Defeating Diabetes...
A story of hope from the Marshall Islands

Brenda Davis, RD
Outline

• Intro to the Marshall Islands

• Diabetes research project
  – Background
  – Intervention details
    • Diet
    • Other
    • Results

• Current efforts; future direction
Where are the Marshall Islands?
**Stats**

- **Number of islands:** 1200
- **Total land area:** 70 square miles
- **Total land area:**
  - Majuro - 3.7 square miles
  - Ebeye: - 0.14 square miles
- **MI Population:** 60,000
- **Majuro Population:** 30,000
- **Ebeye Population:** 15,000
Marshall Islands: State of Emergency

- The Marshallese have the highest death rates from diabetes in the world.

- Estimated prevalence
  - T2 diabetes
    - 50% - 35 years or more
  - Prediabetes or T2D
    - 90% - 35 years or more

- About half of all surgeries on the islands are amputations due to diabetes.
Was Diabetes a Problem in the Past?

- 70 years ago, diabetes was practically unheard of in the Marshall Islands.
- People were slim, physically active and they lived off the land.
What was the traditional diet?

- Coconut
- Breadfruit
- Fish and seafood
- Bananas
- Pelee Leaves
- Pandanas
What happened?
Lifestyles Changed
Diets Changed
Top Sources of Calories in the Marshallese Diet

• White rice
• White bread and rolls
• Donuts and white flour baked goods
• Spam and other canned meat
• Chicken
• Ramen noodles
• Sweetened beverages
• Fish
• Other meat
• Salty snacks
For most Marshallese, 95% of calories come from processed foods and animal products!
Diabetes by Design
The Diabetes Wellness Project
March 2006

- **Founder** – Canvasback Missions Inc. (SDA Medical Mission Group)
- **Funding** – Grant awarded by the US Department of Defence.
- **Partners** – Marshall Islands MOH and Loma Linda University.
The Research...

Aggressive Lifestyle Intervention vs Usual Care

- 169 Majuro residents with HbA1c ≥ 8 or taking diabetes medications
- Assigned using a randomized parallel design with 5 overlapping cohorts for 24 weeks to the intervention program or usual care.
The Goal…
To reverse the diabetes epidemic!

- **Step 1** – Prove that type 2 diabetes can be successfully treated with diet and lifestyle intervention in the Marshall Islands.

- **Step 2** – Adoption of the program as standard treatment for all Marshallese.
<table>
<thead>
<tr>
<th>Week</th>
<th>Frequency</th>
<th>Program Time Commitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, 4, 6</td>
<td>4 Weekdays</td>
<td>Noon session – 1 hour Evening session – 5 hours</td>
</tr>
<tr>
<td>3, 5, 7, 8</td>
<td>Twice weekly</td>
<td>Evening session – 5 hours</td>
</tr>
<tr>
<td>9-12</td>
<td>Weekly</td>
<td>Evening session – 5 hours</td>
</tr>
</tbody>
</table>
Primary Diet Objective

• To restore insulin sensitivity:
  ✓ Produce weight loss in overweight participants
  ✓ Improve blood glucose control
  ✓ Reduce oxidation and inflammation
  ✓ Restore nutritional health.
Conquering the Metabolic Monster

- Chronic Inflammation
- Oxidative Stress
- Endothelial Dysfunction
- Overweight/Obesity
- Elevated Blood Glucose
- Insulin Resistance
- Pre-diabetes
- Diabetes
- Overeating
- Lack of Sleep
- Unhealthy Gut Flora/Leaky Gut
- Nutritional Excesses and Deficiencies
- Hormonal Imbalances
Diet Design
1. Whole Foods, Plant-based Diet

Why?
- Optimize protective dietary factors.
- Minimize pathogenic dietary factors.
Protective Factors

• Fiber
• Healthful macronutrients
  – Unrefined carbohydrates
  – Plant proteins
  – Unsaturated fats, EFA
• Micronutrients
• Phytochemicals
• Antioxidants
• Plant sterols and stanols
• Pre- and probiotics
• Plant enzymes
Pathogenic Factors:

- Trans fatty acids
- Saturated fat
- Cholesterol; oxidized cholesterol
- Refined carbohydrates
- Excessive sodium
- Animal protein
- Excessive heme iron
- Artificial food additives
- Chemical contaminants
- Products of high temperature cooking
- Neu5Gc
- Carnitine + unfriendly gut flora → TMAO
Return to Local Foods?

• While a return to local foods makes sense from a health perspective, it is not possible from a practical perspective because there are more people than the island can sustain.
The Answer: Local foods + Healthy Imported Foods

• A switch from damaging imported foods to healthful, low cost imported foods is an imperative.

