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ECONOMICS AND POLICY IN DIABETES (AA BAIG AND N LAITEERAPONG, SECTION EDITORS)

Diabetes Prevention and Care Programs in the US-Affiliated Pacific Islands: Challenges, Innovation, and Recommendations for Effective Scale-Up

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Abstract

Purpose of Review This review describes some of the unique challenges faced by the US-Affiliated Pacific Islands (USAPIs) in addressing diabetes prevention and care and presents innovative population-level strategies that have been employed to address them.

Recent Findings Challenges include an unhealthy food environment and a strained health care infrastructure, both compounded by geography. Innovations in addressing these challenges include attempts to modify the food environment, a focus on early life prevention, and task shifting among the health workforce. Many of the successful interventions share a focus on culture, community, and capacity building.

Summary Although the USAPIs are uniquely challenged by environmental, structural, and health system barriers, there have been a number of innovative and successful strategies employed that highlight the resilience of these island nations in addressing their current disease burden when provided with the opportunity and resources to do so. Health policies to protect, support, and promote diabetes prevention and care are essential and may be informed by the interventions described.

Keywords Diabetes · US-Affiliated Pacific Islands · Prevention · Treatment · Pacific Islander

Introduction

Many studies have shown that Native Hawaiian and Pacific Islanders (NHPIs) are disproportionately affected by diabetes compared to other racial/ethnic groups [1, 2•, 3]. In this issue, McElfish and colleagues report that within the 50 states of the USA, self-reported prevalence of diabetes among the growing NHPI population is estimated to be between 12.0 and 19.1% [3], which is significantly higher than the general US population prevalence of 8.5% despite concerns about significant under diagnosis in the NHPI group. The prevalence of diabetes in the Pacific Island

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nations, however, is considerably higher; the International Diabetes Federation estimates that the Western Pacific region is home to 37% of the total number of those living with diabetes globally [4] and prevalence is increasing more rapidly in this region than in any other [2•].

The USAPIs consist of over 2200 islands scattered across more than seven million square miles of Pacific Ocean. Six of the island jurisdictions that contribute to estimates of diabetes burden in the Western Pacific region are US affiliates: three (American Samoa [population: 55,641 (2017)], Guam [population: 164,229 (2017)], and the Commonwealth of the Northern Mariana Islands (CNMI; population: 55,144 (2017)) are US territories, while three (the Republic of Palau [population: 21,729 (2017)], the Federated States of Micronesia (FSM; population: 105,544 (2017)), and the Republic of the Marshall Islands (RMI; population: 53,127 (2017)) are sovereign nations who hold compacts of free association (COFA) with the USA (Fig. 1) [5]. While the USA supports many of the health care expenditures for COFA nations, the expenditures are lower per capita than they are in the continental USA [6]. Furthermore, if persons from COFA nations migrate to the USA, they are required to purchase health insurance, but are not eligible for Medicaid or other federal safety-net programs [7]. Although published diabetes prevalence data for these US-Affiliated Pacific Islands (USAPIs) is limited, all six report a higher prevalence of diabetes than the mainland USA. A pooled population-based study in 2014 found that the prevalence of diabetes in American Samoa was 31% in men and 33% in women, giving it the highest national prevalence of the disease [2•]. In its 2017 Diabetes Atlas, the International Diabetes Federation reported a diabetes prevalence of 23.1% in Guam, 32.9% in the Marshall Islands, 10.6% in the FSM, and 17.9% in Palau [4].

Identifying effective strategies to both prevent the onset of disease and treat established cases of diabetes is of obvious importance to the USAPIs. Despite what the high and rising prevalence of diabetes globally might suggest, diabetes is preventable and, once established, maintaining careful glycemic and cardiovascular risk factor control can prevent many of the adverse consequences associated with the condition. In other settings, lifestyle interventions targeting weight control, dietary intake, and physical activity have been shown to both prevent disease onset and promote glycemic control [8]. There are also a number of pharmacological treatment options that can be tailored in their intensity depending on disease duration, presence or absence of comorbidities, patient age, attitude toward therapy, or even resources and support available [9]. Few interventions, either for prevention or treatment of diabetes, have, however, been tested in the USAPIs.

