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The prevalence of diabetes mellitus and retinopathy among Pacific peoples residing in South Auckland, New Zealand

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Abstract

Aims: To describe the prevalence of diabetes mellitus (DM) and diabetic retinopathy (DR) among Pacific peoples residing in a region of New Zealand with the highest Pacific population the - Counties Manukau District Health Board (CMDHB).

Materials and methods: A secondary analysis of two routinely collected databases: The Virtual Diabetes Register (a national DM monitoring tool), and CMDHB's DR screening database. The datasets were probabilistically linked to identify Pacific peoples (aged ≥ 15 years) with DM. Variables examined included socio-demographic characteristics, health profile, and DM management. The software package R was used for statistical analysis. Two-tailed chi-square tests of association were used to determine significance between proportions, and T-tests for differences in means.

Results: Of the 74,040 estimated Pacific peoples (aged 15 years and older) residing in the CMDHB region, 16,784 (23%) were identified with DM. Among those who were referred for retinal screening and attended the CMDHB ophthalmology clinics, 65% had DR. The prevalence of DR was highest among Pacific men (66%), and those of Fijian (74%) ethnicity. Among those who had been diagnosed with DM for ≤ 5 years, DR prevalence was relatively high (58%). The majority of Pacific peoples with DR also had maculopathy (82%), dyslipidaemia (66%), and hypertension (64%).

Conclusions: The burden of DM and DR among Pacific peoples in New Zealand has been largely under-estimated. The relatively high prevalence of DM (23%) among Pacific peoples in the CMDHB region, and among those a high prevalence of DR (65%), found in this study confirms the need to review current best-practice guidelines for DM prevention activities including particular emphasis on retinal screening. Further epidemiological research is required to determine the prevalence of DR among Pacific peoples residing in the wider New Zealand.

Introduction

Globally, rates of diabetes mellitus (DM) are reaching epidemic proportions, with 422 million people estimated to have DM in 2014 [1]. In New Zealand (NZ), DM prevalence rates are particularly high among Māori, South Asian and Pacific peoples [2]. The 2014/15 NZ Health Survey identified Pacific peoples as almost four times more likely to have type 2 diabetes (T2D) compared to non-Pacific peoples [3].

Most studies have associated the higher rates of DM among the Pacific community in NZ with diet and lifestyle related obesity, rather than genetic factors [3]. Compared to the national average (31%), Pacific adults have much higher rates of obesity (66%) [3,4]. Reasons for this may include the impact of migration, which led to changes in the availability of Western food for Pacific migrants [5]. Pacific peoples face socio-economic disadvantage, earning lower than national median incomes, with stresses exacerbated by cultural expectations around family size and gift-giving obligations to family and church. Stress not only increases unhealthy eating behaviours, but also fuels cortisol release linked with weight gain and inflammatory processes associated with DM [6]. A study by Simmons *et al.* which surveyed people in South Auckland's knowledge of DM, found that Pacific peoples in comparison to other ethnic groups were more likely to have comparatively poorer health literacy regarding DM [7].

Diabetic retinopathy (DR) is eye disease of the retina, resulting from changes in the microvascular system within the retina [8]. In the non-proliferative stages of DR, loss of cells (particularly pericytes) result in the breakdown of retinal capillaries which can leak fluid in the retina, distorting vision [8]. Blood vessels can also swell, clog and become blocked preventing certain areas in the retina from gaining blood supply. In the more proliferative stages, abnormal, new blood vessels form, which are fragile, and thereby more prone to haemorrhage. Retinal detachment can occur in more severe stages, causing permanent vision loss [8]. According to the World Health Organization (WHO), 75% of people who have had DM for 20 years or longer, will develop some form of DR [9]. DR is recognised as one of the leading causes of vision impairment within Pacific Island countries, with prevalence rates among those with DM reported to be as high as 52.6%, 52.9% and 69% in Fiji, Vanuatu and Nauru respectively [10-12].

