



The Glycemic Control of Adult Population in Nauru

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Aims: The first aim of the present study is to evaluate the current glycemic control and characteristics of overall and newly diagnosed diabetes mellitus (DM) population from two cohorts population (2011–2012 and 2014–2015). Furthermore, the hemoglobin A1C (HbA1C) levels of newly diagnosed in these two cohorts population will be also compared to HbA1C levels on 2013 in subjects of previous diagnosed DM ongoing therapy. **Settings and Design:** This is a retrospective observational cohort study. **Subjects and Methods:** All of the data come from the Nauru Diabetes Registry database from Nauru Public Health Center from 2011 to 2015. All patients with their HbA1C will be analyzed and compared between year of 2011–2012 and 2014–2015. **Statistical Analysis Used:** Descriptive results of continuous variables will be expressed as means $\pm$ standard deviation. We use unpaired *t*-test for comparisons of quantitative variables. A two-tailed $P < 0.05$ was considered statistically significant. The statistical analyses will be performed using the program SPSS (Chicago, Illinois, USA; version 18.0). **Results:** A total of 614 patients were enrolled for the analysis with mean age of 49.8 year old and mean diabetic duration of 10.1 years. The mean age of onset of DM is 40.4 year old. The female population had long duration of DM than male population. The overall HbA1C levels are slightly greater in 2014–2015 than 2011–2012 without statistical significance ($10.9\% \pm 2.7\%$ and $10.6\% \pm 2.2\%$, respectively). The HbA1C levels also do not differ among DM patients with regular outpatient visits. The mean HbA1C of newly diagnosed DM is significant higher in 2014-15 than that in 2011-2012 ($11.5\% \pm 2.4$ and $10.6\% \pm 2.1\%$, respectively, $P = 0.039$), but not different from HbA1C levels in 2013 in DM patients who received ongoing treatment ($10.9\% \pm 2.3\%$). Furthermore, HbA1C worsened significantly in 2 of the 15 districts between 2011–2012 and 2014–2015. **Conclusions:** Nauru has a high prevalence rate with early onset and inadequately controlled diabetes. It needs to propose strategy to early detect and improve glycemic control early to prevent future diabetic complications.

Key words: Diabetes mellitus, Nauru, hemoglobin A1C, Nauru Public Health Center

INTRODUCTION

The prevalence of diabetes mellitus (DM) had been increased gradually all worldwide. According to the data of International Diabetes Federation (IDF), the diabetes patients will increase from 425 million in 2017 to 629 million in 2045.¹ DM will cause socioeconomic burden due to its related comorbidity and chronic complications, including micro-and macro-vascular complications. According to the previous studies, the best strategies to prevent chronic diabetic complications are “the

earlier, the better” and possible “the lower, the better from the initial diagnosis”, that is so-called legacy effect.^{2,3} Therefore, it is also very important to treat subjects with DM in the early stage aggressively.

Nauru is one of the countries with high prevalence of diabetes in the world. The World Health Organization (WHO) has implemented a nation-wide Stepwise Surveillance of Risk Factors for Noncommunicable Diseases Survey (Nauru-STEPS) in 2004.⁴ In that survey, it is

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shown that the overall prevalence of DM is 16.2% in adult population. The prevalence rate also increased with age, from 3.8% of age 15–24 years old to 45% of age from 55 to 64 year old.⁴ Although it once seemed that the prevalence of DM has decreased according to previous reports,^{5–7} the latest prevalence of the DM in Nauru was 23.3% by the data of IDF in 2014.¹ Therefore, DM was still an important issue in Nauru because the annual cost for DM was estimated about 20% of the annual health-care expenditure of governments.⁸

According to the reports of the government, the most of the mortality and morbidity comes from metabolic disorder, which DM being the most important contributor. Moreover, the prevalence of diabetic complications is higher than other Pacific Islands countries.⁹ Moreover, these complications are closely associated with glycemic control and duration of the DM.⁹ Therefore, it is important to understand the current overall DM control in Nauru, followed by taking action to reduce the incidence of DM and its related complications. However, there was no previous study to explore the overall glycemic control of patients with DM in Nauru in the past. Furthermore, according to the early study, it suggests that the diabetic management may not be effective in Nauru about decades ago.¹⁰ It needs to know whether this condition had been changed or not under the current medical resources.

Therefore, the first aim of the present study is to evaluate the current glycemic control and characteristics of overall and newly diagnosed DM population from two cohort population (2011–2012 and 2014–2015). Furthermore, the hemoglobin A1C (HbA1C) levels of newly diagnosed in these two cohorts population will be also compared to HbA1C levels on 2013 in subjects of previous diagnosed DM ongoing therapy.