In this paper we provide insight into a number of specific challenges that the USAPIs face in the prevention and treatment of diabetes and use several case studies to highlight creative strategies—first at the cross-jurisdiction level and then in individual USAPIs—that have been implemented to address these challenges and intervene on the high burden of diabetes-related illness. Although there are few randomized controlled trials among the interventions tested, many offer ideas that have the potential for scale-up and national- or regional-level impact.

Challenges to Diabetes Prevention and Care in the US-Affiliated Pacific Islands

The Food Environment

One of the major barriers to the prevention and treatment of diabetes experienced by the USAPIs is the food environment. As is the case in many other developing nations where prevalence of diabetes in increasing rapidly, there have been dramatic shifts in dietary intake in the USAPIs in recent decades that may be attributed to modernization, urbanization, increasing income, and integration into global food markets [10]. Since the 1970s, low costs, heavy marketing, and increasing availability of fast foods and high-calorie density processed foods have led to decreased consumption of local foods and increased fat intake [11, 12]. Specific to diabetes, the rapid replacement of low-glycemic index, locally produced, starchy root crops (breadfruit, taro, bananas, yams, and sweet potatoes), which often came with significant physical activity required to harvest them, with refined carbohydrates in white rice, white bread, pasta, or other "ultra-processed" foods is a major concern [10, 12].

In addition to the changing nutritional content of the diet in the USAPIs there are challenges to food security that span availability, access, and utilization. The availability of food can be inconsistent; the reliable production of local crops is being increasingly challenged by climatic events in the region (cyclones as well as rising sea levels attributable to global warming) leading to both transient and long-term shortages of key staple foods [13]. Increasing reliance on imported foods combined with relative geographic isolation also leads to a dependence by the islands on infrequent or uncertain shipments of food. At a 2009 conference on food security in American Samoa, it was estimated that if a disaster were to strike and shipments of food were to be delayed, there would only be enough food to sustain the population for 2 to 3 weeks [14]. Access to food can also be problematic. In general, the USAPIs rely heavily on USA and other foreign aid and have significantly lower incomes and higher poverty rates than the US mainland. For example,

