Evaluation of a Traditional Food for Health Intervention in Pohnpei, Federated States of Micronesia

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This thesis is dedicated to my family.....
who inspires me to explore.

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Abstract

As a nation, Federated States of Micronesia (FSM) faces increasing rates of non-communicable diseases related to the replacement of the traditional diet with processed imported food and adoption of sedentary lifestyles. To reverse this trend, a food-based intervention in Pohnpei, FSM, used various approaches to promote local food (LF) production and consumption. Evaluation of the intervention in one community assessed changes in diet and health status in a random sample of households (n=47). Process indicators were also examined. Results from dietary assessments indicated increased (110%) provitamin A carotenoid intake; increased frequency of consumption of local banana (53%), giant swamp taro (475%), and local vegetables (130%); and increased diversity from LF. There was no change in health measures. However, exposure to intervention activities was high, and behaviour towards LF appeared to have changed positively. It is recommended that the intervention continue and expand to further affect dietary change and improve health.

Résumé

Les États fédérés de Micronésie (EFM) font face à une augmentation du taux de maladies non-contagieuses reliées au remplacement des habitudes alimentaires traditionnelles par des mets transformés importés ainsi que l'adoption d'un mode de vie sédentaire. Afin de remédier à cette situation, une intervention alimentaire à Pohnpei, EFM a employé une variété d'approches pour promouvoir la production et la consommation de denrées locales. Dans la communauté, l'évaluation de l'intervention a noté les changements de régimes et d'état de santé auprès d'un échantillon aléatoire de foyers (n=47). Les indicateurs de processus ont aussi été évalués. Les résultats des analyses nutritionnelles indiquent une augmentation de l'apport en carotène provitamine-A (110%); une augmentation de la fréquence de consommation de bananes locales (53%), de taro géants des marais (475%) et de légumes locaux (130%), de même qu'une plus grande variété de nourriture locale. Il n'y a eu aucun changement dans les mesures de santé. Cependant, les gens ont reçu une exposition importante aux activités d'intervention et leur comportement envers les aliments locaux semble avoir changé de façon positive. Il est recommandé de poursuivre et d'amplifier cette intervention afin d'influencer d'avantage les habitudes alimentaires dans le but d'améliorer la santé de cette population.

Contribution of Authors

Laura Kaufer, Master of Science candidate, entered the community for two months in 2007 to contribute to the evaluation of the project in Mand. This entailed overseeing the follow-up data collection, training of interviewers and development of additional evaluation tools.

Dr. Lois Englberger and Adelino Lorens of IFCP created the Traditional Food for Health Project, conducted baseline data collection in 2005 and developed the intervention activities. Dr. Englberger facilitated use of food composition data specific to Pohnpei and access to Xyris software.

Dr. Harriet Kuhnlein was the overall leader of the CINE Indigenous Peoples' Food Systems for Health program together with Chief Bill Erasmus. Funding was obtained from Canadian Institutes of Health Research to develop the evaluation plan in Mand.

The 2007 evaluation was carried out by a Pohnpeian research team. Douglas Nelber, Mihne Pretrick and Welsy Hagilmai conducted interviews, Ali Alik, Amy Levendusky and Sylvia Nennis took anthropometric measurements and Pelihna Moses and Yumiko Paul took health measurements.

Dr. Roger Cue guided statistical methodologies. Drs. Johns and Kuhnlein provided guidance on thesis content.

Table of Contents

List of Figures

List of Tables

Acronyms

AI – Adequate intake

BCE – Beta-carotene equivalents

BMI – Body mass index

BP – Blood pressure

CINE – Centre for Indigenous Peoples' Nutrition and Environment, McGill University

DBP – Diastolic blood pressure

DDS – Dietary diversity score

DGLVs – Dark-green leafy vegetables

DM2 – Type 2 diabetes mellitus

EFNEP – Expanded Food and Nutrition Education Program

FAO – Food and Agriculture Organization of the United Nations

FPG – Fasting plasma glucose

FFQ – Food frequency questionnaire

FSM – Federated States of Micronesia

FVS – Food variety score

GLVs – Green leafy vegetables

IFCP – Island Food Community of Pohnpei

MCWG – Mand Community Working Group

NCDs – Non-communicable diseases

NR-NCDs – Nutrition-related non-communicable diseases

PAC – Provitamin A carotenoids

RCB – Randomized complete block design

RDA – Recommended dietary allowance

SBP – Systolic blood pressure

U.S. – United States of America

USDA – United States Department of Agriculture

VAD – Vitamin A deficiency

WC – Waist circumference

WHO – World Health Organization of the United Nations

Introduction

As in many parts of the world, obesity and non-communicable diseases (NCDs) in the Pacific are increasing as a result of economic and dietary transitions and changes in activity levels (Anderson et al. 2006). Over the past 30 years, residents of the Federated States of Micronesia (FSM) have become increasingly reliant on energy-dense, nutrient-poor imported food and have spent less time on farming, food gathering, food preparation and other forms of physical activity. Obesity, heart disease, type 2 diabetes mellitus (DM2) and vitamin A deficiency (VAD) are now major health concerns (Englberger et al. 2003a).

These circumstances prompted the Island Food Community of Pohnpei (IFCP), a local island NGO and a community on the island of Pohnpei, FSM to join the Centre for Indigenous Peoples' Nutrition and Environment (CINE) Indigenous Peoples' Food Systems for Health program to research and promote the nutritional properties of traditional island food to improve long-term health (CINE 2007). Imported foods that are heavily processed, nutrient-poor and energy-dense have replaced many local foods from the average daily diet (Corsi et al. 2008; Englberger et al. 2008a). From 2005 to 2007, an intervention used various food-based approaches, including education, training, agriculture and social marketing, to encourage local food production and consumption on the island of Pohnpei, FSM.

This thesis has examined changes in diet and health that may have been affected by the intervention. This was done in three approaches: progress evaluation, outcome evaluation and process evaluation.

Objectives

- To conduct progress evaluation by assessing changes in diet using measures of nutrient intake, consumption frequency and dietary diversity

- To conduct outcome evaluation by assessing changes in health status using measures of body mass index, waist circumference, fasting plasma glucose and blood pressure

- To conduct process evaluation by examining the intervention activities in terms of exposure, awareness and acceptability

Literature Review

Indigenous Peoples are some of the poorest and most disadvantaged in the world and are at the greatest risk of suffering poor health (Stephens et al. 2005; Bartlett et al. 2007). The disproportionately high prevalence of preventable diseases that are found in indigenous populations exist in a broader context of systematic social and cultural marginalization (Stephens et al. 2005; Stephens et al. 2006). It is estimated that there are 370 million Indigenous Peoples living in 70 countries around the world (Bartlett et al. 2007). While no universal definition applies or is required, it is important for locally relevant and clear characterizations of Indigenous People to better recognize their unique health context and to plan meaningful research and appropriate health improvement programs (Bartlett et al. 2007). Public health solutions must address health as well as the local and national context of environment, land and discrimination (Stephens et al. 2006). The nutritional status of Indigenous People are also affected by these factors, and with declining reliance on their traditional food systems, there is reduction in culture-specific food activities, dietary diversity and cultural morale (Kuhnlein and Receveur 1996).

In the Western Pacific, the focal region of this thesis research, the indigenous population remains the majority population (Anderson et al. 2006). However, like in numerous other indigenous histories, the Micronesian population declined with initial colonization from dispossession, social change and introduced infectious disease (Anderson et al. 2006). The health effects from foreign influence continue, although now in the context of a nutrition transition (WHO 2003a).

Nutrition Transition in the Pacific

High, middle and low-income countries worldwide are experiencing a nutrition transition, which is described as the shift in diet and lifestyle that results in increased obesity rates and the appearance of nutrition-related non-communicable diseases (NR-NCDs) (Popkin 2002). Globally, foods that are high in total fat, cholesterol, sugar and refined carbohydrates and low in polyunsaturated fatty acids and fibre have been replacing foods that are starchy, low in fat and high in fibre (Popkin 2002). Key changes contributing to this are increases in the global food supply of sugar, oil and animal meat (Prentice 2006). Activity levels have also become more sedentary in this transition (Popkin 2002). Global trends include a shift from agriculture and energy-intensive

occupations towards service sector, reductions in the level of physical activity within each occupation, reduced physical activity in transportation, the mechanization of home production-related activities and the reduction in food preparation time by over half (Prentice 2006). The emergence of simplified diets and a lack of dietary diversity have contributed to the nutrition transition (Frison et al. 2006).

In this context, obesity has become a problem followed by morbidity and mortality from NCDs, including cardiovascular disease, DM2 and cancer (Popkin 2002). The nutrition transition has contributed to an increasing burden on health care systems and has had adverse effects on economic development from mid-life death and disability due to the rising prevalence of NR-NCDs (Popkin 2002). A double burden of disease now exists where the pandemic of obesity and NR-NCDs accompany conditions of childhood malnutrition, tuberculosis, malaria and AIDS (acquired immune deficiency syndrome) (Prentice 2006). The prevalence of households in which underweight and overweight coexist was 3-15% in six countries studied (Popkin 2001). There is strong evidence that obesity increases the risk of chronic disease providing evidence that preventative measures are key (Prentice 2006).

The nutrition transition in the Pacific has been marked by the transition from a time of high prevalence of infectious disease, high infant mortality, protein-energy malnutrition and micronutrient deficiencies to a longer lifespan, changing diet, lack of physical activity, stress, tobacco and alcohol use and chronic NCDs (WHO 1999a). The Pacific obesity epidemic has been linked to increased urbanization and consumption of high-fat foods that require little physical activity (WHO 2003a). Food behaviours maintained for thousands of years provided for relatively healthy populations (WHO 2003a). Now, the highest rates of obesity (body mass index (BMI) > 30 kg/m^2) in the world are found in several Pacific Islands (Prentice 2006). The health problems from before are still prevalent and combined with the present-day health situation, there now exists a 'double burden' for individuals and health programs (WHO 1999a). The health implications are rising rates of DM2, obesity, hypertension, cardiovascular disease, gout and cancer (WHO 1999a).

It has been repeatedly shown in longitudinal studies in children and adults that dietary and activity patterns affect the prevalence of obesity (Popkin 2001). In the Western Pacific, imported foods that are energy-dense, high in saturated fat and salt and low in fibre are now very prevalent (WHO 1999a). Up to 90% of all foods consumed are imported in several Pacific countries (WHO 2002). Commonly-consumed high-fat imported products are oil, margarine, butter, meat, chicken,

tinned meat and tinned fish (WHO 1999a). Imported meats are often low quality, high-fat cuts such as turkey tails and mutton flaps (WHO 1999a). Chronic diseases are related to not only increased consumption of detrimental, unhealthy foods (i.e. imported food) but also decreased consumption of protective foods (i.e. traditional foods) (WHO 1999a). While there are no survey data available on current activity levels in the Pacific, there is a general consensus that there has been an increase in sedentary lifestyle due to improved transport, sedentary work, passive environment, less domestic work and lack of safe exercise facilities (WHO 2002).

Historic and economic factors have contributed to the nutrition transition in the Pacific and created a dependency on imported food (WHO 1999a). Imported foods are generally cheaper, more accessible, more convenient and have higher status than traditional food (WHO 1999a). However, they are less nutritious than the foods they have replaced (WHO 1999a). This dependency on imported foods has had adverse outcomes in terms of food, health and economy (WHO 1999a). There is also a sociocultural context. Being overweight is culturally appropriate on islands, given the historic means of survival throughout unpredictable food cycles (WHO 1999a). Compounding the issue, the focus of health care in most Pacific countries is on the clinical management of obesity-related disease rather than obesity itself (WHO 2002).

The highest rates of obesity in the world are found in the Pacific (WHO 2002). Rates of overweight and obesity in adults are greater than 50% in many Pacific countries, with a prevalence as high as 75% in some countries (WHO 2003a). Modernization has been associated with a very high prevalence of obesity in West and South Pacific islands, with high rates of severe obesity (BMI $\geq$ 40 kg/m^2) mirroring the rates found among Native American groups in United States (U.S.) (Popkin and Doak 1998). Trends indicate that women become obese earlier than men, but this gap is closing (WHO 2003a). There is a higher prevalence of obesity in urban areas than rural, but this difference is also diminishing (WHO 2003a). Weight gain occurs between 20–45 years of age and the lower BMI of older populations may reflect cohorts of survivors rather then a trend to lose weight with age and there is a growing concern that obesity is starting in infancy or early childhood (WHO 2003a).

Overweight and obesity are closely associated with increased risk of hypertension, cardiovascular disease and DM2 (WHO 2003a). Chronic diseases are the major cause of death and disability worldwide (WHO 2005a). In the Western Pacific, chronic diseases are projected to account for 78% of all deaths by 2015 (WHO 2005a). This is an increase of 20% and DM2, the

biggest contributor to mortality, is expected to increase by 51% (WHO 2005a). The prevalence of obesity-related conditions in the Pacific ranges from 12-31% for hypertension and 8-33% for DM2 (WHO 2002).

Food-based Interventions to Improve Health

It is estimated that at least 80% of premature heart disease, stroke and DM2 as well as 40% of cancer could be prevented through healthy diet, regular physical activity and avoidance of tobacco products (WHO 2005a). Food-based approaches are directly relevant to the current situation of malnutrition, overweight and obesity-related diseases. Accessible, sustainable and locally-adapted resources can be mobilized to reverse the nutrition transition trend (Johns and Eyzaguirre 2006). This approach can improve micronutrient status, improve the quality and diversity of diet, reduce consumption of less nutritious carbohydrate and fat-rich foods and increase the intake of essential fatty acids and phytonutrients (Allen 2008). A food-based approach can also increase energy expenditure through the physical activity involved in local food production and preparation. Local plant foods have been emphasized as a solution for their diversity, high nutrient content and functionality in terms of energy-density, glycaemic control, oxidative stress and immuno-stimulation (Johns and Eyzaguirre 2006).

Food-based strategies increase production and consumption of micronutrient-rich, healthy foods using approaches that are sustainable, long-term and overall economically beneficial (FAO 1997). The benefits of this strategy are that it is preventive, cost-effective and sustainable in the long-term; improves overall diet quality; can be adapted to the local context of culture, tradition and feasibility; minimizes the risk of toxicity; and complements and supports the role of breastfeeding and special diets and care of children (FAO 1997). These strategies can also be environmentally-sustainable by promoting local farming that protects the micronutrient content of soil and crops (FAO 1997). However, food sources need to be locally available to make the program sustainable at the family and community level (FAO 1997).

Under conditions of food access and availability, food diversity should supply sufficient micronutrients to meet the needs of the general population (FAO/WHO 2002). However, in situations limited by availability and affordability of high-quality foods, fortification and supplementation are alternatives that can complement food-based approaches (FAO/WHO 2002).

Types of Food-based Interventions

Food-based approaches to improve health can include agriculture, education, training, marketing, research and economic initiatives (FAO 1997). Success of these programs requires intersectoral collaboration (FAO 1997). Direct involvement of the community in all stages of the intervention is also important for acceptability and to ensure that what the community perceives as the problem is addressed (FAO 1997). Dietary modification and diversification through community-based approaches can also be used to empower the community to be more self-reliant in addressing its nutritional problems (Tontisirin et al. 2002).

Agricultural approaches include home gardens and small-scale cultivation. A home garden is "a small-scale, supplementary food production system by and for household members that mimics the natural, multi-layered ecosystem" (FAO 1997). It requires strong commitment by agriculture extension services to disseminate techniques of small-scale fruit and vegetable production (FAO 1997), as a supplement to traditional methods. The agricultural biodiversity approach uses local biodiversity to ensure dietary diversity (Frison et al. 2006). Encompassed in this holistic approach is the need for awareness and promotion of the healthful components of traditional diets (Frison et al. 2006). Dietary diversity in terms of fruits, vegetables and other plant foods generally contributes to lower rates of morbidity and mortality (Johns and Eyzaguirre 2006). The 1992 International Conference on Nutrition declared that promotion of dietary diversity and use of indigenous and traditional foods (that are locally available and nutrient-rich) was an appropriate strategy to address food insecurity, malnutrition and disease (Frison et al. 2006).

Nutrition education and training can strengthen and complement efforts to enhance the production of micronutrient-rich foods by increasing the capacity of households to use existing food resources to their maximum advantage (FAO 1997). "Without nutrition education, increased production may not lead to increased consumption among vulnerable groups" (FAO 1997).

Appropriate communication strategies for effective food and health promotion, such as social marketing, are also important and require "a vigorous and concerted effort of [agriculture, health, education and industry] sectors through a variety of communication channels" (FAO 1997). Important components of a social marketing campaign are recognizing nutritionally beneficial traditional practices, targeting various stakeholders, understanding current food preferences and selecting the appropriate communication channels (FAO 1997). Implementation includes selecting

the appropriate foods, locations and methods of promotion, as well as ensuring that such foods are affordable (WHO 2002).

Advantages of Targeting Traditional Food

The practices of Indigenous Peoples that have been followed consistently throughout their cultural histories are likely valid for developing healthy populations (Kuhnlein et al. 2006). Rather, it is the more recent external influences and environmental changes that have contributed to the poor health situations of Indigenous People seen today (Kuhnlein et al. 2006). Traditional practices can be nutritionally beneficial and include breastfeeding, gathering of wild leafy vegetables, collection of wild fruit by young children and fermentation of staple crops (FAO 1997). However, social, economic and cultural changes have undermined the healthful components of traditional diets (Frison et al. 2006). For example, when incomes rise, people often breastfeed less frequently, stop gathering wild foods and eat fewer leafy vegetables because they are considered low status activities (FAO 1997). "It is practical to promote and support what people already do or want to do, than ask them to change" (WHO 1999a).

Evidence of Dietary Effects on Health

Epidemiologic evidence from Asia indicates that high reliance on a traditional diet (low in fat and high in vegetables) in South Korea may be the reason for the lack of high obesity rates that are prevalent in comparable Asian countries (Lee et al. 2002). Fruits and vegetables are good sources of micronutrients and phytochemicals, such as antioxidants, which can mitigate effects of oxidative stress and prevent chronic disease (Rao and Rao 2007). For example, carotenoid-rich foods may have a protective role against chronic disease including cancer, cardiovascular disease, DM2 and age-related macular degeneration (Mares-Perlman et al. 2002; Coyne et al. 2005; WCRF/AICR 2007; Haskell et al. 2004).

The relationship between food-based vitamin A intake and vitamin A status is not linear and may depend on the context and type of food. In an Indonesian nutrition surveillance study , plant foods contributed eight times more to vitamin A intake than animal food (using conventional conversion factors), but serum retinol concentrations did not reflect this large of a difference (de Pee et al. 1998a). This study also demonstrated the influence of other factors: women from the

lowest socio-economic status did not benefit in terms of serum retinol level despite their relatively high vegetable intake (de Pee et al. 1999). Also, carotenoids from carotenoid-rich orange fruit have been found to have greater vitamin A activity than carrots and dark-green leafy vegetables (de Pee et al. 1998b).

Food-based strategies have been effective in increasing food production and consumption and also improving nutritional and health status. Following a 7-week food-based intervention in which 10 diabetic Australian Aboriginals returned to their traditional diet, which was low in fat and calories, there was improved control of blood glucose levels and decreased fasting triglyceride levels (O'Dea 1984). In a second study, 20 native Hawaiians ate a prescribed *ad libitum* traditional diet, which was low in energy density and fat, for a three-week period in a clinical setting (Shintani et al. 1991). As a result, body weight, cholesterol levels and BP decreased significantly (Shintani et al. 1991). Cultural pride was listed as one motivating factor for the high level of adherence seen in this study (Shintani et al. 1991).

Over a three-year period, a food-based intervention targeted 37,000 households in southwestern Nepal to improve vitamin A and iron intake (Jones et al. 2005). Kitchen gardens were encouraged through training, technical assistance and seed distribution of 16 micronutrient-rich, local crops, including eight dark-green leafy vegetables (DGLVs) (Jones et al. 2005). After 36 months, comparison of control and intervention households revealed increased self-reported consumption frequency of these homegrown vegetables and fruit (Jones et al. 2005). In tandem, nutrition education was delivered by informational materials and training sessions on causes of micronutrient deficiency, the local sources of vitamin A and iron, cooking tips and modern preservation techniques (Jones et al. 2005). Knowledge of the nutrition messages was significantly higher in the intervention group compared to the control group (Jones et al. 2005).

Another nutrition education and food-based intervention promoting traditional food and health in a Nuxalk community of British Columbia, Canada for three years found a significant improvement in adult vitamin A (plasma retinol) and erythrocyte folate status (Kuhnlein and Burgess 1997). Over 375 educational activities had taken place including food preservation and preparation demonstrations, community harvesting excursions and school-based sessions (Kuhnlein and Burgess 1997).

An effective social marketing campaign to control VAD was exemplified in Indonesia (de Pee et al. 1998c). Banners, billboards, posters and radio media channels as well as face-to-face

communication were used to promote consumption of eggs and DGLVs (de Pee et al. 1998c). After nine months, there was increased consumption of both foods, increased daily vitamin A intake and improved vitamin A status (serum retinol) (de Pee et al. 1998c).

After a two-year horticultural and nutritional education intervention to control vitamin A deficiency in Tanzania, several significant changes in knowledge and practice had occurred upon follow-up five years later (Kidala et al. 2000). Compared to the control villages, villages that were targeted by the intervention had home gardens, were growing carotenoid-rich crops provided by the intervention and vitamin A-rich foods were being consumed by children more than seven times a week. However, there was no evidence of improved vitamin A status, as measured by serum retinol. In fact, the control area had significantly higher retinol levels. This was explained by the external factor of higher helminth infection in the experimental villages (Kidala et al. 2000).

Fourteen studies of food-based projects to control VAD in developing countries, published between 1995 and 2000, were reviewed by Ruel (Ruel 2001). Included in this review were the studies by de Pee et al. in 1998 and Kidala et al. in 2000 mentioned previously. The projects consisted of nutrition education, social marketing, and mass media campaigns with and without a home garden component and the studies consistently documented significant increases in consumption of vitamin A-rich foods and/or vitamin A intake (Ruel 2001). However, only ten of these studies measured nutritional status outcome, and of these seven found improved nutritional status (Ruel 2001).

In comparison, food-based projects from the 1970s and 1980s generally focused on agriculture and food production without education or marketing components (Ruel 2001). These projects failed to demonstrate significant change in food intake or nutritional status (Ruel 2001). For example, a home garden project in Senegal failed to increase energy, protein, vitamin, or mineral intake (Brun et al. 1989). The reason for this lack of effect in the Senegal study was attributed to the fact that only a small fraction of the vegetables produced were consumed by the family and that income generated by the sale of vegetables was almost never used for food purchases (Brun et al. 1989). Ruel attributes the overall lack of change in this group of projects prior to 1990s to the lack of nutrition education and communication components in their food promotion strategies (Ruel 2001).

Review of evaluation studies suggests that food-based strategies have clear potential to improve vitamin A nutrition particularly when home garden, communication (media and social

marketing) and education interventions are combined (Ruel 2001). It is also important to consider how external factors may have influenced the results from an evaluation study.

Evaluation Methodology

Dietary Assessment Methodology to Evaluate Progress

Impact evaluation serves as an assessment of the intervention's immediate impact on one or more dependent variables (Green and Lewis 1986). Indicators of the immediate effect of health education interventions can include knowledge, beliefs, attitudes, skills, social supports and behaviour (Green and Lewis 1986). Progress evaluation of a nutrition intervention can examine the adoption of skills and behaviours that increase micronutrient intake and may reflect the intervention's impact. Such measurable indicators can include new recipes using a higher proportion of micronutrient-rich food, food preparation methods that preserve micronutrients (boiling rather than frying), the number of servings of micronutrient-rich foods at mealtime and as snacks, eating leaves not traditionally consumed, the proportion of traditional food in the diet compared to introduced, nutrient-poor foods, and new food combinations (FAO 1997). In this study, the dietary assessment provided the measures by which to evaluate progress towards the goals of the intervention.

Dietary assessment can be used to estimate nutrient intake as well as consumption frequency and dietary diversity. Methods include 24-hour recall and food frequency (Willet 1998). The quantified 24-hour dietary recall is a short-term method to estimate nutrient intakes by recording foods and amounts that were actually consumed by the individual on specific days (Willet 1998). The recall is open-ended and can be used flexibly for data analysis by examining nutrients, individual foods, food groups and/or meals (Willet 1998). In contrast to the recall method, the food frequency questionnaire (FFQ) provides information on what foods are consumed and the frequency of consumption over a longer period (Willet 1998). Important considerations for developing a FFQ are the choice of foods, the clarity of the questions and the format of the frequency response section (Willet 1998).

There is natural variation in dietary habits, and the ability of assessment tools to capture 'normal' intake is limited by systematic biases including the day of the week, season and measurement error (Willet 1998). Challenges in dietary assessment are participant memory,

awareness of intake, portion size estimation and psychological traits that motivate bias (Gibson 2005). The magnitude of these concerns depends on the methods used and on the administration of dietary assessment (Gibson 2005). Limitations of the recall method are that it is only a single day of intake whereas day-to-day intake is highly variable for many individuals (Willet 1998). Thus, collection of intake on multiple days is required to estimate typical nutrient intake (Willet 1998). Two recalls can provide more valid estimates than a single recall as long as the sample is representative and the days of the week are adequately represented (Gibson 2005). For use in determining the effectiveness of an intervention program and estimating change in absolute nutrient intakes, having an appropriate balance of recall days of the week is of importance (Willet 1998). Advantages of the FFQ are that it is practical, easy-to-use, less time intensive and spans a longer time period than the 24-hour recall method (Willet 1998). However, less detail is obtained and the analysis will have less precise results and may be less accurate (Willet 1998; Macbeth and MacClancy 2004).

Underreporting of daily energy intake can often be a problem in quantitative dietary assessment (Gibson 2005). The Goldberg cutoff method can be used to identify records of poor validity that are statistically unlikely to reflect habitual, long-term intake (Goldberg et al. 1991; Gibson 2005). This method compares the ratio of an individual's average daily reported intake and estimated basal metabolic rate with a statistical cutoff based on number of days of dietary assessment (Gibson 2005). The basal metabolic rate is estimated for each individual based on age- and sex-specific equations derived by Schofield (1985) using weight and height (Gibson 2005). The Goldberg statistical cutoff represents the value below which the reported energy intake is not plausible at the 95% confidence limit (Gibson 2005).