SUBJECTS AND METHODS

Study population

This research was designed to collect the HbA1C levels to evaluate their glycemic control of Nauru adult population between years of 2011 and 2015. The diagnosis of DM is made by either randomized blood sugar levels 200 mg/dl or above, fasting plasma glucose (FPG) levels 126 mg/dl or above, HbA1C 6.5% or above, or on medical treatment for DM. All of the demographic characteristics and diabetic profiles (diabetic duration, age of DM being diagnosed, and HbA1C) come from DM Registry database of the Nauru Public Health Center, where the major place for caring diabetic patients in Nauru. The data were divided by 15 different Districts. The data from diabetic population were also separated by two cohorts (2011–2012 and 2014–2015) and analyzed for their difference of the HbA1C levels. HbA1C levels will

be averaged if they were performed >1 time. Patients were classified as regular outpatient visits if they were diagnosed as DM before 2012 and had HbA1C data during two cohort period and outpatient visit to clinic at least twice among each year. HbA1C levels in 2013 will be obtained and considered as previously diagnosed DM patients and compared to newly diagnosed DM patients in two cohort population. The change of HbA1C levels was also evaluated among different districts during these two cohort population. The HbA1C were performed by DCA Vantage Analyzer (Siemens, Unites States). The study was a collaborative initiative between the Nauru Ministry of Health, and Taiwan Ministry of Foreign Affairs, and Tri-Service General Hospital, Taiwan. Ethics approval was granted by the Institutional Review Board of Nauru Noncommunicable Disease Steering Committee and Nauru Ministry of Health.

Statistical analysis

Descriptive results of continuous variables will be expressed as means $\pm$ standard deviation. We use unpaired *t*-test for comparisons of quantitative variables. A two-tailed $P < 0.05$ was considered statistically significant. The statistical analyses will be performed using the program SPSS (Chicago, Illinois, USA; version 18.0).

RESULTS

There was a total of 755 cases from the DM registry database. After excluding cases with missing demographic characteristics and concern about definitive diagnosis of DM, a total of 614 patients with female predominance (57%) were enrolled for the analysis with mean age of 49.8 years old and diabetic duration of 10.1 years [Table 1]. The female population had long duration of DM than male population (11.2 ± 9.9 and 8.7 ± 7.6 years, respectively, $P < 0.001$). The age of onset of DM is 40.4 years old. The overall HbA1C levels are slightly greater in 2014–2015 (614 participants) than 2011–2012 (566 participants) without statistical significance ($10.9\% \pm 2.7\%$ and $10.6\% \pm 2.2\%$, respectively) [Table 1]. The HbA1C of newly diagnosed DM is significant higher in 2014–2015 (44 participants) than that in 2011–2012 (65 participants) ($11.5\% \pm 2.4\%$ and $10.6\% \pm 2.1\%$, respectively, $P = 0.039$), but not different from HbA1C levels on 2013 in previously diagnosed DM ($10.9\% \pm 2.3\%$) [Figure 1]. The HbA1C level between newly diagnosed DM patients among 2011–2012 cohort and ongoing therapy in 2013 during follow-up was not different (data were not shown). The HbA1C levels also do not differ among DM patients with regular outpatient visits (112 participants) between 2011–2012 and 2014–2015 cohort

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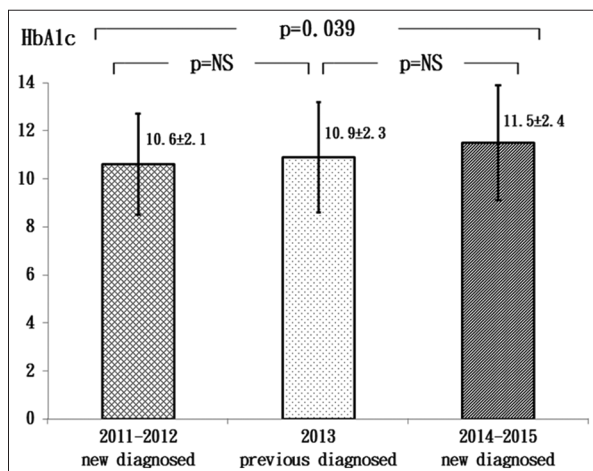


Figure 1: The hemoglobin A1C of previously diagnosed diabetes in 2013 and newly diagnosed diabetes in 2011–2012 and 2014–2015 cohort

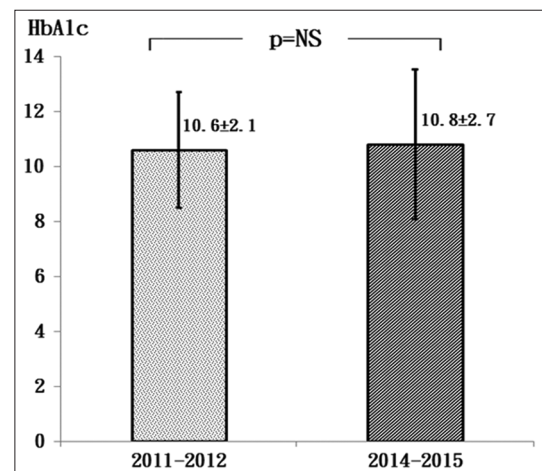


Figure 2: The change of hemoglobin A1C among patients with diabetes with regular outpatient visits

