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COMMENT

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Health disparities and climate change in the Marshall Islands

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ABSTRACT

The small island nations, territories, and states dotting the Pacific are among the most disproportionately affected populations worldwide in the face of climate change. Sea level rise coupled with increased tropical storms contribute to seawater incursion, flooding, personal injury, trauma, and death. They face an existential threat due to the consequences of global warming, specifically ice melt resulting in sea level rise, repercussions for which they are not historically culpable. Along with these environmental threats, Pacific Island communities are further burdened with high rates of adverse health conditions such as diabetes and obesity yet have limited healthcare resources due to minimal economic development. The Republic of the Marshall Islands (RMI) has one of the highest amputation rates worldwide due to advanced diabetes from lifestyle factors, limited healthcare infrastructure, financial disparities, and a culturally based hesitancy to seek medical attention, all of which lead to an increased incidence of diabetic complications. Challenges posed by non-communicable chronic diseases include diabetes and infectious diseases like tuberculosis, hepatitis, malaria, and Zika. Just as crucial to the narrative of the Marshallese people is a fundamental indigenous knowledge of their surroundings and an inseparable relationship to the environment, aquatic animals, and communities around them, denoting a holistic living system. Though the outlook is precarious, solutions centering on lifestyle interventions that are informed by Indigenous cultural strengths can provide a responsive framework and a ray of hope, offering potential solutions to these two. This short perspective highlights the RMI as a case study of the challenges the Pacific Island nations bear, from a legacy of annexation to the modern threat of climate change, compounded by health disparities.

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Background

Like many island territories, The Republic of the Marshall Islands is an archipelago of 29 low-lying atolls (a series of islets) and islands. The nation includes roughly 1,200 islands and islets, with Majuro, the capital, encircling a lagoon of 64 islets within 25 miles. The RMI's rich culture and traditions have been disrupted through a succession of occupations by the Spanish, Germans, Japanese, and finally, Americans, with each change resulting in lifestyle-related consequences, particularly from dietary degradation. White rice became a staple during Japanese control, replacing the traditional starch sources that included taro, pandanus, and breadfruit as family groves of coconut (copra) transformed into a commercial commodity [1]. As the population grew, particularly on the main islands and atolls of Majuro and Ebeye, overcrowded conditions emerged, with more opportunity for the spread of infectious diseases, and exposure to more concentrated environmental hazards such as pollution which can exacerbate chronic illness [2]. After the United States took control of the islands from the Japanese following World War II, canned goods and processed foods imported by American troops became commonplace. Currently, an estimated 80-90% of all Marshallese food is imported [1,3]. This reliance on imported food is common throughout the Pacific Island region, which may be playing into the rise of diabetes and its complications [4].

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Nuclear testing

Due to its strategic and remote location, the U.S. government selected the Pacific Island region to test nuclear weapons between 1946 and 1958, which required the relocation of several hundred Marshallese residents. A total of 67 devices were detonated, devastating not only the environment but the lives of many Marshallese for generations. Radiation degraded traditional food sources like breadfruit, and lingering nuclear fallout resulted in health issues that are still reverberating today, including congenital disabilities, miscarriages, and cancers, particularly thyroid cancers [5,6]. Subsequent reliance on foreign support followed, resulting in the importation of low-quality non-perishable foods for many of the displaced residents [1,7]. Further, the local fish and seafood frequently consumed in the more remote outer islands became less available to those living in the urban centers (78% of the population in 2021) where fewer perishable items could be acquired [8].

