Comparing metabolic control and complications in type 2 diabetes in two Pacific Islands at baseline and following diabetes care intervention

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ABSTRACT

Aim: To compare metabolic control and complications in people with type 2 diabetes in Nauru and the Solomon Islands before and after a project intervention.

Methods: This follow-up study compared metabolic control and complications in a cohort of 216 people with diabetes (81 from Nauru and 135 from the Solomon Islands) at baseline and 15 months following a project intervention (upgrading and equipping the existing diabetes centres, and providing training and clinical support systems) aimed at improving the quality of clinical diabetes care. Subjects were screened using a standardised protocol which gathered information on demographics, treatment, physical and biochemical parameters and their outcomes.

Results: At follow-up, glycaemic control had improved and mean HbA1c had decreased in study participants in both Nauru (mean difference (MD) = −0.9 ± 2.3%) and the Solomon Islands (MD = −0.6 ± 1.4%), P < 0.001. Mean blood pressure was reduced in the Solomon Islands (systolic MD = −11.6 ± 19.2 mmHg and diastolic MD = −5.4 ± 10.5 mmHg), P < 0.001. There were no significant changes in mean blood lipids (S.T. Win Tin). At follow-up, glycaemic control had improved and mean HbA1c had decreased in study participants in both Nauru (mean difference (MD) = −0.9 ± 2.3%) and the Solomon Islands (MD = −0.6 ± 1.4%), P < 0.001. Mean blood pressure was reduced in the Solomon Islands (systolic MD = −11.6 ± 19.2 mmHg and diastolic MD = −5.4 ± 10.5 mmHg), P < 0.001. There were no significant changes in mean blood lipids or albumin–creatinine ratio. Overall the percentage of subjects achieving recommended clinical targets increased. However these percentages remained low, e.g. 23.5% of participants in Nauru and 20.7% in the Solomon Islands achieved an HbA1c target <7% (53 mmol/mol). A trend towards lower complications rates of foot problems was observed but there were no significant changes in the prevalence of other diabetes complications.

Conclusions: This study indicates improved metabolic control but little change in diabetes complications 15 months after intervention. Efforts to improve and evaluate the ongoing quality and accessibility of diabetes care in Pacific Island settings need to be further strengthened.

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Introduction

Diabetes is a major health problem and a global threat to human and economic development, striking hardest at the world’s low and middle income countries [1,2]. This is particularly apparent in Pacific Island countries (PICs) which account for seven of the top ten countries with the highest diabetes prevalence worldwide [3,4].

Diabetes complications rates in PICs are high. For example, the prevalence of diabetic retinopathy is reportedly over 50% in Nauru and Fiji [5,6]; microalbuminuria was over 40% in Nauru, Vanuatu and Papua New Guinea [5,7]; and diabetes related amputations were approximately 11% in the Solomon Islands, Nauru and Vanuatu [5]. The prevalence of risk factors for developing diabetes complications was also substantial. For example, over half of the adult population in most PICs were physically inactive; over 70% were overweight and/or obese in countries such as American Samoa, Samoa, Tokelau and Nauru; and more than 80% consumed too few fruits and vegetables in Cook Islands, Kiribati, Nauru and Tokelau [8]. Studies in the Solomon Islands, Nauru, Vanuatu and Papua New Guinea also reported poor clinical outcomes in people with diabetes with over 60% [5,9] not meeting glycaemic control targets thus exacerbating existing diabetes complications.

Much of the human and social impact caused by diabetes could be averted through cost effective interventions [10,11] and certain clinical processes and practices can delay the onset of diabetes and its complications [12–15]. Despite this, there remain major...
deficiencies in access to essential treatments, technologies, and recommended standards of care for people with diabetes in most if not all PICs [9,16,17]. In addition, there are serious knowledge and evidence gaps which hamper progress. For example, a recent review of the status of the epidemiological, health, social, and economic impact of diabetes in PICs [18] found deficiencies in the quantity, quality and currency of the evidence about diabetes care and outcomes in PICs. Several of the 35 studies reviewed were published 20 or more years ago. In the available studies, sample sizes and characteristics (e.g., age range) varied considerably as did the diagnostic tools and criteria used, thus making comparisons virtually impossible. Only one costing study was available and no pre-post evaluations of interventions were reported.