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New Zealand has the highest concentration of Pacific peoples outside of the Pacific Islands region, with 7.4% (295,941 people) of the population identifying as Pacific. Around 66% (194,958 people) of the Pacific population reside in Auckland (NZ's largest city) [14]. Despite such high numbers of at-risk populations, little is known about the burden of DR among Pacific peoples in NZ. Previous studies have included small sample sizes, and therefore are unlikely to represent the true burden of disease [14,15]. Current available literature on DR prevalence in NZ indicates substantial variations in DR prevalence across demographic groups, ranging from 2% for people with DM aged ≥ 18 years in Waikato, to 60% for T2D among those aged 30-82 years in Canterbury [16,17]. A key prevention strategy for DR is regular retinal screening, with New Zealand guidelines, recommending people with DM undergo retinal screening every two years. However a recent audit (unpublished) of general practice primary care management systems in the Counties Manukau District Health Board (CMDHB), found that 31% of DM cases had no prior record of retinal screening, and that 27% of Pacific peoples and Indians with DM had never been screened [18].

The aim of this study was to estimate the prevalence of DM and DR, and explore DR screening rates among Pacific peoples residing in the CMDHB region home to 38% of NZ's Pacific population [19]. The specific objectives were to:

1. Describe the profile of Pacific peoples with DM and DR residing in the region
2. Assess the completeness and accuracy of routinely collected data on DM and DR in this region.

Materials and methods

For the purpose of this research the term "Pacific peoples" has been used to describe individuals from the Pacific Islands in the regions of Polynesia, Micronesia and Melanesia, and includes individuals born in NZ of Pacific Island ethnicity, and Pacific populations with transnational citizenship [20]. The study involved a descriptive analysis of two routinely collected datasets; the Virtual Diabetes Register (VDR), and the VIP.net database.

Data sources

The VDR is maintained by the Ministry of Health (MoH) and includes information from a wide variety of national data sources, including pharmacy prescriptions, hospital admissions, retinal screening, laboratory orders and outpatient attendances, for estimating the burden of DM and the quality of DM care nationally [21]. In order to be captured by the VDR, an individual needs to have had either four HbA1c measurements, undergone retinal screening, attended a diabetes outpatient clinic, or been prescribed two or more oral hypoglycaemic agents [21]. The level of capture is dependent on the degree and accuracy of coding, data availability, geographical variations and the certainty of the standard that has been set [21]. Information contained in the VDR is displayed in the appendix.

The VIP.net is a DR clinical management system used by the CMDHB. It includes data on patients enrolled within a Primary Health Organisation (PHO), who are registered with a local healthcare practitioner and are referred to the DHB's community ophthalmology clinics for DM retinal screening [18]. In addition to the general patient information captured by the VDR, the VIP.net also includes: type of DM, DR diagnoses and grade, HbA1c levels, and co-morbidities (Appendix). Currently the VIP.net data does not contribute to the VDR.

The population of interest for this study was Pacific peoples aged 15 years and over with a diagnosis of DM, residing in the CMDHB region between January 2010 and December 2014. This four-year time-period was selected, based on the assumption that all people with DM living in the CMDHB region should be captured by the VIP.net, if the New Zealand standards for retinal screening are adhered to i.e. biennial screening. The VDR unlike the VIP.net is a cumulative record of diabetes-related information for an individual, therefore restricting this information to a particular time period was not feasible. For this reason, data was extracted from the VDR for all Pacific peoples with DM residing in the CMDHB region until December 2014. Individuals that were not enrolled in a primary health organisation (PHO) were included in the study, while those noted as deceased or as having migrated, were removed from both databases.

Linkage process

The databases were probabilistically linked using patient's unique National Health Index (NHI) number. Three sets of records containing 'eligible cases' were formulated using filtering, cross-checking and linkage processes: 'VIP' (records within the VIP database), 'VDR' (records within the VDR) and 'Linked' (combined unique records from both databases post-linkage).

Variables examined

The variables examined in each database, including information pertaining to DM and DR are displayed in Table 1. Information from the VIP.net database was limited to records from the most recent visit (unless specified otherwise).