Diet and disease

Many Marshallese, particularly those in urban centers such as Majuro and Ebeye, transitioned away from their traditional diet to one primarily made up of white rice, sugary beverages, ramen noodles, and canned and cheap meat products, setting in motion an epidemic of overweight and obesity (75% of the adult population) and resultant metabolic complications. Today, the RMI has among the highest rates of diabetes worldwide. The International Diabetes Federation reports that 23% of the adult population lives with diabetes [9], though other research puts the estimate higher, at 41% (the University of Arkansas for Medical Sciences 2017 health screenings) [10]. The Marshallese routinely suffer from high incidences of late-stage amputations due to prolonged, poorly managed hyperglycemia. Their dietary transition, high urban population density, and financial barriers to accessing higher quality food have impacted children with poor nutrition, resulting in 35.5% of one to five-year-olds suffering from stunted growth (2003) [7,11], and larger adults carrying more weight. This common state of overweight in communities may be adding to a perception among islanders that large body size is healthy [12], which is not generally true, making the human body more prone toward diabetes, cardiovascular and respiratory complications, and inflammation. Further, a cultural stigma among the Marshallese against illness and therefore, a reluctance to seek medical care until later stages of disease pervades [13].

This burden of disease experienced by the Marshallese is compounded by the emerging effects of climate change, with the heaviest burden falling on women, children, those experiencing poverty, and those with pre-existing illnesses [14]. Because of this, Pacific Island nations, including the RMI, are often considered the 'canaries in the coal mine of climate change'. Because of their position on the front lines of climate change, they also bring a unique understanding to the narrative of finding potential solutions, notably a fundamental Indigenous knowledge of their surroundings and an inseparable relationship to the environment, aquatic animals, and the communities around them, denoting a holistic living system.

Past to present challenges

Though a sovereign state since 1979, successive occupations of the RMI, population growth, urbanization, and resource scarcity have impacted its people's resilience to cope in many ways, including diet and lifestyle change, the transfer of traditional knowledge, preserving cultural foundations, and managing ecosystem services. These challenges are exacerbated by climate change and the threat of displacement it brings, including hotter, wetter climates and more vector-borne diseases such as dengue. Moreover, respiratory diseases pose significant threats to the RMI as infectious diseases such as tuberculosis spread more readily in nutritionally challenged, densely populated areas like the city islands of Majuro and Ebeye. However, with these existential challenges come opportunities to advance the rights of the Pacific Island peoples and address health disparities. Economically advanced nations have a duty and responsibility to help these local populations adapt and survive. Yet, responses must address the complexity of interactions between the people, animals and environment, and align with local traditions to find the best solutions for the global good. This demands a rigorous level of communication with indigenous communities to manage their complex human and natural ecosystems [15].

Reparations

In 1986, the U.S. recognized the RMI as a sovereign nation and settled claims related to its nuclear testing program. Pursuant to that settlement the U.S. has provided over $80 million in assistance from 2004 to 2023 [16]. Negotiators have agreed to drastically increase funding to the RMI (as well as Palau and the Federated States of Micronesia) and new agreements are now being finalized by the U.S. Congress [17]. It is unclear

if reparations are adequate to compensate for the environmental and health damages done [18].

For example, the World Health Organization has projected that global mortality due to intensifying climate change effects (diarrheal disease, malaria, malnutrition, and heat-related illness) will result in approximately 250,000 additional deaths worldwide per year by 2050, due to undernutrition, malaria, diarrhea and heat stress alone [19].

Vulnerabilities

Like many emergent countries, the RMI is more vulnerable to the effects of natural disasters due to limited resources and infrastructure. Each storm, flood, drought, or heat wave threatens food and water security, public health, and safety. For the Pacific Island inhabitants, circumstances will likely become increasingly difficult to overcome in the near future, potentially resulting in the necessity to flee their homes for higher ground nearby, or in diaspora, posing an existential challenge to maintain community, culture, and customs. Past examples of disasters affecting the health of the Marshallese include the drought of 1997-1998 during strong El Nino activity followed by a cholera epidemic in Ebeye (December 2000). High waves in Majuro followed severe droughts in the northern outer atolls in 2001 and 2007, flooding the capital. An outbreak of dengue ensued. In 2002 and 2004, typhoons and tropical storms caused significant damage and loss of life in the nearby Federated States of Micronesia, causing major damage to hospitals. In 2013, Typhoon Haiyan caused similar damage in the Republic of Palau.