In order to improve the quality of diabetes care and contribute to the pool of knowledge about the effectiveness, or otherwise, of intervention in PICs, we undertook a diabetes capacity building project in Nauru and the Solomon Islands in partnership with the respective Ministries of Health. The aim of the overarching project was to design and implement a locally relevant and sustainable model to increase the capacity of Nauru and the Solomon Islands to manage, monitor and improve diabetes care and reduce diabetes complications.

The methodology for the overarching project has previously been described for an identical project in Vanuatu [19]. The quality of care component of the project was predicated on:

1. Upgrading diabetes care facilities through the introduction of:
   - DCA analysers to enable measurement of HbA1c and microalbuminuria, LDX analysers to enable measurement of lipids, and basic equipment for assessing blood pressure, capillary blood glucose, peripheral neuropathy, etc
   - Computers and electronic patient records to enable standardised data collection of metabolic control and complications

2. Introducing agreed diagnostic criteria, clinical targets and protocols [19], and referral criteria for assessing and managing metabolic control and complications.

3. Upskilling local staff and strengthening interaction between hospital and community health care workers through:
   - in-Australian training for key PICs personnel on all aspects of the project
   - in-country training for local diabetes teams by visiting specialist diabetes teams from Australia
   - a national diabetes care training program for primary health care workers
   - the introduction of staff competencies for diabetes care

This current study was one of a number of evaluations undertaken to assess the impact of the overarching project. It was conducted under a Memorandum of Understanding between the researchers and Ministries of Health and Medical Services in Nauru and the Solomon Islands with the approval of the Human Research Ethics Committee, the University of Sydney and Research Ethics Committees of the Nauru and Solomon Islands.

Aim

The aim of this study was to compare metabolic control and complications in a cohort of people with type 2 diabetes in Nauru and the Solomon Islands at baseline and 15 months following intervention.

Subjects, materials and methods

Metabolic control and diabetes complications were assessed at baseline and 15 months following intervention in a cohort of 216 people with type 2 diabetes (81 from Nauru and 135 from the Solomon Islands).

Subjects

At baseline, a convenience sample of 260 subjects (100 from Nauru and 160 from the Solomon Islands) attending the diabetes clinics in each country during a one week period, which coincided with a visit by an Australian diabetes team, were screened for metabolic control and diabetes complications and the results have been reported elsewhere [5]. At 15 months following intervention, a cohort of 216 subjects (81 from Nauru and 135 from the Solomon Islands) returned for reassessment. Overall follow-up rate was 83% (81% from Nauru and 84% from the Solomon Islands).

The intervention

The key component of the project intervention relevant to this study centred on upgrading and equipping the existing Diabetes Centres in both countries, and providing training and clinical support systems to assist the local diabetes care teams to better assess and manage metabolic control and diabetes complications. At baseline, clinical management guidelines and protocols (including agreed clinical targets) were introduced. These, including education materials, were based on internationally recognised evidence-based guidelines and adapted specifically to each local setting for literacy and cultural appropriateness in collaboration with the local diabetes teams and Ministries of Health. An electronic patient record and information system previously adapted for use in the Pacific, along with appropriate computer hardware and software to support it, was introduced in both countries. The local diabetes staff of doctors and nurses were trained on the above, initially by two of the project leaders and visiting diabetologist according to a pre-developed training package. The package included limited patient education training but a strong focus on foot care and training in the use of new equipment, reagents and supplies for physical and biochemical assessment of metabolic control and complications as described below under Diagnostic methods, criteria and targets.

Subjects were screened and assessed at the diabetes centre of the national referral hospitals in each country by an Australian diabetes team assisted by the local diabetes team using a standardised protocol which gathered information on demographics, treatment, physical and biochemical parameters and outcomes.