Data analysis

Descriptive analyses were used to describe the profile of Pacific peoples with DM and DR. Two-tailed chi-square tests of association were used to determine significance between proportions, and T-tests for differences in means. Prevalence estimates were based on the proportion of people with DM within the 'linked' database, compared to the 2014 population estimates for Pacific peoples residing in the CMDHB region [22]. Denominator data for DM prevalence by gender, was based on the 2013 Census [19]. Denominator data for Pacific sub-group population by expanded ethnic categories (i.e. level 2 ethnicity coding) and by socio-economic status is not publically available for the CMDHB region, therefore DM prevalence rates for these sub-groups were unable to be calculated. Data analysis was undertaken using the statistical software package R x64 3.2.2 a.

Ethics approval

This study obtained ethics approval on August 5, 2015, from the University of Auckland Ethics Committee (ref: 015265) and institutional approval from the CMDHB Research Committee (ref: 2126) on August 27, 2015.

Results

Data linkage resulted in the identification of 16,784 unique records of Pacific adults (≥ 15 years of age) residing in the CMDHB region with DM. Just under three quarters (n=11,997, 71.5%) of cases were identified in the VIP database, and 14,707 (87.6%) in the VDR database. The characteristics of people with DM included in each of the source datasets and in the linked dataset are presented in Table 1.

Diabetes mellitus

The linked dataset revealed an estimated prevalence of DM among Pacific peoples (aged ≥ 15 years) in the CMDHB region of 23% (16,784/74,040 estimated Pacific adult population residing in

Table 1. Characteristics of Pacific peoples with Diabetes Mellitus in the Counties Manukau District Health Board region: VIP, VDR and Linked databases.

Population Characteristics		VIP database	VDR database	*P*	Linked dataset
Total		11,997	14,707		16,784
Gender	Male	5688 (47.2%)*	6663 (45.3%)	0.001	7806 (46.5%)
	Female	6325 (52.7%)	8044 (54.7%)		8926 (53.2%)
Age Mean (years)		57.8	56.9		57.6
Age Groups (years)	15-19	25 (0.2%)	61 (0.4%)	<0.0001	60 (0.4%)
	20-29	223 (1.9%)	365 (2.5%)		375 (2.2%)
	30-39	771 (6.4%)	1075 (7.3%)		1173 (7.0%)
	40-49	2065 (17.2%)	2719 (18.5%)		2932 (17.5%)
	50-59	3413 (28.4%)	4125 (28.1%)		4624 (27.6%)
	60-69	3204 (26.7%)	3716 (25.3%)		4304 (25.6%)
	70 and over	2296 (19.1%)	2046 (18.0%)		3316 (19.7%)
Ethnicity	Samoan	4840 (40.3%)	6231 (42.4%)	<0.0001	6749 (40.2%)
	Tongan	2229 (18.6%)	2914 (19.8%)		3159 (18.8%)
	Cook Island Māori	1852 (15.4%)	2221 (15.1%)		2494 (14.9%)
	Fijian & Fijian Indian**	2328(19.4%)	2172 (14.8%)		3185(18.9%)
	Niuean	650 (5.4%)	782 (5.3%)		870 (5.2%)
	Other PI	98 (0.8%)	387 (2.6%)		327 (1.9%)
NZ Deprivation Index Quintiles (Q)	Q1 (least deprived)	N/A	300 (2.0%)		394 (2.3%)
	Q2	N/A	279 (1.9%)		372 (2.2%)
	Q3	N/A	613 (4.2%)		744 (4.3%)
	Q4	N/A	1071 (7.3%)		1478 (8.6%)
	Q5 (most deprived)	N/A	12,468 (84.6%)		14139 (82.0%)
Mean duration with DM in years (range)		9.5 (0 – 64)	6.4 (1 – 16)		8.8 (0-64)
Duration with DM (years)	5 and under	4028 (40.0%)	6499 (51.6%)	<0.00001	6641 (39.6%)
	6-10	2523 (25.0%)	4004 (31.8%)		4509 (26.9%)
	11-15	1755 (17.4%)	1918 (15.2%)		3245 (19.3%)
	16 and more	1766 (17.5%)	171 (1.4%)		2389 (14.2%)
Medication management	Insulin	2340 (41.1%)	2831(19.2%)	<0.00001	N/A
	Tablet	9916 (93.7%)	10529 (71.6%)		N/A
HbA1c levels taken		9988 (92.4%)	8106 (55.1%)	<.001	N/A

