8%) from SWS self-reported overweight or obesity (885 people), similar to 2011-13 (54.4%). No significant trend for diabetes risk factor of obesity or overweight (p>0.3 for all regression analysis) across the time interval.

Fig. 4 Trends in obesity, overweight and overweight/obesity in South Western Sydney adults aged 16 years and over (2011-2016)



In 2014, the NSW School Students Health Behaviours Survey (self-completed questionnaire) showed that approximately 29% students aged 12-17 years were overweight or obese and 7.2% were obese only in 2014 (Fig 5). The rates have remained stable from 2005 to 2014 (p>0.05) but were higher than the rates of overweight or obese among children of same age from NSW (20.6%) (Australian Bureau of Statistics. Australian Health Survey. Available at: http://www.abs.gov.au/australianhealthsurvey).

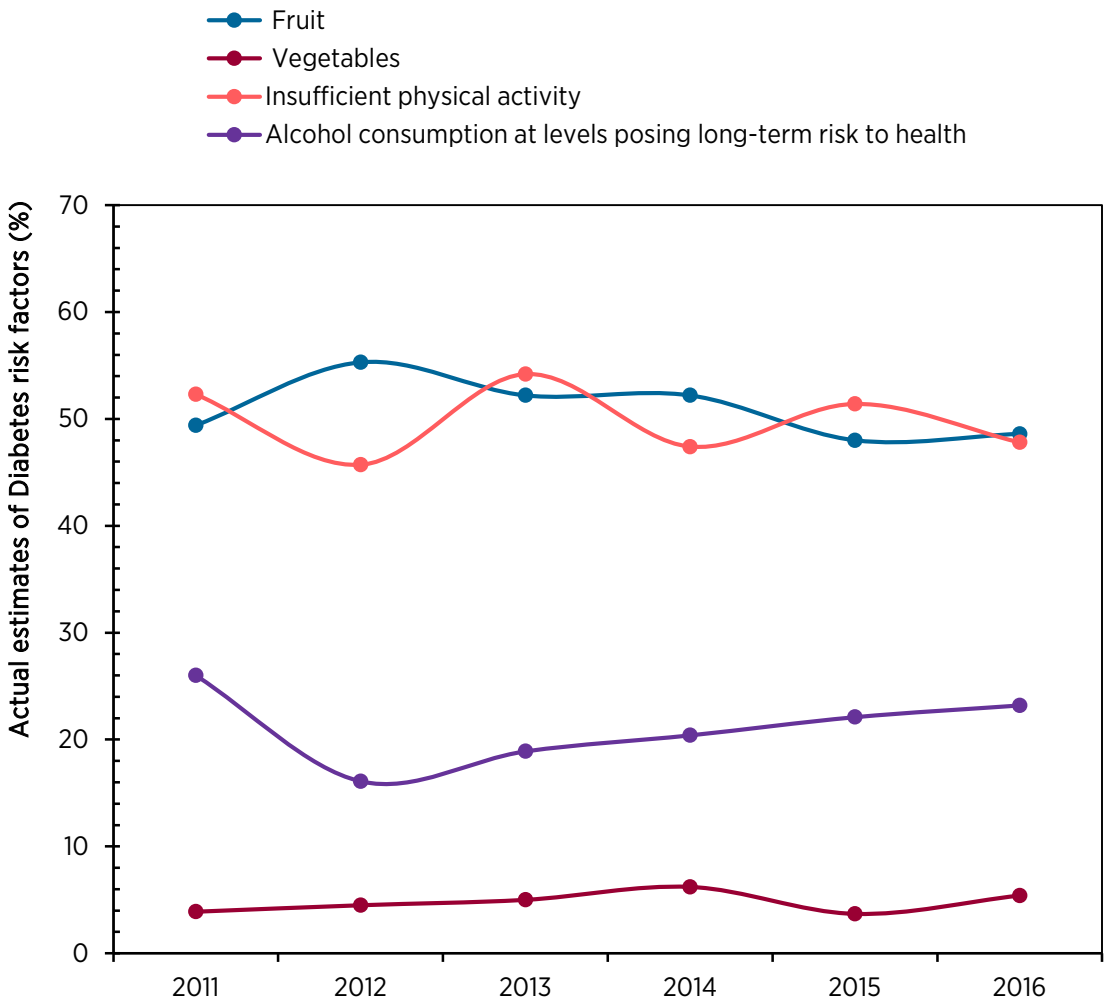
Fig 5. Rates of Obesity and overweight among secondary school students aged 12-17 years in South Western Sydney from 2005-2014.



Nutrition status

Good nutrition can have many positive health benefits. Figure 6 shows the mean estimates for inadequate fruit and vegetable consumption, alcohol consumption in dangerous amount, for respondents from SWS aged 16 years and over who participated in the 2011 – 2016 Adult Health surveys. Although the rate of alcohol consumption increased from 16.1% (95%CI:12.4-19.7%) in 2012 to 23.2% (19.6-26.8%) in 2016 and adequate fruit consumption rate dropped from 55.3% (47.4-63.1%) to 48.6% (44.5-52.7%), there was no obvious trend for any of the diabetes risk factors (p>0.3 for all regression analysis) across the time interval.