Diagnostic methods, criteria and targets

The following diagnostic methods and criteria were used.

i) Height and weight were measured and body mass index (BMI) was calculated. Overweight was defined as a BMI ≥25 and obese as a BMI ≥30.

ii) Resting blood pressure was measured three times using the Omron digital automatic blood pressure monitor and mean blood pressure was used in the analysis. Hypertension was defined as a systolic blood pressure of ≥140 mmHg and/or diastolic blood pressure of ≥90 mmHg or taking anti-hypertensive medications.

iii) Visual acuity was checked and fundus examination through dilated pupils was performed by an experienced optometrist.

iv) Foot sensation was assessed by trained nurses using a 10 g monofilament. Neuropathy (abnormal foot sensation) was defined as a loss of the ability to detect this pressure at one or more anatomic sites on the plantar surface of the foot.
DCA analyser was used to measure HbA1c and urinary albumin/creatinine ratio (ACR). Microalbuminuria was defined as an ACR > 2.5 mg/mmol for men or > 3.5 mg/mmol for women.

Cholestech LDX analyser was used to measure blood lipids (total cholesterol, HDL cholesterol, LDL cholesterol and triglycerides).

The following clinical targets were used.

- HbA1c < 7.0% (53 mmol/mol)
- Blood pressure < 130/85 mmHg
- Total cholesterol < 5.0 mmol/L
- HDL cholesterol > 1.0 mmol/L
- LDL cholesterol < 2.5 mmol/L
- Triglycerides < 2.0 mmol/L

Data analysis

The data were analysed using IBM SPSS statistical package version 21. Data are reported as mean ± standard deviation (SD) and percentage (%). Continuous variables were compared using paired sample T test or Wilcoxon signed rank test, and categorical variables were compared using McNemar test. Statistical significance was defined as P < 0.05.

Results

Two hundred and sixteen subjects were assessed at 15 month follow-up. They were 81 subjects from Nauru (female 62%, mean age 54 years and mean duration of diabetes 14 years) and 135 from the Solomon Islands (female 44%, mean age 55 years and mean duration of diabetes 10 years).

Of the original cohort of 260 subjects assessed at baseline, 44 (17%) did not attend the follow-up assessment. Eleven (4%) subjects [8 (8%) from Nauru and 3 (2%) from the Solomon Islands] were deceased and the remaining 33 (13%) subjects [11 (11%) from Nauru and 22 (14%) from the Solomon Islands] were travelling overseas at the time of assessment or had moved away.

The average hospital visits was 19 visits/person in Nauru and 17 visits/person in the Solomon Islands during 15 month intervention period.

Nauru

Table 1 compares the treatment, risk factors for complications and complications of diabetes of the 81 subjects from Nauru. With regard to medications, insulin (8.6% vs. 17.3%), oral anti-diabetic (51.9% vs. 70.4%) and anti-hypertensive (38.3% vs. 45.7%) use increased significantly (P < 0.001).

Data are shown as mean ± SD or N (%). P values are derived from Paired Sample T test.