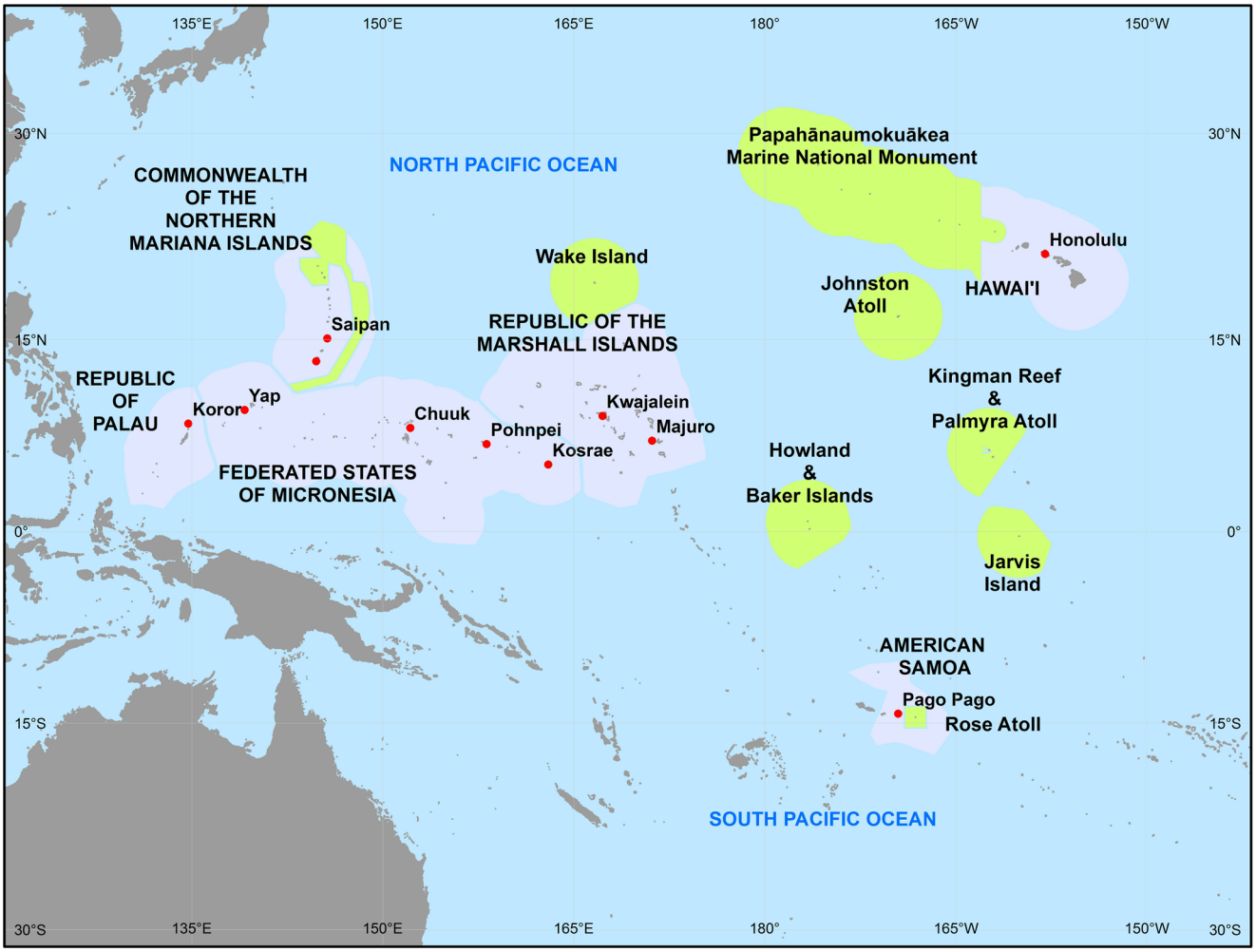

Fig. 1 The US-Affiliated Pacific Islands (with permission from Laura Brewington, The East-West Center, Honolulu, HI, USA)

the per capita gross domestic products in the USAPIs range from $3069 in the FSM to $16,820 in the CNMI, which is in stark contrast to the US mainland ($57,467) [5]. Despite strong family networks that often buffer absolute food insecurity, the ability to purchase food—particularly healthy or fresh foods that are often more costly—is often compromised. Reliance on imports also causes USAPIs to be easily impacted by shifts in global market costs of food and the price of freight carriage, costs that are passed on from importer to store owners and eventually to consumers. Finally, timely utilization of food can be challenging. Because there is limited access to refrigeration (for example, only 43% of Marshallese families have access to a refrigerator [15]), fresh foods often require immediate consumption, encouraging reliance on dried goods or pre-packaged, highly processed, and nutrient poor alternatives. To be successful, diabetes interventions need to address not just individual behavior but also the factors that create the food environment that heavily influences and ultimately dictates dietary choices.

Highly Prevalent Overweight and Obesity

Excess weight is an established risk factor for type 2 diabetes, with several potential mechanisms (increased inflammation, insulin resistance, ectopic fat deposition, mitochondrial dysfunction) linking the two diseases [16]. Indeed, the global epidemic of obesity largely explains the dramatic increase in the incidence and prevalence of type 2 diabetes over the past 20 years [17]. As is the case with type 2 diabetes, the Pacific Island jurisdictions are disproportionately affected by obesity [18]. In the Pacific region, the mean body mass index (BMI) of adults rose by more than 2.0 kg/m^2 per decade between 1980 and 2008, which is a five times greater increase compared to the world over the same period [19]. In each of the USAPIs, more than half of the adult population is obese (BMI $\geq$30 kg/m^2) with women generally more affected than men [18]. Since modest weight reduction—whether through lifestyle interventions, obesity medications, or bariatric surgery—has been shown to have a positive impact on glycemic control and to reduce diabetes risk, exploring interventions that simultaneously target the two conditions may be of benefit.