Dietary diversity has been found to be a valid proxy for evaluating dietary quality (Roche et al. 2008) and nutritional adequacy of diet (Hatloy et al. 1998; Spigelski 2004). Dietary diversity measures have been positively correlated with micronutrient intake and longevity of life and have been found to be strong predictors of disease risk (Savige 2002; Kant and Graubard 2005). However, there is a lack of consensus in the literature of a standard measure of dietary diversity (Ruel 2003). One common measure is food variety score (FVS), which is a count of the different food items consumed over a recorded reference period (Frison et al. 2006). Another score is the dietary diversity score (DDS) which indicates the number of food groups consumed over a reference period (Frison et al. 2006). Methodological considerations include type of score, type of

assessment tool, reference period and importance of quantity and frequency (Frison et al. 2006). While one study found FVS from a 7-day FFQ to be a valid indicator of micronutrient intake and superior to DDS (Spigelski 2004), another study found DDS to be more significantly linked with anthropometric indices (Savy et al. 2005). Inclusion of condiments and spices is important; although consumed in small quantities, such foods may contribute to diversity of and nutrients in daily diets (Frison et al. 2006). A critique of FVS is that it may be limited when the score includes energy-dense foods that contribute to obesity (Kennedy 2004).

In 1999 a World Health Organization of the United Nations (WHO) report for the Western Pacific recommended that dietary diversity be incorporated into food-based guidelines. Specifically, the guidelines recommended that people eat at least twenty biologically distinct foods[1] a week drawing from all food groups. In this report, four individual assessment categories were suggested: marginal - < 20 food species consumed per week, fair - 20-24, good - 25-29 and very good - > 30 (WHO 1999a).

Health Status Assessment Methodology to Evaluate Outcome

Outcome evaluation is the examination of the long-term effects of an intervention, which can include changes in incidence and prevalence of health risk factors, morbidity and mortality (Green and Lewis 1986). An objective of anthropometric indicators is the identification of individuals or populations at risk of morbidity and mortality; this can be used to examine present health risk and/or predict future risk (WHO 1995). Population-based screening of DM2 and BP is also important alongside measures of overweight. Obese individuals (BMI $\geq$ 30 kg/m^2) have over three times greater risk of developing DM2 and two to three times greater risk of hypertension (WHO 1999b).

BMI is an index of weight-for-height (kilograms/meters^2) that is commonly used to classify states of underweight, healthy weight, overweight and obesity in adults (WHO 1999b). BMI is considered the most useful population-level measure of obesity and is an indirect estimate of relative risk of adverse health conditions related to high body fat (WHO 1995; WHO 1999b). To indicate the degree of health risk associated with high BMI, three cutoffs were proposed by the WHO in 1995: 25 kg/m^2 (grade one overweight), 30 kg/m^2 (grade two overweight) and 40 kg/m^2

[1] The publication did not indicate whether cultivar (species varieties) were included as biologically distinct in this recommendation.

(grade three overweight) (WHO 1995). In this thesis these categories are referred to as overweight, obese, and very obese, respectively. The different grades of obesity are associated with increased risk of hypertension, coronary heart disease, DM2 and gallstones (Bailey and FerroLuzzi 1995).

However, BMI does not differentiate between weight associated with muscle and weight associated with fat (WHO 1999b). The relationship between BMI and body fat content varies according to body build, which can vary across populations (Mhurchu et al. 2004). For example, Polynesians tend to have lower fat (higher muscle) percentage than Caucasian Australians at the same BMI (WHO 1999b). Overall, the 1995 expert committee of WHO recommended use of BMI ≥ 30 cutoff as a provisional standard applicable to all adults because of available data on risks of morbidity and mortality support this cutoff (WHO 1995). In fact, a meta-analysis of prospective studies in Asian and Australasian populations found a strong positive association between BMI and risks of stroke and ischemic heart disease that began at BMI of 20 kg/m^2 (Mhurchu et al. 2004).

Age and gender[2] are important factors in examining BMI. Body fat percentage increases with age up to 60-65 years and is higher in women than in men of identical BMI (WHO 1999b). Moderate obesity in the elderly has not been associated with poor health or increased risk of mortality (WHO 1995). The relationship between BMI and risk of comorbidity can also be affected by factors including diet, ethnicity and activity level (WHO 1999b).

Measurement of BMI in conjunction with fat distribution (such as waist circumference (WC)) is important when calculating risk of obesity comorbidities (WHO 1999b). Abdominal obesity is associated with greater risks to health than peripheral fat distribution (WHO 1999b). WC measurements are used to identify individuals at increased risk of obesity-related illness (WHO 1999b). Measured at the midpoint between the lower border of the rib cage and the iliac crest, WC is closely correlated with BMI and waist-to-hip ratio and provides an approximate index of intra-abdominal fat mass and total body fat (WHO 1999b). Changes in WC tend to reflect changes in risk factors for cardiovascular disease and other chronic diseases (WHO 1999b).

Ethnic populations have different levels of health risk associated with WC measurements; thus no globally applicable cut-off points have been developed (WHO 1999b). Identification of risk using WC must be population-specific and will depend on levels of obesity and other risk factors for cardiovascular disease and DM2 (WHO 1999b). Sex-specific cutoffs are also needed as women

[2] The word 'gender' is used in this thesis when examining the differences between women and men.

show increased relative risk of coronary heart disease at lower WC than men (WHO 1999b). Examination of WC, gender and risk of metabolic complications associated with obesity in Caucasians revealed the following cutoffs: for men risk of metabolic complications was increased at a WC ≥ 94 cm and substantially increased at ≥ 102 cm; for women, there was increased risk at ≥ 80 cm and substantially increased risk at ≥ 88 cm (WHO 1999b).

The level of plasma glucose concentration after fasting for at least eight hours is referred to as fasting plasma glucose (FPG) (ADA 2003). The cutoff of FPG ≥ 126 mg/dl is one of several criteria that can be used to diagnose DM2 and identify increased risk of premature mortality and microvascular and cardiovascular complications (ADA 2003; WHO and IDF 2006). The FPG measure is appropriate for epidemiological studies to estimate DM2 prevalence and incidence, but this approach slightly underestimates DM2 prevalence compared to what would be obtained from FPG combined with the oral glucose tolerance test (ADA 2003). A positive association between obesity and the risk of developing DM2 has also been observed in cross-sectional and prospective studies (WHO and IDF 2006).

Hypertension can be defined as high BP resulting from obesity, insulin resistance, high salt intake and perhaps sedentary lifestyle and stress (Carretero and Oparil 2000). NHANES II data from the U.S. indicate a 2.9-fold higher prevalence of hypertension in overweight adults compared to normal weight adults (WHO 1999b). The risk of developing hypertension increases with the duration of obesity, especially in women (WHO 1999b). Hypertension is also a major modifiable risk factor for cardiovascular disease (Carretero and Oparil 2000). The 1999 WHO and International Society of Hypertension Guidelines for the Management of Hypertension defined and classified hypertension in adults in the following way (WHO and ISH 1999): optimal – <120mmHg systolic blood pressure (SBP) /<80mmHg diastolic blood pressure (DBP); normal – <130 SBP / <85 DBP; high normal – 130-139 SBP / 85-89 DBP; borderline – 140-149 SBP / 90-94 DBP; mild hypertension – 140-159 SBP / 90-99 DBP; moderate hypertension – 160-179 SBP / 100-109 DBP; severe hypertension – ≥180 SBP / ≥110 DBP.

Process Evaluation Methodology

Process evaluation examines the inputs or processes of the intervention, such as appropriate content, methods and performance and can include measures of knowledge, participation, services delivered and completion of project (Green and Lewis 1986). This

examination allows for identification of key effective intervention components, for whom the intervention was effective and under what conditions the intervention was effective (Linnan and Steckler 2002). Process evaluation can support and enhance causal inference in assessment studies (Nutbeam 1998), which can have positive implications for both research and practice (Linnan and Steckler 2002). Along with quantitative process measures, process evaluation may also refer to qualitative assessment of the dynamics of program operation (Linnan and Steckler 2002). As well this qualitative research can enrich the understanding of intervention effects and guide systematic reviews (Rychetnik et al. 2002).

Several process indicators have been proposed to evaluate the intervention success of the CINE Indigenous Peoples' Food Systems for Health projects. Such indicators include the number of activities, participation counts, media events, extent of community leader involvement, new intersectoral involvement and quantity of foods and crop varieties produced (Kuhnlein et al. 2006). Ownership by the target population and perceptions of relevance to the population's needs can be used to assess acceptability of the program (Nutbeam 1998). "Successful public health work with indigenous communities depends entirely on good process...that the community informs and controls the research and shapes it to its own priorities" (Kuhnlein et al. 2006). Other measures of process include the frequency and extent of implementation, the level of exposure and acceptability in the target population and whether the program was implemented as planned (Nutbeam 1998; Linnan and Steckler 2002).

A social marketing campaign promoting dietary diversification in Indonesia collected process indicators that were useful for monitoring and evaluation (Bloem et al. 2002). These indicators included records of types of media used and coverage rates. Similarly, in Bangladesh process indicators were collected to monitor food production as part of a home-gardening program. Measured indicators included type and size of garden, number of varieties produced, time spent in the garden and knowledge of vitamin A-rich foods (Bloem et al. 2002). Studies of community-based cardiovascular disease prevention programs found that by assessing the dose of the intervention delivered, the study was able to examine the effect that the activities had on targeted risk factors over time, which resulted in a corrective feedback process (Linnan and Steckler 2002).

Rationale

Diseases of modernization resulting from cultural, economic and nutrition transitions are an epidemic problem facing many countries of the world. Existing alongside conditions of malnutrition, this double burden affects individuals in terms of chronic morbidity and mortality.

A valid solution to these problems is food-based interventions at the community level that affect positive behaviour change in a sustainable manner. Successful approaches have combined nutritional education, agriculture and social marketing. Success of such interventions has been credited to strong support and involvement at the community level and intersectoral collaboration.

Evaluation is a strong and necessary component of such interventions that provides evidence of change or lack of change. Evaluation also aids in understanding the process by which such outcomes may have been attained. This level of follow-up is important to document so that the methodology of successful intervention approaches can be shared and expanded.

In Pohnpei, FSM, NR-NCDs and malnutrition are serious health problems. These problems are attributed to rapid changes in diet and lifestyle over the last forty years. Returning to a diet of traditional food has been proposed as a way of reversing these preventable health conditions in a sustainable way.

The IFCP organization has worked with a Pohnpeian community on a 'Traditional Food for Health' intervention for two years. Numerous activities promoting traditional food targeted women and men of all ages in the community during this period. Activities were principally educational and agricultural, but also involved social marketing components (such as traditional recipe sharing) and construction of smokeless charcoal ovens to facilitate traditional food preparation.

This thesis research evaluated this community-based intervention to measure behaviour change relating to food consumption practices (progress evaluation). An outcome evaluation examined changes in health status that could be linked to the intervention. The research also investigated the process by which the intervention may have caused such behaviour change (process evaluation).

Study Background

Federated States of Micronesia

FSM is a group of islands in the Western Pacific. Modern-day FSM has been largely affected by foreign influence, particularly in the last 40 years (Cassels 2006; Englberger et al. 2003a). FSM is divided into four states (from west to east): Yap, Chuuk, Pohnpei (the state in which this study took place) and Kosrae (Lee et al. 2001). The development of a cash-based economy, the increased availability and affordability of imported food, changing food habits and preferences and the loss of food production have resulted in a nutrition transition whereby obesity and chronic diseases now exist alongside infectious disease, malnutrition and micronutrient deficiencies. The following summary of FSM provides context to the current nutrition and health situation.

Historical and Political Context

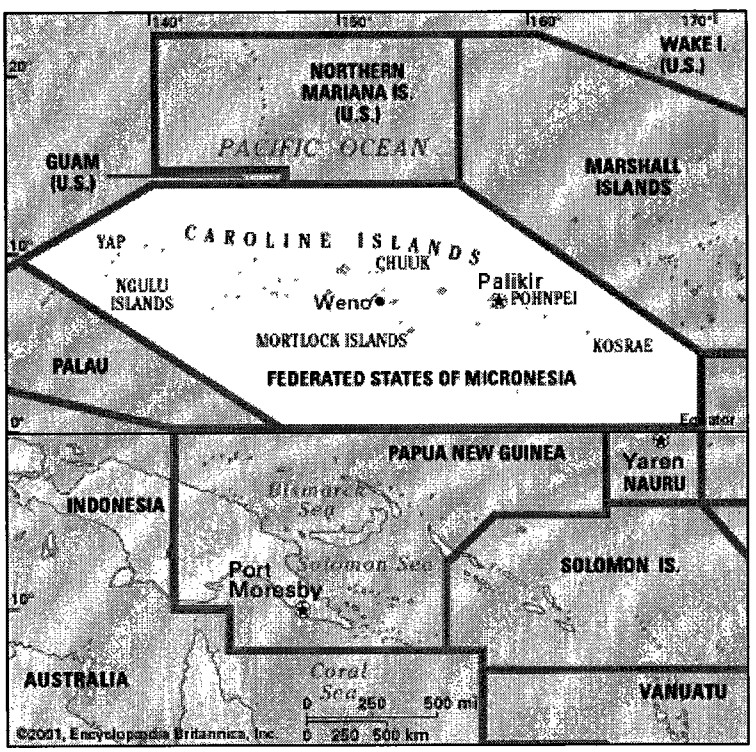

Figure 1:
Map of Federated States of Micronesia

FSM is located in the western Pacific Ocean, north of the equator and east of the Philippines (Figure 1 (Merriam-Webster 2001)). The country is comprised of more than 600 volcanic and coral-based (atoll) islands, of which 60 are inhabited (Lee et al. 2001; Golbuu et al. 2008). This territory

spans over 2.5 million square kilometers (Englberger et al. 2008a), but has a land mass of only 702 square kilometers (Lee et al. 2001). The average temperature is 27°C and annual rainfall is 250 - 500 centimeters per year (Englberger et al. 2003a).

Micronesians descended from Asian and Polynesian ancestors who began populating the islands between 2,000 BC and 500 BC (Anderson et al. 2006). Over the thousands of years before the arrival of European and Asian colonizers, Micronesians developed sophisticated cultures, traveled the oceans, lived in relative comfort and constructed monumental projects relying on stone, bone and food species caught or grown on the islands (Wenkam and Baker 1973).

The territory known today as FSM was first colonized by Spain in 1886, followed by Germany in 1899. Then Japan controlled the islands from 1914 until losing the territory at the end of World War II. At this point the United Nations gave the U.S. administering authority of the islands (Cassels 2006). In 1986, the individual island states joined together to become the independent country of FSM (Cassels 2006). However, a relationship with the U.S. has continued in the form of Compacts of Free Association, which provide FSM with economic assistance as well as immigration and employment rights in the U.S. in return for the use of the islands for defense and military operations (Anderson et al. 2006; Cassels 2006). During the first Compact agreement from 1986 to 2003, FSM received $1.5 billion USD (Cassels 2006). The second Compact agreement provides FSM with a total of $2.1 billion USD in aid until 2023 (Cassels 2006; Shaeffer 2006). The Compacts have had a strong influence on the economy, food production and consumption, and health in FSM (Englberger et al. 2003a).

The colonizers of FSM have each left their imprint on the islands, but none has been as influential as the U.S. The Spanish introduced several plants and animals to the islands (Wenkam and Baker 1973). The Germans developed systems of transportation, governance and land tenure (Wenkam and Baker 1973). The Japanese built a thriving economy, including rice plantations on the islands (Cassels 2006). In the first 20 years of U.S. administration, there was little economic investment or activity within Micronesia (Englberger et al. 2003a). However, following criticism by the United Nations, the U.S. began sending subsidies to the islands which increased quickly from $6 million in 1962 to $130 million in 1978 (Englberger et al. 2003a; Cassels 2006). Since the 1960s, there have been numerous social, economic and cultural changes that have included growth of a cash-based economy, urbanization, an influx of processed foods from the U.S.,

increased conversion to motorized land and sea transportation, and decreased traditional fishing and local agriculture (Anderson et al. 2006).

People and Agriculture

While indigenous Micronesians have always been the majority population on the islands (Anderson et al. 2006), there has been a significant and noticeable loss of Micronesian culture over the last 50 years in terms of music, dance, construction and craft skills, agriculture, religion and language, among others (Lee et al. 2001; WHO 2003a). For example, based on the current rate of traditional knowledge loss, it has been predicted that, if not prevented, knowledge of breadfruit fermentation may disappear in one generation and taro production may only survive an additional four generations (Lee et al. 2001).

The economy of the islands was traditionally based on social networks and subsistence (WHO 2003a) and the agricultural resources available were generally adequate for food production (Englberger et al. 2003a). Forty-five percent of the FSM population still engages in subsistence agriculture and household production (Hezel and Lightfoot 2005). Agriculture has also existed on a commercial level but this makes up less than one percent of total exports (FAO 2006). Exports have included betel nuts, copra, black pepper, citrus, banana and sakau (kava) from 1992 to present (Hezel and Lightfoot 2005; Shaeffer 2006). However, documented trends indicate that overall knowledge, availability, diversity and use of local food to date are decreasing (Lee et al. 2001; Englberger et al. 2003a; Englberger et al. 2008a).

Diet

Local Micronesian food includes many diverse species and cultivars of root crops, fruits from trees and fish. Traditional island meals were generally made up of a starchy staple (such as breadfruit, taro, yams and/or sweet potato) and fish or seafood (including freshwater, reef and ocean fish and crustaceans) (Englberger et al. 2003a; Cassels 2006). Meals were supplemented with leafy vegetables, coconuts and fruits (WHO 2003a). Large servings of starchy root crops were consumed, up to four kilograms daily (WHO 2003a). Sugar cane and additional fruits were eaten as snacks (Englberger et al. 2003a). The traditional diet was rich in fibre, vitamins and minerals (Englberger et al. 2003a).

As a result of foreign influence, the diet today is not the same as it was before colonization. The Spanish colonizers introduced maize, cassava, sweet potatoes, chickens and pigs (Cassels 2006). Rice became a staple following Japanese occupation (Wenkam and Baker 1973; Englberger et al. 2003a). Traditional diets incorporated some of these foods; however, the most dramatic dietary changes occurred during the American occupation (Englberger et al. 2003a; Cassels 2006).

Where the traditional meal was once breadfruit and fresh fish, it has now been replaced with rice and canned fish (Hezel 2004). A nutrition survey conducted in 1954 showed a strong reliance on local foods (Cassels 2006), while in 1986 40% of the total value of all imports to the country was imported food and drinks (Englberger et al. 2003a). Most sources agree that the major shift in diet, nutrient intake and food preference occurred in the last forty to fifty years (Englberger et al. 2003a; Anderson et al. 2006; Cassels 2006). The principal reasons for this are cited below.

Firstly, the continued dependence on foreign aid and an enhanced global food trade (Cassels 2006) has created a food dependency (WHO 2003a). With a substantial growth of the cash economy in the 1960s and 1970s resulting from the U.S. financial subsidies, imported foods became more affordable (Cassels 2006). Secondly, urbanization caused a major shift in lifestyle. Approximately 24% of the present FSM population are urban dwellers (WHO 2003a; UNICEF 2008). Many families living on the island of Pohnpei have moved from the outer islands or neighboring states to more urban dwellings with reduced access to land and have to buy their local food (Englberger 2008a). Urban families transitioned from using traditional fat-free cooking methods to fat-assisted methods and began supplementing traditional food with easily-accessible purchased foods (WHO 2003a).

Thirdly, U.S. food and agriculture programs have been implemented without significant modification or regard for the Micronesian traditional diet and local food production. One set of programs directly influencing food habits from the 1960s to the early 1990s was the United States Department of Agriculture (USDA) supplementary feeding programs, which provided food for school lunches and people in need (Englberger et al. 2003a). At one point, the school lunch program, which included rice and tinned foods, provided food for 30% of the population on 180 days of the year (Englberger et al. 2003a). A second program established in 1985 was the USDA Expanded Food and Nutrition Education Program (EFNEP), which promoted U.S. food and U.S. food guides across FSM (Englberger et al. 2003a).

Fourthly, while agricultural policies of the new FSM government were written to promote subsistence local food production, actual development efforts focused on export crops (Raynor 1991). Lastly, throughout the islands there has been a widespread belief and assumption that imported foods are superior to local foods (Englberger et al. 2003a).

As a result of this situation, imported foods became more accessible, convenient and affordable and were considered tastier and more prestigious than traditional food. It was during the last fifty years that rice consumption became a major staple in the diet, along with sugar and tinned meats (Englberger et al. 2003a). Imported cereal (white flour and rice) is now the largest provider of energy for Pacific countries (WHO 2003a). Main protein sources in the Micronesian diet are now local and canned fish, imported chicken and turkey tails (Cassels 2006). Imported poultry (chicken and turkey tail) consumption increased by 80% between 1980 and 2002 (Cassels 2006). In 1997, approximately one-quarter of fish intake was from canned sources (Cassels 2006). Many imported foods are processed and high in fat, particularly saturated fat, and/or refined sugar or flour with little fibre or micronutrients (WHO 2003a; Cassels 2006).

Health

The current population of FSM is 111,000 of whom 45% are under the age of 18 (UNICEF 2008). NR-NCDs and malnutrition are now serious problems across the country (Englberger et al. 2003a). "Nutritional imbalances at birth and in adulthood are making islander people a target for disease at both ends of the life cycle: malnutrition in its various forms early on and non-communicable diseases later in life" p.11 (Hezel 2004). The dietary and lifestyle changes discussed above are largely responsible for the health problems that are currently burdening the country's health system and its potential growth (Englberger et al. 2003a; Hezel 2004).

Obesity, chronic disease and malnutrition are relatively new phenomena in Micronesia. Early explorers of the Pacific, including Ferdinand Magellan (in 1521) and James Cook (in the 1770s), described the Islanders as muscular, well-proportioned and healthy with bountiful diets (WHO 2003a; Cassels 2006). In fact, a health survey conducted by the U.S. Navy in the 1940s (after World War II) indicated a near absence of obesity, hypertension or DM2 (Cassels 2006). Infectious disease and intestinal parasites were common causes of morbidity and mortality, DM2 and hypertension were unusual and there was little evidence of malnutrition (Englberger et al. 2003a).

Obesity

Weight gain and being 'overweight' were not traditionally viewed negatively in the Micronesian culture. Body size was and may still be regarded as a symbol of prosperity (Hezel 2004). While few Micronesians would have been called overweight one hundred years ago, chiefs were easily identifiable because they ate well and engaged in little physical activity (Hezel 2004). In the Pacific, a high value was placed on fatty foods (WHO 2003a). In addition, there is a local disdain for physical exertion when it is not required (Hezel 2004).

Currently, there is a high prevalence of overweight and obesity in FSM. The National Nutrition Survey in 1987 revealed that one third of women (aged 15-45) were moderately overweight (25 kg/m^2 < BMI < 30 kg/m^2) (Elymore et al. 1989). In 1993, 66-81% of women (aged 30-64) were overweight or obese (BMI > 25 kg/m^2) across the FSM states (Lippwe 2002). The prevalence of overweight and obesity in similarly aged men ranged between 65-92% (Lippwe 2002). The WHO STEP survey of the Pohnpei state found 44% of men and women (aged 25-64) were obese (BMI ≥ 30 kg/m^2) (WHO 1999c).

Chronic Disease

The prevalence of chronic diseases is also high. A 1992-94 study on NCDs in 4,500 adults across FSM revealed high prevalences of obesity, hypertension, DM2 and dyslipidaemia (Englberger et al. 2003a). In 2002, the prevalence of hypertension and DM2 was 17% and 12%, respectively (WHO 2003a). Mortality data indicate an increasing burden of chronic NCDs (Anderson et al. 2006). Sixty-four percent of deaths in FSM in 2002 were from chronic diseases, including cardiovascular disease, cancer, chronic respiratory disease and DM2 (WHO 2005b).

Malnutrition

There was little evidence of malnutrition in the Pacific before the 1950s (WHO 2003a). South Pacific Health Services nutrition surveys carried out between 1951 and 1970 indicate few cases of malnutrition before colonization and found that indigenous languages lacked a word for malnutrition (WHO 2003a). However in 1988, the FSM National Nutritional Survey found high rates of mild to moderate anemia (based on haemoglobin) in women aged 15-49 (Elymore et al. 1989). Anemia prevalence (based on haemoglobin) among children ranged from 10–33% in surveys

conducted in Pohnpei (1994), Yap (2000) and Kosrae (2000) (Englberger et al. 2003a). In the 1988 National Nutritional Survey, 10% of children aged 0-4 years were stunted and 13% were underweight (based on <80% of WHO standards) (Elymore et al. 1989). A 1975 study found intestinal parasites in one third of all hospitalized children (Englberger et al. 2003a).

VAD was first documented in FSM in 1988 (Lloyd-Puryear et al. 1989). VAD among FSM children has been documented as some of the most prevalent in the world (WHO 2003a). In 2000, VAD (serum retinol <20 µg/dl) among children aged 24-59 months was 63.3% and 33.8% in Kosrae and Yap, respectively (Englberger et al. 2003a). In women, the prevalence of VAD (serum retinol <30 µg/dl) was 58% in Kosrae and 11.7% in Yap (Sowell et al. 2001). A vitamin A supplementation campaign of vitamin A capsules and deworming tablets started in 1993 (Lippwe 2002). In 2005, vitamin A supplement coverage rate of children 6-59 months old was 73% (UNICEF 2008).

Pohnpei and its Traditional Food System

The current study took place in the state of Pohnpei on the volcanic island of Pohnpei, which is the largest and tallest island in FSM (Golbuu et al. 2008). It is also one of the wettest places on earth receiving 838 cm per year at its peak (Golbuu et al. 2008). Its coastline is fringed with mangrove forest and a coral reef barrier surrounds the island at two to four kilometers from the coast (Golbuu et al. 2008). The population of Pohnpei state was documented at 34,500 in 2000, making it the second most populated state in FSM after Chuuk (Englberger et al. 2003a). There is no distinct rainy season in Pohnpei and the majority of local foods are harvested year-round (Englberger et al. 2008a). The seasonal foods include breadfruit (in season May to August), yam (in season September to March), mango (in season April and May) and pandanus (generally peaking November to February) (Englberger 2005; Englberger et al. 2008a).