| Table 1 | Treatment, risk factors for complications and complications of diabetes in Nauru (baseline vs. follow up) |
|---------|---------------------------------------------------------------|
|          | Baseline (n = 81)                                            | Follow up (n = 81) | Mean difference | P value |
| Diabetes treatment |                                                |                    |                 |         |
| Diet alone          | 32 (39.5%)          | 10 (12.3%)          |                   | <0.001 2 |
| Oral anti-diabetic agents | 42 (51.9%)          | 57 (70.4%)          |                   |         |
| Insulin             | 7 (8.6%)            | 14 (17.3%)          |                   |         |
| BMI (kg/m^2)        | 31.6 ± 5.8          | 30.7 ± 5.3          | -0.9 ± 1.8       | <0.001  |
| Normal weight       | 6 (7.4%)            | 13 (16.0%)          |                   |         |
| Overweight          | 29 (35.8%)          | 27 (33.3%)          |                   |         |
| Obese               | 46 (56.8%)          | 41 (50.6%)          |                   |         |
| Systolic blood pressure (mmHg) | 127.1 ± 19.6       | 127.4 ± 20.9       | 0.3 ± 20.6       | 0.910   |
| Diastolic blood pressure (mmHg) | 73.8 ± 10.6        | 73.4 ± 11.7        | -0.4 ± 11.6      | 0.774   |
| Hypertension        | 34 (42.0%)          | 37 (45.7%)          |                   | 0.031   |
| Hypertension treatment | 31 (38.3%)          | 37 (45.7%)          |                   |         |
| Blood pressure <130/85 mmHg | 44 (54.3%)        | 48 (59.3%)          | 0.4 ± 25.2       | 0.685 1 |
| HbA1c (%)           | 9.8 ± 2.8           | 8.9 ± 1.9           | -0.9 ± 2.3       | 0.001   |
| HbA1c (mmol/mol)    | 84                  | 74                  |                   |         |
| Glycaemic control   |                                                |                    |                 | <0.012  |
| HbA1c < 7.0 (<53 mmol/mol) | 17 (21.0%)      | 19 (23.5%)          |                   |         |
| HbA1c 7–7.9 (53–63 mmol/mol) | 11 (13.6%)      | 11 (13.6%)          |                   |         |
| HbA1c 8–8.9 (64–74 mmol/mol) | 6 (7.4%)       | 22 (27.2%)          |                   |         |
| HbA1c 9–9.9 (75–85 mmol/mol) | 10 (12.3%)     | 15 (18.5%)          |                   |         |
| HbA1c ≥ 10 (>86 mmol/mol) | 37 (45.3%)     | 14 (17.3%)          |                   |         |
| ACR (mg/mmol)       | 213 ± 32.2          | 241 ± 32.7          | 0.8 ± 25.2       | 0.685 1 |
| Microalbuminuria    | 55 (67.9%)          | 58 (71.6%)          |                   | 0.250   |
| Total cholesterol (mmol/L) | 5.2 ± 1.1        | 4.9 ± 1.3           | -0.2 ± 1.3       | 0.118   |
| Total cholesterol <5.0 mmol/L | 37 (45.7%)   | 40 (49.4%)          |                   | 0.690 2 |
| HDL cholesterol (mmol/L) | 0.8 ± 0.3      | 0.9 ± 0.3           | 0.04 ± 0.3       | 0.174   |
| HDL >1.0 mmol/L     | 26 (32.1%)          | 28 (34.6%)          |                   | 0.791   |
| LDL cholesterol (mmol/L) | 3.4 ± 0.9      | 3.3 ± 1.1           | -0.1 ± 0.9       | 0.210   |
| LDL <2.5 mmol/L     | 10 (12.3%)          | 14 (17.3%)          |                   | 0.424   |
| Triglycerides (mmol/L) | 2.1 ± 1.1        | 2.1 ± 1.1           | -0.04 ± 1.3      | 0.805   |
| Triglycerides <2.0 mmol/L | 41 (50.6%)    | 45 (55.6%)          |                   | 0.541   |
| Diabetic retinopathy | 54 (66.7%)          | 56 (69.1%)          |                   | 0.500   |
| Abnormal foot sensation | 22 (27.2%)     | 18 (22.2%)          |                   | 0.344   |
| Abnormal digital foot pulse | 19 (23.5%) | 14 (17.3%)          |                   | 0.227   |
| Foot ulcer          | 7 (8.6%)            | 4 (4.9%)            |                   | 0.453   |
| Amputation          | 8 (9.9%)            | 9 (11.1%)           |                   | >0.999  |
Mean BMI decreased from 31.6 ± 5.8 kg/m² to 30.7 ± 5.3 kg/m² (mean difference (MD) = −0.9 ± 1.8 kg/m², P < 0.001) and mean HbA1c decreased from 9.8 ± 2.8% (84 mmol/mol) to 8.9 ± 1.9% (74 mmol/mol) (MD = −0.9 ± 2.3%, P = 0.001). There were no significant changes in mean blood lipids, blood pressure and ACR. The percentages of subjects who were overweight (35.8% vs. 33.3%) and obese (56.8% vs. 50.6%) decreased, and the percentage of subjects with normal weight increased (7.4% vs. 16.0%), P = 0.021. The percentage of subjects with HbA1c ≥ 10% (86 mmol/mol) decreased from 45.7% to 17.3%, and 23.5% (21% at baseline) achieved blood glucose target. There were no significant changes in the percentages of subjects achieving blood pressure and blood lipid targets.

The prevalence of abnormal foot sensation, abnormal digital foot pulse and foot ulcer reduced whereas the prevalence of retinopathy and amputation increased slightly. However these changes were not statistically significant. New cases of abnormal foot sensation (three subjects), abnormal digital foot pulse (three subjects), foot ulcer (two subjects), retinopathy (two subjects) and amputation (one subject) were identified at follow-up.