Strained Health Infrastructure

The American Diabetes Association (ADA) standards of medical care suggest 3-yearly screening beginning at 45 years of age for those with known risk factors (one of which is Pacific Islander ethnicity); provision of medical care by a physician-coordinated team including nurses, dieticians, pharmacists, and mental health professions; and timely diagnosis and intervention on complications from diabetes [20]. Providing this standard of care, however, requires a health infrastructure more robust than the overburdened health care systems in the USAPIs. As is the case in many developing nations, health systems in the USAPIs are generally designed to provide acute care and are experienced in the prevention, diagnosis, and treatment of infectious diseases [21, 22••]. They are less well equipped to deal with the chronic nature of diabetes and other related non-communicable diseases, and the significant financial costs of treating these diseases are putting increasing strain on clinical facilities largely supported by US government grants and international donors. In Palau, for example, based on the scarcity of human and physical resources and the cost to import supplies, the estimated cost of dialysis is ~US $27,000 per patient per year, more than 20 times the nation's per capita expenditure on health [23].

The high cost of service provision leads to many USAPIs declining to offer specialist services, like dialysis, at all, so they are generally only available in a very small number of well-equipped, state-run hospitals in the region (American Samoa, Guam, FSM) leading to issues of accessibility for patients, long delays in treatment onset, and sub-optimal frequency of follow-up care. Because of the widespread geography of the USAPIs, few patients are in easy reach of specialist care, deliveries of medical supplies are often limited to the few flights that arrive each week, and timely transportation of critically ill patients or laboratory specimens is a challenge. Many residents of the USAPIs travel off-island to Honolulu, the Philippines, Taiwan, or the US mainland for care [21, 22••], although the great personal expense, or high cost to the government (in those jurisdictions where Medicare/Medicaid support is available), means that this is only an option for a very small proportion of those requiring care and that wealth-related health disparities are perpetuated.

Although diabetes screening and treatment does not require access to medical specialist per se, it does require a skilled workforce. Unfortunately, many of the USAPIs struggle to maintain a fully staffed health system. Although there are degree or community college programs in nursing and the allied health professions in several of the jurisdictions, there are no medical training facilities, requiring that clinicians train elsewhere in the Pacific (Fiji, Samoa, or Papua New Guinea) or in Taiwan, New Zealand, Australia, and the USA. Increased salaries and greater opportunity for educational development in these settings often translates to few trainees that return to their home countries for their careers. In Guam, the most economically robust of the USAPIs, the physician to population ration is 0.98 per thousand compared to 2.42 per thousand in the mainland USA [5]. In the FSM it has been estimated to be as low as 0.19 [5]. As a result, all of the USAPI jurisdictions have been designated Health Professional Shortage Areas and Medically Underserved by the US Health Resources and Service Administration [24].

Finally, as evidenced by the limited availability of diabetes prevalence data for the USAPIs, there is a lack of large-scale population-based survey data or robust health surveillance systems to capture real-time estimates of incidence, prevalence, and diabetes care-related needs, meaning that already limited resources cannot be intelligently allocated. Much like the need to consider the food environment in the development of any new diabetes intervention, the status of the health system must also be considered. The interventions that are likely to be most successful will be those requiring few additional resources, those that can be built into existing infrastructure, and those that consider alternatives to a physician-led model of care. Whatever the model, building local capacity, optimizing existing resources, and focusing on sustainability would be crucial for future scale-up.

Coordinated Efforts to Prevent and Treat Diabetes

Although separately governed and connected to the USA through a variety of different mechanisms, the USAPIs have a history of collaboration on major issues, and the current non-communicable disease crisis is a pertinent example. As far back as 1998 the USAPIs have been collaborating and sharing best practices for the prevention of diabetes. The *Pacific Diabetes Today* Resource Center (PDTRC) was established by the Division of Diabetes Translation (DDT) at the Centers for Disease Control and Prevention (CDC) and the Papa Ola Lōkahi Native Hawaiian Health Care System with the goal of developing community coalitions within each jurisdiction to plan, implement, and evaluate their own diabetes prevention and control programs [25, 26]. The program was widely successful, leading to the establishment of diabetes-focused organizations in each of the USAPIs and Hawaii and a number of successful community events that reached more than 3000 participants [26]. The PDTRC itself focused on supporting translation of educational materials into local languages, facilitating exchange among members, reducing feelings of isolation, sharing successful initiatives, and developing the capacity of members to impact local health-related policy. Although funding for the program expired in 2004, many of the resources developed through the program are still available and can be accessed here: http://www.pdep.org/pdtrc.htm.