Nutritionally-related disorders are serious problems in Pohnpei. From 1998 to 2002, the leading causes of death were heart disease, stroke, cancer, chronic obstructive pulmonary disease and sepsis (Anderson et al. 2006). The 1994 child health survey in Pohnpei found 51% of children aged 24–47 months were VAD (serum retinol < 20 µg/dl) (Englberger et al. 2003a). A survey in 1994 of Pohnpei children aged 2-4 years revealed iron anemia (haemoglobin <11.5 g/dl) in 33% (Lippwe 2002; Englberger et al. 2003a). The shift in diet from traditional food to imported food and a change in lifestyle are thought to have contributed to these health problems (Englberger et al. 2003a).

The traditional food system of Pohnpei was documented in 2005 using modifications to a published methodology manual ({Englberger et al. 2008a; manual: Kuhnlein et al. 2004a). Over 370 different local foods[3] and food varieties (cultivars[4]) were identified from this research in the Pohnpei community of Mand (Englberger et al. 2008a). For example, 15 local cultivars of breadfruit were documented (Englberger et al. 2008a). Breadfruit was noted as the most commonly consumed local staple in FSM; it is a good source of energy and fiber and has some vitamin C (Englberger et al. 2003a). Twelve giant swamp taro cultivars were identified (Englberger et al. 2008a). These root crops have been found to be good sources of fibre and calcium, as well as provitamin A carotenoids (PAC) in yellow-fleshed varieties (Englberger et al. 2003a).

Twenty-six banana cultivars were also identified, of which 15 were yellow-fleshed (Englberger 2005). Bananas are traditionally prepared as main dishes, eaten as snacks and fed as a weaning food (Englberger et al. 2003a). In general, bananas are good sources of energy, vitamin C, potassium and fibre (Englberger et al. 2003a). Yellow-fleshed varieties are particularly rich in PAC (Englberger et al. 2003d) and some are also good sources of riboflavin, niacin and vitamin E (Englberger et al. 2006).

Twenty-five different species of vegetables were identified including 12 DGLVs (Englberger et al. 2008a). DGLVs were traditionally regarded as pig food and have been promoted in the past as a vitamin A (PAC)-rich food with limited success (Englberger et al. 2003a). Twenty-five fruit species, not including banana, were documented (Englberger et al. 2008a). However, the traditional diet does not generally include many different fruits; and while papaya and mango are good PAC sources when ripe, they are commonly eaten green. (Englberger et al. 2003a). The wealth of seafood in Pohnpei was apparent; 127 fish species and 26 seafood species were documented in this community-based survey (Englberger et al. 2008a).

Key-informant interviews and informal group discussions revealed that not all of these documented species and cultivars were consumed regularly. Some varieties were noted as rare, some fish were not hunted, while some other foods were not very popular (Englberger et al. 2008a). Negligence and over-dependence on other family members were named as major reasons why local food production and consumption has decreased in recent history (Englberger et al. 2008a).

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[3] Local food is the commonly used term in Micronesia and the Pacific for traditional food.
[4] Cultivars refer to varieties produced upon cultivation.

Study Population

The Mand community of Pohnpei island has been the principal site of the Traditional Food for Health Intervention, which was evaluated in this thesis research. It is the same community involved in the documentation of the Pohnpei traditional food system, discussed previously. Involvement of the Mand Community began in 2005 when community members and a local non-governmental organization, IFCP, joined the CINE Indigenous Peoples' Food Systems for Health program representing the Oceana region (Englberger et al. 2008a). Community selection was based on several criteria set by CINE: a community that was rural, accessible and willing to participate.

The Mand community is located in the southeast corner of Pohnpei island in the rural municipality of Madolenihmw (Englberger et al. 2008a). In 2005, over 500 people were living in Mand, which was originally founded in 1954 by 60 people who came from Pingelap, a neighboring, coral-based (atoll) island (Englberger et al. 2008a). The community is walking distance to the sea, but lacks direct access and is located 40 kilometers from Kolonia, the town center of Pohnpei, on the island-perimeter road (Englberger et al. 2008a). Each original household in Mand had agricultural land plots available for local food production located five to twenty minutes from their home (Shaeffer 2006). The average size was 27.5 m^2 based on a random sample of plots surveyed in 2005 (Shaeffer 2006). This survey also revealed that these plots were not all actively being used for food production (Shaeffer 2006).

In 2005, the community relied predominantly on producing and catching the local food consumed; 83% of surveyed households responded that over half of the local food consumed was cultivated and/or caught by the household. Local food production was generally conducted at the household level, rather than at the community level. Agroforestry production occurred along the perimeter of houses as well as on the agricultural land plots (Shaeffer 2006). Processed imported food was available at several shops in the community and 80% of households in 2005 indicated that at least one person in the household had a salaried job (Englberger et al. 2008a).

Island Food Community of Pohnpei

IFCP is based in Kolonia, the town center of Pohnpei Island. The organization is non-governmental having received its charter from the FSM national government in January 2004. The

vision of IFCP is to see Pohnpeians live on a productive, environmentally-sound island where a diversity of locally-grown island food is produced and consumed, providing food security, sustainable development, economic benefits, self-reliance, improved health, cultural preservation and human dignity and at the same time protecting the natural resources (IFCP 2007). IFCP promotes local food across the island, through awareness-building, education, agriculture, conservation, food preservation and research.

'Traditional Food for Health' Community-based Intervention

For two years, a Traditional Food for Health intervention was implemented in the Mand community by IFCP to "assist the residents of Mand to meet their food needs, increase self-reliance, improve health and nutrition, economic savings and protect agricultural biodiversity" (Levendusky 2005). Initial involvement of Mand took place for documentation of the traditional food system in the summer of 2005 (Englberger et al. 2008a). Following this, intervention activities were held from September 2005 to June 2007 with significant community involvement and inter-agency collaboration. The Mand Community Working Group (MCWG), originally formed for the documentation study, continued to meet regularly throughout the intervention period and was involved in planning and implementing intervention activities. Twenty micronutrient-rich foods were chosen by MCWG at the beginning of the intervention from the traditional food list as important and appropriate to promote for nutritional, health and cultural reasons (Englberger et al. 2008a).

A variety of methods were used to promote locally grown foods that had high potential health benefits and good acceptability (Englberger et al. 2008b). Activities focused mainly on education and agriculture. Several educational activities targeted youth and women, while others were open to the entire community. Agricultural activities promoted home gardens and agroforestry by providing planting materials, tools and training/workshops. Social marketing and media were also used to publicize the project within Mand and on the greater Pohnpei Island. In addition, smokeless charcoal ovens were built and promoted during the intervention to improve convenience and practicality of preparing traditional food.

Methods

The CINE Indigenous Peoples' Food Systems for Health program has facilitated food-based projects in twelve community settings of indigenous populations around the world, of which this thesis research is one part (CINE 2007). A comparison of pre- and post-intervention measures was decided upon by project partners to be the most appropriate methodology to evaluate the various interventions in the program (Kuhnlein et al. 2006). The single group pretest-posttest evaluative design is limited by reduced internal validity due to the influence of external events, maturation of the subjects and the educational effect of the pretest (Green and Lewis 1986). As a result, this research is not able to make conclusions about the direct effects of the intervention (Green and Lewis 1986). Rather, this evaluation attempts to highlight the community's effort (in the past two years) to make their health and well-being a priority (Kuhnlein et al. 2006).

To evaluate the effects of changing nutritional, health and socioeconomic influences, indicators must reflect a response to past and present interventions (WHO 1995). Triangulation is a method of using more than one approach to answer the same question (Nutbeam 1998). Three levels and types of outcomes can be measured to evaluate an intervention: long-term outcome measures, such as a change in mortality, morbidity or quality of life; intermediate impact or progress measures, such as a change in skills, attitudes or behaviour; and short-term process measures that examine levels of participation, program reach or recall of key messages (Green and Lewis 1986; King et al. 1994).

For this thesis study, diet, health and process indicators were used to evaluate the intervention at these three levels with the overall goal of understanding the degree of behaviour change related to traditional, locally-grown food. A single-group, pretest-posttest design was used in this thesis to evaluate diet and health status. The aim of the intervention was to improve health status through diet. Thus, diet was the intermediary step and a comparison of pre-intervention and post-intervention dietary patterns is referred to as the progress evaluation. Next, an examination of changes in health status over the intervention period formed the outcome evaluation. Finally, a process evaluation was conducted to examine how measured changes in diet and health status may have been effected by the intervention.

Health and diet were assessed by survey in the community of Mand in Pohnpei, FSM in 2005 (Englberger et al. 2008a). Then for two years, the IFCP conducted the Traditional Food for Health intervention. In 2007, a follow-up survey was conducted to assess health and dietary

changes and examine intervention implementation. This thesis research comprises the data collection in 2007, the descriptive and statistical comparison of the two time points and the overall evaluation of the intervention.

Research Design

The baseline and follow-up surveys were conducted from June to August in 2005 and 2007, respectively, during the same season, the breadfruit season. Qualitative and quantitative data approaches were used in 2007 to make follow-up observations on 2005 baseline data. Both surveys assessed health, diet and agricultural practices with similar methodology. Awareness and exposure to the intervention was also assessed by questionnaire in 2007.

The research incorporated the principles of participatory health research (WHO 2003b). Research agreements were signed in 2005 and 2007 between the Mand Community Leader, IFCP and the McGill University collaborator. These agreements explained the research purpose, informed consent, survey methodology, dissemination of results and benefits to the community and researcher (Appendix A). Collaboration for the health assessment research was granted by the FSM Department of Health and Social Affairs (Appendix B). Ethics approval for this thesis research was obtained by the McGill University Faculty of Agriculture and Environmental Sciences Research Ethics Board (Appendix C). At the individual level, informed consent was obtained verbally in 2005 and 2007. Verbal consent is more appropriate than written consent in this context given the oral culture of Pohnpei (Gordon 2000).

The 2007 survey was designed to match the methodology used in 2005 and together the two surveys form a longitudinal study on the same random sample. Diet was assessed in each survey period by two, non-consecutive, quantitative 24-hour recalls and a 7-day FFQ. The same random sample of adults (women) completed the dietary assessment in 2005 and 2007. Adult health of the community was assessed by measures of height, weight, WC, BP and FPG in 2005 and 2007. Adults were defined as individuals of 18 years of age or older during the 2005 survey. In 2005, additional information on agricultural practices, local and homegrown food use, food costs and attitudes was gathered by household questionnaires (Shaeffer 2006; Englberger et al. 2008a). In 2007, a project evaluation questionnaire was used to collect follow-up responses as well as additional information on awareness and exposure to the intervention activities and materials. The health assessments and the initial dietary interviews took place at the Mand Community Hall. The

second dietary interview and additional questionnaires were completed during household visits. While the forms and questionnaires used in the survey were written in English, the interviews were primarily conducted in Pohnpeian or Pingelapese and then transcribed in English. This method improved precision and was preferred by the multilingual interviewers.

In 2005, the random sample of 47 households was selected using a random number table and a list of all households in Mand (n=71) with the objective of including more than half of all households in the sample. Then in 2007 the same households from 2005 survey were invited to participate. These households were not targeted by the two-year intervention any more than other households; rather, intervention activities were open to the entire community. To recruit this sample during the 2007 survey, a sign was posted on the door of Mand Community Hall the day prior to the first day of survey (Appendix D). This advertisement informed participants to fast overnight for blood glucose testing and also listed the names of 2005 survey participants. House-to-house visits and announcements at church by community leaders were also used to inform participants of subsequent days of survey work.

The health assessment was open to the entire community but recruiting efforts focused on reaching adults from the random sample of households. For the dietary assessment, only one adult woman from each household in the random sample was interviewed. Between 2005 and 2007, there were several changes (migration, death, household composition changes) that reduced the number of households and individuals in the random sample. Households were defined as the group of individuals who regularly ate their meals in the same house.

Research Team

The primary research team in 2007 included twelve officers from eight different agencies, including the community of Mand, the Pohnpei Government, College of Micronesia-FSM, IFCP and McGill University. Nine of these officers were part of the original 2005 research team. In both surveys there were 4 interviewers, 2 nurses and 3 research assistants collecting primary data. All interviewers in 2007 were the same as in 2005 except for one, and all were fluent in English and Pohnpeian, with the majority also fluent in Pingelapese. The interviewers from 2005 were retrained on dietary assessment protocols in 2007, while the new interviewer received complete training. Interviewers also received training on the project evaluation questionnaire. The nurses were

professionally trained and were responsible for taking BP and FPG measurements. The research assistants were trained to measure height, weight and WC.

The thesis candidate oversaw and coordinated the 2007 collection of survey data, with much assistance from IFCP and the Mand Community. All data in 2005 and 2007 were collected by the research team over an eight week survey period from June to August. During this period, survey data were also entered electronically by the thesis candidate and one of the interviewers. Original questionnaires were stored in the IFCP office. The thesis candidate completed subsequent data management and analysis at McGill University in Montreal, Canada.

Dietary Assessment

The dietary assessment comprised of a longitudinal study with measurements taken in 2005 and 2007 from the same sample population during the breadfruit season. The focus of this assessment was to measure changes in micronutrient intake and consumption patterns over the two-year intervention period. In both surveys a 7-day FFQ and two non-consecutive 24-hour recalls were administered during one-on-one interviews to assess usual individual intake. Dietary interviews were conducted with one adult woman from each household in the random sample responding about her own diet and the diet of one child in the household between the ages of one and ten. Pohnpeian women are the primary persons in the household to purchase and prepare food (Corsi et al. 2008), and thus are the most knowledgeable about the foods eaten in the household. Only dietary data of the adult were analyzed for the purpose of this thesis. Dietary forms and methodology were consistent between surveys. At the field site, completed forms were reviewed after each interview by the thesis candidate for omissions and inconsistencies.

Food Frequency Questionnaire

A FFQ was used to examine the frequency of consumption of selected foods over a seven day period and to assess diversity of foods, species and cultivars consumed (Appendix E). The 7-day FFQ used in the 2005 and 2007 surveys was modified from FFQs previously developed for FSM (Englberger 2003; Englberger et al. 2005; Corsi et al. 2008) to include foods from the Pohnpeian traditional food system and to distinguish between imported and locally grown foods. Specific food species and cultivars were also added to obtain details on their consumption.

Thirty-three food items and 200 sub-items were included in the FFQ. For each food item, interviewers asked the participant: "On how many days in the last seven days did you eat _____?" The participant was also asked if they had eaten any of the sub-items in the past seven days; the interviewer circled the item if it had been consumed at least once. The same questionnaire was used in 2005 and 2007 except that peanut butter was added as a sub-item to 'imported fat' and 'imported sugar' food items because informal interviews prior to the 2007 survey indicated that this was a common food in the diet. Forty-seven and 43 food frequencies were taken in 2005 and 2007, respectively.

24-hour Recall

Two 24-hour recalls (Appendix F) were taken from individuals on non-consecutive days in each household at baseline (n=44) and follow-up (n=44) to estimate usual daily nutrient intake, daily intake of certain foods, consumption frequency and dietary diversity. A standardized protocol was used to obtain the foods and quantities eaten over the 24-hour recall period. Interviewers explained the 24-hour reference period and then asked about all food and drink consumed during this period. Responses were recorded one food item per line with details on raw or cooked form, cooking method, cultivar, maturity and brand names. These additional details improved the accuracy of the dietary assessment; for example, the carotenoid content of bananas varies among cultivars (Englberger et al. 2003c; Englberger et al. 2003d). Quantities consumed were then recorded using household measures. Visual aids of commonly consumed foods were provided to assist with portion size estimation. Measuring cups, plates, tablespoons, teaspoons and rulers were also provided to quantify portions of food consumed. Interviewer bias was reduced by alternating interviewers so that the repeated 24-hour recalls were not completed by the same interviewer.

Data Management

The inclusion criterion for data analysis was that each household included in the dietary assessment have complete dietary records (FFQ and two 24-recalls) from both years. There were 40 such dietary assessments representing 40 different households from the random sample. In

three of these households the respondent changed between survey years because of changes in household composition.

Data from FFQ were entered into Excel worksheets (Microsoft Office Professional Edition 2003). The 24-hour recalls were entered and analysed with FoodWorks Professional Edition (version 4.0, Xyris Software, Australia), which used Pacific Islands food composition data published by the Food and Agriculture Organization of the United Nations (FAO) (Dignan et al. 2004). Of the 119 different foods appearing in the 24-hour recalls, the majority were found in the FAO food composition database. Several green leafy vegetables (GLVs), namely chaya (*Cnidoscolus chayamansa*), chili leaves (*Capsicum annuum*), and two species of local spinach (*Alternanthera sissoo* and *Gynura crepioides*), were entered as 'tropical spinach' because individual food entries did not exist in the database. Nutrient composition of banana cultivar varieties did not exist in the database either. However, two local yellow-fleshed banana cultivars (Daiwang and Akadahn) were added to the database as the composition of these varieties has been analysed and published (Englberger et al. 2003b; Englberger et al. 2003d). The white-fleshed banana varieties were entered as either 'cooking banana' or 'ripe banana' food entries depending on their maturity when consumed. Ripe and unripe papaya (pawpaw) was also distinguished in food entries.

In addition, eggless recipes of pancake and doughnut were added to the food database to more accurately reflect local preparation. Instant noodles, or ramen, were entered consistently as magi-type noodles. All the remaining food items were closely matched to food entries appearing in the FAO database. Usual fortification of foods, namely niacin, thiamin and iron of rice, instant noodles and wheat flour, were used as they appear in the FAO database; there was no additional fortification noted in Pohnpei or added to the database. There were no missing values in the database for nutrients assessed.

Gram weights of portion sizes recorded on recalls were determined using a standard portion size list used previously in FSM (Englberger 2003; Englberger et al. 2005). Food entries in FoodWorks were grouped as either imported or local. Daily intakes from imported, local and all foods were calculated and entered into Excel. Estimates of the average daily intake values were then determined by least square mean statistics for energy, protein, fat, carbohydrate, vitamin C, vitamin A, retinol, beta-carotene equivalents (BCE), calcium and iron. To note, FoodWorks reports vitamin A as retinol activity equivalents, using 1:12 beta-carotene equivalent conversion. Individual food items and quantities consumed over the 48-hour recall period were also entered into Excel to

examine changes in consumption quantity, frequency and dietary diversity between the two survey years.

Additional Computations

Nutrient Intake

Vitamin and mineral supplement usage was infrequent and appeared in two out of 86 recall observations in 2007 and was not included in nutrient intake computations. The Goldberg cutoff method (Goldberg et al. 1991) was used to improve validity of the 24-hour recalls records by examining underreporting based on individual reported energy intakes. The cutoff method compares the ratio of the individual's average daily energy intake estimate (determined by recall) and their estimated basal metabolic rate (determined by published age- and sex-specific equations) to the published cutoff values based on two days of dietary assessment (Gibson 2005). These calculations revealed that two individuals had underreported in 2005 and five additional individuals had underreported in 2007. As a result the 24-hour recalls from seven individuals were excluded.

In another attempt to improve validity of the dietary records, lactating women, as determined by an interview question on recall forms, were excluded from nutrient analysis, because these women have larger energy and nutrient requirements and it was felt that inclusion of these women could skew the intake results. As a result seven additional women were excluded because they were lactating during one or both survey periods. In total, recalls from 14 subjects were excluded and the sample size for analysis of nutrient and quantity daily intake was 26 (n=40-14).

Dietary Diversity

Information on dietary diversity was analysed separately for both dietary assessment methods. Three scores of dietary diversity were computed for each: food group variety, species diversity and food item variety. Food groups were created for imported and local food items separately. Local food items were grouped into one of six groups: starchy staples, meat and nuts (including fish), fruit, vegetable, fat and snacks. Imported food items were grouped into the same groups with two additional groups for dairy and sweets. A food group score was calculated as the number of imported, local and total food groups consumed by the individual during the reference

period as captured by the dietary assessment tools (two days from the repeat recalls and seven days from the FFQ).

Species diversity was defined as the number of unique individual imported species, local species and total species consumed by each individual over the reference period. Cultivar varieties were not included in the score. Species distinctions of spinach, shrimp, reef fish, and tuna were not available in the food composition database and/or were not captured by dietary assessment. Similarly, the food item variety, or FVS, was the number of all food items and sub-items consumed by each individual during the reference period. Cultivar varieties were included in the score as unique food items.

All forty repeat 24-hour recalls from each year were used for this diversity analysis, rather than the reduced sample size due to Goldberg exclusion. This was done based on the assumption that while some respondents may have underreported quantities consumed, it was felt by the research team that the dietary recalls accurately captured the variety of food items consumed. Alcohol and local kava (sakau en Pohnpei) were not included in diversity scores.

Consumption Frequency

All forty food frequency questionnaires and repeat 24-hour recalls from each year were also used for consumption frequency calculations. As stated above, the recalls were assumed to accurately capture all food items consumed. Rather, the several instances of underreporting were believed to be due to misreporting of quantities consumed.

Health Status Assessment

There were 158 total survey participants in 2005 and 119 total survey participants in 2007 from the random sample of households, with 116 individuals participating in both years. In 2005 and 2007, there were also 45 and 41 volunteers who participated in the health assessments, respectively; however, these individuals were not included in data analysis. For each assessment, there are different subsets of participants who had complete measurements taken in both 2005 and 2007 and were included in data analysis: BMI – 68 individuals, WC – 84 individuals, FPG – 108 individuals and BP – 112 individuals.

The 2005 and 2007 health status assessments were conducted free of charge in the Mand Community Hall. Providing this service freely and conveniently in their village setting was considered as one way to attract participants, as the hospital charges for such assessments and may be difficult to access given its location in Kolonia. The objective of the assessment was to examine health status in a longitudinal study by taking measures of anthropometry, FPG and BP on the same individuals in 2005 and 2007. All community members aged 18 or older were invited to participate; however, only the measurements from individuals in the random sample were included in data analysis. Brief counseling at the time of the survey was provided to participants explaining each measurement and the associated health risk. The results and health risk categories were provided immediately after the health assessment to each participant on a results slip (Appendix G).

Anthropometry

Standing height was measured with a microtoise (CMS Weighing Equipment. Ltd., London). Subjects were asked to take off their shoes and stand against the wall with their heels, buttocks, upper back and head touching the wall and attention directed forward. Height was recorded with a precision of 0.1 cm.

Weight was measured using a digital electronic scale (Seca, model 890, Hamburg), reading to the nearest 0.1 kg. Women were weighed without shoes in undergarments and light clothing, normally a tee-shirt and skirt or dress. Similarly, men were weighed shoeless in undergarments and light clothing, normally a tee-shirt and shorts or light trousers.

BMI was calculated immediately for the participant using a height and weight table with colored regions indicating BMI ranges for underweight (<18 kg/m^2), normal (18-24.9 kg/m^2), overweight (25-29.9 kg/m^2) and obese (≥30 kg/m^2). Quantitative calculation of BMI for statistical analysis was completed after the survey.

WC was measured using a flexible measuring tape. For women the measurement was taken over light clothing, while men were asked to lift their shirt. The tape measure was held at the navel one finger width from the skin and measurement was taken with a precision of 0.1 cm when the participant was not holding their breath. As population-specific cutoffs have not been developed, WHO cutoffs indicating substantially increased health risk were used (greater than 88

cm for women and 102 cm for men) (WHO 1999b) . These cutoffs indicate the degree of abdominal adiposity.

Blood Pressure

BP measurements were taken by a professional nurse using a BP monitor. Participants were asked to sit for at least five minutes prior to BP measurement. Measurement was repeated for cases outside the normal ranges. When measurements indicated hypertension, the associated health risk was explained to the participant. Participants, who had high BP (>140/90 mmHg) after repeated measures, were referred to the health dispensary for further assessment and counseling.

Fasting Plasma Glucose

FPG levels were measured by a public health nurse using a mobile blood glucose monitor (Accu-Chek®, Roche Diagnostics). While whole blood from fingertip was applied to the test strip, Accu-Chek meters are calibrated to deliver plasma-like values (Roche 2008). Prior to the test, participants were asked whether they had eaten anything between midnight and arrival to the assessment site. The test was not completed on individuals in a non-fasting state, who were asked to return on the following survey day. If the FPG level was abnormal (≥126 mg/dl), the nurse explained their risk of DM2 and requested that they follow up with public health doctor at the Diabetes Control Program. The contact information for this doctor was provided on the individual results slip (Appendix G).

Data Management

All data were recorded at the field site and later entered into Excel. Inclusion criteria for data analysis were that the individual was a household member in the random sample and that measurements were taken in both 2005 and 2007. Data were examined for significant change between years as continuous variables and as health risk categories. For BP, if one of the systolic or diastolic measures fell into a risk category, the higher risk category was assigned, as is common practice (WHO and ISH 1999). When multiple BP readings were obtained, averages were taken.

Intervention Evaluation Questionnaire

A four-page, 25-question evaluation questionnaire was administered to examine non-dietary changes that may be attributable to the intervention (Appendix H). This questionnaire was developed over a two-week period as a result of considerable discussion with a Mand community leader, IFCP staff and the primary research team. The thoughtful insight and review provided by these individuals familiar with the project aided in the formulation of relevant, clear and culturally-appropriate questions. The questionnaire was structured with open-ended questions and pre-coded responses. The final survey was pilot tested on one individual unfamiliar with the project to review question comprehension. The survey interviewers were trained on this questionnaire, which was completed by one-on-one interview either following the second 24-hour recall or on a separate day.

The first part of the questionnaire elicited responses on exposure, participation and opinion of the main intervention activities and materials used. Another section examined agricultural practices of plants that were promoted and distributed during the intervention period, namely: banana, vegetables (grouped as GLVs and non-GLVs) and citrus. Additional questions related to DM2, vitamin A, local and homegrown food consumption in household and monthly spending on food. Several of these questions were formulated to obtain follow-up information on 2005 survey data (Shaeffer 2006; Englberger et al. 2008a).

Data were collected from 42 households and then entered in Excel and analysed. Responses were combined and grouped to obtain scores of awareness, exposure and practice, as well as an understanding of crop diversity between survey years. The responses were also examined for repeated themes.