In Majuro and Ebeye, every household is within reach of the lagoon or ocean. Without mitigation strategies, rising sea levels will soon make many islands uninhabitable, possibly within the next few decades [20,21]. The existing RMI health infrastructure is already poorly equipped and financially unable to address their present health needs; for example, there is no dialysis available, and thus, those in need must separate from family and travel to Micronesia or Hawai'i to receive care [22,23].

As sea level rise progresses, the Marshallese will be forced to migrate to the bigger cities of Majuro and Ebeye, increasing population density and opportunities for infectious spread, including tuberculosis (T.B.) transmission. The RMI already has one of the highest T.B. rates in the world at 500 cases per 100,000 (2019) [24–26]. Poor nutrition and lack of healthcare help to drive what is now the world's longest-lasting pandemic [27].

Diabetes in the RMI

Type 2 diabetes, a non-communicable disease strongly associated with ischemic heart disease [28], is the most prevalent medical and public health issue in the RMI, and may be associated with a rise in T.B [29]. The two epidemics synergistically feed one another [30], amplified by the pressures of climate change variables such as temperature, precipitation, humidity, and wind speed, which can alter host factors [31]. Further, the current Marshallese diet does not support overcoming these exacerbated health challenges. It helps to push these dual pandemics into an aggravated syndemic, negatively influenced by social and environmental challenges. Conquering it will require a concerted public health effort to shift dietary and lifestyle patterns, address disparities in social determinants of health, promote economic stability, improve access to quality healthcare and education, and enhance community-based social connections, along with climate change mitigation and adaptation.

Lifestyle as a successful intervention

Recently the RMI has experienced a fresh infusion of hope. An example of a successful community-based approach to their challenges is found in the recent lifestyle intervention program to treat type 2 diabetes in the RMI. The program protocols were designed by John Kelly, MD and Joan Sabate, MD, while dietary protocols, menus, recipes, and nutritional education materials were developed by Brenda Davis, RD [32].

Beginning in the late 1990s as a collaboration between the RMI government and Canvasback Missions Inc., a lifestyle intervention program was introduced into the community setting of Majuro, utilizing a plant-predominant diet along with exercise. Research and data collection took place in 2006. The results in this population with diabetes that has limited exposure to diabetic medications revealed that a twelve-week lifestyle intervention to treat and manage type 2 diabetes was more effective than standard diabetes care (anti-hyperglycemic for glucose control with education on weight management, healthy diet, and exercise) [32]. As initially reported, through a predominantly whole plant food diet, exercise, and behavior change education, HbA1c, BMI, C-reactive protein, and waist circumference all decreased (HbA1c by $1.3 \pm 0.3\%$ and $0.7 \pm 0.3\%$ at weeks 12 and 24, respectively, and BMI by 1.1 kg/m2, both at weeks 12 and 24, compared to standard of care) [32]. Noted in its recently published final report, as the study progressed, many of those receiving the standard care began eating more

like the intervention group, so they saw some positive changes as well, resulting in an HbA1c change in the intervention participants as well (an average of a 2.0 decrease at 12 weeks) [32–34].

Lifestyle medicine recognizes that medical outcomes rely on more than pharmaceutical treatment or any one intervention, as health is affected by one's overall lifestyle, safety, and social connections. Thus, this intensive lifestyle treatment program was designed as a community-wide project undertaken by community leaders and male and female community members alike. Research has consistently shown that behavior change intervention works best when delivered in a culturally appropriate community setting rather than in an isolated individual format, as demonstrated by this program [32]. Community cooking, exercise, and educational sessions made the program enjoyable and reinforced social connection and family, which are important to Marshallese culture. Box gardening lessons encouraged the tending and consumption of affordable vegetables, while shopping and agricultural trips reinforced lifestyle goals.