Fig. 6 Trends in consumption of fruit, vegetable and alcohol and physical activity rate in South Western Sydney adults aged 16 years and over (2011-2016)



In 2014-16, nearly one in two (48.6%) SWS adults met the Australian Dietary Guidelines for recommended daily serves of fruit, while 5.4% met the guidelines for serves of vegetables. While the uptake of recommended daily serves of fruit has reduced from 48.6% in 2016 to 52.2% in 2013, that of vegetables has remained unchanged. About one-half of SWS adults (52.2%) participate in sufficient physical activity (more than 150 minutes of moderate physical activity or more than 75 minutes of vigorous physical activity, or an equivalent combination of both, including walking) between 2014 and 15 and nearly one in two (47.8%) was insufficiently active (less than 150 minutes in the last week).

In 2014-16, 23.2% of adults from SWS consumed more than the recommended two standard drinks per day on average (exceeding the lifetime alcohol risk guidelines) [30], up from 18.9% in 2011-13. This amounts to about one in four adults who exceeded the lifetime risk guidelines in 2016.

Table 3. Trends in diabetes risk factors for SWS adults aged 16 years and over (2011-16)

Risk factors		*n*	% (95% CI)	*n*	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
	Gender	**2011**		**2012**		**2013**		**2014**		**2015**		**2016**	
Obese	M	306	22.7(16.5-28.8)	413	27.5(14.4-40.6)	468	18.4(14.4-22.4)	418	21.0(15.7-26.3)	396	24.5(17.7-31.2)	381	**22.9(17.8-28.0)**
	F	560	21.5(17.6-25.4)	499	25.2(17.2-33.2)	570	22.0(18.2-25.9)	460	22.3(17.6-27.1)	471	21.2(15.4-26.9)	504	**25.2(20.6-29.9)**
	Total	866	22.1(18.4-25.7)	912	26.4(18.5-34.3)	1,038	20.3(17.5-23.1)	878	21.7(18.1-25.2)	867	22.8(18.4-27.2)	885	**24.1(20.6-27.5)**
Overweight /obese	M	306	57.8(50.6-65.1)	413	58.4(47.1-69.9)	468	64.4(58.9-69.8)	418	62.2(56.3-68.1)	396	63.7(55.6-71.8)	381	**59.6(53.4-65.7)**
	F	560	45.5(40.3-50.7)	499	60.9(50.6-71.1)	570	44.6(39.7-49.5)	460	50.6(44.8-56.4)	471	46.2(38.8-53.5)	504	**52.1(46.6-57.6**)
	Total	866	51.6(47.1-56.1)	912	59.6(51.9-67.3)	1,038	54.4(50.6-58.1)	878	56.4(52.2-60.5)	867	54.7(49.1-60.4)	885	**55.8(51.7-59.9)**
Vegetables	Total	909	3.9(2.7-5.1)	926	4.5(3.1-5.9)	1,020	5.0(3.3-6.7)	891	6.2(4.0-8.4)	879	3.7(2.3-5.1)	894	**5.4(3.6-7.3)**
Fruit	Total	920	49.4(45.0-53.7)	959	55.3(47.4-63.1)	1,062	52.2(48.4-55.9)	918	52.2(48.1-56.4)	884	48.0(42.2-53.6)	901	*48.6(44.5-52.7)*
Physical Inactivity	Total	889	52.3(47.9-56.8)	922	45.7(37.7-53.7)	1,002	54.2(50.3-58.0)	880	47.4(43.2-51.6)	855	51.4(45.7-57.1)	855	*47.8(43.6-52.0)*
Alcohol[α]	Total	923	26.0 (22.0-30.1)	959	16.1(12.4-19.7)	1,071	18.9(15.8-22.1)	921	20.4(17.1-23.7)	889	22.1(16.7-27.4)	908	*23.2(19.6-26.8)*

*Where the diabetes risk factors have increased or decreased from 2011 -16, estimates were **bolded** or in *italics*, respectively (none are statistically significant).
[α]Proportion of adults who consumed more than 2 standard drinks on a day when they consume alcohol.

COMPLICATIONS DUE TO DIABETES FOR SOUTH WESTERN SYDNEY

Hospitalisation: Principal diagnosis

The hospitalisation rate for diabetes as a principal diagnosis has remained relatively stable between 2010-11 and 2013-14, across SWSLGA except for Wingecarribee where the hospitalisation rate fell significantly from 158.7 per 100,000 populations in 2010-11 to 134.3 in 2016-17 ($p=0.04$). In 2016-17, the rate of hospitalisation from T2DM exceeded that from T1DM across the LGA ($p<0.05$). While Type 2 diabetes accounts for up to 87% of all diabetes cases in the community, it accounted for around 63% of all hospitalisations for diabetes as a primary diagnosis in 2016-17. Similarly, while Type 1 diabetes accounted for around 31% of hospitalisations, it was present in only 8% of people with diabetes, indicating the high morbidity in this group. Gestational diabetes accounted for around 5% of hospitalisations.