* In 4 records, gender was not recorded

** For the purposes of this table, Fijian and Fijian Indian populations have been combined

the CMDHB region). The prevalence of DM in the VDR and VIP.net databases was 20% and 16% respectively (p<0.0001). Of interest, 23.4% (n= 349) of those in the VDR database categorised as not being enrolled in a Primary Health Organisation (PHO), were present in the VIP databases which requires people to be registered with a PHO in order to be able to access their services.

Socio-Demographic Characteristics of People with Diabetes Mellitus: Based on the combined linked dataset, DM prevalence was the highest among males (29% cf. 22%; p<0.0001). The mean age of diagnosis of DM was 58 years, with the majority of people with DM (53%) aged between 50 and 69 years, and of Samoan ethnicity (40% of cases). Information on area level deprivation (NZ Dep 2013) was only available from the VDR database. Based on this data, the majority (85%) of Pacific peoples with DM resided in areas of high deprivation (levels 9 and 10).

Health status: The VDR data indicated that 19% of people with DM were prescribed insulin and 72% oral DM medication (Table 1). This was significantly lower than what the VIP.net data indicated (41% and 72% respectively, p <.001). Dietary management is only captured by the VIP.net and revealed that 11% of people with DM were managed solely on diet alone, with 5% reported as non-compliant to medication.

Significantly more Pacific peoples in the VIP.net database were recorded as having HbA1c tests undertaken compared to those captured in the VDR database (92% cf. 55%, p <.001). Of those with DM that were referred for retinal screening, 39% had moderate HbA1c levels (7.0-8.9), with 30% having poor HbA1c levels (>=9.0). Comorbidities were common among Pacific peoples with DM, with 67% recorded as having maculopathy, 65% dyslipidaemia, and 64% hypertension. Nephropathy was recorded in only 15% of cases.

Diabetic retinopathy

Diabetic Retinopathy (DR) screening is captured in the VIP.net database (i.e. diagnosis, grading); VDR records only capture DR screens in the last two years [21]. Based on the combined linked data, 65% of Pacific peoples with DM residing in the CMDHB region had completed retinal screening in the preceding two years as per the MOH recommendations.

Almost two-thirds (n=7748, 65%) of DM cases who presented to the CMDHB ophthalmology outpatient clinic screened positive for DR. Of note, 3059 (39%) of these did not have a DR grade documented in the VIP.net. Of the 4689 DR cases who had a DR grade recorded, 3381 (72%) had mild-minimal DR (grade 1-2), 977 (21%) had moderate-severe DR (grade 3-4), and 330 (6%) had proliferative-advanced DR (grade 5-6) The prevalence of DR was highest among Pacific men

(66%), and those of Fijian (74%) ethnicity. Among those who had been diagnosed with DM for 16 years or longer, DR prevalence was 80%. The majority of Pacific peoples with DR also had maculopathy (82%), dyslipidaemia (66%), and hypertension (64%).

Our data showed that 565 (7%) of those with DR were recorded as having completed full treatment for DR. Of those with proliferative-advanced DR, 215 (65%) had completed full treatment, while 162 (17%) of those with moderate-severe DR had completed full treatment.

Discussion

To the best of our knowledge, this is the first published NZ study to estimate the prevalence of DM and DR among Pacific peoples living the CMDHB area, which has the highest concentration of Pacific peoples living outside Pacific Islands region. The study found that 23% of Pacific peoples (aged ≥ 15 years) residing in the CMDHB region had received a diagnosis of DM. Two-thirds of Pacific peoples with DM that were referred for retinal screening and attended the CMDHB ophthalmology clinics, were found to have DR (65%), with the majority having minimal to mild degrees of DR (72%). The overall prevalence of DR was higher among Pacific men, particularly those aged between 50 and 69 years, and of Fijian, Fijian Indian, Samoan and Tongan ethnicities. The DR prevalence among Pacific peoples was 58% for those who had had DM for 5 years or less; the rate increased to 80% for those living with DM for 16 years or longer.