The Solomon Islands

Table 2 compares the treatment, risk factors for complications and complications of diabetes of the 135 subjects from the Solomon Islands. With regard to medications, insulin (4.4% vs. 10.4%), oral anti-diabetic (81.5% vs. 84.4%) and anti-hypertensive (34.1% vs. 55.6%) use increased significantly (P < 0.001).

Mean BMI decreased from 28.7 ± 4.7 kg/m² to 28.1 ± 4.1 kg/m² (MD = −0.7 ± 1.4 kg/m², P < 0.001), mean systolic blood pressure decreased from 140.6 ± 23.5 mmHg to 128.9 ± 10.6 mmHg (MD = −11.6 ± 19.2 mmHg, P < 0.001), mean diastolic blood pressure decreased from 80.9 ± 11.9 mmHg to 75.4 ± 7.7 mmHg (MD = −5.4 ± 10.5 mmHg, P < 0.001) and mean HbA1c decreased from 9.5 ± 2.4% (80 mmol/mol) to 8.8 ± 1.9% (73 mmol/mol) (MD = −0.6 ± 1.4%, P < 0.001). There were no significant changes in mean blood lipids and ACR.

The percentage of subjects achieving blood pressure target increased (33.3% vs. 45.9%, P < 0.001). The percentage of subjects with HbA1c ≥ 10% (86 mmol/mol) decreased from 38.5% to 20.7%, and 20.7% (16.3% at baseline) achieved blood glucose target, P < 0.001. The percentage of subjects achieving blood lipid targets increased slightly but not statistically significant.

The prevalence of abnormal foot sensation, abnormal digital foot pulse and foot ulcer reduced whereas the prevalence of retinopathy increased slightly. New cases of abnormal foot sensation (three subjects), abnormal digital foot pulse (five subjects), foot ulcer (three subjects) and retinopathy (two subjects) were identified at follow-up.

Table 2

|                     | Baseline (n = 135) | Follow up (n = 135) | Mean difference | P value |
|---------------------|-------------------|---------------------|-----------------|---------|
| Diabetes treatment  |                   |                     |                 |         |
| Diet alone          | 19 (14.1%)        | 7 (5.2%)            |                 | <0.001  |
| Oral anti-diabetic agents | 110 (81.5%) | 114 (84.4%)        |                 |         |
| Insulin             | 6 (4.4%)          | 10 (7.4%)           |                  |         |
| BMI (kg/m²)         | 28.7 ± 4.7        | 28.1 ± 4.1          | −0.7 ± 1.4      | <0.001  |
| Normal weight       | 28 (20.7%)        | 31 (23.0%)          |                 | 0.270   |
| Overweight          | 63 (46.7%)        | 63 (46.7%)          |                 |         |
| Obese               | 44 (32.6%)        | 41 (30.4%)          |                 |         |
| Systolic blood pressure (mmHg) | 140.6 ± 23.5 | 128.9 ± 10.6       | −11.6 ± 19.2    | <0.001  |
| Diastolic blood pressure (mmHg) | 80.9 ± 11.9 | 75.4 ± 7.7         | −5.4 ± 10.5     | <0.001  |
| Hypertension        | 74 (54.8%)        | 75 (55.6%)          |                 | <0.001  |
| Hypertension treatment | 46 (34.1%)    | 46 (34.1%)          |                 |         |
| Blood pressure <130/85 mmHg | 45 (33.3%) | 62 (45.9%)         |                 | 0.009   |
| HbA1c (%)           | 9.5 ± 2.4         | 8.8 ± 1.9           | −0.6 ± 1.4      | <0.001  |
| HbA1c (mmol/mol)    | 79                | 73                  |                 | <0.001  |
| Glycemic Control    |                   |                     |                 |         |
| HbA1c <7.0 (<53 mmol/mol) | 22 (16.3%)  | 28 (20.7%)          |                 |         |
| HbA1c 7–7.9 (53–63 mmol/mol) | 17 (12.6%) | 32 (23.7%)          |                 |         |
| HbA1c 8–8.9 (64–74 mmol/mol) | 28 (20.7%) | 22 (16.3%)          |                 |         |
| HbA1c 9–9.9 (75–85 mmol/mol) | 16 (11.9%) | 25 (18.5%)          |                 |         |
| HbA1c ≥ 10 (>86 mmol/mol) | 52 (38.5%) | 28 (20.7%)          |                 |         |
| ACR (mg/mmol)       | 76 ± 8.4          | 8.0 ± 10.4          | 0.4 ± 5.6       | 0.498   |
| Microalbuminuria    | 47 (34.8%)        | 50 (37.0%)          |                 | 0.250   |
| Total cholesterol (mmol/L) | 4.9 ± 1.3     | 4.9 ± 1.1           | −0.1 ± 0.5      | 0.185   |
| Total cholesterol <5.0 mmol/L | 72 (53.3%) | 80 (59.3%)          |                 | 0.096   |
| HDL cholesterol (mmol/L) | 0.9 ± 0.3     | 0.9 ± 0.3           | 0.02 ± 0.2      | 0.241   |
| LDL cholesterol (mmol/L) | 3.2 ± 0.9      | 3.1 ± 0.9           | −0.06 ± 0.5     | 0.154   |
| LDL <2.5 mmol/L     | 32 (23.7%)        | 40 (29.6%)          |                 | 0.057   |
| Triglycerides (mmol/L) | 2.1 ± 1.1      | 1.9 ± 0.9           | −0.1 ± 0.6      | 0.091   |
| Triglycerides <2.0 mmol/L | 65 (48.1%) | 73 (54.1%)          |                 | 0.057   |
| Diabetic retinopathy | 53 (39.3%)       | 55 (40.7%)          |                 | 0.500   |
| Abnormal foot sensation | 32 (23.7%) | 23 (17.0%)          |                 | 0.035   |
| Abnormal digital foot pulse | 25 (18.5%) | 20 (14.8%)          |                 | 0.302   |
| Foot ulcer           | 10 (7.4%)         | 6 (4.4%)            |                 | 0.344   |
| Amputation           | 14 (10.4%)        | 14 (10.4%)          |                 | >0.999  |