• Good choices are legumes, barley and low cost vegetables such as cabbage and squash.
2. Negative Energy Balance

Caloric deficit to produce weight loss in obese and overweight individuals.

- Decrease energy input
  - Eat less.

- Increase energy output:
  - Move more.

Overweight and obesity rates:
  - 75% - women
  - 50%+ - men
Emphasize whole foods with low caloric density

<table>
<thead>
<tr>
<th>Food</th>
<th>Calories per Gram</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olive oil</td>
<td>8.8</td>
</tr>
<tr>
<td>Cheddar cheese</td>
<td>4.0</td>
</tr>
<tr>
<td>Donuts</td>
<td>4.0</td>
</tr>
<tr>
<td>Spam</td>
<td>3.1</td>
</tr>
<tr>
<td>Fried Chicken</td>
<td>3.0</td>
</tr>
<tr>
<td>Beans</td>
<td>1.4</td>
</tr>
<tr>
<td>Barley</td>
<td>1.2</td>
</tr>
<tr>
<td>Banana</td>
<td>0.9</td>
</tr>
<tr>
<td>Watermelon</td>
<td>0.3</td>
</tr>
<tr>
<td>Romaine lettuce</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Minimize Liquid Calories

- Liquid calories do not provide the satiety or nutrition of solid foods.
  - Sugar-laden beverages such as soda and fruit “drinks” such as Luau are avoided.
  - Alcoholic beverages are minimized.

- Water and tea are primary beverages; fresh coconut water is consumed in smaller amounts.
Control Portion Sizes

- Generous portions of non-starchy vegetables and legumes are encouraged.
- Smaller portions of grains and starchy vegetables are served.
3. High Nutrient Density

- **Nutrient Density** = nutrients per calorie
- Nutrient density is maximized so that nutritional status is restored, even in the face of a caloric deficit.
- Most residents are have multiple micronutrient deficiencies.
Every calorie consumed serves to heal the body rather than contribute to disease.
## Nutrient Density Index

<table>
<thead>
<tr>
<th>Food</th>
<th>Nutrients per Calorie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green leafy vegetables</td>
<td>300-1000</td>
</tr>
<tr>
<td>Other non-starchy vegetables</td>
<td>100-500</td>
</tr>
<tr>
<td>Fruit</td>
<td>50-200</td>
</tr>
<tr>
<td>Starchy vegetables</td>
<td>30-100</td>
</tr>
<tr>
<td>Legumes</td>
<td>50-70</td>
</tr>
<tr>
<td>Fish</td>
<td>30-50</td>
</tr>
<tr>
<td>Nuts and seeds</td>
<td>15-50 (Brazil nuts = 116)</td>
</tr>
<tr>
<td>Whole grains</td>
<td>20-40</td>
</tr>
<tr>
<td>Milk, yogurt</td>
<td>20-35</td>
</tr>
<tr>
<td>Meat, poultry, eggs</td>
<td>10-30</td>
</tr>
<tr>
<td>Hard Cheese</td>
<td>11</td>
</tr>
<tr>
<td>French fries</td>
<td>7</td>
</tr>
<tr>
<td>Olive oil</td>
<td>2</td>
</tr>
</tbody>
</table>

Aggregate Nutrient Density Index (ANDI) (by Dr. Joel Fuhrman) is calculated using vitamins, minerals, fiber and ORAC score.
4. Minimal Refined Carbohydrates

- Diets rich in refined carbohydrates:
  - Promote overeating and obesity.
  - Adversely affect glycemic control.
  - Increase insulin resistance.
  - Reduce protective HDL-cholesterol.
  - Increase triglycerides.
  - Increase inflammation.

Approximately 95% of the carbs eaten are refined.
Carbohydrates are **NOT** the problem. CHO from whole foods are consistently protective.
Focus on foods that don’t cause a rapid rise in blood sugar.
## GI and GL of Selected Foods