For every 100,000 population of people with diabetes, 152.8 persons (174.0 for males and 132.7 for females) were hospitalized for diabetes as principal diagnosis in 2010-2011, compared to 167.6 per 100,000 populations in 2016-17. In 2016-17 an average of 1.7 hospitalisations per person for diabetes in SWS occurred which was higher than the state average (1.4 hospitalisation per person). In the last 7 years (2010-17), the average hospitalisation rate attributable to diabetes was significantly higher in SWS than in NSW by 14.8 per 100,000 populations ($p=0.005$).

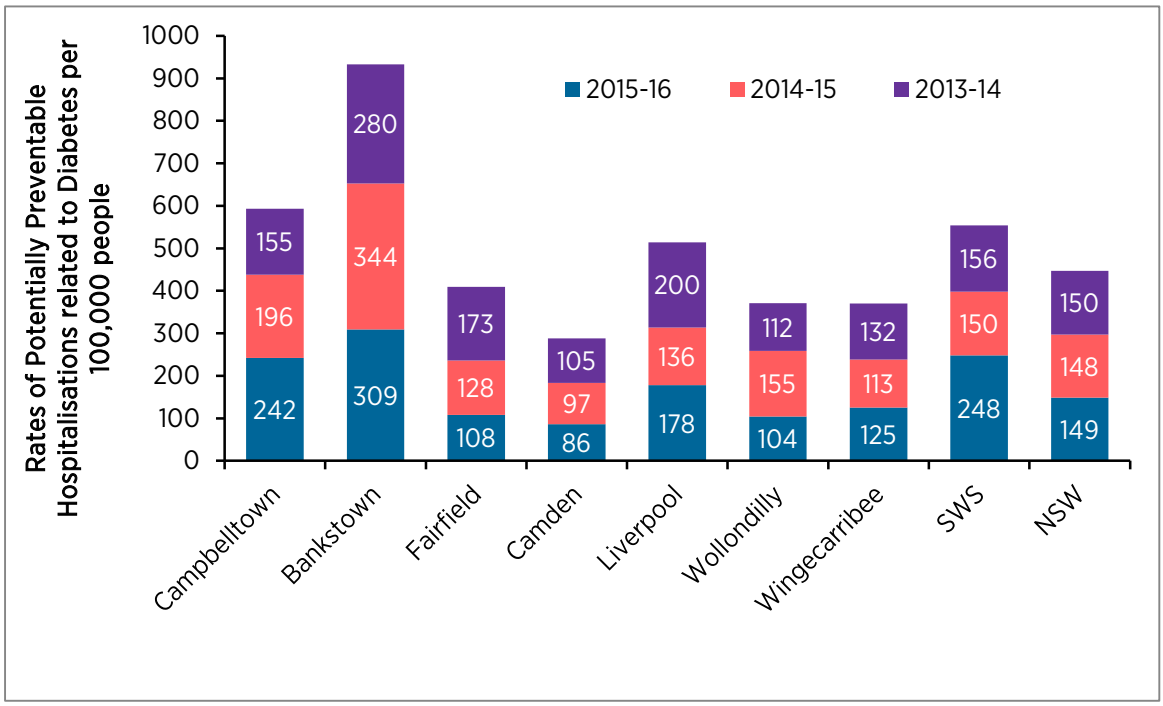
Table 4. Rate of hospitalisation for diabetes as principal diagnosis in South Western Sydney and New South Wales from 2010 to 2017.

Year	Sex	SWS (n)	Rate per 100,000 population	NSW (n)	Rate per 100,000 population
2010-11	Males	676	165.6	5,890	159.8
	Females	621	141.3	5,095	132.5
	Persons	1,297	152.8	10,985	144.6
2011-12	Males	676	162.9	5,866	156.3
	Females	559	123.4	4,910	126.3
	Persons	1,235	141.6	10,776	139.8
2012-13	Males	724	170.8	6,456	167.4
	Females	594	130.7	5,023	125.7
	Persons	1,318	149.4	11,479	145.1
2013-14	Males	866	197.1	4,832	118.3
	Females	636	136.6	2,836	61.4
	Persons	1,502	165.6	12,074	149.9
2014-15	Males	802	178.1	6,774	168.1
	Females	688	146.4	5,408	131.5
	Persons	1,490	161.2	12,182	148.1
2015-16	Males	776	166.8	6,909	167.3
	Females	698	144.4	5,565	133.4
	Persons	1,474	154.4	12,474	148.8
2016-17	Males	886	183.7	7,228	174
	Females	769	153.3	5,578	132.7
	Persons	1,655	167.6	12,806	151.8