Data are shown as mean ± SD or percentage. P values are derived from Paired Sample T test.

1. P value is derived from Wilcoxon Signed Rank test.
2. P values are derived from McNemar test.
Discussion

This study indicates that the intervention to improve the quality of clinical diabetes care in Nauru and the Solomon Islands resulted in improved metabolic control in participating subjects. We found no previous studies reported on pre–post evaluations of diabetes care interventions in PICs to compare with our study. However, our findings are consistent with evidence from studies conducted in Australia, Africa and America which showed that strengthening the quality of diabetes care improved metabolic control and clinical outcomes [12,15,20]. Studies in western countries such as UK and Denmark have also shown that intensive metabolic control reduced the risk of diabetes complications [13,14,21]; therefore, improvement of metabolic control found in our study will likely contribute to the reduction of diabetes complications in Nauru and the Solomon Islands in the long term.

The prevalence of diabetes complications found in this study (at both baseline and follow-up) was high. For example, the prevalence of microalbuminuria was 67.9% at baseline and 71.6% at follow-up in Nauru, and 34.8% at baseline and 37.0% at follow-up in the Solomon Islands which overall was higher than in previous studies in Samoa (23.4%) [22] and in Pacific Islanders in South Auckland [23]. The prevalence of diabetic retinopathy was also high. The highest rates were found in Nauru (66.7% at baseline and 69.1% at follow-up) which are higher than previously reported in Samoa (43.2%) [22] and Fiji (52.6%) [6].

After the intervention, mean HbA1c reduced and glycaemic control improved significantly in both Nauru and the Solomon Islands. A significant increase in the use of insulin and oral anti-diabetic medications as well as a regular hospital follow-up visit (approximately monthly visit) for treatment review and response to treatment could explain the improvement in glycaemic control. Reduced mean BMI, an indicator of positive lifestyle changes, found in the cohort at follow-up may have been a contributing factor to the improvement in glycaemic control. During the project period, the Ministries of Health led several programs to intensify lifestyle interventions including promoting physical activity and healthy diet, tobacco control and diabetes self-care management in their respective countries, and support provided by this diabetes project would contribute to improve metabolic control among cohort subjects. However, overall the percentage of subjects achieving blood glucose targets remained low in both countries (21.0% at baseline and 23.5% at follow-up in Nauru; 16.3% at baseline and 20.7% at follow-up in the Solomon Islands). This highlights that diabetes care needs to be further strengthened to achieve optimal glycaemic control to prevent complications.