The findings of this study should be considered in light of several limitations. The DR prevalence is based on DM cases from the CMDHB region that were referred for retinal screening and attended the CMDHB ophthalmology clinics. It therefore may not represent all cases of DR. There were issues with the completeness and reliability of some of the data, which have limited our ability to draw meaningful conclusions. For example, a screening grade was missing in 3059 DR records, this is likely to have resulted in an underestimation of the severity of disease in this population. Furthermore, there was a lack of consistency in how Fijian Indian ethnicity was recorded in the data sources reviewed which may have resulted in DR prevalence rates within this group being over-estimated.

The DR prevalence of 65% among Pacific peoples with DM in the CMDHB region captured by the data sources reviewed is considerably higher than the 30% estimate stated in the MOH 2008 referral guidelines [23]. Previously reported NZ prevalence estimates have ranged substantially (2% to 60%), with higher estimates being confirmed by examining older populations (>=30 years), that have had DM for 10 years or longer [16,17]. The DR prevalence identified in this study for Pacific peoples is higher than the 16% reported in an earlier study involving biomedical assessments of randomly selected participants from a South Auckland household survey [14], and 29% in a Northland retrospective study of patients within the diabetic retinopathy screening programme [24]. Overall, the rates of DR found among Pacific peoples with DM in this study are similar to rates identified in Western Pacific countries within Melanesia such as Fiji [10] and Vanuatu [11] (52.6% and 52.9% respectively) as well as Micronesia such as Nauru (69%) [12]. The high prevalence of DR among Fijians (75%) with DM, living in the CMDHB region reviewed is higher than that reported in Fiji (53%) [10]. The reasons for this require further investigation but could include delayed detection of DM due to barriers in accessing healthcare services.

This study was not designed to investigate factors that may have influenced DM and DR prevalence among Pacific peoples living in the CMDHB region. For example, recent migrants from the Pacific may be ineligible for many of the publicly funded services for diabetes and retinal screening, although are likely to be at high-risk of diabetes [25]. Fijian, Fijian Indian, Samoan and Tongan populations had the highest prevalence of DR in the present study. These groups are more likely to have recently migrated to NZ or be overseas-born compared to other Pacific peoples [26].

Compared to the total proportion of residents living in deciles 9 and 10 (most deprived regions) in CMDHB in 2015 (36%) [27], the proportion of Pacific peoples with DM identified in this study as living within the same regions (85%) were considerably higher. The association between DM and deprivation is consistent with international findings which link T2D with area deprivation [28]. Socioeconomic disadvantage is known to increase stress, which can contribute to weight gain and the development of DM [6].

Although NZ's 'Living Well with Diabetes' plan has set specific targets to reduce amputations and renal failure rates, both potential complications of diabetes (e.g. reduce renal replacement rates per 1000 people with DM by 20% by 2019), there are no specific targets in regards to DR [29]. The National Action plan has encouraged the use of GP assessment tools to support risk management of DM at a population level. With the current burden of DM and DR in the CMDHB region, greater priority should be given to retinal screening and treatment.

The study findings support the early detection of DM in Pacific peoples in particular attention needs to be focused on women; those aged between 40 and 69 years; people of Samoan, Tongan or Cook Island Maori ethnicities; those living in areas of high deprivation and those who have hypertension or dyslipidaemia. Findings from this study also support a review of current best practice guidelines to promote access to retinal screening for high risk populations who may not be accessing mainstream health services.

Authorship and contributorship

SK was the lead investigator on the project, contributed to the study design, liaised with local stakeholders, coordinated data collection, conducted statistical analysis, and prepared the first draft of the paper and contributed to subsequent revisions. BK and JM co-supervised the research and the write-up of the study. VN was Pacific adviser and SE the clinical adviser for the study, both contributed to all aspects of the study including study design, interpretation of findings and preparation of this manuscript.

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Competing interests

The following authors: SK, BK, VN, and JM declare they have no competing interests. SE is employed by the CMDHB, however it is not

anticipated that the organisation will gain or lose financially from the publication of this manuscript.