Statistical Analysis

SAS (SAS for Windows, version 9.1, SAS Institute Inc., USA) was used to statistically examine the change in various measures between 2005 and 2007. A classification model with a randomized complete block (RCB) design was used to analyse data. A P-value of <0.05 was considered significant. Proc Mixed was used to examine change in dependent variables as continuous quantitative outcomes with a normal distribution. Normality was tested with Proc Univariate, using a Shapiro-Wilk statistic with a P-value >0.01 as an indication of normality. If

normality was not met, power transformations were used (in the order of logarithm, square root, cube root, fourth root). Proc Glimmix was used to examine change in dependent variables as ordered categorical variables with a binomial or multinomial distribution and for quantitative dependent variables with a binomial distribution.

Dietary Assessment

The statistical model for various dietary outcomes was:

$$\text{outcome} = \text{hsld}_i + \text{year}_j + \text{error}$$

where the outcome (dependent) variables were grams consumed, nutrient intake, consumption frequency and dietary diversity. Variation in these outcomes was examined by household (a random effect serving as the block in the RCB design) and year (2005 or 2007, a fixed effect). This model was developed similarly to a paired t-test but with the additional benefit of obtaining variance estimates for the random effects that may be useful for subsequent studies, such as power calculations for experimental design when examining similar outcome variables.

Health Assessment

The statistical model for various health outcomes was:

$$\text{outcome} = \text{hsld}_i + \text{year}_j + \text{gender}_k + \text{age}_l + \text{indvl(hsld, gender)}_{i,k} + \text{error}$$

where the outcome (dependent) variables were BMI, WC, FPG and BP. The independent variables included three fixed effects: year, gender and age and two random effects: household (hsld, the block in the RCB design) and individual (indvl). Each individual was assigned a unique number, which was nested within household and gender. Ages were grouped into five categories: 18-29, 30-39, 40-49, 50-59 and over 60. This model controls for two variables known to influence health status, namely gender and age. Unlike the paired t-test, this model produces variance estimates for the random effects that are provided for informational purposes and may be useful for subsequent studies.

BMI, WC, FPG and BP were examined as continuous dependent variables using Proc Mixed. For this analysis, systolic and diastolic BP were examined separately. Changes in health risk category were also examined statistically in Proc Glimmix using the following ordered categories: BMI – normal, overweight, obese, very obese; WC – lower risk, increased risk; FPG –

normal, abnormal; and BP – optimal/normal, high normal, mild/borderline hypertension, definite hypertension.

Results

Dietary Assessment

Diet was analysed by nutrient intake, food consumption quantity, frequency and dietary diversity. Overall, comparing diets from 2005 and 2007, micronutrient intake had increased, consumption frequency of key foods changed and the diet became more diverse. Increased local food consumption contributed a large amount to these changes. This may reflect changing food habits and behaviour change that have been influenced and promoted by the two-year intervention.

Consumption Quantity (Table 1)

Average daily quantities consumed of top imported and local food items varied between survey years. The average amount of local food consumed per individual increased from 471 grams in 2005 to 618 grams in 2007, while the quantity of imported food consumed decreased from 1,201 grams per individual in 2005 to 951 grams in 2007. The same top 15 foods, ranked by quantity, were consumed in 2005 and 2007. Of the top 15 consumed, seven were local food and included (in order from highest to lowest quantity consumed in 2007) banana, coconut, giant swamp taro, breadfruit, fresh fish, fruit and pork. The average daily consumption of these local foods increased between survey years by 6–200%, except for local fish which decreased by 31%. Top imported foods consumed were rice, chicken, sugar, canned fish, instant noodles, fruit, donuts and bread. There was a significant decrease in daily rice consumption ($P=0.0002$) from an average of 847 grams per day in 2005 to 544 grams per day in 2007. Quantities of other foods were not significantly different or did not meet normality criteria.

Energy and Nutrient Intake (Tables 2 and 3)

Energy, macronutrient and micronutrient intakes were examined in 2005 and 2007 (Table 2). Top food contributors to respective intakes are presented in Table 3. Overall, estimates of average macronutrient intakes in 2005 and 2007 were within WHO recommendations based on their contribution to energy intake except for protein which contributed more than the recommended range of 8-12% (WHO 2003a). Estimated average micronutrient intakes in both years were lower than the recommended dietary allowances (RDAs) and adequate intakes (AIs) for vitamin C,

vitamin A, calcium and iron (Institute of Medicine 1997; Institute of Medicine 2000; Institute of Medicine 2001).

Total estimated average daily energy intake decreased significantly by 11% (P=0.04) (Table 2). This was predominantly due to a significant decrease in total carbohydrate intake (P=0.03). The top five foods contributing to energy in both 2005 and 2007 were rice, chicken, local banana, local fish and canned fish (Table 3).

The significant decrease in average total daily carbohydrate intake in Table 2 is most likely explained by the significant drop in daily rice consumption (P=0.0002) (Table 1). Rice was the top contributor to carbohydrate intake in both years, followed by local banana, imported sugar products, local giant swamp taro and local breadfruit (in 2007) (Table 3). The total daily intake of protein and fat did not change significantly; consumption remained at approximately 97 grams and 62 grams, respectively (Table 2). Top five contributors to protein intake were imported chicken, local fish, rice, imported fish and local pork in both years (Table 3). Top five contributors to fat intake in 2007 were imported chicken, canned fish, oil/margarine, local coconut and local pork. This indicated several changes from 2005 when local fish was the second top contributor to fat intake.

Overall, average daily consumption of many micronutrients was higher in the 2007 survey compared to the 2005 survey. Total average daily vitamin C intake increased non-significantly from an estimated average intake of 43 mg in 2005 to 62 mg in 2007 (Table 2). The 2007 intake approaches the RDA of 75 mg of vitamin C per day for women (Institute of Medicine 2000). Local banana, breadfruit, giant swamp taro and fruit as well as imported fruit were the top five contributors to vitamin C intake in 2007 (Table 3).

Vitamin A intake increased by nine percent from 177 µg to 193 µg; however, this increase was not significant (Table 2). Average daily vitamin A intakes from both years were well below the RDA (700 µg/day for women) (Institute of Medicine 2001). However, BCE intake (the active equivalent of provitamin A carotenoids) increased significantly by 110% between 2005 and 2007, from 227 µg to 476 µg (P=0.02) (Table 2). The top five contributors to BCE intake in 2007 were local GLVs, banana, vegetables (excluding GLVs) and breadfruit as well as imported vegetables (Table 3). The contribution of these foods to BCE intake increased between 2005 and 2007 except for bananas, which actually decreased from 742 µg to 412 µg of vitamin A equivalents. While the quantity of bananas consumed increased between 2005 and 2007 (Table 1), the decrease in BCE contribution from bananas resulted from reduced consumption of the carotenoid-

rich, yellow-fleshed banana varieties. The average daily consumption of these yellow-fleshed varieties was 17 grams in 2005 but two grams in 2007 (data not tabulated). While there was a significant increase in total BCE, total daily retinol intake (another dietary form of vitamin A) did not change significantly (Table 2). The top five contributors to retinol in 2007 were canned fish, imported chicken, margarine and eggs as well as local fish (Table 3).

Total average daily calcium intake increased non-significantly from 246 mg in 2005 to 326 mg in 2007 (Table 2). These estimated average intake values did not meet the adequate intake of 1,000 mg or 1,200 mg of calcium for women of 19-50 years and 51+ years, respectively (Institute of Medicine 1997). Top contributors in 2007 were local giant swamp taro, coconut and fish, as well as imported canned fish and chicken (Table 3). Average iron intake did not change between 2005 and 2007 remaining at approximately 9 mg per day (Table 2). This does not meet the RDA for iron, which is 18 mg and 8 mg for women of 19-50 and 51+ years, respectively (Institute of Medicine 2001). Top contributors to iron in 2007 were imported chicken, rice and canned fish, as well as local banana and fish (Table 3).

Local Food Contribution

The estimate of average daily intake of energy from local food sources did not change significantly between survey years (Table 2), even though the total quantity consumed increased (non-significantly) (Table 1). Major local energy sources included banana, fish, coconut, giant swamp taro and breadfruit (Table 3).

Carbohydrate intake from local foods increased non-significantly by 38% of the 2005 intake value (Table 2). While local sources of carbohydrate increased, there was large variation in intake. As a result, the increase was not statistically significant. Top local carbohydrate sources in both years were banana, giant swamp taro, breadfruit, coconut and dryland taro (Table 3). Protein and fat intake from local foods decreased between 2005 and 2007 by 37% and 39%, respectively, from the 2005 intake values (Table 2). Only the change in fat intake was statistically significant ($P=0.04$). The decrease in both is predominantly due to less daily consumption of local fish, the consumption of which decreased from an estimated daily consumption quantity of 128 grams in 2005 to 88 grams in 2007 (Table 1). Consumption of other top local sources of protein, mainly pork and banana, did not change notably (Table 3). Coconut and pork were other top local sources of dietary fat, the consumption of which remained similar in 2005 and 2007.

Local food contributed 36-98% of all micronutrient intakes (Table 2). Estimated average daily intake of BCE, calcium and vitamin C from local foods increased between surveys, although only the change in BCE intake was significant. The significant increase in total BCE intake was due to local food contribution; the local food contribution to BCE increased significantly by 153%, from 202 µg to 512 µg (P=0.02). GLVs contributed 10-fold more to BCE intake in 2007 than in 2005, becoming the top food contributor in 2007 (Table 3). BCE contribution from local vegetables excluding GLVs (such as cucumber, tomato, bell pepper and eggplant) increased almost 10-fold becoming the third top contributor in 2007 from the seventh in 2005. The contribution of giant swamp taro increased substantially by 200%. Banana and breadfruit remained as top five contributors to BCE in both years. While total consumption of banana increased, as reflected in an increased contribution to energy in 2007, the contribution of banana to BCE and vitamin A actually decreased. As stated above, this was due to reduced consumption of yellow-fleshed bananas in 2007.

The daily retinol intake from local food decreased significantly (P=0.02) by 64%, contributing to the 12% non-significant decrease in vitamin A intake from local foods, despite increased BCE intake (Table 2). This was likely due to decreased local fish (mostly tuna) consumption, which fell from being the top contributor to retinol in 2005 to the third top contributor in 2007 (Table 3).

Increases in banana, giant swamp taro and local vegetable (including GLVs) consumption resulted in a 30% increase in vitamin C intake from local food between 2005 and 2007 (Table 2). Local food contributed 40% in 2005 and 47% in 2007 of total calcium intake. The overall top contributor to calcium was giant swamp taro, the contribution of which increased by 200% between 2005 and 2007 (Table 3). In addition, calcium contribution from coconut and GLVs were 2.5- and 10-fold greater, respectively, in 2007 compared to 2005. Local food contributed 32-33% of iron intake, sources of which included banana, fish, giant swamp taro, coconut and pork.

Imported Food Contribution

Imported food was the principle (>66%) source of energy, protein, fat and carbohydrate intake in both surveys (Table 2). However, carbohydrate intake from imported food sources decreased significantly by 27% (P=0.0007). This was mostly due to the significant decrease in rice consumption in 2007 (P=0.0002) (Table 1). Besides rice, contribution to carbohydrate intake by

sugar and wheat flour-based products (such as pancake, bread, donut and instant noodles) did not vary between survey years (Table 3).

The imported food contribution to total micronutrient intake did not change significantly between 2005 and 2007. Approximately three percent of total vitamin C intake was contributed by imported food, mostly from fruit sources. Approximately half of the vitamin A intake was from imported foods (47% in 2005 and 54% in 2007) (Table 2). This vitamin A contribution was predominantly in the form of retinol from canned fish and imported chicken (Table 3). Imported foods, mostly as vegetables and fruits, contributed 31% and 20% of the total BCE intake in 2005 and 2007, respectively. The contribution to calcium intake from imported sources, particularly canned fish and chicken, did not fluctuate significantly between survey years. The majority of iron intake was from imported sources (64%), mainly chicken, rice (due to the large consumption quantities of rice) and canned fish.

Consumption Frequency (Table 4)

There were numerous changes in consumption patterns between 2005 and 2007. Comparison of the two dietary assessment methods (FFQ and repeat, 24-hour recall) reveals general agreement in trends observed. However, the FFQ tended to capture a greater difference in consumption frequency between years than the recall method. This is likely explained by the longer reference period - seven days by FFQ rather compared to two days by recalls. Results from the FFQ are summarized below followed by the results from the 24-hour recalls. Tables 7 and 8 provide additional information on food items appearing in the FFQ and 24-hour recall.

Of the local starchy staples, giant swamp taro increased significantly from being eaten on less than one day per week in 2005 to one day per week in 2007 ($P<0.0001$). Banana consumption increased significantly; bananas were consumed an average of 2.6 days per week in 2005 and four days per week in 2007 ($P=0.0001$). There was no significant change when white-fleshed and yellow-fleshed bananas were asked about separately. White-fleshed bananas remained more frequently consumed than yellow-fleshed bananas, being eaten on three days a week while yellow-fleshed cultivars were consumed less than one day a week. Consumption of breadfruit and "other starch" (including dryland taro, yam, cassava and sweet potato) did not change significantly; these staples were consumed on four days and less than one day per week in both years, respectively.

Consumption of local fish (including seafood) occurred an average of four days per week in both years. Local meat consumption (pork, chicken, duck and dog) did not change significantly and occurred approximately one day per week.

Of the imported carbohydrates, weekly rice consumption decreased significantly from being eaten seven days per week in 2005 to six days per week in 2007 ($P<0.001$). On average, wheat 'flour products' (including instant noodles, doughnuts and pancakes) consumption frequency increased significantly from four days per week in 2005 to five days a week in 2007 ($P=0.008$). Imported (canned) fish consumption frequency remained at approximately 2.5 days per week between years, while imported meat consumption increased significantly from being eaten on average 1.7 days per week in 2005 to 2.6 days per week in 2007 ($P=0.003$). Consumption of chicken eggs, mostly an imported product, increased significantly from being consumed on one day in 2005 to 1.6 days per week in 2007 ($P=0.03$). Dairy was consumed less than one day per week in both years.

Consumption of all vegetables (local[5] and imported) increased significantly from being eaten on 1.5 days per week in 2005 to 3.4 days per week in 2007 ($P<0.0001$). When asked about separately, consumption frequency of local vegetables increased significantly from 1.4 days a week to 3.3 days a week ($P<0.0001$). Popular local vegetables eaten on a weekly basis included GLVs (particularly chaya, chinese cabbage and spinach), cucumber, bell pepper and eggplant (see Table 7 for scientific names). Imported vegetables were consumed on average less than one day per week in both years.

Consumption frequency of all fruit (local and imported) increased significantly from being eaten an average of three days per week in 2005 to 4.5 days per week in 2007 ($P<0.0001$). Local fruit was consumed an average of 3.5 days per week in 2005 and four days per week in 2007; however, this increase was not significant. Reported imported fruit consumption frequency decreased significantly but remained at less than one day per week ($P=0.0004$). Popular local fruit consumed on a weekly basis included mountain apple, pineapple, papaya, guava and citrus, while imported fruits included apples, oranges and canned pineapple (see Table 7 for scientific names).

Local drink and local snack consumption increased significantly. Consumption frequency of local snacks of sugar cane and coconut husk (the edible exterior of one coconut variety) increased from 0.3 days per week in 2005 to 0.7 days per week in 2007 ($P=0.01$). Popular local

[5] Local vegetables include traditional species as well as introduced species grown locally

drinks, including drinking coconut, madeu (made from cinnamon bark) and lemongrass tea, were consumed 2.4 days a week in 2005 and 3.2 days a week in 2007 (P=0.01). Local nut consumption consisted of chestnuts (*Inocarpus fagifer*), the frequency of which also increased significantly from 0.2 days per week in 2005 to 0.6 days per week in 2007 (P=0.01). Use of coconut fat (including coconut cream, oil and embryo) did not change significantly; consumption frequency remained at less than two days per week.

The frequency of sugar consumption (including sweet imported foods such as donuts, ice cream and cookies as well as sucrose added to local food or local drink) decreased significantly from three days a week in 2005 to two days a week in 2007 (P=0.0002). Conversely, imported drinks with sugar (including soft drinks, koolaid and sucrose added to tea and coffee) increased significantly; these drinks were consumed on two days per week in 2005 and on almost four days per week in 2007 (P<0.0001).

When foods from the repeat, non-consecutive 24-hour recalls were grouped into the same food item groups as the FFQ, far fewer significant differences in consumption frequency were found. The only significant difference was in local vegetable consumption, which increased significantly in 2007, from a consumption frequency of 0.3 to 0.6 days over the two-day recall period (P=0.04). While other trends between 2005 and 2007 paralleled those found in the FFQ, there was little difference captured in the two-day dietary records.

Dietary Diversity (Tables 5, 6, 7)

Dietary diversity was also examined to provide additional clues of dietary changes over the intervention period. Diversity was measured as the number of different food groups ('food group score'), species ('species diversity score') and food items ('food variety score') consumed over a 7-day, consecutive period measured by FFQ and a two-day, non-consecutive period measured by 24-hour recall. The FFQ captured more differences in dietary diversity than the recall, likely reflecting the larger reference period, as was found in the consumption frequency results presented above. Two statistical procedures were used to examine diversity scores between 2005 and 2007. Proc Glimmix used a true binomial distribution, whereas Proc Mixed used an approximation to the binomial distribution. Both procedures produced similar results of significance (Table 5). Lists of imported and local food species and the number of times each food species appeared in the dietary records are tabulated in Tables 6 and 7.

By FFQ, the number of 14 different food groups (six local food groups and eight imported food groups) consumed increased significantly between survey years from an estimated average of 10 in 2005 to 11 in 2007 (P=0.04) (Table 5a). Most of this change occurred within the local food groups which increased significantly from 4.8 to 5.5 groups (P=0.001). While 18% of the sample population consumed from the six local food groups in 2005, 58% consumed from the six local food groups in 2007 (data not tabulated). The imported food group score did not change significantly between years, remaining at an estimated average of five food groups. By recall method, food group scores did not change significantly; an estimated average of 3.5 local food groups and four imported food groups were consumed in both years (Table 5b).

A total of 72 different species were consumed by the sample population over a 7-day period as captured by FFQ (Table 5a). Of these, 51 were from local sources and 21 were from imported sources. By FFQ, an estimated average of 18 different species were consumed in 2007 compared to 12 different species in 2005 (P<0.0001). This increase in total dietary diversity was due to a more diverse diet of local species; the estimated average weekly consumption of local species increased significantly by five species from 12 in 2005 to 17 in 2007 (P<0.0001). In 2005, 11 species was the upper limit of local species consumed, whereas in 2007, 48% of the sample population consumed more than 11 different local species (percentage not tabulated). Imported species diversity did not change significantly.

As captured by recall, a total of 56 different species were consumed over the two-day period, of which 40 were local and 24 were imported (Table 5b). There was some overlap between imported and local food species, thus the total number of species is less than the sum of local and imported food species. According to the data captured by recall, species diversity did not differ significantly between years. The average number of total species consumed increased from 8.2 in 2005 to 8.9 in 2007, local species consumed increased from 4.4 to 4.8, and imported species remained at four.

By FFQ, 100 different local food items and 66 different imported food items were captured by the 7-day FFQ (Table 5a). An estimated average of 12 additional food items in total were consumed in 2007 compared to 2005; this 52% increase from 21 in 2005 to 33 in 2007 was significant (P<0.0001). Significant increases in local and imported food variety were also found, with increases of 65% and 37%, respectively (P<0.0001 for both). While the upper limit of local food items eaten in 2005 was 19, the upper limit in 2007 more than doubled to 43. By recall, 119

different food items were captured. Total food variety captured by recall increased from 11 to 13 in 2007; this increase was statistically significant in the Proc Mixed test (P=0.03) but not in the Proc Glimmix test for significance (Table 5b). Local and imported food variety by recall did not change significantly.

Promoted Foods Score (data not tabulated)

A 'promoted foods score' was calculated to examine changes in consumption of the key micronutrient-rich foods promoted in various activities by the IFCP. Twenty foods were originally selected by the community for promotion (Table 5 in Englberger et al. 2008a). The calculated score was the number of the top five promoted foods consumed per individual in each year. These main promoted foods were yellow-fleshed banana, giant swamp taro, breadfruit, yam and GLVs. By FFQ, there was a significant increase between 2005 and 2007 (P=0.003). In 2005, the average individual consumed less than two of these promoted local foods, whereas in 2007 the estimated average number of promoted foods consumed was 2.5. In 2005, the upper limit of promoted foods consumed was three, whereas in 2007, 25% of individuals ate more than three of these promoted foods. Results from the 24-hour recall demonstrated a modest, but non-significant increase in consumption of these foods from one in 2005 to 1.2 in 2007.

Health Status Assessment

Four measures of health status were assessed in 2005 and 2007: BMI, WC, FPG and BP. Each of these health outcomes was analysed at the individual level for effects of year, age and gender using raw measures as well as classification according to health risk. Health risk categories and corresponding cutoff measures are presented in Table 8. Overall, there was no indication of significant change in health status between the 2005 and 2007 survey years. Prevalence of obesity and DM2 remained high.

Body Mass Index (Tables 8, 9)

Estimated average BMI of the sample population did not change significantly between years, remaining at approximately 31 kg/m^2, using the outcome variable as the raw BMI value (Proc

Mixed) or BMI category (Proc Glimmix using assigned ordered categories of 1, 2, 3, 4 for normal, overweight, obese and very obese, respectively) (Table 8). In the sample population, 13% and 19% had a normal BMI in 2005 and 2007, respectively. None of the participants were underweight and the majority was obese or very obese in both years. The estimated average individual change in BMI between 2005 and 2007 was 0.4% with a nearly equal number of people gaining and losing weight (data not tabulated). The percent change ranged from an increase in BMI by 16% to a decrease of 17%.

There was a significant difference in BMI due to gender (P=0.005) (Table 8). The estimated average BMI for women was 33.6 kg/m^2, which falls in the obese range, while that of men was in the overweight range at 29.2 kg/m^2. More men than women had a normal BMI; in 2007, 35% of men and 8% of women were in normal BMI range (Table 9). Over 90% of women had BMI $\geq$ 25 kg/m^2 and 70% were obese (BMI $\geq$ 30 kg/m^2). The majority of men was overweight but not to the same extent; in both years over 64% of men had a BMI $\geq$ 25 kg/m^2 and 38% were obese or very obese. Age did not have a significant effect (Table 8). BMI among men was highest at age 30-39, while the trend of BMI among women increased moderately across the age groups (Table 9).

Waist Circumference (Table 8)

The estimated average WC of the sample population was 98 cm in 2005 and 100.5 cm in 2007; there was no significant difference between years. Over 70% of the sample population in both years had a WC indicating substantially increased risk of obesity-related illness (based on sex-specific cutoffs presented in Table 8). Between 2005 and 2007, WC of individuals changed an average of 0.8%; the largest increase observed was 18% and the largest decrease was 16% (data not tabulated). On average, women had a higher WC than men (women: 100.9 cm, men: 95.4 cm) although there was no significant effect of gender. Prevalence of increased risk was 85% among women and 41% among men (data not tabulated). The effect of age approached significance (P=0.05). The highest average WC was in the age group of 40-49 years.

Fasting Plasma Glucose (Table 8, 10)

There was no significant difference in FPG concentration or classification category (normal or abnormal) between the survey years (Table 8). Over 60% of the sample population had normal FPG levels. The prevalence of DM2 (FPG ≥ 126 mg/dl) was 34% and 38% in 2005 and 2007, respectively. The estimated average FPG concentration in both years was higher than recommended (2005: 128.2 mg/dl, 2007: 129.1 mg/dl). Several individuals with FPG levels exceeding 300 mg/dl may have skewed the estimated averages.[6]

There were 25 incidental cases of DM2 indicated by abnormal FPG in 2005 and an additional 10 cases of DM2 discovered in 2007 (i.e. these 10 individuals had normal FPG levels in 2005 and abnormal FPG levels in 2007) (Table 10). Of the 41 cases of diabetes found in 2007, 13 had been diagnosed prior to the 2005 survey (participants were questioned at check-in), 18 were incidental cases found in 2005 and 10 were incidental cases indicated in the 2007 survey.

There was no significant effect of gender on FPG levels (Table 8). The prevalence of abnormal FPG was 3-4% higher in women than men in both years (Table 10). On the other hand, age had a significant positive effect on FPG level ($P<0.0001$) (Table 8). FPG increased across age groups, particularly after 40 years of age when the estimated average FPG level was abnormal. In both survey years, more than 50% of men over 50 years had abnormal FPG levels. For women, this trend occurred in a younger age group with more than 50% of women 40 years and older having abnormal FPG levels (Table 10).

Blood Pressure (Table 8)

Over 79% of the sample population in both years had BP measurements in the optimal range and 4-5% had definite cases of hypertension. Systolic and diastolic BP measures were examined separately as continuous variables. Neither measure was significantly different between 2005 and 2007. The estimated averages in both years for systolic and diastolic BP were 115 mmHg and 73 mmHg, respectively, which fall in the optimal range. There was no significant effect of gender on BP. Systolic and diastolic BP both increased significantly with age ($P<0.0001$). The estimated average systolic BP increased with age reaching the 'high normal' risk category at age 50 years and older. The estimated average diastolic measures remained in the optimal range.

[6] There were eleven individuals with FPG >300 mg/dl in 2005 and nine individuals with FPG >300 mg/dl in 2007.

Intervention Assessment

The process evaluation of the intervention was conducted by examining the intervention activities and materials delivered and the practices that were directly facilitated by the intervention. This provided evidence of the behaviour change process as it relates to local food production and consumption. Descriptions of the 10 intervention activities and four materials included in the assessment are presented in Table 11. These activities and materials were selected because they directly involved the community of Mand. There were additional activities and materials not included in the intervention assessment that did not specifically target the Mand community but instead were island-wide targeting all Pohnpeians (Englberger et al. 2008b).

Awareness and Exposure

Intervention Activities (Table 12)

For each principal activity carried out during the intervention, respondents were asked whether they had heard about the activity (awareness), whether someone in their household had participated (exposure), their opinion of the activity and the most important thing they had learned from the activity.

Awareness of the MCWG was the highest of all 10 activities with 93% of respondents having heard about this working group. Exposure was high as well with 60% of sampled households participating in the MCWG meetings. The most important concepts learned from the this activity were the benefits of consuming and planting local food, healthy cooking and health topics including vitamin A, DM2, breastfeeding and heart disease. One respondent commented that they "learned how our culture is being neglected." One person recommended improving the records of plant distribution.