Hospitalisation: Secondary diagnosis

Across SWSLGAs between 2013-14 and 2015-16, the hospitalisation rate for diabetes as a secondary diagnosis changed linearly ($p<0.05$) in Campbelltown and Camden but the rates were relatively stable in other LGAs ($p>0.050$). The rate of hospitalisations for potentially preventable conditions that are related to diabetes in SWSLGA was 156 per 100,000 people and 248 per 100,000 people in 2013-14 and 2015-16, respectively which was significantly higher than the rates in NSW (149 per 100,000 people and 150 per 100,000 people, respectively). At every time period, a large proportion of the patients involved residents from Bankstown LGA (one-third) as shown in Figure 7. Compared to the State, the rate of diabetes related hospitalisation was higher by about 49 cases per 100,000 people in Campbelltown ($p=0.195$) and lower by about 53 and 26 per 100,000 people in Camden and Wingecarribee, ($p<0.01$), respectively. Bankstown diabetes was the secondary cause of 309 hospitalisations per 100,000 people, which was significantly and substantially (110%) higher than the State rate in 2015-16.

Fig. 7 Preventable hospitalisations from diabetes in South Western Sydney (2013-2016).



Amputations

Data for the breakdown of amputations due to diabetes were not available by LGA. Compared to other districts in NSW, SWS ranked second highest in the total number of people with lower limb amputations due to diabetes between 2014-17 with about 146.3 amputations per 100,000 people occurring each year (11.1% of the State annual average (1320.3 per 100,000 people)) [17]. Of the average number of amputations below (168 per 100,000 people) and above (74.3 per 100,000 people) the knee that occurred in NSW, residents from SWS were mostly affected (highest number 19.7 and 11.0 per, 100,000 people respectively) and the 2nd most affected for the number of Toe/foot/Ankle amputations in NSW (115.7:1078, per 100,000 people, 10.7%) between 2014 and 2017.

CONGENITAL MALFORMATIONS IN PREGNANCY DUE TO DIABETES

Table 5 shows the rate of malformation for women with diabetes in SWS who attended Macarthur diabetes service. There were high rates of malformations (12.4%), and other pregnancy outcomes including neonatal hypoglycaemia (24.5%), macrosomia (29.8%), and miscarriage (8.0%) and these were similar between women with T1DM and T2DM ($p>0.05$). Overall, the rate of congenital malformations in SWS (6.8 - 12.4%) found in the recent study [25] was higher than that of the background population (1.7%, from 2005-10) [31] and few other Australian studies [32, 33].

Table 5. Rate of congenital malformations in pregnant women with diabetes from Macarthur in South Western Sydney (2010-15) [25].

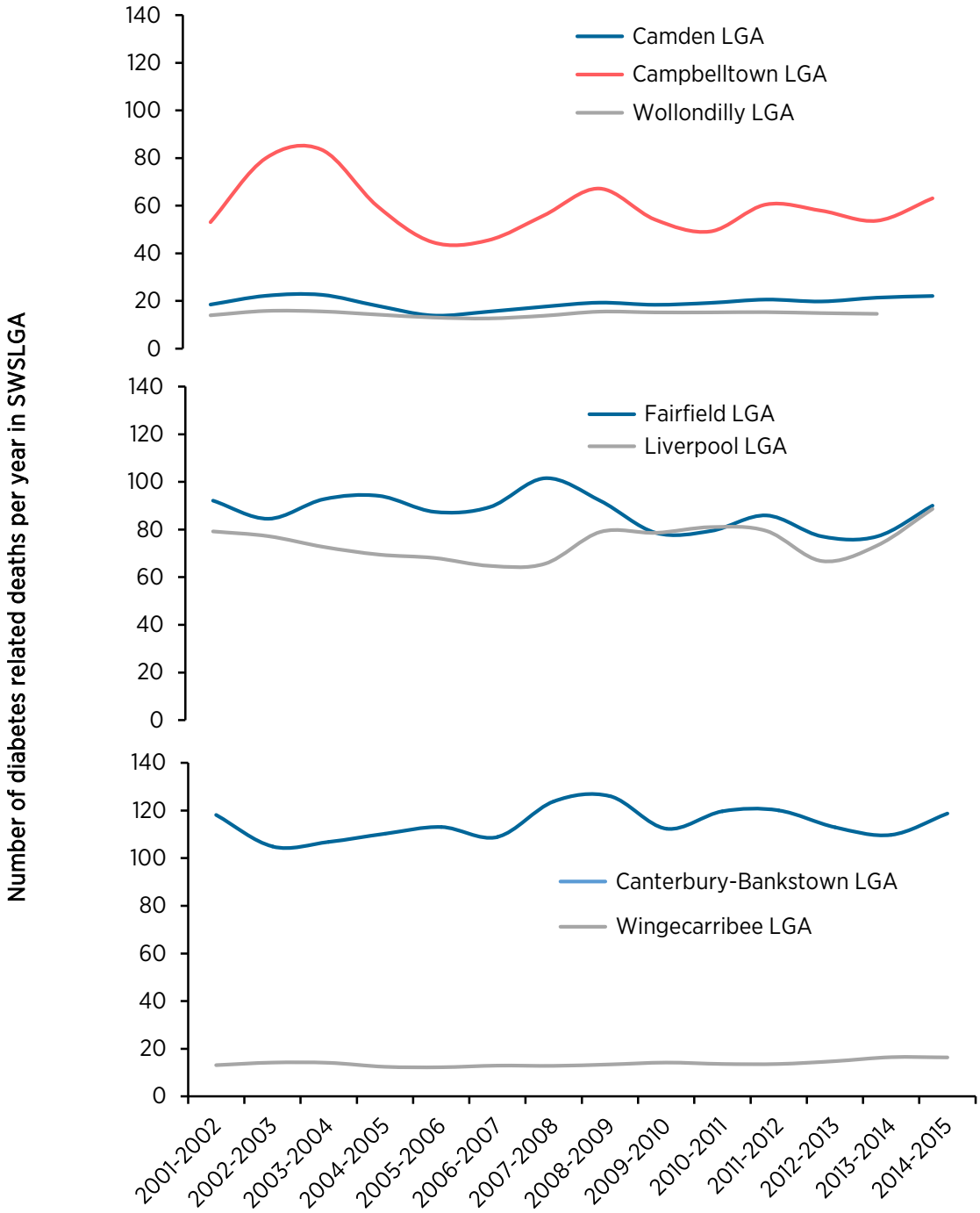
Malformations	All diabetes	T1DM	T2DM	*P*-value
Neonatal hypoglycaemia	12/49 (24.5%)	9/25 (36%)	3/24 (12.5%)	0.12
Any congenital malformations	11/89 (12.4%)	4/44 (9.1%)	7/45 (15.6%)	0.25
Major	8/89 (9%)	4/44 (9.1%)	4/45 (8.9%)	0.55
Minor	4/89 (4.5%)	0	4/45 (8.9%)	
Macrosomia	28/94 (29.8%)	17/49 (34.7%)	11/45 (24.4%)	0.5
Miscarriage	4/94 (4.3%)	4/50 (8%)	0	