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Appendix. Socio-demographic and health status variables included in VIP.net and VDR dataset and in the resulting linked dataset.

VARIABLE	VARIABLES PRESENT		
	VIP.net	***VDR***	***Linked dataset***
INCLUSION/ EXCLUSION CRITERIA			
NATIONAL HEALTH INDEX NUMBER	✓	✓	✓ Used to link VIP with VDR records.
PRIMARY HEALTH ORGANISATION (PHO) ENROLMENT	✗ All cases require PHO-enrolment.	✓ Non-PHO enrolled included in study.	✓ Non-PHO enrolled included in study.
SOCIO-DEMOGRAPHIC CHARACTERISTICS			
GEOGRAPHICAL (DOMICILE) LOCATION	✓ Suburb that a diabetic resides within. Self-reported, but cross-checked with NHI records (within CMDHB ophthalmology clinics).	✓ DOM-Code recorded.	✓ DOM-Code was used. N.B. When suburbs in both databases did not match, but were either (1) located within the CMDHB region OR (2) had the VDR location as within the CMDHB region, then the 'geographical location' was classified as the locality noted in the VDR. If the suburb noted in the VIP.net database was within the CMDHB region, but outside the CMDHB region in the VDR, then locality was classified as "No match".
AGE	✓ 15 years and over as at 31/12/15.	✓ All cases were aged 15 years and over. Age was adjusted to a common index-date of 31/12/15	15 years and over
GENDER	✓ (M/F)	✓ (M/F/Unknown)	✓ (M/F)
ETHNICITY	✓ Self-identification of one 'main' ethnicity, plus additional 'minor' ethnicities. (15 categories for Pacific ethnicity including Fijian Indian).	✓ Ethnicity is based on records from health care services. Ministry Of Health (MOH) prioritized ethnicity - Level 2 coding for "Pacific peoples" used*. NB. Fijian Indian not included	
LEVEL OF DEPRIVATION	✗	✓ NZDep13 indicated through domicile code. The deprivation categories based on quintiles 1-5 i.e. Quantile 1 (least deprived), Quantile 5 (most deprived)	✗
DIABETES-RELATED INFORMATION			
DM DIAGNOSIS	✓ Made by GP/other health professional	✓ Estimated by linking datasets (HbA1c, out-patient-referral, retinal screening, pharmacy dispensing)	✓
TYPE OF DM	✓ T1D, T2D, Gestational DM, Other (e.g. steroid-induced DM)	✗	✓
DURATION WITH DM	✓ Predicted duration (years) by health professional as at 31/12/15 based on age of diagnosis, severity at last examination and presence of risk factors.	✓ First "diagnosis" date detected (i.e. first inpatient/ outpatient/ labs/ pharmacy date). Adjusted to the date 31st December 2015.	✓ The maximum duration out of the two estimated in the VIP.net and VDR was selected.
DIABETIC RETINOPATHY RELATED VARIABLES			
RETINAL SCREENING	✓ No specific 'retinal screened' variable in the VIP.net database. An assumption was made that if an individual was referred to CMDHB Ophthalmology clinics and attended the clinic, then retinal screening occurred.	✓ Counts of screens in the last two years examined. Based on DR screening purchase unit code [21]	✓
DR GRADE	✓ As per the Grading categories: R0=no DR, R1=minimal DR, R2=mild DR, R3=moderate DR, R4=severe DR, R5=proliferative DR and R6=advanced DR) [23]. In cases where the screening result differed between eyes, the higher grade of the two was used.	✗	✗
TREATMENT FOR RETINOPATHY	✓	✗	✗
INSULIN	✓ prescribed	✓ dispensed	✓ prescribed and dispensed
ORAL DIABETES MEDICATION	✓ prescribed	✓ dispensed	✓ prescribed and dispensed

*Source: Ministry of Health. 2004. *Ethnicity Data Protocols for the Health and Disability Sector* [Online]. Wellington: Ministry of Health. Available: http://www.health.govt.nz/publication/ethnicity-data-protocols-health-and-disability-sector.