The Youth School Education activity, which took place at the Mand Elementary school, had a level of awareness of 76% and 33% of the respondents said that a child in their household had participated. The general comment among responses was that it was good training for the children. One person stated, "Students need to learn about their own local food." According to the adult responses, important concepts their children learned were that different banana varieties are nutritious, have vitamin content and are good for health. Children also learned how to make recipes using banana. One respondent commented that their daughter shared the three-banana

salad recipe she learned at school (made with orange, yellow and white-fleshed bananas) with her family. Another respondent said that their daughter did not eat bananas before the activity but now does. One recommendation made was that the program should be expanded to all grades.

The Youth Drama Club was the activity with the third highest level of awareness at 88%. Over 25% of the households sampled had a child who participated. Adults reported that their children learned about yellow-fleshed banana varieties, the vitamin content of bananas and how to create and act out a drama skit. The children also learned to share with community members the importance of local food. It was also considered to be a good activity to keep the children busy after school hours.

Eighty-three percent of respondents were aware of the Breastfeeding Support Group, while 33% of the households had at least one member participate in these regular meetings. Overall, respondents said that this was a good activity for both mother and baby. One person stated, "[We] needed to learn the facts about breastfeeding, verses the beliefs from before." Another person commented that breastfeeding was good for the community to promote. As a result of this activity, respondents learned the definition and importance of exclusive breastfeeding and how breastfeeding reduces the chances of their child getting sick.

Planting material distribution and training occurred at community working group meetings and during workshops over the intervention period. Eighty-six percent of respondents said they were aware of this activity and 50% said that someone from their household had participated. Respondents were pleased with the activity noting that, as a result, they planted more varieties, including rare varieties and are producing more local food. Some of the most important concepts learned were how to plant using new methods, make seedlings, compost and take care of their plants. Several comments made were that homegrown food can be good for health, recognizing "the benefit of using what you grow." Respondents recommended that this activity be expanded to have plant distribution more frequently, on a monthly or quarterly basis.

Seventy-six percent of respondents were aware of the Home Gardening activity and 48% of households had at least one member participate. The common themes among the responses were that the container gardens improved accessibility to and decreased cost of vegetables. One remark was that these gardens were very convenient in that they were created next to the house and require minimal space. Other respondents mentioned that they made container gardens at work, out of tires, in the back of an old truck and in plastic bags. From this training, people learned

how to make a container garden, plant seeds, transplant seedlings, compost and protect the garden from animals. However, one person commented that it was too much work to make the container and gather soil.

The Cooking Training conducted by two agriculture and nutrition extension agents had an awareness level of 83% and an exposure level of 50%. All participants appeared to enjoy sharing and learning new and healthy recipes at this workshop. One important concept appearing in the responses was that participants learned new combinations and ways of mixing food by incorporating local food into imported food dishes. For example, one respondent commented, "With this training, even with a can of meat I will add pumpkin plant tips [flowers]. Kids love it." Respondents mentioned the following local foods that they learned to mix with imported food: chili pepper, spinach, banana blossom, leafy vegetables and pumpkin plant tips.

The activity with the second highest level of awareness (90%) was the Smokeless Charcoal Oven training and distribution. The exposure level was 50%. Learning the benefits of the smokeless charcoal oven compared to the traditional oven (uhmw) was given most importance. Benefits mentioned included that it makes food preparation easier and healthier, saves time, reduces frying, reduces firewood use and uses less cooking fuel (kerosene) or electricity. Other responses were, "I use it all the time" and "Using local food in a local way [using local material for charcoal] promotes healthy living."

The sample population was least aware of and least exposed to the U.S. Ambassador's Dinner at 57% and 21%, respectively. Respondents saw this activity as a way to promote local food in a setting that allowed sharing of traditional recipes among women.

Seventy-one percent of the respondents were aware of the planting and weight loss competitions and 50% of households had participated. These competitions were focused on horticulture of uncommon varieties of food species and separately, on awareness of weight control and physical activity. The majority of responses applied to the weight loss competition; a salient theme was, "Part of health improvement is exercise." Some of the most important concepts learned were that excessive weight is linked to increased health problems, that weight can be controlled with physical activity and that physical activity improves health. A recommendation was to expand this competition. However, one person remarked that they were weighed too many times as part of the weight loss competition.

Intervention Materials (Table 12, Figure 2)

The intervention's social marketing campaign, which included posters, billboards, as well as a regular presence in the island-wide newspaper and on the local radio station, had been noticed by a broad audience. The Pohnpei Bananas Poster (Figure 2a) and the Pacific Island Indigenous Food Poster were widely recognized by 95% and 33% of the sample population, respectively. Nearly the entire sample population (98%) had seen the Go Local Billboard (Figure 2d) in 2007 compared to 76% in 2005 (2005 data not tabulated). Seventy-six percent of respondents knew about the regular media reports, which often reported on the Mand intervention (eg. Figure 2c).

Intervention Messages (data not tabulated)

Exposure to the vitamin A message was ascertained in the evaluation questionnaire in 2007 using the question, "What do yellow-fleshed bananas have a lot of that white-fleshed bananas do not have?" Overall the majority (56%) of respondents stated vitamins. Of this, 21% specifically stated vitamin A and 10% stated the most complete and accurate response, beta-carotene.

In 2005 and 2007, respondents were also asked by questionnaire what they thought was the cause of DM2. In 2005, 40% said that diet and lack of exercise cause DM2. This increased slightly in 2007, when 43% gave this combined response. Heredity was also given as a cause of DM2 by 8% in 2005 and 18% in 2007.

Practice

Household Agriculture Practices (Table 13a)

Local food production was supported by the intervention with several of the intervention activities described above. To examine the potential impact of the intervention on agricultural practice, the evaluation questionnaire in 2007 focused on banana and vegetable cultivation. Information on the number of plants planted in the past two years, the varieties planted and the source of planting materials was obtained by this questionnaire.

Bananas had been planted by 88% of respondents in the past two years. An average of 50 banana plants had been planted per household between 2005 and 2007, consisting of six different

banana cultivars - three white-fleshed varieties and three yellow-fleshed varieties (data not tabulated). Most of these banana plants had been obtained from their own land (50% of the sample population responded that they had obtained banana planting material from their own land), followed by the pilot farm (a nearby agriculture station, 48%), family and friends (43%) and the MCWG meetings (17%) (data not tabulated; more than one response was permitted thus percentages do not add to 100%).

Vegetable production was divided into two categories: GLVs and other vegetables. The majority of households (76%) had planted GLVs plants in the past two years. An average of 32 GLV plants of three different species were planted (data not tabulated). The most commonly planted GLVs included (from most to least common) spinach, Chinese cabbage, chaya, pele, kangkong and katuk. When vegetables other than GLVs were asked about separately, 67% of respondants planted one or more of these vegetables in the past two years. An average of 23 vegetable plants of three different species had been planted including (from most to least commonly planted) eggplant, cucumber, bell pepper, string beans, cassava, sweet potato and avocado (data not tabulated). Twenty-four percent of the sample population obtained their GLV planting materials from the MCWG meetings, and 29% obtained their other vegetable planting materials from these community meetings (data not tabulated). Species names are provided in Table 7.

Household Food Practices (Table 13b)

The 2007 evaluation questionnaire included questions on how much local food and homegrown food was consumed in the household and how much money was spent on food. These questions were repeated from the 2005 survey.

Overall, responses indicated that less food was spent on food in 2007 compared to 2005. Sixty-three percent of households responded that they spent more than half of their monthly salary on food in 2005. In 2007, only 33% responded that they spent more than half of their monthly salary on food. Another 33% of households in 2007 spent half of their monthly salary on food and 28% spent less than half.

The proportion of local food in the household increased moderately between years. In 2005, 89% reported that local food made up half or less than half of their household food, while in

2007, only 65% reported this. The number of households reporting that local food made up greater than 75% of their total food increased by five households from 3% in 2005 to 15% in 2007.

To understand the amount of homegrown food consumed, the question was asked: "What proportion of the local food your household consumes is homegrown?" The majority of respondents in both years reported that more than 75% of the local food consumed was homegrown – 78% in 2005 and 83% in 2007. Sixteen percent responded that homegrown food made up less than half of their local food in 2005 and 10% responded this way in 2007.

Discussion

This thesis research has served to document the changes that have occurred following a food-based intervention in a community setting using baseline and follow-up data as well as qualitative measurements. The goal of the intervention was to increase local food consumption and production and ultimately to improve health. The intervention targeted a broad audience with numerous different activities over the two-year period. It is the cumulative outcome and quality of these efforts that are documented in this evaluation, rather than the pinpointing of individual activities, materials or recipients.

The evaluation approach has been three-pronged. First, evaluation of intermediate progress examined dietary changes in consumption quantity, consumption frequency, nutrient intake and dietary diversity. Secondly, the long-term outcome of improved health status was assessed. Lastly, the process of intervention implementation was examined by self-reported responses on awareness, exposure, knowledge and opinion of activities and materials. While small in scale, the triangulation evaluative approach permitted a comprehensive examination of behaviours relating to local food that may have been influenced by the persistent messages and numerous activities of the intervention.

Limitations

There have been several limitations to this thesis research. Firstly, the evaluation design did not have the scientific rigour needed to establish a relationship of cause and effect between the intervention and observed changes. Indeed, the use of replicate comparison sites has been recommended for evaluation of food-based interventions (Ruel 2001). However, in the current study it was not possible to have even a single comparison site, because portions of the intervention had been conducted across the island, particularly the social marketing components.

Secondly, the evaluation focused on nutrition and health and did not collect extensive data on agricultural crop production and on external factors that may have affected food consumption patterns, including availability, accessibility and affordability of food. Thus, the attribution of potential causes for the changes documented is limited. What the evaluation results do suggest is that there has been an increase in good practices relating to local food. This indicates, though not conclusively, that some of the information provided by the intervention over the two-year period has been acted upon.

Thirdly, because of the longitudinal pretest-posttest design of the evaluation, the posttest responses may be biased by knowledge gained from the pretest experience two years prior and from the intervention itself. This is a potential source of experimental bias in the current study. However, if response bias was very common, then additional changes other than the ones seen would likely have been captured. For example, frequency and cultivar counts indicate that dietary patterns relating to yellow-fleshed bananas had not changed, which is contrary to one of the major messages of the intervention.

Fourthly, a two-year period may not have been sufficiently long enough to observe the effects of behaviour change relating to local food production and consumption. For example, some of the planting materials distributed require a two-year or longer cultivation period. This results in a lag time longer than two years to observe the effects from agricultural production and cultivation on food consumption. In addition the health effects resulting from increased consumption of local, nutrient-rich foods may take longer than two years to become evident. The long-term effects of fruits and vegetables as functional foods, i.e. protection against DM2 and chronic disease (Frison et al. 2006; Rao and Rao 2007), were not investigated in this evaluation.

Fifthly, a larger sample size may have improved the power to detect significant changes in diet and health status. For example, an evaluation of a nine-month social marketing intervention in Indonesia found a significant 11% increase in daily vitamin A intake (de Pee et al. 1998c). Dietary data had been collected by five cross-sectional surveys on 7,200 people each time. Based on this finding, the nine percent increase in vitamin A intake seen in the current study with a sample size of 40 perhaps could have been significant if a larger sample size had been used. However, because the current study was longitudinal in design, an even larger effect size would need to be observed compared to the cross-sectional study. Ultimately, the community size limited the size of the random sample; the community was small with 71 total households and a population of 500. A further reduction in sample size due to exclusion of underreporters and lactation for examination of nutrient intake was appropriate, but likely removed intakes at both ends of the nutrient intake ranges.

Finally, because the intervention used an inter-agency, participatory and community-based approach, the evaluation results are context-specific. There will never be a single 'how-to' handbook to implement and evaluate food-based interventions. Rather the utility of this thesis

research is to provide documentation of what happened, what changed, and what did not, so that lessons learned can be considered in other situations and geographic regions.

Progress Evaluation – Dietary Assessment

Dietary records from the same randomly selected households in both 2005 and 2007 revealed significant changes in nutrient intake, consumption frequency and dietary diversity in the adult sample interviewed. Many of these changes reflected increased local food consumption and may provide evidence of behaviour change and intervention progress. Dietary assessments taken during the breadfruit season, one of two seasons on Pohnpei, of 2005 and 2007 likely reflect typical dietary patterns. While breadfruit would not be eaten as frequently during other parts of the year, most other local and imported foods are available year-round. Only yam, mango and pandanus were not in season during the survey period, but these foods were still locally available as evidenced by their appearance in the dietary survey records. Local food was either harvested locally or purchased at markets in Kolonia, located 40 minutes by car from Mand. Processed imported foods were purchased at several shops in Mand or at grocery stores in Kolonia, which sell both processed and fresh imported items.

Of the local starchy staples, giant swamp taro and banana were particularly promoted by the intervention. During the intervention, educational activities and social marketing materials publicized the high nutrient content of different giant swamp taro and banana cultivars emphasizing yellow-fleshed varieties as particularly nutrient-rich and good for long-term health. For example, promotional posters with pictures and corresponding carotenoid contents of different giant swamp taro and banana cultivars were displayed in the community and used in workshops and trainings (Figure 2a,b). An additional tool was Banana Bingo, a game developed for the Youth School activity to help students identify nutrient-rich banana varieties (for more details see Englberger et al. 2008b). Yellow-fleshed varieties of both staples, which are higher in BCE than white-fleshed varieties, had been rated in 2005 as top foods to promote during the intervention (Englberger et al. 2008a). Consumption of the carotenoid-rich varieties of local food was encouraged during the intervention with the message that carotenoids from such local plants may have a protective effect against chronic disease and VAD (Englberger et al. 2003b). One particularly successful tool was the Pohnpei Bananas poster, which was devoted to the yellow-fleshed bananas of Pohnpei and had a 95% visibility in 2007 (Figure 2a).

Evaluation results indicated that weekly consumption of both banana and giant swamp taro increased significantly between 2005 and 2007. Giant swamp taro consumption quantity and contribution to vitamin C, BCE, and calcium was higher in 2007 than 2005. While weekly consumption of all types of banana increased significantly, there was no significant increase in frequency of yellow-fleshed banana consumption when this group was asked about separately. In fact, the total quantity of yellow-fleshed bananas consumed decreased between 2005 and 2007, from a daily consumption in the sample population of 440 g to 100 g, which decreased the contribution of bananas to vitamin A intake in 2007. Yellow-fleshed banana cultivars had been consumed by 10 individuals in 2005 and 16 individuals in 2007 by FFQ (Table 7). Consumption frequency of yellow-fleshed giant swamp taro cultivars was not included as a separate category in the FFQ.

The lack of change in yellow-fleshed banana consumption may be explained by various reasons. Firstly, while yellow-fleshed bananas are often preferred over white-fleshed bananas, they are rarer and harder to find (Englberger 2008a). Secondly, while yellow-fleshed banana varieties had been planted in the past two years (as determined by evaluation questionnaire), the cultivation period is frequently longer than two years and depends on the type of cultivar, the size of the planting material and the environmental and growing conditions (Englberger 2008b). Thirdly, it is also likely that not all of the yellow-fleshed planting materials distributed during the intervention survived. The community-based monitoring of distributed crops during the intervention period revealed that the plants had not always been properly cared for (Englberger 2008b). Yellow-fleshed varieties also take more skill and are more difficult to grow than white-fleshed varieties (Englberger 2008c). Overall it appears that the increase in frequency of banana consumption was a result of women taking better care of and harvesting more of what they already had, which were mostly white-fleshed varieties (Englberger 2008b).

Imported rice consumption decreased significantly in 2007 compared to 2005, both in frequency and average daily consumption quantity. Although rice remained the top contributor of energy and carbohydrate, decreased rice consumption likely explained the significant decreases seen in energy and carbohydrate intake. This change in rice consumption may have been affected indirectly by the intervention; rice was compared to local foods in intervention messages as the commonly consumed imported food without micronutrient or fiber content. If this was the case, it could reflect an important behaviour change of local starches replacing rice in meals. However,

changes resulting from external factors including rising rice prices cannot be ruled out. Since 2000, global rice reserves have decreased by half and for the last 25 years rice consumption has outpaced production (Bradsher 2008). Conditions of drought and plant disease in 2008 along with economic uncertainty has made countries that depend on rice imports, such as FSM, vulnerable to extreme price swings (Bradsher 2008). Yet, the dramatic changes have occurred after the 2007 survey; the yearly average volatility in rice on the Chicago Board of Trade actually decreased from 21.9 in 2005 to 17.4 in 2007 (Chicago Board of Trade 2008). Thus, it is unlikely that price fluctuations influenced the observed decrease in rice consumption.

Consumption frequency of local fish and meat did not change between 2005 and 2007; neither was there change in the local food contribution to daily protein intake. However, local food contribution to daily fat intake decreased significantly, which was likely contributed by the (non significant) decrease in average daily local fish consumption. The intervention predominantly focused on local plant foods, rather than local fish and meat. It is possible that by focusing on plant foods, the intervention indirectly affected the time and energy spent on local fish cultivation. It is also possible that this change in fish consumption reflected external fluctuations in accessibility and availability, some of which may relate to the Pacific export tuna industry and continued food dependence in FSM (Cassels 2006). Local factors of increasing fuel costs and diminishing fish resources on Pohnpei may have also contributed (Englberger 2008b; Englberger 2008c).

Weekly consumption of liver and egg increased significantly between 2005 and 2007, but these foods had not been the focus of intervention activities other than as part of nutrition education messages as good sources of retinol. Liver eaten in 2007 was predominantly from local fish including reef fish and tuna, but also from imported chicken. Total daily intake of retinol did not change and local food contribution to retinol actually decreased significantly. This may be due to the reduced local fish intake, mentioned above. In addition, liver and eggs were eaten infrequently and their long-term contribution to average retinol intake may not have been captured by two 24-hour recalls (Willet 1998).

Local vegetable consumption increased significantly in 2007 on a weekly basis by FFQ as well as on the two days captured by 24-hour recall. GLVs, as a group, contributed more to BCE, vitamin A and calcium intake in 2007 than in 2005. The significant increases in frequency of local vegetables and giant swamp taro consumption produced the significantly higher average daily BCE intake seen in 2007. In particular, the contribution of GLVs to BCE intake increased 10-fold

between 2005 and 2007. Homegrown vegetable production was directly encouraged by the home garden activities that included training workshops, creation of community demonstration plots, the distribution of planting materials, the creation of a community nursery to grow seedlings, planting competitions and cooking demonstrations that incorporated locally-grown vegetables into commonly eaten imported dishes. These intervention activities were a product of considerable collaboration and investment among the Mand Community, IFCP, the Natural Resource Conservation Service of USDA and EFNEP.

Local fruit consumption did not change significantly between survey years. Fruit planting materials for pineapple, soursop, guava and citrus were distributed during the intervention and general fruit consumption was promoted at each MCWG meeting. However, the time needed for these to grow to maturity and bear fruit is greater than the two-year period of this intervention. This may explain the lack of change in fruit consumption.

Weekly consumption of local snacks and drinks also increased significantly which may represent additional reliance on local foods outside of meal times. Weekly consumption frequency of sugar added to local food and sugar from imported products decreased significantly between 2005 and 2007; however, the consumption frequency of imported drinks containing sugar, including soft drinks increased significantly. Local snacks and drinks had been promoted and served at the MCWG meetings in place of donuts and soft drinks, which commonly accompany community meetings and gatherings. Additional messages specifically targeting soft drinks and sugar added to tea and coffee may be required.

Dietary diversity was a particularly valid measure in the study context given the large amount of biodiversity on the island of Pohnpei (Englberger et al. 2008a). Consumption of 14 different food groups, 72 different species and 166 different food items were examined as captured by FFQ. The focus among these different measures was on the diversity of local foods consumed, which had increased significantly for all FFQ-based diversity measures between 2005 and 2007. More cultivars of the promoted staple foods, breadfruit, giant swamp taro and banana, were consumed in 2007 compared to 2005 (Table 7). For example, the number of yellow-fleshed banana cultivars consumed increased from three in 2005 to seven in 2007 (by FFQ, Table 7). Cultivar and crop varieties of local foods, which are captured in the FVS, had been promoted by several posters distributed in Mand (Figure 2a,b) and had been the focus of community discussion and educational intervention activities. Cultivar variety was a key component emphasized by the

intervention: the majority of banana planting materials distributed were yellow-fleshed, different flesh colours were used in cooking demonstrations and media messages promoting local starchy staples consistently mentioned the additional nutritional benefits of eating yellow-fleshed varieties.

The local FVS is likely the most strongly associated with nutrient adequacy as it captures the micronutrient-rich cultivar varieties of local starchy staples. However, if the imported FVS is included in a total dietary diversity score, products of low dietary quality (high in sugar, salt and/or fat; low in fibre and nutrients) may reduce the ability of the score to predict nutrient adequacy. Hence, a combined approach that includes all local food species and cultivars (local FVS) and all imported food species (imported species diversity score) may be appropriate for future measures of dietary diversity in the Pohnpeian and Micronesian context. For example, all imported items that are wheat-based would be included as one item. Murphy et al. found a positive association between four different measures of dietary diversity (6 food groups, 22 food subgroups, similar-nutrient food groupings and total food items) and nutrient adequacy (Murphy et al. 2006). However, extrapolation to this context is difficult as species and cultivars were not included in the diversity scores used by Murphy et al.

Methodological Considerations

Epidemiologic evidence from prospective studies in the U.S. found high dietary diversity (measured by both high quality foods and food groups) to be associated with greater longevity and reduced incidences of cardiovascular disease, DM2 and cancer (Frison et al. 2006; Kant et al. 1995; Kant et al. 2000). The current study found that a 7-day FFQ captured far more diversity than two, non-consecutive 24-hour recalls. Perhaps an additional day of recall would have provided results comparable to the FFQ, as another study of dietary diversity found a 7-day food frequency to be comparable to three, non-consecutive 24-hour recalls (Spigelski 2004).

While only the repeat 24-hour recalls provided quantitative dietary data that was used to estimate daily energy and nutrient intakes, both the recalls and the FFQ were used to examine changing patterns of consumption frequency and dietary diversity. In general, the two types of dietary records captured similar trends between 2005 and 2007. However, the FFQ captured more changes that were significant than the 24-hour recall, likely due to the longer dietary reference period (seven days versus two days). The FFQ listed pre-defined foods items whereas the recall was open-ended. However, partially validating the FFQ for its ability to measure total dietary intake

of food, there were very few food items that appeared on the recall that were not on the FFQ. In fact, different cultivars of breadfruit and giant swamp taro were captured by the FFQ but this information was not consistently recorded during the 24-hour recall interviews.

The 24-hour recalls of seven individuals (17.5% of the sample population) were excluded from quantitative analysis because their average energy intake from one or both surveys years was lower than expected given their estimated basal metabolic rate. This exclusion criteria has been used to measure the validity of energy intake in numerous other food intake studies (Gibson 2005; Olendzki et al. 2008). Underreporting of energy intake is a common problem of self-reported dietary assessments; it is also more prevalent than overreporting and occurs more often in obese subjects (Olendzki et al. 2008). Thus, it is recommended that future dietary studies in the Pacific review quantitative dietary data for valid energy intakes during data collection and repeat interviews as necessary. Also, consideration of the potential need for exclusion due to underreporting and lactation should be made when deciding on sample size during the planning phase.

Limitations

Dietary assessments have limitations in terms of the tools used, the data collection process and specificity of food composition data. Sources of error include nonresponse bias, respondent bias, interviewer bias, respondent memory lapses, incorrect estimation of portion size, supplement usage, coding errors and handling of mixed dishes (Gibson 2005). The majority of these relate to the quantitative use of the 24-hour recall to estimate average daily nutrient intake; however, respondent bias, interviewer bias and memory lapses also may have resulted in errors of food frequency intakes and dietary diversity scores.

Nonresponse bias does not appear to be of particular concern in this study. The loss-to-follow-up among dietary assessment participants was minimal and reflected customary changes in demographics; three households moved away from the community and one participant passed away and was not replaced. Respondents from five households were replaced with another woman in the household due to changes in household composition. Social desirability may have been a cause of possible respondent bias, particularly since the sample population was the same in both 2005 and 2007 surveys. Interviewer training, individual retraining during field work and switching interviewers for the repeat 24-hour recalls were carried out to reduce sources of interviewer bias.

Interviews repeated on different days and seasons are needed in order to minimize error due to intra-individual variability (Willet 1998; Gibson 2005). In this study, 24-hour recalls were administered on two, nonconsecutive days, which may not have been sufficient when estimating 'typical' daily intakes of certain vitamins and minerals. However, this concern was nominal as assessment of nutritional adequacy was not an objective of this study. Baseline and follow-up dietary data were recorded during a single season. This was appropriate for this comparison study between two, similar time points, but the dietary information attained should not be extrapolated to the non-breadfruit season. Ultimately, the quality of data depends on the participants' willingness and ability to communicate information; this was aided by the existing familiarity between many of the interviewers and participants.

Probing questions were used in the 24-hour recall and FFQ to assist in participants' ability to recall foods. It has been reported that it is more difficult to estimate large portion sizes than small portions sizes irrespective of body weight (Gibson 2005). Given the cultural and social setting of Pohnpei where large quantities of starchy stables are consumed, this may have contributed to the degree of underreporting found in this study. Three-dimensional measurement aids of household measures and real food samples were available during the interviews to assist in portion size estimation. Bias caused by underreporting, the probability of which has been found to increase with BMI (Gibson 2005), was reduced by excluding several recall data sets.

24-hour Recall-specific Considerations

Coding errors were limited by applying rules for consistent food entry between 2005 and 2007. For example, local tuna was entered into FoodWorks as either 'tuna, composite, flesh, raw' if it was eaten raw (sashimi) or as 'tuna, composite, flesh, baked' if it was eaten cooked. If the tuna was fried, the interviewer was trained to enter the amount of oil used to fry on a separate line of the 24-hour recall form. If the interviewer did not follow this, a standard amount of oil was applied (1 tbs vegetable oil per 100 g tuna). Mixed dishes in the 24-hour recall were handled by separating the ingredients and entering each ingredient on a separate line. This minimized error and also allowed for accurate grouping of foods into food groups for diversity scores.