Table 1: The characteristics and glycemic control of the study population in 2014–2015

Group	All (614)	Male (264)	Female (350)	P*
Age (years)	49.8±12.3	48.3±12.4	50.9±12.1	0.734
DM duration	10.1±9.1	8.7±7.6	11.2±9.9	<0.001*
Age of DM diagnosis	40.4±11.8	40.2±11.5	40.6±12.1	0.316
HbA1C (2011–2012)	10.6±2.2	10.7±2.3	10.6±2.1	0.218
HbA1C (2014–2015)	10.9±2.7	10.8±2.7	11.0±2.6	0.285

*A two-tailed $P < 0.05$ was considered statistically significant. P value indicated difference between male and female population. DM=Diabetes mellitus; HbA1C=Hemoglobin A1C

[Figure 2]. Furthermore, there are differences of diabetic profiles and HbA1C change among different districts. Except for districts of Anetan, and Anibare, where HbA1C increased from 2011–2012 to 2014–2015, the HbA1C levels do not change significantly in the rest of the districts [Table 2]. The other diabetic profiles were similar among districts.

DISCUSSION

This study is first one to explore the diabetic control among overall and newly diagnosed DM patients from different districts in Nauru. The results show that diabetic control seems to be poor both in subjects of newly diagnosed and previously known DM in Nauru. This message is very important for Nauru government to take action early to prevent further development of chronic complications because most of the burden or mortality of this country comes from DM and its related complications.

The overall diabetic control seems to be poor across the following up period both in newly and previously diagnosed subjects of DM. Although nonsignificantly different, there is

a trend to show deteriorated glycemic control from 2011 to 2015 (from 10.6 ± 2.2 , 10.9 ± 2.3 , to 10.9 ± 2.7). Besides, the glycemic control also did not improve for those who with regular outpatient visit. It suggested that the current strategy in the diabetic management does not work in the past few years. This situation was similar to the previous finding.¹⁰ There are several possibilities to explain why the strategy does not improve glycemic control. The first one should be the limited medical resources, which only older anti-diabetic medications are available, including only biguanides and sulfonylureas for oral and human regular insulin and neutral protamine Hagedorn for injection. Furthermore, many patients received insulin therapy do not have good compliance for injection due to their ability to learn this technique or lack of strips to perform self-monitor of blood glucose. Second, high proportional percentage of patients just refills medications from the nurse instead of visiting physician when they run out of the medications. Therefore, they did not adjust the medications or dose for improvement their diabetic control. Finally, the unhealthy lifestyle pattern also plays an important role to this unsuccessful treatment. Most of the people, including diabetics only unhealthy lifestyle habit, including low level of physical activity, habit of smoking and alcohol drinking, and eat less vegetables and fruits.^{4,11} About 96.9% of the population consumed fewer than five combined servings of fruit and/or vegetables per day according to the report of WHO STEPS in 2004.⁴ Furthermore, they consume sugar-sweetened beverage a lot, just like other Pacific Islands countries.¹² Our results are different from recent report, which demonstrated improved glycemic control (-0.9% of HbA1C level) during a 15-month interval follow-up. This discrepancy may attribute the difference of study design, numbers of population, and frequency of hospital visits.¹³

Table 2: Characteristics of diabetic patients and their change of A1C among patients from different districts

District	Age	DM duration	Diagnosis age	2011-2012 A1C	2014-2015 A1C
All	49.8±12.3	10.1±9.1	40.4±11.8	10.5±2.2	10.9±2.7
Aiwo	49.3±11.9	10.3±10.9	39.0±11.8	11.1±2.2	11.2±2.9
Anabar	48.0±13.4	10.4±12.0	37.9±12.3	10.3±2.1	11.2±2.7
Anetan	51.7±14.8	10.6±2.1	42.3±13.9	9.6±2.6	12.4±1.6*
Anibare	47.3±10.6	7.9±8.2	39.7±11.4	9.8±2.3	12.3±3.2*
Baitsi	54.2±10.8	10.1±8.4	42.7±10.3	11.6±2.8	10.6±2.8
Boe	53.8±12.9	13.6±10.7	41.5±11.6	10.1±2.1	10.1±2.5
Buada	45.7±10.2	8.5±7.3	37.9±9.1	10.4±2.1	10.2±2.4
Denig	50.5±13.5	9.9±8.5	41.9±13.8	10.7±2.0	10.1±3.3
Ewa	51.7±16.6	13.6±9.4	38.9±13.6	11.6±2.7	11.0±2.4
Ijuw	50.3±7.9	12.5±10.3	38.0±6.1	10.6±2.1	11.3±2.8
Location	49.1±11.9	7.1±5.2	42.7±12.2	10.8±2.4	10.7±2.8
Meneng	50.9±11.0	9.7±8.6	42.2±11.6	10.6±1.6	10.7±2.6
Nibok	51.4±11.3	11.56±9.4	41.1±12.8	10.5±2.1	10.8±2.5
Uaboe	43.8±13.5	9.3±8.4	35.5±12.9	11.7±2.1	11.3±3.1
Yaren	48.3±11.8	10.6±10.3	39.1±10.6	10.7±2.4	11.4±2.5