In a similar attempt to foster regional collaboration, the Pacific Chronic Diseases Council (PCDC) was formed in

2009 with the assistance of the CDC DDT, Papa Ola Lōkahi, and the National Association of Chronic Disease Directors [27]. With a membership including the NCD program coordinators and Diabetes Prevention and Control coordinators from each of the six jurisdictions, the goal in establishing the PCDC was to provide an avenue for collaboration to develop successful chronic disease programs. After a comprehensive health system and data needs assessment, the PCDC developed the Pacific Care Model (PCM) [28]. Drawing on their history of voyaging and star navigation, the model suggests that six inter-related PCM elements (including clinical information systems, self-management support, community resources, and partnerships), represented by stars, should be used to navigate patients, families, and health care teams, represented by a canoe, to improved health services and outcomes [28]. In a series of coordinated pilot studies across the FSM and RMI collaborative clinical teams were established (a physician, registered nurse, nutrition expert, community health worker, and data specialist) and trained in the PCM model to target health system improvements. They selected 50–100 patients on whom baseline measures were collected before the PCM model was implemented. Evaluation post-implementation suggested that all teams were successful in reducing HbA1c among their participants, with a median decrease in HbA1c of 1.4% noted across the sites [28].

Additionally, the Pacific Island Health Officers Association (PIHOA) have been undertaking extensive NCD surveillance and response activities in the region, since they declared a Regional State of Emergency due to Non-Communicable Diseases in the USAPIs in 2010 [29]. The declaration directed the PIHOA secretariat to partner with a wide variety of regional groups to develop a regional NCD policy to help coordinate partners and resources more effectively and make recommendations to potential donors, health agencies, and legislative authorities. Since the declaration, they have developed a regional NCD strategy map, NCD response timeline, NCD Core Surveillance Framework (which is now used to direct regional reporting), NCD Policy Commitment Package, and NCD Policy Toolkit. All of these resources are available at www.pihoa.org. Successes from these efforts include improved NCD surveillance, increased epidemiological capacity building through a Pacific-specific field epidemiology training program [30], and NCD policy mapping with the Monitoring Alliance for NCD Action (MANA).

The activities described above demonstrate that the USAPIs, with support from many invested partners, have developed a strong support system for their chronic disease prevention activities. Despite a common lack of sufficient funding for health care, by sharing experiences and resources, programs in each of the USAPIs have been able to successfully create and implement interventions at the community and health-system levels. In placing Pacific culture at the center of their activities, both the PDTRC and PCDC have successfully navigated interface between traditional cultural approaches and cutting-edge science and empowered communities to develop intervention approaches that can operate within their own cultural framework. The activities of these organizations are, of course, limited in their scope by the availability of funding, but continued investment in this collaborative approach and the pooling of resources across jurisdictions is likely to enable larger scale and more advanced intervention projects.

Interventions to Address Diabetes Prevention and Care

Despite the numerous challenges faced by the USAPIs in intervening on the rapidly rising prevalence of diabetes in the region, there have been several examples of innovation by researchers working in individual jurisdictions to address these challenges. The studies described below target the food environment, address health care professional shortages, and create a political environment in which to cultivate diabetes intervention scale-up and the sharing of knowledge.

Improving Access to Healthful Foods

Between 1999 and 2001, a multidisciplinary team of US researchers and Marshallese public health professionals designed and implemented a food-store based intervention on the island of Majuro to address environmental factors leading to rising obesity prevalence [31]. Noting that prior interventions to address diet-related illnesses had focused on changing individual behavior rather than the food environment, the researchers conducted formative work to understand store owners' motivations for stocking certain foods, local perceptions of food and food choice, and customer purchasing patterns. This work identified that the major constraints to healthy eating were the high costs of healthy food, lack of knowledge of healthy foods and how to prepare them, and the general lack of healthy foods available in stores. Store managers were rightly concerned with profit, noting that stock choices were entirely based on consumer demand and that fresh produce had the lowest profit margins. In general, they stated that fresh fruits and vegetables tended to attract customers, but there were consistently high rates of spoilage that undermined profits. These barriers were tackled by an intervention that focused on increasing consumer knowledge of healthy foods and recipes, through mass media campaigns, cooking demonstrations, taste tests, recipe cards, and shelf labels. Through these efforts, they intended to increase consumer demand for health foods, a change that they hoped would translate into incentives for storeowners to stock these healthy foods regularly, making them more accessible and eventually reducing cost. Evaluation of the intervention