The benefits from the intervention went beyond the participants as the community experienced the improved offerings of healthy food in grocery stores and restaurants, enhancing the overall food quality available to the islanders. This study exemplifies what an effective collaboration between government and supporting agencies can accomplish within a community framework, even when faced with challenges. Given the encouraging results, we see this intervention model as one that would integrate well with current climate change mitigation efforts such as the World Health Organization's 'Healthy Islands' framework for climate change in the Pacific - an ambitious adaptation plan for the Federated States of Micronesia, Marshall Islands, and Palau [14].

Mitigation, adaptation, and proposed solutions

In 2013, the RMI government established the National Disaster Committee in response to a drought that decimated fruit trees and local food crops, including coconuts. It comprised four clusters of government organizations to manage specific interventions for water, sanitation, hygiene, health, food security, and logistics. Early response strategies included solar-powered reverse osmosis water sanitation units, and supplementary foods provided by government agencies (the RMI, USAID and USDA) [1]. U.S. food baskets included 'rice, wheat flour, cooking oil, canned yams and fruits, and fruit juices'. The RMI added flour, tuna, milk powder, tins of biscuits, cans of mixed vegetables, and cans of fruit. Baskets included a number of healthful items and omitted many common, less healthful options such as canned meats, ramen, and sugar. Because the initiative was created to respond to urgent drought conditions, it is possible that insufficient attention was paid to providing culturally appropriate foods that would promote nutritional health and minimize risk of chronic diseases, including type 2 diabetes and its complications [1]. Ongoing dependence on foreign aid has often resulted in continued exposure to processed, low-fiber foods that contribute to chronic disease.

Historically, food aid has led to a reduction in local food production and a reliance on more food imports. Moreover, overpopulation in Majuro and Ebeye has made it difficult for the RMI to produce enough food to feed current population levels. Because of the ongoing need to import food, and decreasing traditional agricultural practices, ensuring the importation of healthy staples such as lentils, beans, barley, and familiar whole foods, along with the appropriate education on preparation, is essential. The social stigma and other factors contributing to the decline in agricultural culture, which once sustained the islands, warrant further discussion. Further food-related challenges present themselves, including inadequate cooking facilities that may act as a barrier to cooking dry beans. Agricultural policies will need to be adjusted as well. With arable land at just under 50% of the total local land area [35], food security in the RMI must be a strategic priority for long-term recovery, and ideally include the planting of drought- and salt-resistant crops ('indigenous breadfruit, swamp taro, banana, pandanus, and coconut, as well as the introduction of eggplant, cucumber, radish, tomato, watermelon, pumpkin, papaya, long beans, okra, and spinach [1]. Leveraging Indigenous knowledge to revitalize traditional foods through government investment could play a crucial role in this endeavor. As demonstrated by the Marshall Islands Diabetes Wellness Program [32,34], the integration of healthy food into local diets can be achieved. It should be considered a human right for all peoples to access healthy food, with special attention given to those previously marginalized.

Local communities like this one can lead in the implementation of new technologies, from testing salt- and drought-tolerant crops, planting vegetation to protect coastlines, and revitalizing traditional wells, to drawing up their own climate-smart development blueprints. Such local initiatives can pave the way for future-oriented solutions. For a nation reliant on imported food, changing consumption patterns may be the biggest challenge. Solutions may be found in

subsidizing fruits, vegetables, and local foods, which, in itself, would make the cost of unhealthy food choices more expensive by comparison, including sugar-sweetened beverages, Spam, white rice, white flour, and other packaged and ultra-processed foods. Also, improving disaster relief supplemental food offerings [1] and nutrition education programs must have a central role. Further, interventions that utilize lifestyle medicine to restore health can be a critical lever to resolve the health and environmental challenges of the Marshallese. Along with a healthy plant-predominant diet, the other pillars of lifestyle medicine - physical activity, stress management, social connection, adequate sleep, and the avoidance of risky substances, can improve health outcomes and improve communities. These behaviors can be taught and reinforced by healthcare practitioners within the communities in which they serve to foster resilience in the face of climate change.