Another key finding was that mean blood pressure was reduced significantly and the percentage of subjects achieving the recommended blood pressure targets increased significantly in the Solomon Islands. A significant increase in the use of anti-hypertensive treatment in the Solomon Islands could explain the improvement in blood pressure control. Although mean blood pressure and subjects achieving the blood pressure targets did not improve significantly in Nauru, mean blood pressure remained lower (127/74 mmHg at baseline and 127/73 mmHg at follow-up) and the percentage of subjects achieving blood pressure targets remained higher (54.3% at baseline and 59.3% at follow-up) than those of the Solomon Islands (mean blood pressure 141/81 mmHg at baseline and 129/75 mmHg at follow up; subject achieving blood pressure target 33.3% at baseline and 45.9% at follow-up). Despite these improvements, only 59.3% in Nauru and 45.9% in the Solomon Islands achieved recommended blood pressure target at follow-up. This suggests that intensive blood pressure control needs to be further strengthened.

There is evidence that reduction in serum cholesterol level using lipid lowering medications increases life expectancy and is cost-effective [24]. In contrast to our favourable findings for glycaemic and blood pressure control, blood lipid control was not improved at follow-up and a considerable proportion of subjects (approximately 50%) did not achieve blood lipid targets. The lack of lipid lowering medications combined with the increasing availability of high fat, calorie dense foods in both Nauru and the Solomon Islands may explain this effect. While programs to intensify lifestyle interventions and policies to improve the availability of healthy non-energy dense foods need to be actively pursued, it is imperative that the governments of Nauru and the Solomon Islands make appropriate lipid lowering agents available for the treatment of people with diabetes.

Given the short (15month) timeframe between the collection of baseline and follow-up data in this study, it is not surprising that, aside from foot problems, there was no improvement in overall diabetes complications. However, nor did they worsen and there were no significant changes in the prevalence of diabetes complications. Although the prevalence of diabetes foot complications was not significantly reduced, a trend towards lower complications rates of foot problems was observed. For example, the prevalence of foot ulcer in Nauru was 8.6% at baseline and 4.9% at follow-up, and in the Solomon Islands was 7.4% at baseline and 4.4% at follow-up. This represents a positive outcome of the foot care intervention that was implemented in both countries by taking into consideration the findings of key precipitating events and factors preceding diabetes related amputations reported for PICs [25]. Indeed, had there been no intervention, it is likely that diabetes related foot problems and other diabetes complication rates would have been higher over a 15 month period.

Nonetheless, our study had certain limitations. Due to local logistics and resource constraints, a control group was not used. Subject selection was not randomised. However, the subjects were recruited from among the local clinic populations which treat virtually all people with diabetes on both islands. Subjects could therefore be assumed to reasonably represent the diabetes population especially as there was nothing remarkable about the timing of the assessments. The study timeframe of 15 months was too short to detect tangible changes in longer-term complications. Nor did the study design allow determination of which aspects of the interventions were the most effective in achieving the positive outcomes, or any deficits in that may have accounted for lack of improvement. Future studies specifically designed to enable attribution of different components of quality of care interventions in the Pacific Island context would be useful in guiding future allocation of resources and training. In addition, the impact on staff morale empowered by this project by provision of training, new equipment, database, etc., should be assessed in future studies.

Despite these limitations, the follow-up rate was high (>80%) and, although there was no control group, the magnitude of the improvement in glycaemic and blood pressure control indicates important, tangible outcomes associated with the intervention. A further strength of the study was the use of standardised protocols, diagnostic methods and targets at both baseline and follow-up, making comparisons reliable and credible.

In conclusion, this study provides evidence to support appropriate interventions to improve metabolic control and reduce diabetes complications. Quality services delivered through our project resulted in positive clinical outcomes and could ultimately reduce diabetes complications in the long term – a result which is likely attributed to the quality of care. This diabetes care model and interventions in Nauru and the Solomon Islands could be transportable to other low and middle income countries including other PICs where diabetes is a major global threat to human and economic development. Despite some improvements obtained from this project, health
systems need to be further strengthened to provide quality diabetes services to larger populations in PICs and to sustain the project in the long term.

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Conflict of interest

The authors declare they have no conflicts of interest.

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