* The HbA1c increased from 2011-2012 to 2014-2015 significantly in districts of Anetan and Anibare.

We want to explore if there is difference of glycemic control among different characteristics of patients. We found the glycemic control deteriorate when time goes by in patients from the district of Anetan and Anibare. More interestingly, diabetic patients from Anibare district have higher HbA1C levels with a relatively short duration of DM than other districts. It is hard to explore this observation because other demographic characteristics were not available, but it needs to look at the problem why these patients do not control their DM well. We also found the older age the patients they are, the better glycemic control they have (data were not shown). This association was observed both in 2011–2012 and 2014–2015, but more close in 2014–2015. This should be considered a warning sign to young population with DM and advised to control their blood glucose as early as possible to avoid future complications. Because of the major reasons leading to the chronic complications in Pacific Islands countries included delaying treatment and use of traditional treatments, which conditions were common in Nauru.¹⁴

One interesting finding of the current study demonstrated that the HbA1C levels were higher in 2014–2015 than that in 2011–2012 among newly diagnosed DM. It means the diagnosis of DM has been delayed or the poor awareness of the DM. The main possibility for this delay of DM diagnosis may contribute to the method of DM diagnosis. Most of the patients were diagnosed of DM through randomized blood sugar concentrations (blood

sugar levels, either fasting, or postprandial). These patients often come to the clinic with typical symptoms of DM and presented with very high blood glucose concentrations. It was reported that random plasma glucose levels may underestimate the true prevalence of diabetes¹⁵ and a single FPG level is limited to detect less diabetic subjects as comparing to other diagnostic criteria.¹⁶ Second, lack of awareness of symptoms or signs of the DM may also another possibility for the delay diagnosis of DM. It is noticed that there are no physicians from their own country and most of the foreign doctors also rotated with various interval, which maybe a barrier for success of the policy. Furthermore, there is no large national wide survey for noncommunicable diseases in Nauru since STEPS performed by the WHO in 2004.⁴ It may need to modify the policy of public health promotion plan although some strategy (such as outreach clinic) had proposed to identify more patients with unknown DM. Finally, not every physician follows-up the guideline to manage patients with DM. Some diabetic patients with mild elevated HbA1C levels (around 7%–8%) just received on diet control and lost outpatient follow-up later and returned to the clinic with very high HbA1C levels eventually. The life span of patients with DM was about 10 years shorter than those who without DM.^{17,18} The average of life expectancy in Nauru was 56.8 years for male and 62.8 years for female population according to the government's report. Because the age of diabetic onset is young (40 years) in Nauru, and a latest study demonstrated most of the patients needed hemodialysis (HD) had DM (70%) and the 5-year survival probabilities after HD was 25.9%.¹⁹ It means that we should treat these diabetic patients more aggressively to lead them to a better life.

The major strength of the current study is to explore the latest glycemic control among a high diabetic prevalence country, where had never evaluated previously. There are still several limitations about this study. The first, only a half of the estimated DM patients were analyzed, which made the interpretation with caution. Second, we use the average HbA1C levels for evaluation of glycemic control, but the HbA1C levels may fluctuation during outpatient visits. We cannot approach the detail information precipitating to the HbA1C change. Furthermore, someone may concern about the method to measure HbA1C levels is not the standardized one, but this method had been proved to support the use of the DCA HbA1c test as a reliable aid in the diagnosis of DM.²⁰ Third, the relatively small numbers of the patients with regular outpatient follow-up (112 subjects) although the trend is similar to the overall population. Finally, the data of demographic characteristics were not completely available, such as their initial and current weight, and treatment regimen so we do not know if there was different treatment response between different subgroups.

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CONCLUSION

Nauru has a high prevalence rate with early onset and inadequately controlled diabetes. It needs to propose strategy to early detect and improve glycemic control early to prevent future diabetic complications. In brief, the overall glycemic control and treatment strategy needs to take action to develop strategy to improve diabetes care and health outcomes for this risk population.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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