suggested that the intervention reached many in the target population (65% of the population, for example, had heard half or more of the radio campaigns implemented) and that exposure to the intervention was associated with increased purchasing of healthy foods, greater ability to read food labels, improved diabetes knowledge, and increased healthy home cooking.

A second intervention tackled the issue of local food production, rather than food purchasing habits. This intervention by the Island Food Community of Pohnpei, conducted between 2005 and 2007, focused on promotion of local and "yellow" foods to address concurrent obesity, stunting, and micronutrient deficiencies among the FSM population [32]. The FSM have experienced a more rapid shift in dietary patterns than many other areas of the Pacific, particularly because of the controversial US Department of Agriculture Supplemental Feeding Programs that were implemented there between the 1960s and 1990s [33]. Through this program, surplus USDA commodities, including rice and tinned foods, were distributed to schools, families in poverty, and as disaster relief and the easy access to these foods displaced local produce and establishing new food preferences [33]. To reverse this trend, the intervention focused on three main concepts: (1) "Let's Go Local" was used as a slogan to promote retaining traditional values and customs including growing and consuming local food, (2) "Going Yellow" conveyed the message that yellow-fleshed varieties of several local fruits and vegetables were rich sources of nutrients and should be consumed for their health benefits, and (3) "Practice What You Preach" encouraged local communities to engage with the other two messages and prepare and serve local and yellow foods at community events [32]. Between September 2005 and June 2007 the intervention reached more than 500 community members through an extremely comprehensive, community-engaged set of activities. Community meetings, educational workshops, film viewings, and cooking demonstrations reinforced the local foods messaging. Guidelines were provided to community partners to enable them to prepare and serve healthy and hygienic meals at community meetings and events, and planting materials were provided to local famers to support the growth of bananas, soursop, and citrus fruits. The team also implemented weight loss competitions, trained communities in container gardening, developed charcoal ovens, started a youth drama club who performed short pieces to reinforce the value of local foods, and targeted nutritional knowledge among breastfeeding women. These activities were reinforced by additional efforts at the state level and a broad mass media campaign, all of which are described in detail by Englberger et al. [32]. In their evaluation of the program, the authors noted changed attitudes to food, with increased value placed on local foods. Although there were no significant changes in measured health outcomes (BMI and fasting blood glucose) they did observe a significant increase in local and yellow food consumption (consumption of taro, for example increased from 30.8 to 92.3 g/person/day and a broadening of dietary diversity accompanied by a decrease in rice consumption (from 846 to 544 g per day from 2005 to 2007). A follow-up study in 2009, 2 years after the intervention ended, showed signs of a sustained change in attitude toward local foods with local vegetable and taro consumption maintained at 2007 levels as well as a ban on soft drinks at community events [32].

Although there is little long-term published information on if these results were sustained, both interventions had the potential to have longstanding impact because they focused on system-level factors that create the food environment and aimed to support their participants in making healthy food choices. Both studies did this by directly educating participants about their food choices, but also manipulating the availability and attractiveness of certain foods. This allowed them to overcome the barrier of the unhealthy food environment created by cheap and readily accessible processed foods. The food store intervention in the RMI was innovative in that they worked with small, family-run food stores—typical of the type of store most commonly used across the USAPIs—rather than larger supermarkets, which is where the majority of similar interventions had been tested in developed country settings. They were also successful in reaching men, who are traditionally a hard-to-reach group in health interventions, by implementing their intervention in a very socially acceptable setting. The FSM Let's Go Local approach was innovative in its approach to community engagement. Those who were the targets of the intervention were also heavily involved in the planning process, allowing them ownership and ensuring the potential for sustainability. Lessons learned from both of these interventions may be applied in other settings to provide a supportive environment for diabetes prevention.