<table>
<thead>
<tr>
<th>Food</th>
<th>Glycemic Index</th>
<th>Serving Size</th>
<th>Glycemic Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>White rice (Calrose)</td>
<td>83</td>
<td>5 oz</td>
<td>36</td>
</tr>
<tr>
<td>Cornflakes</td>
<td>81</td>
<td>1 oz</td>
<td>20</td>
</tr>
<tr>
<td>Potato, boiled</td>
<td>78</td>
<td>5 oz</td>
<td>21</td>
</tr>
<tr>
<td>White bread</td>
<td>75</td>
<td>1 oz</td>
<td>11</td>
</tr>
<tr>
<td>100% whole wheat bread</td>
<td>74</td>
<td>1 oz</td>
<td>9</td>
</tr>
<tr>
<td>Watermelon</td>
<td>72</td>
<td>2 tsp</td>
<td>4</td>
</tr>
<tr>
<td>Oatmeal</td>
<td>55</td>
<td>8 oz</td>
<td>13</td>
</tr>
<tr>
<td>Heavy specialty grain bread</td>
<td>53</td>
<td>1 oz</td>
<td>7</td>
</tr>
<tr>
<td>Banana</td>
<td>51</td>
<td>4 oz</td>
<td>13</td>
</tr>
<tr>
<td>White spaghetti</td>
<td>49</td>
<td>6 oz</td>
<td>24</td>
</tr>
<tr>
<td>Whole wheat spaghetti</td>
<td>48</td>
<td>6 oz</td>
<td>18</td>
</tr>
<tr>
<td>Beans (average)</td>
<td>29</td>
<td>5 oz</td>
<td>5</td>
</tr>
<tr>
<td>Barley</td>
<td>28</td>
<td>5 oz</td>
<td>12</td>
</tr>
<tr>
<td>Peanuts</td>
<td>14</td>
<td>1.8 oz</td>
<td>1</td>
</tr>
</tbody>
</table>

**Key:**
- **Low**
- **Medium**
- **High**
Participant Pointers

• Emphasize non-starchy vegetables and beans.
• Limit servings sizes of starchy vegetables and grains.
• Carefully select grains:
  – Use mainly intact whole grains.
  – Minimize use of refined grains, especially ground and puffed grains.
  – Emphasize low GI grains, e.g. barley (GI = 28).
Whole Grain Hierarchy

Intact whole grains
e.g. wheat berries, brown rice, barley, oat groats, quinoa

Broken whole grains
e.g. Red River cereal, 12 grain cereal

Rolled whole grains
e.g. rolled oats, barley, rye

Shredded whole grains
e.g. shredded wheat

Ground whole grains
e.g. whole wheat flour products

Flaked whole grains
e.g. cold flaked cereals

Puffed whole grains
e.g. puffed wheat, rice, millet
High Fiber

35+ grams per day.
Current diet provides 5-10 grams per day.
Aim for at least 10 grams of fiber per meal. Focus on viscous fiber (legumes, barley, oats, flax).
7. Moderate total fat; focus on healthy fat.

• While fat has little impact on blood glucose in the short term, it can have an impact in the long term.

• High fat diets can contribute to insulin resistance, increase oxidative damage to body tissues, cause excessive accumulation of intramyocellular lipids and hinder weight loss efforts.

Suggested Targets

• Total fat about 20-25% of calories.

• Traditional Marshallese diets were high in fat, with about 50-60% of calories coming from coconut (young coconut meat, coconut water, mature coconut, coconut sprout, coconut milk, etc.).
Low Saturated Fat

- **Saturated fat:**
  - Increases total and LDL cholesterol and triglycerides.
  - Triggers inflammation.
  - Reduces glucose tolerance and insulin sensitivity.

- **Saturated fat \( \leq 7\% \) of calories.**
  - 1600 kcal diet < 13 g
  - 2000 kcal diet < 16 g

USDA Nutrition Evidence Library, 2010, Van Beek, 2010
Zero Trans Fatty Acids

- Trans fatty Acids:
  - Change the structure, permeability, shape and flexibility of cell membranes.
  - Competitively inhibit the incorporation of EFA into cell membranes.
  - Adversely affect blood lipids:
    - Increase LDL-cholesterol
    - Decrease HDL-cholesterol
    - Increase Lp(a)
Moderate Healthy Fats

- Focus on fats derived from whole plant foods – nuts, seeds, coconut and legumes.
- Ensure sufficient EFA and maximum absorption of fat-soluble nutrients and phytochemicals.
- Minimize concentrated fats and oils as they provide many calories with few nutrients.
Sufficient Omega-3 Fatty Acids

- Include about 3 grams of plant sources of omega-3 fatty acids such as 1 heaping Tbsp ground flaxseeds or 1 ounce of walnuts.
- Allow moderate intakes of local, fish (not fried) – post intensive, if desired.
- Favorable effects on insulin sensitivity and arterial elasticity may be counteracted by environmental contaminants.

Antioxidant status is compromised with poorly controlled blood glucose.

Reduced antioxidant status accelerates complications.