Limitations on the data entry by using the FAO Pacific Islands' food composition database (Dignan et al. 2004) included the lack of cultivar entries for banana, giant swamp taro, and breadfruit; missing entries for two species of GLVs: chaya (*Cnidoscolus chayamansa*) and chilli

leaves (*Capsicum annuum*); and a lack of species-specific entries for local spinach (*Alternanthera sissoo* and *Gynura crepioides*). However, the carotenoid and mineral contents of many Micronesian cultivar varieties of banana, giant swamp taro and breadfruit are known due to extensive study and analysis by Dr. Englberger and IFCP (Englberger et al. 2003b; Englberger et al. 2003c; Englberger et al. 2003d). Because names of specific banana cultivars were known by participants and recorded, the published nutrient composition data for two yellow-fleshed bananas were added to the composition database and included in the analysis to more accurately estimate average BCE, calcium and iron intakes. Unfortunately, names of giant swamp taro and breadfruit cultivars consumed during the recall period were not consistently obtained during dietary interviews, largely due to participants not knowing which cultivars they consumed. Thus, the published cultivar-specific composition data could not be used in the nutrient analysis of this study and the FAO database values were used instead (27 µg BCE/100 g edible portion of giant swamp taro and 30 µg BCE/100 g edible portion of breadfruit).

However, for the purpose of discussion, if half of the total quantity of giant swamp taro consumed had been yellow-fleshed and the median value of BCE content from published Pohnpeian cultivar varieties was applied to this portion (1400 µg/100 g edible portion, (Englberger et al. 2003b)), the giant swamp taro contribution to BCE would have increased 26-fold (from 648 µg to 17,128 µg in 2007). In this case, giant swamp taro would have been the highest contributor to BCE in both 2005 and 2007. Similarly, if half of the breadfruit quantity consumed had been yellow-fleshed with a BCE content of 410 µg/100 g edible portion (the median of published Pohnpeian varieties (Englberger et al. 2003b)), then contribution of breadfruit to BCE intake would have increased 7-fold (from 692 µg to 5,079 µg in 2007). Based on these changes, breadfruit would have been the second highest contributor to BCE after banana in 2005 and GLVs in 2007.

Thus, by not including the specific BCE content of giant swamp taro and breadfruit cultivars consumed in nutrient intake analysis, the calculated average daily BCE intake for both years was likely underestimated. Nevertheless, even without including this important contribution of yellow-fleshed cultivars of giant swamp taro and breadfruit, there were significant increases in average daily BCE intake from local food and also from total food consumed from 2005 to 2007, as noted in Table 2. If yellow-fleshed varieties had been recorded and specifically included in the analysis, a more dramatic increase in intake may have been found.

Outcome Evaluation – Health Status Assessment

Over a two-year period from 2005 to 2007, the intervention in the Mand community of Pohnpei promoted traditional food as a healthier alternative to imported food. The main intervention message was that health conditions of obesity, heart disease, DM2, cancer, VAD and anemia can be prevented and controlled by a healthy local diet, which is high in fibre, vitamins and carotenoids and low in fat. A healthy diet can reverse the deterioration in glucose tolerance commonly seen in diets high in fat and low in carbohydrate and fibre (WHO 1999b). Worldwide, it is estimated that if no one had a BMI greater than 25, then 64% of DM2 cases in men and 74% of DM2 cases in women could theoretically have been prevented (WHO 1999b).

Indeed, examination of local food contribution to nutrient intake revealed that local food was low in fat and a good source of vitamin C and BCE. Dietary fibre and healthy unsaturated fat was not measured but local food was likely a top contributor of these beneficial food components because local foods are nominally processed, fish is a good source of omega 3 fatty acids, and coconut is a good source of medium-chain fatty acids (Whitney and Rolfes 2002). However, there was no significant change in health status of the Mand community immediately following the two-year intervention. Obesity and DM2 rates remained high and hypertension was still of moderate concern. The prevalence of obesity (BMI $\geq$ 30 kg/m^2) was 57% and the estimated average WC remained at 98 cm. The situation was comparable to that of a neighboring island in FSM, Kosrae, where 59% of the entire adult population (>20 years) in 1994 was obese (BMI $\geq$ 30 kg/m^2) and the average WC was 91 cm (Shmulewitz et al. 2001).

As discussed previously, the association of BMI and obesity-related morbidity and mortality can vary across populations due to differences in body composition and proportion (WHO 1999b). For example, some Pacific populations have a lower percentage of body fat than Caucasian populations at a given BMI (WHO 1999b; Barba et al. 2004). Despite these considerations, obesity is still a significant problem in Mand; ten percent of the sample population was very obese (BMI $\geq$ 40 kg/m^2). Also, the assessment of obesity in this study is robust using both BMI and WC as measures of health risk..

The incidence and prevalence of DM2 is also a concern in the population. DM2 prevalence remained at approximately 36%. The prevalence in Mand was higher than in Kosrae where DM2 was found in 12% of the adult population, using similar diagnosis criteria (Shmulewitz et al. 2001). Hypertension (borderline and definite cases) prevalence was slightly lower in Mand at 12% in 2007

compared to Kosrae where the prevalence was 17%, using the same cutoff values (Shmulewitz et al. 2001).

Gender and age were found to be significant predictors of health status in this study. BMI was significantly higher in women than men and both FPG and BP increased significantly with age. Thus, intervention activities that targeted women were appropriate. While it appears important to target the older generation with information on DM2 and hypertension, targeting younger age groups, particularly youth, was also of particular importance to prevent the onset of such adverse health conditions.

While promotion of the traditional diet in Pohnpei is seen as an appropriate corrective and preventive public health action to address increasing prevalence of chronic disease, it may be too early to measure such long-term health outcomes of this food-based intervention. In addition, the intervention may also need to continue for more than two years in order to have sustained impact on dietary behaviour and health. Thus, it is recommended that intervention activities continue and follow-up health assessments take place at five year intervals to better document changes in health status.

According to a WHO report, the main focus of interventions and public health messages on obesity should be on obesity prevention and weight control as well as normalizing weight-related disorders and metabolic risk factors associated with excess weight, rather than weight loss (WHO 1995). "Weight gain in adult life may be associated with increased morbidity and mortality independently of the original degree of overweight" (p.312 WHO 1995). Thus, the indication of weight maintenance over a two year period in this study may in fact be indicative of a positive effect of the intervention. However, this finding cannot be confirmed at present without data from a comparison control group.

Process Evaluation – Intervention Assessment

The two-year intervention has promoted local food production and consumption using food-based strategies of education, social marketing, training and agriculture. The methods used to accomplish these strategies (targeting, promoting, collaborating and communicating) appear to have been far-reaching and comprehensive in the Mand community intervention as indicated by the high levels of awareness and exposure. The intervention also extended beyond the community and there were numerous other island-wide activities that affected Mand residents that were not

included in the intervention assessment, such as the creation of carotenoid-rich banana stamps, distribution of 'Go Local' T-shirts, and involvement in annual World Food Day activities (Englberger et al. 2008b).

The exposure level to the intervention activities was high ranging from 57-93%. As a process indicator, exposure ratings have been associated with message recall and intervention success in other studies. A nutrition education intervention in six health centres in Peru found that exposure to key activities, which ranged from 9.2% to 19.5% after the first year of the intervention, was significantly influential in explaining the extent of message recall (Robert et al. 2006). Significant improvements in energy, iron, and zinc intakes and decreased stunting were found in the experimental areas compared to control areas after the two years of the intervention (Penny et al. 2005). Similarly, in a church-based nutrition intervention in North Carolina, exposure to activities, which ranged from 61-93%, was associated with greater fruit and vegetable intake at two-years (Campbell et al. 2000).

Of the main intervention activities described here for Mand, two were targeted to youth, one was targeted to breastfeeding mothers, another was targeted to all women and six were open to the entire community. Local food promotion occurred by cooking demonstration, expansion of agroforestry crops and crop varieties, home garden development, nutrition education and social marketing. These numerous venues for promotion likely contributed to improved education about and self-efficacy of producing and preparing local foods. Smokeless charcoal ovens distributed to 34 households in the community may have also made local food preparation more feasible. Lateral promotion of physical activity occurred in group settings through education, exercise, agriculture and competition. Incorporation of physical activity was an appropriate compliment to healthy food promotion as both are necessary for health improvement.

Partnership and collaboration were integral parts of the intervention and likely contributed to the success of the intervention. IFCP worked regularly with community leaders and residents during weekly meetings of the MCWG. The Youth School Education project was conducted jointly with the Conservation Society of Pohnpei in the Mand Elementary School for two school years. The Youth Drama club was led by an instructor from the College of Micronesia – FSM during his spare time. Upon request of IFCP, the College of Micronesia-FSM Cooperative Extension Service implemented the 10-day EFNEP training in Mand. Partnership with the Natural Resource

Conservation Service made the construction of demonstration home gardens and related workshops possible.

Communication strategies and channels were numerous. Media presence was strong; regular radio broadcasts and newspaper articles highlighting the intervention activities were heard and seen by 76% of the sample population. Attractive posters with pictures and nutritional content of rare yellow-fleshed banana cultivars and other traditional foods also had high visibility among community members. Additional social marketing strategies reinforced the intervention messages and encouraged participation. Fourteen women from Mand had been photographed with the traditional dishes they prepared for community meetings. These photographs and recipes were published in the local newspaper, included in the Mand Community Recipe Book and distributed in the community. The Youth Drama club shared their creative skits about local food at the community Easter celebrations.

In essence, the message of the importance of traditional food for health was widespread and delivered numerous times. It reached community members directly through activities and materials and indirectly through family and friends. Salient themes appearing in the questionnaire responses on the intervention included the connection between eating local food and health, the practice of mixing local homegrown vegetables with meals of rice and instant noodles, the ability of regular physical activity to improve health and the transfer of information from youth to adults. While not measured, the intervention likely reinforced both self- and community-efficacy by encouraging individuals and the community as a whole to be proactive about their health. Evidence of thorough intervention implementation was that all of the intervention activities proposed in 2005 during the documentation stage by the community working group had been carried out during the intervention (Englberger et al. 2008a).

Conclusion

Faced with the pandemic of obesity and obesity-related conditions that coexist with malnutrition, it has been recommended that food and nutrition programs adopt food-based approaches that improve diet quality, employ agricultural biodiversity (recognizing its benefits for food security and health), revitalize and mobilize the indigenous and traditional food systems, improve the well-being of rural and urban populations and reintroduce indigenous staple and non-staple foods known to be rich in micronutrients and non-nutrient phytochemicals (Frison et al. 2006). The intervention approach by IFCP in Mand met this recommendation; the production and consumption of local foods known to be micronutrient and carotenoid-rich were promoted. The approach used was also multidimensional; local food promotion was incorporated with concepts of local culture, environmental sustainability and long-term food security.

Based on the evaluation results, the intervention may have successfully increased local food consumption in the community. The frequency and variety of traditional food consumption increased over the intervention period and these changes contributed to improved micronutrient intake. Health status remained unchanged, but could improve in the future if the healthy dietary patterns documented in 2007 are sustained and augmented. Increased consumption and reliance on local food means that people are more likely to meet the recommended intakes for micronutrients, particularly vitamin A, vitamin C and calcium, and are more likely to be eating a diverse diet. For health outcomes, micronutrients and phytochemicals in fruits and vegetables may correct deficiencies and prevent disease in the long-term. The low-fat and high-fibre properties of traditional Pohnpeian foods may also contribute to the correction of metabolic and hypertensive disorders if consumed in sufficient quantities and for sufficient duration. In addition to the positive health effects of reliance on the traditional diet, increased self-reliance on Pohnpei also provides for improved food security. This is particularly relevant in the current context of increasing costs of rice and fuel on the world market.

The nutrition education, health awareness, cooking training and agriculture workshops appear to be valid in that they were targeted, well-received and covered the spectrum of possible food-based strategies. In particular, the youth education, cooking demonstrations and agricultural production appear to have been particularly successful in their reach, acceptability, message penetration and influence. The rich soil and tropical climate on Pohnpei make home gardens and agroforestry plots feasible and sustainable. In addition, the Breastfeeding Support Group appears

to hold particular value to the community in terms of the long-term health and social engagement of mothers, babies and family.

This evaluation of process, progress and outcome can provide insights to affect future efforts in Pohnpei, other islands in FSM and internationally. It is recommended that the intervention continue to work with community members and leaders, youth and women to promote local food consumption and production. Methods of practical agricultural and food preparation training should be encouraged in tandem with educational workshops and social marketing (Ruel 2003). The intervention should remain community-based with strong community involvement, but should adapt to local contexts as it expands. IFCP has already begun working to increase availability of micronutrient-foods alongside its community activities by developing commercial production of locally processed banana products and preservation techniques, such as solar drying, to maintain food storage and preservation. Promotion of physical activity and weight maintenance should continue to be integrated into the intervention activities.

Diet, health and implementation process were examined to provide evidence of the food-based intervention implemented by IFCP in the community of Mand and change (or lack of change) in diet and health. While small in scale, the evaluation was able to demonstrate improved dietary quality and diversity over the two-year period. It is evident that this intervention has striven to meet the 1992 International Conference on Nutrition declaration to promote dietary diversity and use of indigenous and traditional foods to address food insecurity, malnutrition and disease. The economic and total welfare of the country depends on developing and promoting sustainable services, infrastructure, production and behaviour that will allow more self-sufficient means of providing for Micronesians. This Traditional Food for Health food-based intervention appears to be meeting this need. Both the intervention and evaluation approaches used here can be considered in other contexts around the world where micronutrient-rich traditional food is available but is not commonly consumed. It is hoped that the methodology, results, limitations and recommendations presented in this thesis will be used in planning and making follow-up observations on future food-based initiatives.

Figure 2 and Tables

Figure 2: Several intervention materials used in Pohnpei to promote local food

a – Banana poster: displaying carotenoid content of yellow-fleshed Pohnpeian bananas
b – Vitamin A poster: displaying carotenoid content of banana, giant swamp taro, breadfruit, and pandanus
c – Newspaper article on Mand Drama Club in Kaselehlie Press
d – Go Local billboard: posted in Mand community and two locations in Kolonia, Pohnpei
e – Example of two stamps developed by IFCP to promote local, micronutrient-rich bananas

Table 1: Top foods consumed by one Pohnpeian community in 2005 and 2007
by repeat, non-consecutive 24-hour recall (26 hslds/yr; 1 indvl/hsld) reported as average daily consumption

2005			2007		
Source	Food Item	average daily consumption per indvl (g)	Source	Food Item	average daily consumption per indvl (g)
imported	rice	846.9	imported	rice	544.1*
local	banana, all	131.0	local	banana, all	170.2
local	(fresh) fish	127.8	imported	chicken	149.8
imported	chicken	111.0	local	coconut product	94.2
local	breadfruit	80.8	local	taro, giant swamp	92.3
imported	sugar products	71.8	local	breadfruit	88.8
local	coconut product	41.5	local	(fresh) fish	87.9
imported	(canned) fish	39.5	imported	sugar products	62.1
imported	instant noodles	35.6	imported	(canned) fish	52.9
local	taro, giant swamp	30.8	imported	instant noodles	29.6
local	local fruit	21.4	local	local fruit	22.7
imported	canned meat	20.1	imported	imported fruit	20.7
local	pork	14.4	imported	donut	20.1
imported	bread	14.2	imported	bread	18.1
imported	donut	13.4	local	pork	16.5
quantity of local food consumed		**471.3**	**quantity of local food consumed**		**618.3**
quantity of imported food consumed		**1,201.2**	**quantity of imported food consumed**		**951.3**

* Significant decrease from 2005 (P=0.0002).
Remaining food items were compared statistically but were not normally distributed and not statistically significant.

Explanation of food items

canned fish - canned mackerel, tuna and sardines
coconut products - cream, flesh, juice and germinating
fresh fish - all local fish (tuna, mackerel and reef fish)
local fruit - excluding banana; including pineapple, pawpaw, pandanus and malay apple
sugar products - granulated sugar added to food and drinks containing sugar (incl. soft drinks)

Table 2: Average daily energy and nutrient intake in one Pohnpeian community in 2005 and 2007 by repeat, non-consecutive 24-hour recall (26 hslds/yr; 1 indvl/hsld)

		2005		2007				Variance Parameter Estimates[2]	
		LS Mean[1]	% of energy	LS Mean[1]	% of energy	% change	P-value	Household	Residual
Total	Energy (KJ)	9,879.3		8,833.4		-10.6	0.04[a]	0.01	0.04
	Carbohydrate (g)	354.6	59.8	303.7	56.5	-14.4	0.03	873.58	6,138.63
	Protein (g)	100.7	17.0	92.7	17.3	-8.0	0.39[a]	0.00	0.12
	Fat (g)	61.3	23.3	62.6	26.2	2.0	0.82	0.53	389.80
	Vitamin C (mg)	43.2		61.8		43.1	0.08[a]	0.08	0.48
	Vitamin A (µg)	176.5		193.2		9.4	0.59[a]	0.05	0.36
	Retinol (µg)	176.0		148.1		-15.8	0.30	1,058.44	9,013.64
	Beta-carotene equivalents (µg)	226.6		475.7		109.9	0.02[a]	0.00	1.25
	Calcium (mg)	246.0		326.4		32.7	0.16[a]	0.01	0.50
	Iron (mg)	9.9		9.2		-7.0	0.39[a]	0.01	0.09
			% of total[3]		% of total[3]				
Local Food Contribution	Energy (KJ)	2,286.2	23.2	2,127.6	24.3	-6.9	0.71[be]	0.00	256.57
	Carbohydrate (g)	51.1	14.8	70.3	24.6	37.7	0.24[b]	0.00	13.90
	Protein (g)	31.9	33.9	20.1	23.5	-37.2	0.06[ce]	0.18	0.72
	Fat (g)	18.6	33.3	11.3	20.1	-38.9	0.04[b]	0.10	2.40
	Vitamin C (mg)	42.0	97.6	55.0	97.0	31.0	0.21[b]	0.64	7.00
	Vitamin A (µg)	92.3	52.8	80.4	46.1	-12.9	0.59[b]	0.00	18.50
	Retinol (µg)	53.4	43.1	19.0	18.1	-64.4	0.02[b]	0.00	17.98
	Beta-carotene equivalents (µg)	202.1	68.6	511.6	79.7	153.2	0.02[b]	0.00	146.95
	Calcium (mg)	89.9	40.5	137.9	47.5	53.5	0.25[de]	0.00	1.05
	Iron (mg)	3.4	35.7	3.1	36.4	-9.2	0.67[ce]	0.00	0.16
Imported Food Contribution	Energy (KJ)	7,587.7	76.8	6,624.5	75.7	-12.7	0.09	220,635.00	4,002,796.00
	Carbohydrate (g)	294.5	85.2	216.1	75.4	-26.6	0.0007	1,122.54	5,388.80
	Protein (g)	62.2	66.1	65.2	76.5	4.8	0.68[a]	0.00	0.16
	Fat (g)	37.1	66.7	45.0	79.9	21.2	0.10[a]	0.00	0.17
	Vitamin C (mg)	1.0	2.4	1.7	3.0	67.1	0.54[de]	0.01	0.64
	Vitamin A (µg)	82.3	47.2	94.1	53.9	14.4	0.55[a]	0.03	0.63
	Retinol (µg)	70.6	56.9	85.8	81.9	21.6	0.42[a]	0.00	0.75
	Beta-carotene equivalents (µg)	92.3	31.4	130.0	20.3	40.8	0.64[e]	0.00	81,776.00
	Calcium (mg)	131.9	59.5	152.2	52.5	15.4	0.41[a]	0.18	0.40
	Iron (mg)	6.2	64.3	5.4	63.6	-11.8	0.16[a]	0.00	0.10

[1] Least square mean estimate (Standard errors (SE) of least square mean estimates cannot be obtained for transformed variables. Hence for consistency, SE are not presented.)

[2] Variance estimates are from Proc Mixed. Estimate at zero indicates that there is no variation for this parameter. Eg. There was no variance among households for total protein intake

[3] Because total, local, and imported intakes were analyzed separately, the LS Mean for local and LS Mean for imported do not exactly equal the LS Mean for total. Hence, for comparison, % of total was calculated by the sum of the LS Means for local and imported.

[a] log transformation

[b] squareroot transformation

[c] cuberoot transformation

[d] fourthroot transformation

[e] unable to find power transformation producing normality; the transformation used was closest to normality

Bold denotes significant difference

Table 3: Top foods contributing to energy and nutrient intake in one Pohnpeian community
(total intakes and percent contribution from repeat, non-consecutive 24-hour recall, 26 hslds/yr; 1 indvl/hsld)

Top Contributors to Energy

2005				2007			
Source	Food Item	Energy (KJ)	% Contribution	Source	Food Item	Energy (KJ)	% Contribution
imported	rice	113,381	44.4	imported	rice	72,842	30.4
imported	(frozen) chicken	29,585	11.6	imported	(frozen) chicken	39,513	16.5
local	(fresh) fish	22,246	8.7	local	banana, all	20,458	8.6
local	banana, all	14,183	5.6	local	(fresh) fish	13,458	5.6
imported	sugar products	10,312	4.0	imported	(canned) fish	12,449	5.2
imported	(canned) fish	9,133	3.6	imported	sugar products	12,238	5.1
local	breadfruit	6,573	2.6	local	coconut product	8,234	3.4
local	coconut product	6,248	2.4	imported	donut	8,091	3.4
imported	donut	5,386	2.1	local	taro, giant swamp	7,239	3.0
local	pork (meat)	5,311	2.1	local	breadfruit	7,226	3.0
imported	canned meat	4,987	2.0	imported	oil/margarine	6,829	2.9
imported	instant noodles	3,838	1.5	local	pork (meat)	6,090	2.5
imported	pancake (eggless)	4,325	1.7	imported	bread	4,765	2.0
imported	bread	3,746	1.5	imported	pancake (eggless)	4,601	1.9
imported	oil/margarine	3,481	1.4	imported	instant noodles	3,194	1.3

Top Contributors to Carbohydrate

2005				2007			
Source	Food Item	CHO (g)	% Contribution	Source	Food Item	CHO (g)	% Contribution
imported	rice	6,166	67.7	imported	rice	3,961	50.9
local	banana, all	880	9.7	local	banana, all	1,159	14.9
imported	sugar products	625	6.9	imported	sugar products	724	9.3
local	breadfruit	302	3.3	local	taro, giant swamp	390	5.0
imported	pancake (eggless)	223	2.4	local	breadfruit	332	4.3
imported	bread	174	1.9	imported	pancake (eggless)	237	3.0
imported	donut	139	1.5	imported	bread	222	2.9
local	taro, giant swamp	130	1.4	imported	donut	208	2.7
imported	instant noodles	125	1.4	local	coconut product	118	1.5
imported	ship biscuit	62	0.7	imported	instant noodles	104	1.3
local	local fruit	57	0.6	local	taro, dryland	66	0.8
local	yam, composite, boiled	55	0.6	imported	imported fruit	55	0.7
local	coconut product	54	0.6	local	local fruit	42	0.5
local	taro, dryland	22	0.2	local	sugar cane juice	41	0.5
imported	flour	19	0.2	imported	ship biscuit	28	0.4

Explanation of food items

canned fish - canned mackerel, tuna and sardines
coconut products - cream, flesh, juice and germinating
dairy - milk, cheese and ice cream
fresh fish - all local fish (tuna, mackerel and reef fish)
GLV - green leafy vegetables
imported fruit - apple, orange, canned pineapple and juice
local fruit - excluding banana; including pineapple, pawpaw, pandanus and malay apple
local vegetable, not GLV - includes cucumber, tomato, sweet potato and pumpkin
oil/margarine - includes butter (consumed infrequently)
other beef products - excluding canned meats; including hamburger and hot dog
peanut product - whole peanuts and peanut butter
sugar products - granulated sugar added to food and drinks containing sugar (incl. soft drinks)

Table 3: Continued

Top Contributors to Protein							
2005				2007			
Source	Food Item	Protein (g)	% Contribution	Source	Food Item	Protein (g)	% Contribution
local	(fresh) fish	811	29.5	imported	(frozen) chicken	1,016	39.0
imported	(frozen) chicken	742	27.0	local	(fresh) fish	550	21.1
imported	rice	506	18.4	imported	rice	325	12.5
imported	(canned) fish	197	7.2	imported	(canned) fish	264	10.2
imported	canned meat	105	3.8	local	pork (meat)	108	4.2
local	pork (meat)	95	3.4	local	banana, all	49	1.9
local	banana, all	36	1.3	imported	bread	39	1.5
imported	bread	30	1.1	imported	donut	31	1.2
local	breadfruit	27	1.0	local	breadfruit	30	1.2
imported	other beef products	27	1.0	imported	pancake (eggless)	28	1.1
imported	pancake (eggless)	26	0.9	local	coconut product	26	1.0
imported	egg	25	0.9	imported	instant noodles	20	0.8
imported	instant noodles	24	0.9	imported	egg	15	0.6
imported	donut	21	0.8	imported	turkey tail	13	0.5
local	coconut product	20	0.7	imported	canned meat	12	0.4

Top Contributors to Fat							
2005				2007			
Source	Food Item	Fat (g)	% Contribution	Source	Food Item	Fat (g)	% Contribution
imported	(frozen) chicken	459	29.7	imported	(frozen) chicken	601	34.8
local	(fresh) fish	224	14.5	imported	(canned) fish	215	12.4
imported	(canned) fish	156	10.1	imported	oil/margarine	184	10.7
local	coconut product	134	8.7	local	coconut product	155	9.0
local	pork (meat)	100	6.5	local	pork (meat)	115	6.6
imported	oil/margarine	94	6.1	imported	donut	108	6.2
imported	canned meat	85	5.5	local	(fresh) fish	107	6.2
imported	donut	72	4.6	imported	instant noodles	29	1.7
imported	rice	44	2.9	imported	canned meat	29	1.7
imported	instant noodles	35	2.3	imported	rice	28	1.6
imported	other beef products	29	1.9	local	pork fat	25	1.4
imported	peanut product	22	1.4	local	breadfruit	21	1.2
imported	egg	21	1.4	imported	other beef products	18	1.0
local	breadfruit	19	1.2	imported	peanut product	18	1.0
imported	dairy	10	0.6	imported	egg	13	0.7