Reducing Childhood Obesity

Acknowledging that prevention of adult chronic disease may be most effectively achieved by targeting children, a US Department of Agriculture supported initiative—the Children's Healthy Living Program (CHL)—created a partnership among academic and community organizations across the USAPIs to design and implement a community randomized controlled trial for obesity prevention [34]. The 18-month-long CHL community intervention was implemented between 2013 and 2015 in five jurisdictions, including three of the USAPIs: Guam, American Samoa, and the CNMI. The FSM, Palau, and the RMI contributed prevalence data but were not engaged in the intervention. Through a process of community consultations each jurisdiction developed their own intervention approach to target six key behavioral outcomes: increasing fruit/vegetable intake, water consumption, physical activity, and sleep and decreasing screen time and

intake of sugar-sweetened beverages. After controlling for age and sex and accounting for intervention site and clustering, early results suggest that the CHL community intervention was effective in decreasing the prevalence of overweight and obesity (effect size = − 3.95%; 95% CI − 0.43, − 7.47) among its 2- to 10-year-old participants, reducing the prevalence of acanthosis nigricans (hyperpigmentation of the skin indicative of glucose intolerance; − 2.28%; 95% CI − 1.57, − 2.77), and decreasing screen time by almost an hour a day (58 min) [35].

As well as being innovative in its life course approach, the CHL program's attention to sustainability through capacity building is particularly novel. Alongside the implementation of the intervention, the program aimed to train 22 current and future professionals in food, nutrition, public health, and research evaluation to address future need in the region [36]. The program has provided training opportunities for Bachelors, Masters, Masters in Public Health, and PhD students from the region through partnerships with USAPI academic institutions and the University of Hawaii, Manoa, where the CHL program is housed. The training was integrated into program activities; trainees were able to participate in collection of prevalence data, community consultations to develop intervention targets, and the implementation and evaluation of the intervention program. Many of the students have returned to their home jurisdictions and are working with community organizations and local health departments to improve health outcomes [37]. While this approach required a level of funding that is challenging to replicate ($25 million over 5 years), the basic tenants of its integrated approach and particularly the focus on capacity building should be a consideration in future health and diabetes-related projects. As the study continues through 2021, its longer-term effects on childhood obesity will be documented.

Addressing Health System Shortages

Several attempts have been made in the USAPIs to address the fundamental challenges that health system constraints present in preventing and treating non-communicable diseases. Specific to diabetes, there have been two studies: one in American Samoa and another in the Guam. Between February 2009 and May 2010 the "Diabetes Care in American Samoa" study enrolled 268 participants (adults with a diagnosis of type 2 diabetes) in a randomized controlled trial to test the effectiveness of a culturally adapted, primary care-based, nurse-community health worker team intervention for diabetes self-management [38]. Designed to address the lack of specialist clinicians in the territory, a nurse case manager was employed to oversee community health workers (CHWs) who were trained in research practice, ADA standards of diabetes care, and measurement of diabetes-related outcomes (blood glucose, blood pressure). Based on their risk profile (a combination of long term glucose-control (HbA1c), blood pressure, smoking status, alcohol use, and Patient Health Questionnaire (PHQ-9) depression scores) those randomized to the intervention either attended weekly group meetings with the nurse case manager and CHW (high risk), had monthly visits from the CHWs (moderate risk), or had 3-monthly visits by the CHWs (low risk). Families were encouraged to attend all of these visits alongside the intervention participant. Intervention content was guided by both patient risk and self-selected goals, but focused on eight topics: introducing diabetes, healthy eating, being active, using medication, self-monitoring, reducing risk, healthy coping, and problem solving. Those randomized to the wait-list control group continued to receive usual care from their regular providers, but were provided with the intervention materials at the end of the trial. At the conclusion of the 12-month treatment period and after controlling for possible confounding, HbA1c levels were lower by 0.53 units in the CHW intervention group than the usual care group [38]. Of those receiving the CHW intervention, 42.1% made a clinically significant change in HbA1c (a decrease of more than 0.5%) versus only 31.8% of usual care participants. Of note though, a follow-up study examining the long-term impact of the CHW intervention demonstrated a sustained effect of the intervention 1 year after completion, but no effect 2 years later [39]. Investigators postulated that these results suggest that time-limited CHW programs improve diabetes control in the short term, but that ongoing programs are needed for sustained impact.