For the 827 women diagnosed with GDM who gave birth at Liverpool Hospital of SWS between July 2007 and July 2010, 36.4% of Pacific Island women had babies whose birthweights were above 90th percentile of the standard national birthweight percentile chart as compared to 13.3% of Anglo-European women ($p < 0.001$). In contrast, 21.3% of offspring of women from South Asia had birthweight below 10th percentile as compared to 6.7% of Anglo-European women ($p < 0.001$). However, these differences became non-significant when the study adjusted for mothers ethnicity and weight [26]. While there was no significant effect of ethnicity on neonatal death between the five ethnic groups, the percentage of neonatal death ranged from 0.5% among South East Asian women to 2.7% among women who were from the Middle East.

DIABETES RELATED DEATHS IN SOUTH WESTERN SYDNEY

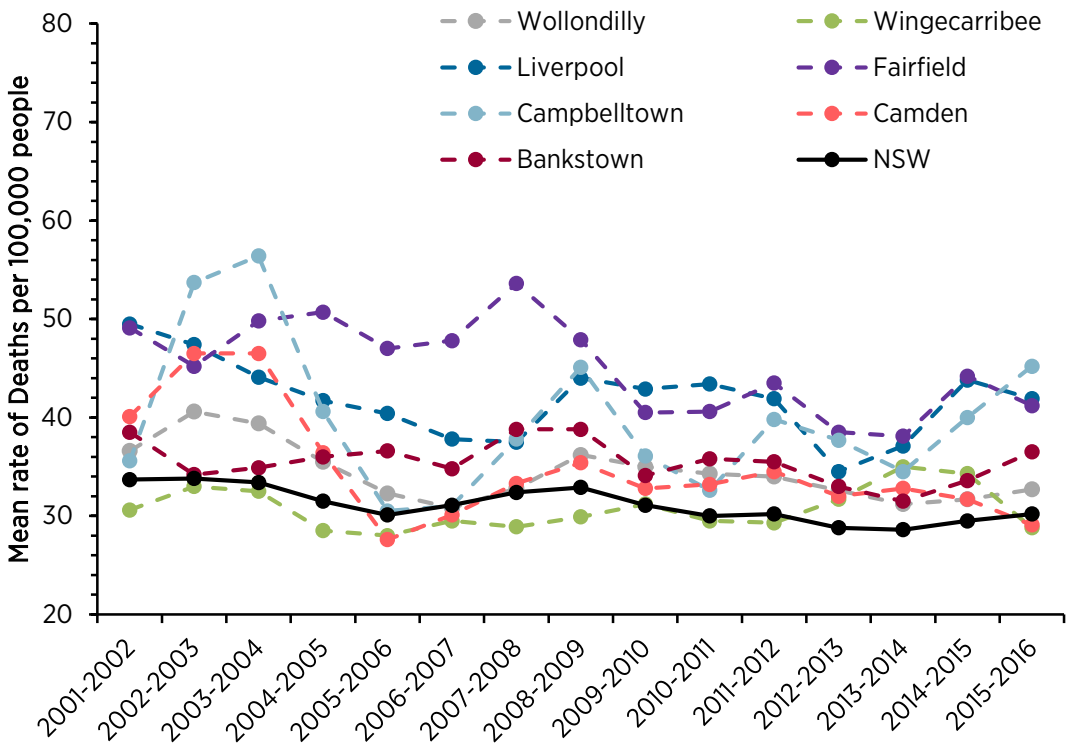
The number of deaths due to diabetes (either as an underlying and associated cause) in SWSLGA is shown in Figure 8 for the different LGAs. While diabetes was the principal (underlying) cause of around 3% of all deaths in NSW in 2016 (1,673 deaths), SWS accounted for around 11.4% (191) of these deaths. In NSW, 3029 deaths were directly related to diabetes in 2016 and 368 (12.1%) were SWS residents and 12.7% (555) of deaths in SWS involved diabetes in some way.