The development and implementation of interventions must be approached in a culturally sensitive manner, as we have learned from many past failures in building trust. For example, indigenous populations may exhibit a mistrust of healthcare practitioners outside the local community who propose interventions. This is understandable given the historical lack of representation of Indigenous people within the medical community and the improper use of Indigenous members' blood samples in research data [36]. To rebuild trust, we should, at the onset, establish open and honest communication, collaborating with the local Indigenous population in a way that respects local values and includes their voice throughout the process [37].

Conclusion

The people of the RMI serve as an example of many Pacific Island nations sharing the legacy of occupation and Western influence that have forever changed their way of life. Unlike many island countries experiencing dwindling numbers of indigenous people, like Hawai'i and Aotearoa/New Zealand, the Marshall Islands still has a majority indigenous population. Their geography away from cosmopolitan centers and their relatively small economy and population may inadvertently keep them from being recognized as full global citizens and therefore, more expendable, as their islands shrink with sea level rise and their peoples are forced to flee [38,39]. The loss of traditional knowledge, dependence on unhealthy imported food, reduced physical activity, rising rates of obesity, type 2 diabetes and its complications, infectious diseases, and intergenerational trauma present significant challenges [40].

The calculus for deciding to stay or leave is complex, yet the Marshallese have emerged determined to face these challenges, including those posed by climate change. As an example, the Pacific Rim nations were early adaptors committed to embracing renewable energy and reducing greenhouse gas emissions in their 2013 Majuro Declaration. The Marshallese affirm that it is the responsibility of every nation and every person to address global warming, and they will not surrender to climate change. As such, they have shown outstanding leadership in the climate change discourse internationally, even though their contribution to the climate crisis is negligible. Such resilience may help them change lifestyle habits to address the epidemics of diabetes and obesity in the region. Education, agricultural transition, and the implementation of lifestyle medicine may allow for the most effective path forward.

In addressing the 2013 Pacific Islands Forum, the RMI President Chris Loeak declared, '*My land is my home, my heritage and my identity… This is my country, and I will always stay here. If water comes, it comes*' [41]. Even with vigilant mitigation and adaptation, their future is uncertain, yet the choice to stay must be theirs. It is up to the economically privileged nations to support the efforts of the Pacific Island nations as they shape their destiny with aggressive actions to limit greenhouse gas emissions and promote attainable, appropriate, healthy lifestyle solutions. While their future remains uncertain, the Marshallese deserve the fundamental right to preserve their health, heritage, and home.

From the Minister of Health

In closing, the Honorable Ota Kisino, Minister of Health and Human Services of the Republic of the Marshall Islands, shares his perspectives here:

> I have read [this journal article] and am encouraged to see a peer-reviewed paper that eloquently addresses many of the most significant challenges the Marshallese people face. The RMI has a rich cultural heritage that spans centuries, but our way of life is being eroded by extreme health and environmental disparities. Publishing this paper in a prestigious peer-reviewed journal will help to increase awareness of these challenges on the wider global political and scientific stages and ignite interest in supporting solutions that will protect our people and preserve our islands for future generations.
>
> As the RMI Minister of Health, my load is lightened when the global community gains a deeper understanding of the challenges we face and stands with us to preserve our health and home. This thoughtful report makes an important contribution to this task.

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Authors contributions

Author contributions to this paper are as follows: conception and design: Kathryn J. Pollard; draft manuscript preparation: Kathryn J. Pollard; writing, study reporting, and interpretation of study results: Brenda Davis; Cory Davis, Kathryn J. Pollard; writing, editing and lifestyle medicine commentary: David Donohue, William Wong, Ali Saad, Gia Merlo, Neha Pathak. All authors contributed to the writing and editing of this article and approved the final version of the manuscript.

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Data availability statement

This commentary is not original research and therefore has no data to report. Data of the research referenced can be found here: [32,34].

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