Top Contributors to Vitamin C							
2005				2007			
Source	Food Item	Vitamin C (mg)	% Contribution	Source	Food Item	Vitamin C (mg)	% Contribution
local	breadfruit	462	32.8	local	banana, all	565	29.1
local	banana, all	430	30.5	local	breadfruit	508	26.1
local	local fruit	183	13.0	imported	imported fruit	225	11.6
imported	imported vegetable	67	4.8	local	taro, giant swamp	187	9.6
local	taro, giant swamp	63	4.5	local	local fruit	155	8.0
local	yam, composite, boiled	52	3.7	imported	imported vegetable	81	4.1
imported	imported fruit	33	2.4	local	green leafy vegetable	68	3.5
local	(fresh) fish	28	2.0	local	coconut product	53	2.7
local	coconut product	27	1.9	local	vegetable, not GLV	42	2.1
imported	other beef products	22	1.5	local	(fresh) fish	22	1.2
local	green leafy vegetable	9	0.6	local	taro, dryland	15	0.8
local	vegetable, not GLV	8	0.6	imported	(canned) fish	10	0.5
imported	(canned) fish	8	0.6	imported	other beef products	10	0.5
imported	sugar products	7	0.5	imported	dairy	1	0.1
local	taro, dryland	5	0.4	imported	instant noodles	1	0.0

Table 3: Continued

Top Contributors to Vitamin A							
2005				2007			
Source	Food Item	Vitamin A (µg)	% Contribution	Source	Food Item	Vitamin A (µg)	% Contribution
local	(fresh) fish	1,803	32.5	imported	(canned) fish	1,622	27.9
imported	(canned) fish	1,235	22.3	imported	(frozen) chicken	948	16.3
imported	(frozen) chicken	775	14.0	local	green leafy vegetable	930	16.0
local	banana, all	742	13.4	local	(fresh) fish	743	12.8
imported	egg	286	5.1	local	banana, all	412	7.1
imported	dairy	124	2.2	imported	oil/margarine	323	5.6
local	green leafy vegetable	91	1.6	local	reef fish	290	5.0
imported	imported vegetable	91	1.6	imported	egg	171	2.9
imported	oil/margarine	85	1.5	local	vegetable, not GLV	171	2.9
imported	canned meat	83	1.5	imported	dairy	114	2.0
local	breadfruit	53	0.9	imported	imported vegetable	111	1.9
local	local fruit	33	0.6	local	breadfruit	58	1.0
local	vegetable, not GLV	24	0.4	local	taro, giant swamp	54	0.9
local	yam, composite, boiled	23	0.4	imported	imported fruit	39	0.7
local	pork (meat)	23	0.4	local	local fruit	31	0.5

Top Contributors to Beta-carotene equivalents (BCE)							
2005				2007			
Source	Food Item	BCE (µg)	% Contribution	Source	Food Item	BCE (µg)	% Contribution
local	banana, all	5,134	51.3	local	green leafy vegetable	11,161	55.7
local	green leafy vegetable	1,097	11.0	local	banana, all	3,058	15.3
imported	imported vegetable	1,061	10.6	local	vegetable, not GLV	2,008	10.0
local	breadfruit	630	6.3	imported	imported vegetable	1,330	6.6
local	vegetable, not GLV	289	2.9	local	breadfruit	693	3.5
local	local fruit	272	2.7	local	taro, giant swamp	648	3.2
local	yam, composite, boiled	270	2.7	imported	imported fruit	469	2.3
imported	canned meat	268	2.7	local	local fruit	274	1.4
local	taro, giant swamp	216	2.2	imported	oil/margarine	181	0.9
imported	sugar products	140	1.4	local	taro, dryland	112	0.6
imported	imported fruit	83	0.8	imported	dairy	67	0.3
imported	dairy	82	0.8	imported	other beef products	26	0.1
imported	oil/margarine	48	0.5	imported	sugar products	5	0.0
imported	other beef products	43	0.4	imported	peanut product	1	0.0
local	taro, dryland	38	0.4	imported	(canned) fish	0	0.0

Top Contributors to Retinol							
2005				2007			
Source	Food Item	Retinol (µg)	% Contribution	Source	Food Item	Retinol (µg)	% Contribution
local	(fresh) fish	1,803	40.9	imported	(canned) fish	1,622	40.8
imported	(canned) fish	1,235	28.0	imported	(frozen) chicken	948	23.9
imported	(frozen) chicken	775	17.6	local	(fresh) fish	743	18.7
imported	egg	286	6.5	imported	oil/margarine	308	7.8
imported	dairy	117	2.6	imported	egg	171	4.3
imported	oil/margarine	81	1.8	imported	dairy	108	2.7
imported	canned meat	60	1.4	local	pork (meat)	26	0.6
local	pork (meat)	23	0.5	imported	sugar products	24	0.6
local	crab	19	0.4	imported	canned meat	15	0.4
imported	other beef products	15	0.3	imported	other beef products	7	0.2
local	pork fat	0	0.0	local	pork fat	2	0.1

Table 3: Continued

Top Contributors to Calcium							
2005				2007			
Source	Food Item	Calcium (mg)	% Contribution	Source	Food Item	Calcium (mg)	% Contribution
imported	(canned) fish	2,205	28.6	local	taro, giant swamp	3,961	32.9
local	taro, giant swamp	1,320	17.1	imported	(canned) fish	2,934	24.4
imported	rice	881	11.4	local	coconut product	634	5.3
local	(fresh) fish	804	10.4	imported	(frozen) chicken	623	5.2
imported	(frozen) chicken	430	5.6	local	(fresh) fish	589	4.9
local	banana, all	318	4.1	imported	rice	566	4.7
local	breadfruit	273	3.5	local	green leafy vegetable	521	4.3
local	coconut product	252	3.3	local	banana, all	452	3.8
imported	donut	212	2.7	imported	donut	318	2.6
imported	dairy	132	1.7	local	breadfruit	300	2.5
local	local fruit	126	1.6	imported	dairy	278	2.3
imported	bread	118	1.5	imported	bread	150	1.3
imported	egg	83	1.1	local	local fruit	114	0.9
imported	instant noodles	71	0.9	local	taro, dryland	100	0.8
imported	canned meat	68	0.9	imported	sugar products	69	0.6

Top Contributors to Iron							
2005				2007			
Source	Food Item	Iron (mg)	% Contribution	Source	Food Item	Iron (mg)	% Contribution
imported	rice	66	24.0	imported	(frozen) chicken	44	17.9
local	(fresh) fish	59	21.6	imported	rice	42	17.2
imported	(frozen) chicken	31	11.1	local	banana, all	32	12.9
local	banana, all	23	8.3	imported	(canned) fish	27	10.9
imported	(canned) fish	20	7.3	local	(fresh) fish	22	8.8
imported	canned meat	17	6.1	local	taro, giant swamp	13	5.4
local	coconut product	8	3.0	local	coconut product	10	4.2
imported	instant noodles	7	2.7	imported	instant noodles	6	2.5
local	pork (meat)	5	1.8	local	pork (meat)	6	2.3
local	taro, giant swamp	4	1.6	imported	donut	5	2.1
local	breadfruit	4	1.5	imported	bread	5	2.1
imported	bread	4	1.5	local	green leafy vegetable	5	2.1
imported	donut	3	1.3	local	breadfruit	5	1.9
imported	egg	3	1.3	imported	pancake (eggless)	3	1.3
imported	pancake (eggless)	3	1.1	local	sugar cane juice	3	1.3

Table 4: Food consumption frequency in one Pohnpeian community by 7-day FFQ and repeat, non-consecutive 24-hour recall (n= 80, 40 hslds/yr; 1 indvl/hsld)

	Food Item	Weekly Consumption (7-day FFQ, 1 count/day)			Two-day Consumption (Repeat 24-hr recall, 1 count/day)		
		LS Means[a]		P-value	LS Means[a]		P-value
		2005	2007		2005	2007	
Local	**banana, all**	**2.6**	**3.9**	**0.0001**	0.7	0.8	0.33
	banana, white-fleshed	2.9	2.9	0.86	0.7	0.8	0.41
	banana, yellow-fleshed	0.5	0.7	0.13	0.1	0.1	0.48
	breadfruit	4.0	3.8	0.41	0.7	0.7	0.87
	coconut fat	1.7	1.3	0.15	0.9	0.6	0.06
	drink, local	**2.4**	**3.2**	**0.01**	0.2	0.3	0.5
	fish, local	3.9	4.2	0.42	0.9	1.1	0.16
	fruit, local[c]	3.5	4.0	0.10	1.0	1.2	0.35
	meat, local	1.5	1.1	0.06	0.3	0.3	0.67
	nut, local	**0.2**	**0.6**	**0.01**	b	b	b
	pandanus	0.0	0.0	1	b	b	b
	snack, local	**0.3**	**0.7**	**0.01**	b	b	b
	starch, all	4.7	4.8	0.78	1.4	1.5	0.72
	starch, other[d]	0.1	0.3	0.07	0.1	0.2	0.12
	taro, giant swamp	**0.2**	**0.9**	**<0.0001**	0.2	0.2	0.45
	vegetable, local	**1.4**	**3.3**	**<0.0001**	**0.3**	**0.6**	**0.04**
Imported	**dairy[e]**	0.6	0.8	0.25	0.1	0.2	0.10
	drink, imported with sugar[f]	**2.0**	**3.6**	**<0.0001**	1.0	1.2	0.16
	egg	**1.1**	**1.6**	**0.03**	0.1	0.1	0.47
	fish, imported	2.4	2.7	0.46	0.7	0.6	0.61
	flour product	**4.1**	**5.0**	**0.008**	1.1	1.3	0.20
	fruit, imported	**0.8**	**0.2**	**0.0004**	0.0	0.1	0.27
	meat, imported	**1.7**	**2.6**	**0.003**	1.1	0.9	0.21
	rice	**6.8**	**6.1**	**<0.001**	1.9	1.8	0.29
	snack, imported	0.3	0.4	0.4	0.0	0.1	0.34
	sugar (imported product or added to local food)[g]	**3.2**	**1.9**	**0.0002**	1.1	1.4	0.06
	turkey tail	0.2	0.2	0.65	b	b	b
	vegetable, imported	0.5	0.6	0.32	0.3	0.3	0.66
Imp and Local	**fat, imported/animal**	2.1	2.4	0.46	0.6	0.9	0.08
	fried food	2.1	2.3	0.45	n/a	n/a	n/a
	fruit, all	**3.0**	**4.5**	**<0.0001**	1.1	1.3	0.27
	liver	**0.1**	**0.5**	**0.001**	n/a	n/a	n/a
	vegetable, all	**1.5**	**3.4**	**<0.0001**	0.5	0.8	0.09

Note: Food item categories defined as appear on 7-day FFQ (Appendix E). Refer to Appendix E for details not included in footnotes

a - Least square mean estimates from Proc Glimmix with binomial distribution (standard errors (SE) of least square mean estimates cannot be obtained for transformed variables; hence for consistency, SE are not presented.)

b - Analysis did not converge

c - Includes ripe banana; excludes pandanus

d - Includes dryland taro, yam, cassava, sweet potato

e - Includes butter, margarine, cheese, milk

f - Includes soft drinks, koolaid and sweetened tea and coffee

g - Includes donuts and sugar added to local food and/or local drink

n/a - Food items not categorizable or did not appear in 24-hour recall

Bold denotes significant difference

Table 5a: Dietary diversity in one Pohnpeian community in 2005 and 2007 by 7-day FFQ (40 hslds/yr; 1 indvl/hsld)

Food Group Score	2005 LS Mean[a]	2005 Range	2007 LS Mean[a]	2007 Range	P-value[b]	P-Value[c]
Total (n=14)	10.1	6 - 13	10.9	6 - 14	**0.04**	**0.04**
Local (n=6)	4.8	2 - 6	5.5	4 - 6	**0.001**	**<0.0001[d]**
Imported (n=8)	5.3	2 - 7	5.4	2 - 8	0.74	0.74[d]
Species Diversity Score						
Total (n=72)	12.4	7 - 18	18.1	9 - 29	**<0.0001**	**<0.0001**
Local (n=51)	12.3	3 - 11	17.3	5 - 23	**<0.0001**	**<0.0001**
Imported (n=21)	5.2	2 - 8	6.0	3 - 11	0.14	0.06
Food Variety Score						
Total (n=166)	21.3	11 - 31	32.5	14 - 66	**<0.0001**	**<0.0001[d]**
Local (n=100)	11.8	4 - 19	19.5	8 - 43	**<0.0001**	**<0.0001[d]**
Imported (n=66)	9.4	3 - 16	12.8	5 - 24	**<0.0001**	**0.0003**

Table 5b: Dietary diversity in one Pohnpeian community in 2005 and 2007 by repeat, non-consecutive 24-hour recall (40 hslds/yr; 1 indvl/hsld)

Food Group Score	2005 LS Mean[a]	2005 Range	2007 LS Mean[a]	2007 Range	P-value[b]	P-Value[c]
Total (n=14)	7.4	4 - 11	8.0	4 - 12	0.19	0.14
Local (n=6)	3.4	2 - 6	3.6	0 - 6	0.58	0.39
Imported (n=8)	4.0	2 - 7	4.4	2 - 7	0.21	0.13
Species Diversity Score						
Total (n=56)[f]	8.2	5 - 15	8.9	4 - 16	0.25	0.10
Local (n=40)	4.4	2 - 9	4.8	0 - 10	0.32	0.24
Imported (n=24)	4.2	2 - 9	4.3	2 - 9	0.76	0.72[d]
Food Variety Score						
Total (n=119)	11.3	7 - 21	12.6	6 - 29	0.09	**0.03**
Local (n=56)	4.7	2 - 10	5.4	0 - 12	0.18	0.15
Imported (n=63)	e	3 - 17	e	3 - 15	e	0.30

a Least square means computed with Proc Glimmix (Standard errors (SE) of least square mean estimates cannot be obtained for transformed variables. Hence for consistency, SE are not presented.)

b Year effect tested with Proc GLIMMIX, binomial distribution

c Year effect tested with Proc MIXED with arcsine transformation

d Nonnormal distribution

e Analysis did not converge

f Due to overlap the total number of species is less than the sum of local and imported species

Bold denotes significant difference

Definitions:

Food Groups Score - the number of different food groups consumed by the individual over the reference period

Local Food Groups (6): starchy staples, meat and nuts (including fish), fruit, vegetable, fat and snacks

Imported Food Groups (8): starchy staples, meat and nuts (including fish), fruit, vegetable, fat, snacks, dairy and sweets

Species Diversity Score - the number of unique individual species, excluding cultivars, consumed over the reference period

Food Variety Score - the number of all food items and sub-items, including cultivars, consumed over the reference period

Table 6: Imported food species consumed in one Pohnpeian community as captured by 24-hour recall and 7-day FFQ (40 hslds/year; 1 indvl/hsld)

Food Group	Imported Food	Description	24-hour recall		FFQ	
			2005 1 count/ 2d	2007 1 count/ 2d	2005 1 count/ 7d	2007 1 count/ 7d
starch	**rice**	white	39	39	40	38
starch	**wheat**	ramen, bread, flour	30	34	35	40
meat	**chicken**	meat, egg	27	30	20	34
meat	**beef products**	canned meat, hamburger	13	6	23	19
meat	**turkey**	turkey tail	0	2	5	7
fish	**mackerel**	canned	12	13	22	28
fish	**sardines**	canned	0	1	1	5
fish	**tuna**	canned	13	9	18	21
nuts	**peanut**	whole, butter	3	4	0	3
dairy	**dairy product**	milk, ice cream, cheese	3	3	10	16
vegetable	**brocolli**		2	1	n/a	n/a
vegetable	**cabbage**	european	3	2	2	3
vegetable	**carrot**		3	2	1	6
vegetable	**chili**		1	0	n/a	n/a
vegetable	**corn**		4	0	0	1
vegetable	**cucumber**		0	0	3	0
vegetable	**garlic**		0	4	n/a	n/a
vegetable	**lettuce**		0	0	1	0
vegetable	**onion**		2	7	n/a	n/a
vegetable	**potato**	fresh, canned	3	2	0	3
vegetable	**tomato**	fresh, canned	1	2	1	2
fruit	**apple**		0	1	2	2
fruit	**grapes**		0	0	1	0
fruit	**guava**	juice	0	1	n/a	n/a
fruit	**orange**	whole, juice	2	1	1	0
fruit	**pineapple**	canned	0	2	8	3

Note: count is the number of households who consumed the food item at least once during the reference period

n/a - food did not appear on FFQ

Table 7: Local food species and cultivars consumed in one Pohnpeian community as captured by 7-day FFQ and 24-hour recall (40 hslds/year; 1 indvl/hsld)

Food Group	Common Name	Cultivar, description or (local name)	Scientific Name[a]	FFQ		24-hour recall	
				2005 1 count/ 7d	2007 1 count/ 7d	2005 1 count/ 2d	2007 1 count/ 2d
starchy staple	**breadfruit**	(mei)	*Artocarpus altilis / mariannensis*	38	33	22	22
		ripe unseeded		16	13	n/c	n/c
		green unseeded		15	22	n/c	n/c
		green seeded		0	2	n/c	n/c
		ripe seeded		0	3	n/c	n/c
starchy staple	**taro, dryland**	(sewa)	*Colocasia esculenta*	5	4	1	5
starchy staple	**taro, giant swamp**	(mweiang)	*Cyrtosperma merkusii*	9	17	6	9
	yellow-fleshed	Pwiliet (Pwilies)		2	5	n/c	n/c
	yellow-fleshed	Simihden		0	2	n/c	n/c
	yellow-fleshed	Sounpwong Weneu		0	1	n/c	n/c
	yellow-fleshed	Tekatek (Sekasek)		0	3	n/c	n/c
starchy staple	**yam**	(kehp)	*Dioscorea* spp.	0	6	1	0
starchy staple	**tapioca**	cassava / tapioca (dapiohka)	*Manihot esculenta*	0	2	0	1
starchy staple	**sweet potato**	(pidehde)	*Ipomea batatas*	0	3	0	1
starchy staple	**banana**	(wis)	*Musa* spp.	33	36	23	24
	white-fleshed	Inahsio (Aroh wis)		2	5	0	2
	white-fleshed	Kaimana (Lokoei)		14	15	3	8
	white-fleshed	Utin Menihle		7	14	0	1
	white-fleshed	Pihsi/Fiji		8	13	1	5
	white-fleshed	Utin Ruk/lihli (Wis in Ruk)		8	13	19	11
	white-fleshed	Utin Wai/ Cavendish (Wis in Wai)		n/a	n/a	0	1
	yellow-fleshed	Akadahn (Lakadahn)		2	1	0	1
	yellow-fleshed	Karat (Wis Karat)		0	3	0	0
	yellow-fleshed	Daiwang		6	7	5	2
	yellow-fleshed	Utimwas		0	2	0	0
	yellow-fleshed	Utin Iap (Wis in Iap)		0	1	0	0
	yellow-fleshed	Utin Kerenis		0	1	0	0
	yellow-fleshed	Utin Rais/Kudud (Sendohki)		2	1	0	1
nuts	**chestnut**	mworopw (mwerepw)	*Inocarpus fagifer*	8	14	1	0

Table 7: Continued

Food Group	Common Name	Cultivar, description or (local name)	Scientific Name[a]	FFQ		24-hour recall	
				2005 1 count/ 7d	2007 1 count/ 7d	2005 1 count/ 2d	2007 1 count/ 2d
fish	**tuna, skipjack and yellowfin**	(lesapwil; pweipwei)	*Katsuwonus pelamis; Thunnus albacares*	13	20	17	19
fish	**reef fish**	fresh, dried	*over 100 different fish*	28	33	14	20
fish	**mackerel, double-lined**	(pweir)	*Grammatorcynus bilineatus*	n/a	n/a	6	2
other seafood	**crab, mangrove**	(elimoang)	*Scylla sirreda*	0	1	1	0
other seafood	**lobster**	(urehna)	*Panilurus spp.*	0	2	0	0
other seafood	**shrimp**	(likedepw)	*Palaemon serrifer*	1	3	0	0
meat	**chicken**	(malek)	*Gallus domesticus*	5	7	0	1
meat	**dog**	(kidi)	*Canis familiaris*	1	0	0	0
meat	**duck**	(deki)	*Aytha fuligula*	0	1	0	0
meat	**pork**	meat, fat (koaso;pwihk)	*Sus scrofa*	17	18	14	11
green leafy veg	**pumpkin**	leaves, flesh (pwengkin)	*Cucurbita moschata*	0	1	0	2
green leafy veg	**chili**	leaves, pepper (sele)	*Capsicum annuum*	2	4	0	2
green leafy veg	**kangkong**	swamp cabbage (kangkong)	*Ipomoea aquatica*	4	6	0	2
green leafy veg	**pele**	(bele)	*Hibiscus manihot*	2	8	0	0
green leafy veg	**spinach, Brazilian and Okinawa**	(sipinis)	*Alternanthera sissoo; Gynura crepidioides*	0	13	3	6
green leafy veg	**chinese cabbage**	(cabbage)	*Brassica chinensis*	2	14	2	5
green leafy veg	**chaya**	(chaya)	*Cnidoscolus chayamansa*	3	15	1	3
green leafy veg	**drumstick**	moringay (drumstick)	*Moringa oleifera*	n/a	n/a	0	1
other veg	**beans**	(pihns)	*Vigna sesquipedalis*	0	4	0	0
other veg	**bell pepper**	(bell pepper)	*Capsicum annuum*	1	11	0	1
other veg	**cucumber**	(kiuhri)	*Cucumis sativus*	7	13	6	3
other veg	**eggplant**	(nasupi; eggplant)	*Solanum melongena*	0	7	0	1
other veg	**ginger**	(sinter; sinser)	*Zingiber officinale*	n/a	n/a	1	0
other veg	**leek**	(nira; lihk)	*Allium schoenoprasum*	0	4	0	0
other veg	**onion, green**	(nengi)	*Allium cepa*	1	8	0	1
other veg	**tomato**	(domado)	*Lycopersicon esculentum*	0	4	0	2

Table 7: Continued

Food Group	Common Name	Cultivar, description or (local name)	Scientific Name[a]	FFQ		24-hour recall	
				2005 1 count/ 7d	2007 1 count/ 7d	2005 1 count/ 2d	2007 1 count/ 2d
fruit	**rose apple, bell apple**	(apel en wai; apeltik; apolsikisik)	*Eugenia jambos*	1	6	0	0
fruit	**citrus**	(karer, karertik;karersik)	*Citrus aurantifolia*	0	13	9	11
fruit	**guava**	(kuahpa)	*Psidium guajava*	3	9	2	0
fruit	**mango**	(kehngid)	*Mangifera indica*	5	2	0	0
fruit	**malay / mountain apple**	(apel en Pohnpei)	*Syzygium malaccensis*	0	20	1	2
fruit	**pandanus**	(kipar)	*Pandanus tectorius*	2	2	2	0
		Swaipwepwe		0	1	n/c	n/c
		Aspwirek		1	0	n/c	n/c
fruit	**papaya / pawpaw**	(memiap; keiniap)	*Carica papaya*	4	15	1	2
fruit	**pineapple**	(pweinaper; pweiniaper)	*Ananas comosus*	10	17	8	5
fruit	**soursop**	(sei)	*Annona muricata*	1	1	0	1
fruit	**starfruit**	(ansu)	*Averrhoa carambola*	n/a	n/a	1	0
fruit	**watermelon**	(sihka; wedamelon)	*Citrullus vulgaris*	0	6	0	1
drinks/spices	**cinnamon**	(madeu)	*Cinnamomum carolinense*	3	8	1	0
drinks/spices	**lemongrass**	(lemon grass)	*Cymbopogon citratus*	0	11	1	2
drinks/spices	**sugar cane**	(sehu; seu)	*Saccharum officinarum*	8	14	0	1
coconut	**coconut**	cream, oil, flesh, embryo (ering; pahr)	*Cocos nucifera*	45	36	30	24

Note: count is the number of households who consumed the food item at least once during the reference period

n/a - food did not appear on FFQ

n/c - not captured by 24-hour recall

a - species names taken from Table 3 in Englberger, L., A. Lorens, et al. (2008). Documentation of the Traditional Food System of Pohnpei. Indigenous Peoples' Food Systems: the Many Dimensions of Culture, Diversity and Environment for Nutrition and Health. in H. Kuhnlein, B. Erasmus and D. Spigelski. Rome, United Nations Food and Agriculture Organization (in press) and spelling has been verified with one other publication (using The International Plant Names Index, FAO Databases, etc.)