Fig 8. Number of deaths with diabetes as an underlying or associated cause in SWSLGA between 2001 and 2015.



There were significant differences in the rates of death due to diabetes (underlying and associated) per 100,000 populations between LGAs (p<0.0001, Fig 9) from 2001-15. The highest differences were found when Fairfield was compared to Wingecarribee (mean difference was 14.61 per 100,000 populations: 95% CI: 9.4, 19.9) and Wollondilly (11.0 per 100,000 populations: 5.70, 16.23, p<0.0001). SWS 'diabetes' death rates were higher than the NSW rates in all but Wingecarribee and Wollondilly.

Fig 9. Mean rate of deaths with diabetes as an underlying or associated cause in SWSLGA between 2001 and 2015



DISCUSSION

The estimates presented here confirm the large and growing burden of diabetes in South Western Sydney (6.7%) established by the higher estimates for almost all SWS LGAs compared to State (5.3%), National (5.1%) and global rates (5.9%) [34]. The burden of diabetes was greatest in Fairfield and Campbelltown LGAs, lowest in Wingecarribee and was affected by ethnicity in people with T1DM and T2DM but not in GDM. With the predicted increase in the population of SWSLHD to about 1,063 947 in 2021, the Diabetes Review Steering Committee of the district in their report on diabetes review 2015/17 projected that there will be an increase in the population with diabetes of 11,360 cases by 2021, yielding estimated cases of 67, 030 within the district. Although the hospitalisation rate due to diabetes as a principal diagnosis have been stable in recent years, the rate was still higher in SWS compared to the National rate (1.7 versus 1.4 hospitalisations per person) and in Campbelltown diabetes was the secondary cause of 2919 hospitalisations per 100,000 people which was significantly (and substantially) higher than the State rate of 2161 per 100,000 people in 2015-17. Additionally, residents from SWS had the highest rate of diabetes related foot amputations in NSW, higher rate of congenital malformations (6.8 - 24%) compared to the background population (1.7%) [35] and 12% of the NSW diabetes related deaths in 2016 involved SWS residents.

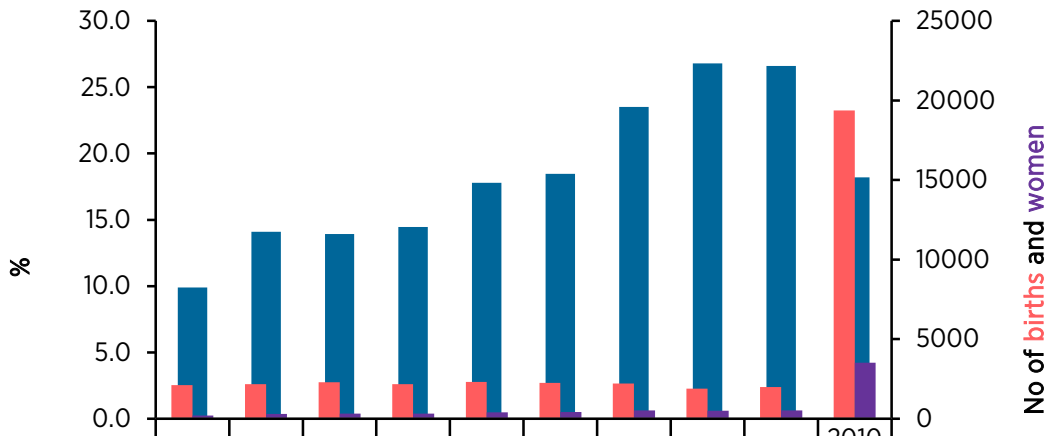
The majority of SWS residents with diabetes were living with T2DM and this was responsible for more than 60% of the diabetes related hospitalisations. However, there was disproportionate hospitalisation rate among those with T1DM which warrants further investigation. The high prevalence of T2DM is consistent with previous reports [6, 7, 9, 36-39], and all LGAs showed a similar pattern of distribution of diabetes types. Except for Banks town and Camden, all SWSLGAs had higher proportion of women with GDM than the National rate while three districts namely, Camden, Wingecarribee and Wollondilly, had higher rates of T1DM (11.1%, 10.0% and 11.0%, respectively) with only Fairfield having higher rates of T2DM (90%) than the National (86.5%) and State (86.2%) rates. Districts with relatively higher socioeconomic disadvantage as classified by ABS [20] had higher rates of T2DM but lower rates of T1DM. No relationship was observed between SEI and GDM rates.