To improve antioxidant status, the diet is rich in colorful vegetables and fruits, legumes, nuts, seeds and whole grains.
<table>
<thead>
<tr>
<th>Color</th>
<th>Common Ingredients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GREEN</strong></td>
<td>Lutein, zeaxanthin, beta-carotene, isoflavones, EGCG, isothiocyanates, indoles</td>
</tr>
<tr>
<td><strong>RED</strong></td>
<td>Lycopene, ellagic acid, quercetin, hesperidin, anthocyanins, capsaicin</td>
</tr>
<tr>
<td><strong>YELLOW/ORANGE</strong></td>
<td>Alpha- and Beta-carotene, beta-crytoxanthin, lutein, zeaxathin, Hesperidin, curcumin, limonoids</td>
</tr>
<tr>
<td><strong>PURPLE/BLUE</strong></td>
<td>Resveratrol, anthocyanins, phenolics, flavonoids</td>
</tr>
<tr>
<td><strong>WHITE/BEIGE/BROWN</strong></td>
<td>Allicin, ajoenes, allylic sulfides, EGCG, quercetin, indoles, glucosinolates, zingerone</td>
</tr>
</tbody>
</table>
9. Low Dietary Oxidants

- **Worst offenders:**
  - **Food contaminants** - pesticides, herbicides, fungicides, hormones, heavy metals, PCBs, DDT, and dioxins.
  - **Oxidized fats** - rancid fats and fats heated to high temperatures.
  - **By-products of high temperature cooking** - e.g. acrylamide, heterocyclic amines, polycyclic aromatic hydrocarbons, advanced glycation end-products.
Advanced Glycation End-Products (AGEs)

• Irreversible final products of the Maillard reaction.
• Linked to the pathogenesis of diabetes and its complications.
• Levels are elevated in people with diabetes.
## AGES in Common Foods

<table>
<thead>
<tr>
<th>Food</th>
<th>AGE (ku)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broiled frankfurters (3 oz)</td>
<td>&gt;10,000</td>
</tr>
<tr>
<td>Boiled frankfurters (3 oz)</td>
<td>&gt;7,000</td>
</tr>
<tr>
<td>Grilled or fried meat, poultry or fish (3 oz)</td>
<td>&gt;5,000</td>
</tr>
<tr>
<td>Butter (1 Tbsp)</td>
<td>4,000</td>
</tr>
<tr>
<td>Grilled or fried tofu (3 oz)</td>
<td>3,000-4,000</td>
</tr>
<tr>
<td>Boiled or steamed meat, poultry or fish (3 oz)</td>
<td>1,000-3,000</td>
</tr>
<tr>
<td>Snack foods (chips, cookies, granola bars, etc.) (1 oz)</td>
<td>200-1,000</td>
</tr>
<tr>
<td>Fruits and Veggies (1 serving)</td>
<td>10-50</td>
</tr>
</tbody>
</table>
10. Moderate Sodium

- **Average Intakes:** 3500 mg+ per day for most adults.
- **Recommended Intakes:** <2300 mg/day for most adults.
75-80% of dietary sodium comes from processed foods!
# Sodium in Foods

<table>
<thead>
<tr>
<th>Food</th>
<th>Sodium Content (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table salt, 1 tsp</td>
<td>2300</td>
</tr>
<tr>
<td>Ramen, 1 pkg</td>
<td>1434</td>
</tr>
<tr>
<td>Spam, 2 oz</td>
<td>767</td>
</tr>
<tr>
<td>Sardines, 1 can</td>
<td>465</td>
</tr>
<tr>
<td>Soy sauce, 1 tsp</td>
<td>310</td>
</tr>
<tr>
<td>RTE cereal, 1 oz</td>
<td>200-350</td>
</tr>
<tr>
<td>Cheese, 1 oz</td>
<td>150-250</td>
</tr>
<tr>
<td>Potato chips, 1 oz</td>
<td>120-200</td>
</tr>
<tr>
<td>Salted peanuts, 1 oz</td>
<td>95</td>
</tr>
</tbody>
</table>
What Did Participants Eat?
Breakfast
Lunch
Dinner
Shopping Tours
Exercise
Cardio Dance and Strength Classes
Daily Walking
Education Sessions

- Lifestyle and chronic disease
- Food and nutrition
- Exercise
- Stress management
- Dental health
- Care of eyes and feet
- Medical management, medications, etc.
- Vegetable gardening
The Affordable Produce Challenge

• Imported produce is expensive.
• Local farming is limited.
Solution: Local Gardens

- Growing season is year-round; sunshine is plentiful.
- Soil quality is a challenge; land space is very limited.
Two-Week Transformation