In Guam, a team from the Veterans Affairs (VA) hospital in Honolulu also attempted to address health care professional shortage by implementing a shared medical appointment intervention, designed to improve diabetes outcomes through education, delivered using telemedicine [40]. In 2013–2014, using a prospective, non-randomized study design, participants ($n = 31$ adults with a diabetes diagnosis and HbA1c ≥ 7.0%) were referred by their primary care provider to the intervention program. Participants received four weekly video-shared medical appointments with two to four other patients followed by two bi-monthly booster appointments, for a total of 5-month engagement with the program. Each appointment was 2 h long and was facilitated by a Honolulu-based nurse practitioner and clinical pharmacist. Video sessions were focused on education, using conversation maps based on the ADA standard of diabetes self-management, and pharmacological intervention. During the video appointments each participant was provided with an individualized risk report card with laboratory results and vital signs (HbA1c, blood pressure, and blood lipid levels), and medications for diabetes, blood pressure, and cholesterol management were introduced or titrated according to the results. Sixty-nine additional patients who attended the Guam community-based outpatient clinic for diabetes care during the enrollment period, but who were not referred to the program, served as the non-active control group. Measured

outcomes in the study included HbA1c, blood pressure, blood lipid levels, emergency department visits, and hospitalizations. A qualitative focus group evaluation was also conducted to determine acceptability of this model of care. After the 5-month treatment period, participants receiving the video-shared medical appointments demonstrated a significant decline in HbA1c (9.1 ± 1.9 to 8.3 ± 1.8%) compared to the control group, whose HbA1c levels remained similar ($p < 0.03$) [40]. No significant changes were observed in ether blood pressure or blood lipid levels but emergency room visits were significantly fewer among the intervention group. Those who participated in the focus groups reported being better equipped to manage their diabetes and indicated high levels of satisfaction with the program itself and the mode of delivery.

Interestingly, both of these interventions utilized group care, an approach that remains relatively novel for diabetes management, but that was perfectly suited to the known collectivist nature of Pacific Islander populations [41]. Although it is now well established that CHWs can manage diabetes prevention and care, the intervention in American Samoa was particularly innovative at the time, since few randomized controlled trials had been conducted, especially in developing country settings. Similarly, although the project in Guam was not the first instance of telemedicine being used to support health care in the USAPIs (see, for example, the Pacific Island Health Care project by the Tripler Army Medical Center, established in the mid-1990s [22••]), it was innovative in its focus on behavioral and pharmacologic treatment for the prevention of diabetes complications; the other telemedicine programs have traditionally focused on addressing end-stage complications with surgical intervention. Something that we should be careful to note, however, is that because the Guamanian intervention did not engage health care professionals (only the patients) there was no opportunity for local capacity building; in contrast, this is where the project in American Samoa excelled. Future interventions that target health system shortcomings should be mindful of both patient outcomes and the importance of attempting to strengthen the health system they are engaging with if the effects are to be sustainable long-term.

Conclusions

Although the USAPIs are uniquely challenged by environmental, structural, and health systems barriers there have been a number of innovative and successful strategies employed by these jurisdictions that are likely to benefit diabetes prevention and control if they could be sustained and successfully scaled. Lessons from the interventions described here can be applied both within the Pacific region and across the globe, since many of the challenges described are common to other developing country settings. The health leadership and the communities of the USAPIs are demonstrating significant strength and resilience in addressing the current burden of diabetes and other chronic disease but there must be continued commitment of technical expertise, political engagement, increases in funding, innovation in intervention, and a focus on health workforce capacity building to realize positive change.

Compliance with Ethical Standards

Conflict of Interest Nicola L. Hawley, Rachel Suss, Haley L. Cash, Nia Aitaoto, Raynald Samoa, Britni Ayers, and Pearl McElfish declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent All reported studies/experiments with human or animal subjects performed by the authors have been previously published and complied with all applicable ethical standards (including the Helsinki declaration and its amendments, institutional/national research committee standards, and international/national/institutional guidelines).

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- •• Of major importance

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