The prevalence of diabetes increased with age, to 19.6% for SWS registrants aged 60 – 69 years and 24.9% for those aged 70-79 years. Similar increases in age have been shown for all populations [4, 6, 7, 9, 34, 36, 38, 40-43] and this was consistent for all the LGAs. That diabetes was more common in people aged 50 years and above (80.5%) is also consistent with

the pattern observed in other high-income countries (74%, aged 50 years and above). In low- and middle-income countries, where there are few older people, diabetes affected mostly people under the age of 50 (59%) [42]. With the projected increases in life expectancy, decreases in infectious disease burden, and higher rates of urbanisation in developing countries, the prevalence of diabetes will also increases in those countries [42]. Self-reported diabetes increased by 3% in SWS adults between 2011-16, confirming the rising prevalence of diabetes in Australia [5, 7, 44] and worldwide [6, 36, 37]. The prevalence of diabetes was similar between males and females (6.7%, each) in SWS, consistent with the Fremantle Diabetes Study [7] and the Australian Diabetes, Obesity and Lifestyle Study (AusDiab) [45].

The rates of GDM in SWSLGAs were higher than the National rate and even though the district was the last to adopt the new criteria for GDM diagnosis proposed in 2010 [46], the rate was still higher than that for other populations [47]. In house data from Bankstown-Lidcombe Hospital Diabetes Centre, SWSLHD also showed higher than the national rate of GDM before (2010-2015, 14%) and after the adoption of the new ADIPS GDM criteria (2016-2018, 26%, see Figure 10). This further indicates that GDM is a concern for the district.

Fig 10. Women with GDM in Bankstown-Lidcombe Hospital



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2010 - 2018
GDM Rates	9.9	14.1	13.9	14.4	17.8	18.5	23.5	26.8	26.6	18.2
Births	2112	2172	2283	2180	2310	2246	2204	1884	1981	19372
Women with GDM	209	306	318	315	411	415	518	505	527	3524

Cheung suggested that approximately 32% T2DM was found in women with past GDM [48] and the risk is even higher in obese women [49]. Women with GDM are at high risk of pregnancy complications and their children are more likely to develop impaired glucose tolerance later in life [50].

Data captured by the Australian Health Institute of Health and Welfare [51] include some of the indices targeted for reduction by the WHO in 2013. The organization aims to achieve at least 10% reduction in prevalence of insufficient physical activity and halt the rise in diabetes and obesity. The findings of a rising prevalence of diabetes, the increase in the rate of obesity in adult females and the higher rate of obesity among secondary school students in SWS compared to state averages (7.2% vs 4.6%), underpin the need for targeted grass-root health interventional programs that are population specific. Encouraging more personal forms of communication, and community-based educational programs that improve health literacy in these communities will lead to greater independence and will empower individuals and communities to make behavioural and lifestyle changes to reduce the burden of diabetes and associated NCDs [52].

The adverse physical effects of overweight and obesity are well-documented [53-55], and a recent global study indicated that the prevalence of overweight and obesity has increased among all age groups and in both genders [56, 57]. Although in our study, more adults reported undertaking adequate physical activity in 2016 than in 2013, overweight/obesity and obesity remain a significant problem among SWS residents consistent with the Australia population [58] and in women, combination of obesity and diabetes have additive effects on complications during pregnancy [57]. The mechanism by which obesity increases the risk of diabetes include increased resistance to insulin, decreased physical activity [58, 59] and longer television viewing time [58]. Reports from Australia [58, 60] and other parts of the world [61, 62] have suggested that watching television for more than 2 hours per day [61, 62], high socioeconomic status and consuming fruit four times or less per week were strongly associated with obesity [61].

There was a decline in adequate fruit and vegetable consumption among SWS residents in 2014-16. For many years, researchers and health promoters have proposed measures to reduce the burden of obesity, including taxation to limit intake of unhealthy foods, subsidising to consumption of healthy foods and restricting advertisement of unhealthy to children [56, 63]. Similar to the Wollondilly Diabetes Program (WDP) [64] which was funded by the Wollondilly Health Alliance in 2016 and implemented by Researchers from Western Sydney University, the district might benefit from implementing an evidence-based model of integrated diabetes care. The WDP aims to promote diabetes awareness and education within the rural area of Wollondilly and provides diabetes specialist expertise to support primary care and integrated diabetes care in several villages across Wollondilly.