- First 2 weeks, participants report:
  - Pain in joints, arms and legs is reduced or eliminated.
  - Able to sleep through the night.
  - Increased energy.
  - No longer constipated.
  - Think more clearly.
<table>
<thead>
<tr>
<th>Measure</th>
<th>Change at 2 weeks</th>
<th>Change at 12 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intervention</td>
<td>Control</td>
</tr>
<tr>
<td>FBS (mg/dL)</td>
<td>-71</td>
<td>-16</td>
</tr>
<tr>
<td>HbA1C</td>
<td>-0.7</td>
<td>-0.2</td>
</tr>
<tr>
<td>HOMA-IR</td>
<td>-2.7</td>
<td>-1.2</td>
</tr>
<tr>
<td>BMI</td>
<td>-0.7</td>
<td>0</td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>-7</td>
<td>+3</td>
</tr>
<tr>
<td>Total Chol</td>
<td>-20</td>
<td>-2</td>
</tr>
<tr>
<td>hsCRP</td>
<td>-1.2</td>
<td>+0.3</td>
</tr>
</tbody>
</table>
Factors Adversely Affecting Results

- About 1/3 of participants were fully committed; 1/3 partially committed; 1/3 fell back into usual patterns.
- Those who went back to former eating patterns often failed to resume taking medications.
- It was impossible to have a true “control group”.
Committed Participants

- The participants who stuck with the program enjoyed the greatest success, many eliminating need for medications and achieving normal blood glucose levels.
Participants in the Diabetes Wellness Program are providing hope amid a deep sense of hopelessness. They have:

- Overcome seemingly insurmountable mountains of Spam, donuts, ramen and cola.
- Put together low cost, healthful meals despite the high cost and poor quality of their produce, and the lack of resources.
- Managed with little education and marginal English skills.
- Succeeded with few gyms, no trails and a cultural taboo against women wearing pants.
Could this type of program work at home?
If there is hope in the Marshall Islands, given the enormous barriers they face, there is hope at home.
• The hope rests on the integration of lifestyle medicine into our health care system. It must be offered as a treatment option!
Meet Carlos

• Medical History
  ✓ Type II diabetes (diagnosis 1993)
  ✓ Coronary Heart Disease – one serious MI
  ✓ High blood pressure
  ✓ High cholesterol
  ✓ Peripheral artery disease
  ✓ Early stage renal failure

• Treatment
  ✓ 17 pills/day
  ✓ Insulin 40 units per day
After almost 3 years on a whole-foods, high raw, vegan diet:

- Carlos takes ZERO insulin and ZERO pills.
  - His **FASTING GLUCOSE** is 80-87 mg/dl.
  - His **A1C** is 4.9.
  - His **BLOOD PRESSURE** is 115/70.
  - His arteries have opened up, without surgical intervention. The scar tissue resulting from his heart attack has shrunk.
  - There are no signs of peripheral artery disease.
  - His kidney function is perfectly normal.
Current Efforts

- Research grant has run out.
- Focus has shifted away from research to community action.
Long Term Success

• The best education program in the world is not enough.
• Marshallese culture is group oriented. Everything is shared, including food.
• Community ownership is key.
• Until changes are embraced culturally, it will be very difficult for individuals to succeed long term.
Collaboration with Ministry of Health and Government to Change Policy and Establish Public Programs
Reaching Children
Partnering with Restaurants and Grocery Stores
Battling our health crisis

Nitijela officials, including Education Minister Nidel Lorak (left) and Clerk Joe Riklon, are getting an intensive two-week training in the two “Es” — eating and exercise — from the Ministry of Health/ Diabetes Wellness Program. It’s part of the effort to promote World Diabetes Day and to give leaders the opportunity to experience first-hand how the Diabetes Wellness Center has been promoting healthy lifestyle for Marshallese to reverse the diabetes crisis in the RMI.

Free Lifestyle Interventions Continue
If you keep doing what you’ve been doing, you’ll keep getting, what you’ve got.
• Government, community groups, schools, churches, stores, restaurants and government have got to come together. It is time to develop policies that make healthy choices easy for people.
Komol Tata – Thank you!
Faculty/Presenter Disclosure

- **Faculty**: Brenda Davis, RD

- **Relationships with commercial interests**: 
  - **Consulting Fees**: Goodman Group; Canvasback Missions 

- **Potential conflict(s) of interest**: None.
Learning Objectives

1. Explain why the Marshallese have among the highest rates of diabetes in the world.

2. State at least 5 factors that can impact insulin resistance.

3. List at least 3 dietary modifications that will reduce the glycemic load of a plant-based diet.

4. Describe at least 4 features of dietary patterns most strongly liked to diabetes risk.