The presence of diabetes has been associated with increased rates of hospitalisation [65]. A Study conducted among people aged 45 years and over found that participants with diabetes were 24% more likely to have a hospital admission for any reason within the year than participants without diabetes and also had more admissions and longer lengths of stay [65]. The high rate of hospitalisations due to diabetes in SWS has a significant impact on the use of health care services. Although the hospitalisation rates due to diabetes as a primary diagnosis has remained stable across SWSLGAs or dropped in few areas such as Wollondilly and Wingecarribee between 2013 and 2016, the rates in SWS were still higher than National average suggesting that this is a concern for health planners. For the LGAs with lower rates, the findings of this study may have been influenced by the lack of access to care due to rurality of the LGAs [66]. In people with diabetes who were aged 45 and over, a study found that the risk of hospitalisation was higher in males, older people, people on low income, current smokers, those who had anxiety or depression or those born in Australia [65]. In Bankstown and Campbelltown, there were more preventable cases of diabetes related hospitalisations which needs further investigation. Additionally, the rate of amputations due to diabetes were quite high and exceeded the National rates considering those that had lower knee amputations between 2014 and 17. There were about 168 amputations for every 100,000 people per year National rates, SWSLGA recorded more diabetes related amputations per year compared to other districts with about 19.7 amputations per 100,000 people per year, mostly below the knee. The reasons for this excess amputation rate warrant further investigation. Some of the admissions could be prevented by timely referral of patients with diabetic foot ulcers to high risk foot clinic, and a streamline referral system should be available for primary care physicians. In 2016, the region accounted for about 12.2% of all diabetes attributable deaths in NSW with Fairfield LGA recording the highest number of diabetes related deaths while the lowest rates were in Wingecarribee.

Diabetes is a strong risk factor for cataract development [67], a condition that is largely related to the ageing process. Previous studies reported that in people with diabetes, increased glycated haemoglobin level was associated with increased risk of nuclear and cortical cataracts [68]. In a large Australian study, where the authors examined the relationship between diabetes and presence of cortical, nuclear, and posterior sub capsular cataracts [69], they found that after controlling for other known risk factors, diabetes was significantly associated with posterior sub-capsular cataracts and previous cataract surgery. Another study found stronger association of diabetes mellitus with cortical cataracts [68]. The lack of data on the rate of cataract among SWS residents with diabetes meant we could not assess this important complication. Studies are needed to shed light on this subject among SWS residents.

There are some limitations in the current study. First, a lack of assessment of other significant

risk factors of diabetes such as family history of diabetes, duration of diabetes, and complications such as cataracts limit our findings as they were not available in the data sets used. Second, the assessment of health risk factors was not provided for the various SWSLGAs in the HealthStats NSW data and some had no gender classification. Third, our study was based on aggregated data provided by the data custodians for fear of patient identification, and the establishment of any relationship between the study factors and the outcomes cannot be established. Coding validity is often an issue with such data, and this was unable to be verified. Fourthly, although the study found high prevalence of diabetes in South Western Sydney, information based on self-reported data only is likely to underestimate the prevalence of diabetes as it cannot include people with undiagnosed diabetes and as was shown in 2012, not all Australians with known diabetes were registered with NDSS [7]. T1DM is the main work of specialist diabetes services and Macarthur diabetes services has more people with T1DM in its catchment than others but data were unavailable for this analysis. The 2011–12 Australian Health Survey, which included both measured and self-report data, showed that for every 4 adults with diagnosed diabetes, there was one who was undiagnosed [70].

Finally, there are many complications of diabetes that could not be presented in this paper. Data relating to the prevalence of cardiovascular disease, end-stage renal disease and retinopathy amongst our population with diabetes unfortunately was not available. Despite these limitations, for the first time, this study provides nationally representative evidence on the prevalence of diabetes in South Western Sydney which is considered a hotspot for diabetes in Australia. Selection bias is unlikely to affect the study findings given the fact that all NDSS registrants are confirmed by a health professional, the high response rate in both males and female respondents of the NSW Health Survey and selection of household participant in the survey was designed to ensure that each member of the household has an equal chance of selection for interview. The use of trained and experienced staff, as well as a standardized protocol for the interview (Up to 7 calls made to establish initial contact with a household, and up to 5 calls in order to contact a selected respondent), health risk factor analysis weighted against populations estimates (eliminated sampling errors), improved the accuracy of the results, and the age-sex specific data were also strengths of this study. We know from previous studies among SWS residents that management of diabetes needs to be individualised including addressing the strong influence of ethnicity on diabetes prevalence in SWS [26, 71, 72]. Understanding these differences is critical in the delivery of optimal care for people from diverse ethnic backgrounds.

CONCLUSION

The current study showed that the prevalence of diabetes, and some severe complications such as amputations, malformations and cataracts were higher in SWS compared to State and National rates and varied between LGAs but showed no preference for gender. Similar to global reports, type 2 diabetes was more prevalent than other diabetes types and was related to the SEI and ethnic distribution of the districts. The hospitalisation rate for people with type 1 diabetes was disproportionately high and warrants further investigation. On the other hand, the rate of GDM, was higher in all SWSLGAs than State and National rates except for Camden. Although prevalence of diabetes was lower in Wollondilly and Wingecarribee, access issues exist due to the rurality of these districts. The modifiable risk factors of diabetes which showed increases between 2011 and 2016 included overweight and obese, while physical inactivity decreased among SWS adults. Consumption of adequate fruit and vegetables decreased within this period. Interventions to increase awareness of diabetes and its complication, may improve health outcomes for the SWS and the entire NSW population.

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