Table 8: Results from health assessments in 2005 and 2007 in one Pohnpeian community and statistical analysis of effects of year, age and gender

Outcome	n = obs (indvls/yr)	Descriptive Statistics			Statistical Analysis			
			2005	2007	Least Square Mean[a]	P-value[a]	P-value[b]	Variance estimates[a]
BMI (kg/m²) Categories: normal 18-24.9; overweight 25-29.9; obese 30-39.9; very obese ≥40	n = 136 (68/yr)	Median	30.6	31	[e] year: 2005= 31.4; 2007=31.4 age: A=30.8, B=31.6, C=30.9, D=30.9, E:32.9 **gender: m=29.24, f=33.55**	year (P=0.78) age (P=0.46) **gender (P=0.005)**	*(multinomial distribution)* year NS (P=0.78) age NS (P=0.44) **gender SS (P=0.006)**	hsld 13.446 indvl 27.51 residual 2.1
		Range	18.3 – 50	20 – 51.9				
		health risk:	**n (%)**	**n (%)**				
		normal	9 (13)	13 (19)				
		overweight	21 (31)	16 (24)				
		obese	31 (46)	32 (47)				
		very obese	7 (10)	7 (10)				
Waist Circumference (cm) Categories: increased risk >88cm (f) >102cm (m)	n = 84 (42/yr)	Median	98	100.5	[e] year: 2005=98.12, 2007=98.21 age: A=90.11, B=99.95, C=101.35, D= 99.58, E=99.84 gender: m=95.43, f=100.9	year (P=0.94) age (P=0.05) gender (P=0.16)	*(binomial distribution)* d	hsld 0 indvl 100.47 residual 24.87
		Range	71.2–131.4	71.2-129.5				
		health risk:	**n (%)**	**n (%)**				
		lower risk	10 (24)	12 (29)				
		increased risk	32 (76)	30 (71)				
Fasting Plasma Glucose (mg/dl) Categories: normal FPG < 126mg/dl; abnormal FPG ≥ 126mg/dl	n = 216 (108/yr)	Median	111	114	[f] year: 2005=128.2, 2007=129.1 **age: A=110.49, B=110.2, C=142.0, D=140.8, E=151.4** gender: m=124.7, f=132.8	year (P=0.74) **age (P<0.0001)** gender (P=0.17)	*(binomial distribution)* year NS (P=0.78) **age SS (P=0.003)** gender NS (P=0.28)	hsld 1.45E-6 indvl 2.0E-6 resid 1.39E-6
		Range	79-436	85-496				
		diabetes risk:	**n (%)**	**n (%)**				
		normal	71 (66)	67 (62)				
		abnormal	37 (34)	41 (38)				
Blood Pressure (mmHg) Categories: optimal/normal <130/85; high normal 130-139/85-89; mild/borderline hypertension 140-159/90-99; definite hypertension ≥160/100	n = 224 (112/yr)	Systolic: Median	110	110	Systolic[e] year: 2005=114.8, 2007=115.1 **age: A=101.4, B=107.8, C=114.9, D=122.2, E=128.4** gender: m=116.6, f=113.3	Systolic year (P=0.85) **age (P<0.0001)** gender (P=0.28)	*(multinomial distribution)* d	Systolic hsld 10.31 indvl 157.24 resid 125.77
		Systolic: Range	90-195	90-180				
		Diastolic: Median	70	70				
		Diastolic: Range	40-120	50-98				
		hypertension:	**n (%)**	**n (%)**				
		optimal/normal	93 (83)	89 (80)	Diastolic[e] year: 2005=72.6, 2007=73.1 **age: A=66.1, B= 68.1, C=74.3, D=75.7, E=80.0** gender: m=74.1, f=71.6	Diastolic year (P=0.64) **age (P<0.0001)** gender (P=0.16)	*(multinomial distribution)* d	Diastolic hsld 4.12 indvl 41.64 resid 67.17
		high normal	8 (7)	9 (8)				
		mild/borderline	7 (6)	8 (7)				
		definite	4 (4)	6 (5)				

a Proc Mixed (outcomes as continuous variables). Note: standard errors (SE) of least square mean estimates cannot be obtained for transformed variables. Hence for consistency, SE are not presented.

b Proc Glimmix (outcome as health risk category)

c Age categories: A(18-29), B(30-39), C(40-49), D(50-59), and E(over 60)

d Analysis did not converge

e No transformation

f Reciprocal transformation

Bold denotes significant difference

Table 9: Body Mass Index (BMI) results from one Pohnpeian community in 2005 and 2007 by gender and age category (n=136; 68 indvls/yr)

2005 Men	n	BMI kg/m^2 Mean (sd)	normal BMI 18-24.9 n (%)	overweight BMI 25-29.9 n (%)	obese BMI 30-39.9 n (%)	very obese BMI ≥ 40 n (%)
18-29y	9	29.5 (8.4)	4 (44)	1 (11)	3 (33)	1 (11)
30-39 y	1	33.1 (n/a)	0	0	1 (100)	0
40-49 y	7	27.4 (5.7)	2 (29)	2 (29)	3 (43)	0
50-59 y	9	29.0 (4.8)	2 (22)	4 (44)	3 (33)	0
60+ y	3	26.3 (1.4)	0	3 (100)	0	0
subtotal	29	28.8 (6.0)	8 (28)	10 (35)	10 (35)	1 (3)
Women	**n**		**n (%)**	**n (%)**	**n (%)**	**n (%)**
18-29 y	6	28.9 (4.1)	1 (17)	1 (17)	4 (67)	0
30-39 y	12	33.5 (7.1)	0	5 (42)	5 (42)	2 (17)
40-49 y	15	35.2 (5.7)	0	2 (13)	10 (67)	3 (20)
50-59 y	3	31.9 (5.3)	0	2 (67)	1 (33)	0
60+ y	3	36.0 (12.2)	0	1 (33)	1 (33)	1 (33)
subtotal	39	33.1 (6.6)	1 (3)	11 (28)	21 (54)	6 (15)
grand total	68	31.3 (6.7)	9 (13)	21 (31)	31 (46)	7

2007 Men	n	BMI kg/m^2 Mean (sd)	normal BMI 18-24.9 n (%)	overweight BMI 25-29.9 n (%)	obese BMI 30-39.9 n (%)	very obese BMI ≥ 40 n (%)
18-29y	7	28.1 (9.6)	4 (57)	1 (14)	1 (14)	1 (14)
30-39 y	2	38.0 (2.1)	0	0	2 (100)	0
40-49 y	8	28.9 (5.6)	2 (25)	2 (25)	4 (50)	0
50-59 y	8	28.0 (5.0)	2 (25)	4 (50)	2 (25)	0
60+ y	4	28.5 (7.1)	2 (50)	1 (25)	1 (25)	0
subtotal	29	29.0 (6.8)	10 (35)	8 (28)	10 (35)	1 (3)
Women	**n**		**n (%)**	**n (%)**	**n (%)**	**n (%)**
18-29 y	5	29.1 (4.4)	1 (20)	2 (40)	2 (40)	0
30-39 y	10	34.5 (7.5)	1 (80)	1 (10)	5 (50)	3 (30)
40-49 y	12	33.8 (7.0)	1 (8)	2 (17)	8 (67)	1 (8)
50-59 y	8	33.5 (4.2)	0	1 (13)	6 (75)	1 (13)
60+ y	4	33.7 (11.1)	0	2 (50)	1 (25)	1 (25)
subtotal	39	33.3 (6.7)	3 (8)	8 (21)	22 (56)	6 (15)
grand total	68	31.5 (7.0)	13 (19)	16 (24)	32 (47)	7 (10)

Table 10: Fasting plasma glucose (FPG) results from one Pohnpeian community in 2005 and 2007 by gender and age categories (n=216, 108 indvls/yr)

2005 Men	n	FPG mg/dl Mean (sd)	FPG mg/dl Range	Normal FPG n (%)	Abnormal FPG[a] n (%)	New cases
18-29 y	18	105 (12)	87 - 138	17 (94)	1 (6)	1
30-39 y	3	114 (15)	101 - 131	2 (67)	1 (33)	1
40-49 y	11	143 (74)	93 - 358	7 (64)	4 (36)	4
50-59 y	9	166 (66)	104 - 303	3 (3)	6 (67)	3
60+ y	3	205 (116)	101 - 330	1 (33)	2 (67)	0
subtotal	44	134 (61)	87 - 358	30 (68)	14 (32)	9
Women						
18-29 y	21	110 (32)	79 - 196	17 (81)	4 (19)	4
30-39 y	17	120 (40)	86 - 258	12 (71)	5 (29)	5
40-49 y	19	199 (107)	102 - 374	9 (47)	10 (53)	5
50-59 y	3	223 (185)	109 - 436	2 (67)	1 (33)	0
60+y	4	180 (111)	113 - 345	1 (25)	3 (75)	2
subtotal	64	149 (87)	79 - 436	41 (64)	23 (36)	16
grand total	108	143 (77)	79 - 436	71 (66)	37 (34)	25

2007 Men	n	FPG mg/dl Mean (sd)	FPG mg/dl Range	Normal FPG n (%)	Abnormal FPG[a] n (%)	New cases
18-29 y	15	110 (19)	87 - 148	12 (80)	3 (20)	3
30-39 y	4	111 (12)	98 - 126	3 (75)	1 (25)	1
40-49 y	13	136 (60)	96 - 301	9 (69)	4 (31)	0
50-59 y	8	187 (79)	100 - 312	2 (25)	6 (75)	0
60+ y	4	234 (179)	116 - 496	2 (50)	2 (50)	0
subtotal	44	143 (78)	87 - 496	28 (64)	16 (36)	4
Women						
18-29 y	19	110 (26)	89 - 195	16 (84)	3 (16)	2
30-39 y	15	112 (19)	85 - 156	11 (73)	4 (27)	2
40-49 y	16	189 (96)	96 - 395	7 (44)	9 (56)	1
50-59 y	9	170 (97)	102 - 415	3 (33)	6 (67)	1
60+y	5	239 (165)	110 - 434	2 (40)	3 (60)	0
subtotal	64	149 (86)	85 - 434	39 (61)	25 (39)	6
grand total	108	146 (82)	85 - 496	67 (62)	41 (38)	10

[a] abnormal FPG ≥126 mg/dl

Table 11: List of intervention activities and materials included in evaluation assessment of one Pohnpeian community

Activity	Description	Approach	Group Targeted
Community Working Group	Community meetings took place for two years on a weekly or bimonthly basis. Initially the group met to document their traditional food system. Then, during the intervention, members planned intervention activities, monitored food production, discussed healthy eating, vitamin A, diabetes, anemia and heart disease and displayed and shared local foods.	Community Involvement and Collaboration	All
Youth School Education	As part of an island-wide Youth-to-Youth school education program of the Conservation Society of Pohnpei, IFCP visited grades 4 and 5 of Mand Elementary School to teach children about local banana varieties, the health value of Pohnpei bananas and encourage banana consumption as snacks and in various recipes.	Education	Youth
Youth Drama Club	Led by an instructor from the College of Micronesia-FSM, children learned the nutritional and health value of local island food through song, dance and skits. The club performed several times, including at the 2006 Mand Easter celebration.	Education	Youth
Breastfeeding Support Group	A group of mothers from Mand met regularly with IFCP staff and an Agriculture and Nutrition Extension Agent to discuss exclusive breastfeeding, complementary feeding, healthy eating and physical exercise. Beliefs and taboos relating to breastfeeding were discussed, such as the idea that eating more increases breastmilk production.	Education	Women
Planting Material Distribution	Over 20 different crops were distributed, including yellow-fleshed banana cultivars, spinach, chaya, taro, pineapple, citrus and soursop. Training on planting and caring for plants accompanied distribution. Monitoring of plant growth was conducted regularly.	Practice (agriculture)	All
Home Gardening	In partnership with Natural Resource Conservation Service of USDA, container gardens and raised beds were constructed on 14 sites to grow vegetables including chinese cabbage, cucumber and eggplant. Public workshops were held on propagation and planting of these crops.	Practice (agriculture)	All
Cooking Training (EFNEP)	This training by EFNEP (Expanded Food and Nutrition Education Program) and initiated by IFCP was part of a 10-day training focusing on the development and use of home gardens. Cooking demonstrations were conducted on how to use home grown vegetables to make healthy and tasty recipes.	Education and Practice (cooking)	Women

Table 11: Continued

Activity	Description	Approach	Group Targeted
Smokeless Charcoal Ovens	Over 30 ovens were built by and distributed to community members to make cooking local foods easier and healthier (compared to frying) and decrease air emissions. The goal was to increase consumption of locally grown foods and decrease reliance on imported foods. A competition was also held to encourage use of the ovens.	Practice (cooking)	All
Ambassador's Dinner	This potluck dinner took place at the U.S. Ambassador Suzanne Hale's residence. The purpose was to encourage preparation of local recipes made with 95% local food.	Practice (cooking)	All
Planting and Weight Loss Competitions	The planting competitions were completed with local food crops of taro, banana, citrus, soursop and vegetables. These were conducted several times over the two-year period in the community and also in conjunction with annual agricultural fairs. Planting tools were given as awards. One weight loss competition was held among women to increase awareness of the health risks of obesity and encourage physical activity.	Practice (agriculture, physical activity) & Social Marketing	All (weight loss - women)

Materials	Description	Category
Pohnpei Bananas Poster	This poster displays color photographs and indicates the beta-carotene content of 15 yellow-fleshed banana cultivars. A message on the poster encourages consumption of these bananas "to help protect against diabetes, heart disease, certain cancer, vitamin A deficiency and anemia." These posters are widely displayed in Mand and Pohnpei at local markets, health clinics, schools, etc.	Social Marketing
Pacific Island Indigenous Food Poster	This poster, produced by FAO and CINE, celebrates the 2nd International Decade of the World's Indigenous Peoples. The colorful pictures of local foods and food preparation on the poster were taken in Mand. Text describes the diversity and micronutrient content of various foods. Several copies of this poster were given to	Social Marketing
Go Local Billboard	One "Go Local" billboard was put up in the Mand community and two others were placed in Kolonia to promote healthy living through local foods. The image depicts a family engaged in local food cultivation surrounded by pandanus, Karat, breadfruit, coconut, taro and other local crops.	Social Marketing
Newspaper	Articles about the intervention were written regularly in the local newspaper, the Kaselehlie Press, by IFCP staff. Subjects included recipe sharing, describing the results of the 2005 survey and publicizing traditional foods. Numerous articles included recipes and photographs of traditional Mand dishes and Mand women.	Social Marketing - media island-wide
Radio	Information about the intervention activities was broadcast regularly on the local radio station.	Social Marketing - media island-wide
Additional outreach materials	FSM postal stamps of carotenoid-rich bananas, 'Go Local' T-shirts, IFCP email network	Social Marketing

Table 12: Process indicators for intervention activities and materials that took place in one Pohnpeian community
(indicators obtained from various sources including IFCP intervention log, newspaper articles, and by 2007 evaluation questionnaire)

Activity	Exposure[b] (n=42)	Awareness[a] (n=42)	Duration	Frequency	Number of Meetings or Visits	Total Participants	Regular Participants	Other
Community Working Group	60%	93%	2 years	weekly - bimonthly	78	126	11	62% women
Charcoal Ovens	50%	90%	8 months	n/a	8	34	n/a	34 smokeless charcoal ovens constructed; each household built their own
Youth Drama Club	29%	88%	6 months	monthly	3 performances; 6 meetings in 2006	20 in first; 10 in second	n/a	ages 10 - 12
Planting Material Distribution	50%	86%	8 months	throughout	n/a	34	n/a	types of plants distributed - 21
Cooking Training	50%	83%	10 days	once	10	25	n/a	
Breastfeeding Support Group	33%	83%	7 months	bimonthly	12	43	34	ages 15-37
Youth School Education	33%	76%	8 months	varied	13	42	n/a	ages 9-15
Home Gardening	48%	76%	12 months	varied	5	20 at first workshop	14 households	14 home gardens constructed, 4 workshops held, 1 nursery created
Planting and Weight Loss Competitions	50%	71%	2 years	2 planting competitions, 1 weight loss competition	n/a	planting competition - 23; weight loss competition - ~40	n/a	over 5 different fruits and vegetables were planted; weight loss participants wanted to be weighed monthly to track progress
U.S. Ambassor's Dinner	21%	57%	1 time	n/a	1	90 (15 from Mand)	n/a	30 different traditional dishes shared

Materials	Frequency	Exposure[c] (n=42)
Pohnpei Bananas Poster	n/a	95%
Pacific Island Indigenous Food Poster	n/a	33%
Go Local Billboard	n/a	98%
Newspaper	bi-monthly	76%
Radio	weekly - biweekly	

a: respondent heard about (from 2007 evaluation questionnaire)
b: someone from household had participated (from 2007 evaluation questionnaire)
c: respondent had seen material (from 2007 evaluation questionnaire)

Table 13a: Household agricultural practices in one Pohnpeian community in 2007
(by questionnaire, n=42)

agriculture fair	64% Participated in past 2 years
planting bananas	88% Planted in past 2 years
planting GLVs	76% Planted in past 2 years
planting vegetables other than GLVs	67% Planted in past 2 years

Table 13b: Household food practices in one Pohnpeian community (by questionnaire)

Proportion of family's salary spent on food:		
	2005 (n=38)	2007 (n=40)
zero	0%	3%
less than half	16%	28%
half	11%	33%
more than half	63%	33%
all	0%	0%
DNK	11%	5%
NR	0%	0%

Proportion of hsld food that is local food:		
	2005 (n=37)	2007 (n=40)
0-25%	35%	25%
26-50%	54%	40%
51-75%	8%	15%
76-100%	3%	15%
NR	0%	3%
DNK	0%	3%

Proportion of local food is home grown:		
	2005 (n=37)	2007 (n=40)
0-25%	11%	5%
26-50%	5%	5%
51-75%	5%	3%
76-100%	78%	83%
NR	0%	3%
DNK	0%	3%

GLVs - green leafy vegetables
DNK - does not know
NR - no response

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Appendices

A. 2007 Research Agreement

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Appendix 1

2007 RESEARCH AGREEMENT

Island Food Community of Pohnpei (IFCP), Community of Mand, and Centre for Indigenous Peoples' Nutrition and Environment (CINE)

The community and the researchers associated with this project agree to conduct this research with the following understanding.

1. The purpose of this research project, as discussed and understood by the community, is:

- To evaluate the two-year, community-based intervention Pohnpei Traditional Food for Health that has promoted the production and use of micronutrient-rich, local food on the island of Pohnpei in the Federated States of Micronesia (FSM), in the Western Pacific.
- This involves measuring the following:
  - dietary intake of promoted micronutrient-rich foods
  - health status, including fasting blood sugar, blood pressure, and anthropometry
  - perception and awareness of intervention activities and materials
  - knowledge and behavior change related to the intervention
  - planting of promoted micronutrient-rich foods

2. The scope of this research project (that is, what issues, events, or activities are to be involved, and the degree of participation by community residents) is discussed with and understood as:

- To conduct assessment of the Pohnpei Traditional Food for Health Initiative.
- The research team uses an inter-agency approach including IFCP, Pohnpei Department of Health Services, College of Micronesia-FSM, and Pohnpei Office of Economic Affairs, Department of Land and Natural Resources, selected community members and Pohnpei residents, and CINE staff and student.
- Community members who will participate as respondents will volunteer approximately one to three hours of their time to participate.

3. Methods to be used, as agreed by the researchers and the community are:

- Participation is confidential and voluntary.
- Interviews will take place in approximately 47 households on diet, food production, and qualitative aspects of the intervention. Interviews will also be

conducted with key informants familiar with the intervention activities, the Mand community, and/or food sales in Pohnpei.
  - o Interviews will take approximately 20 – 45 minutes.
  - o Household interviews will be conducted in the local language and responses recorded in English.
- Informal focus groups will be conducted among Mand residents and individuals familiar with the intervention. Questions will be asked about local food use, market food use, as well as knowledge, awareness, and behavior modification related to the intervention.
- Other methods of collecting information on food and dietary patterns may include a market survey and photography.

4. Community training and participation, as agreed, is to include:

- Community members and other residents of Pohnpei will participate in the research as interviewers and facilitators. These individuals, who are local residents fluent in the local languages (Pohnpeian and Pingelapese), will be provided training on standard interview methods and the research related to this project.
- It is within the goals of this project to develop community capabilities to understand their own data. Data will be stored with the IFCP and remain available to the Mand community.
- The development of this project is based on sincere communication between community members and researchers. All efforts will be made to incorporate and address local concerns and recommendations at each step of the project.
- At the end of the project, as well as during the research, researchers will participate in community meetings to discuss progress and results with community members.

5. Information collected is to be shared, distributed, and stored in these agreed ways.

- The essential health data (fasting blood glucose, blood pressure, and weight and heights) will be provided immediately to each participant along with counseling so that each may follow up and get medical advice and treatment, if needed.
- Data collected are confidential and will be reported such that no individual or household will be identified. Copies will be kept at the IFCP offices and at CINE, where appropriate, and converted to an electronic form. The research team will be available to answer questions and assist community members, and in case the community decides to use the data for different purposes beyond the objectives of this project.
- At the end of the study, the collated results will be presented to the community by leaders of the project and a final report will be distributed after discussion of results with community members. and collaborating agencies. JK

6. Verbal informed consent of individual participants is to be obtained in these agreed ways:

- Verbal informed consent will be obtained by each participant.

- The consent forms will be read by the interviewer or facilitator to the respondent and the respondent will be asked for verbal consent.
- A copy of the consent form will be available to the respondent so that the addresses and telephone numbers of the researchers are available should the respondent wish to contact the researchers for additional information.

7. The names of participants and the community are to be protected in these agreed ways:

- As explained during the informed consent process, the interviews and focus groups are confidential. Names will not be used while analyzing or reporting the data.
- Since the project is being conducted in Mand, Pohnpei, the community will be identified by name unless otherwise agreed by community members.

8. Project progress will be communicated to the community in these agreed ways:

- Researchers will be available during the course of the project to address particular questions that may come up.
- On a mutually agreed upon date, the results of the assessment will be reported to the community. A public meeting will be held to this effect.

9. Communication with the media and other parties (including the funding agencies) outside of the researchers and the community, will be handled in these agreed ways:

- In presentations, locally or internationally, the researchers will be aware of their responsibilities and commitments to the welfare of the community and will provide full acknowledgement of input by the community, agencies involved, and funding sources.

10. Funding has been acquired, or is being sought from the following sources.

- CINE funding: Canadian Institute for Health Research, (CIHR)
- IFCP funding: Global Environmental Fund (GEF) Small Grants Program; Sight and Life; New Zealand Government; Pacific German Regional Forestry Project-GTZ
- Provision of interview assistants and vehicles from IFCP, Department of Health, Office of Economic Affairs, and College of Micronesia-FSM, and Department of Lands and Resources and possibly others from the community.
- In-kind contribution of community interviewees.

11. Benefits

- Benefits likely to be gained by the community through this research project are:
  - Educational—the community researchers will be trained in survey methods.
  - Informational – the community will gain knowledge of the impact the intervention has made and individual participants will gain knowledge of their present health status.

D. 2007 Survey Recruitment Sign

Mand Community Health Survey

Please come to the Community Hall

on Monday June 25th

at 6:30AM – 7:00AM.

Measurements will be taken of:

❖Fasting Blood Sugar	❖Weight	❖Dietary 24-hour Recall
❖Waist Circumference	❖Height	❖Food Frequency Questionnaire

* Please don't eat anything or chew betelnut/ gum from midnight on Sunday till Monday after the Fasting Blood Sugar test.

E. 7-day Food Frequency Questionnaire

Mand 7-day food frequency questionnaire

Date: **Interviewer:**____ **ID#**_____

Name of mom_____ Birthdate_____
Name of child_____ Birthdate_____

Is there someone in your family with diabetes (*soumwahu in suke*)? Yes____ No___
Did you have a feast or funeral in the last seven days? Yes____ No___

For each food below, ask the following question- circle items eaten and give the number 0 to 7 in the box:
How many days in the past 7 days did you eat....? (Mom) (Child)

FOOD ITEM	#days /wk	#days /wk	#meals/ d / hh
1. **Rice**			
2. **Local starch food** of any kind: *mei, wis, mweiang, sewa, kipar, dapiohka, kehp, pidehde*			
3. **Flour products:** bread, ramen, doughnut, pancake, noodles, spaghetti, pie, cake, ship biscuit, cracker, cookie, other			
4. **Breadfruit** (*mei*): green unseeded/seeded, ripe unseeded/seeded, fermented (*mar*)			
5. **Banana of any kind** (*wis*)			
6. **Ripe banana, white, non-yellow** (*Inahsio, Utin Ruk, Utin Menihle, Utin Pihsi, Kaimana, Preisihl, Utin Lihli*, other)			
7. **Ripe banana, yellow** (*Utin Iap, Utimwas, Karat, Akadahn, Taiwang, Ipali, Mangat, Karat en Iap, Utin Kerenis, Sendohki, Iemwahn, Peleu*			
8. **Giant swamp taro** (*mweiang*)- *Pwiliet, Sounpwong Weneu, Saleng Walek, Simihden, Mwang Tekatek, other*			
9. **Pandanus** (kipar)- *Enewedak, Aspwirek, Swaipwepwe, other*			
10. **Dryland taro** (*sewa*), **yam** (*kehp*), **cassava** (*dapiohka*), **sweet potato** (*pidehde*)			
11. **Vegetable of any kind**			
12. **Local vegetables**: kang kong, Chinese cabbage, chaya, pele, spinach, pepper leaves, chilli leaves, pumpkin tips, cucumber, green onions, green beans, egg plant, pumpkin, bell pepper, squash, tomato, radish, other			
13. **Imported vegetables, fresh or canned:** cucumber, carrot, capsicum, head cabbage, imported potato, tomato, catsup, legume beans, lettuce, radish, any canned vegetable, spaghetti sauce, other			
14. **Fruit of any kind** (including ripe banana)			
15. **Local fruits** *(wahntuhke):* ripe banana, ripe mango (*kehngid*), green mango/papaya, apel in pohnpei, apel in wai, wedamelon, karertik, karer, /tangerine, *sei*), pineapple, guava, ripe *memiap*, kipar, kalamansi, other			

16. **Imported fruits, fresh or canned:** apple, orange, pineapple, tangerine, watermelon, grapes, canned fruits or juices, other		
17. **Eggs:** Chicken egg, fish egg		
18. **Local fish and seafood, fresh or frozen:** Reef fish, tuna, other fish, freshwater eel, sea eel, octopus, lobster, shrimp, shellfish, turtle, mangrove crab		
19. **Local meat, fresh or frozen:** local chicken, local pig, dog, carabou, goat, duck,		
20. **Imported and canned fish and seafood:** mackerel, tuna, sardines, other canned fish		
21. **Imported and canned meat, excluding turkey tail:** corned beef, spam, beef stew, canned and frozen chicken, sausage, pork lunch meat, hot dogs		
22. **Turkey tail**		
23. **Liver:** reef fish liver, skipjack tuna liver, yellowfin tuna liver, small fish eaten with the liver inside, chicken, pig, beef		
24. **Local nuts of any kind:** chestnuts (*mworopw*), *dipwopw, kaikes* breadfruit (*mei kole*), other		
25. **Fried food**		
26. **Imported/animal fats:** Vegetable oil, olive oil, oil from turkey tail/chicken/pork, shortening (Crisco)		
27. **Local coconut fat:** coconut oil, coconut cream, copra, embryo		
28. **Local drinks:** drinking coconut, madeu, hibiscus tea, lime tea, lemon grass, pil in guava/pwohmpwompw/pweinaper, karertik		
29. **Imported drinks with sugar:** soft drink, coffee, tea, condensed milk, chocolate milk, koolaid, punch, flavored drinks		
30. **Dairy:** butter, margarine, cheese, whole-cream milk		
31. **Local snack food:** sugar cane, adohl coconut husk		
32. **Imported salty snack food:** Potato chips, cheese crisps, popcorn		
33. **Imported sugar, food/ local drink with sugar:** donuts, cookies, candy, candy bars, chocolate, ice cream, local foods cooked with sugar like breadfruit, banana, taro, local drink with sugar		
34. **Alcohol** *(sakau en wai)*: beer, wine, whiskey, yeast, other		
35. **Sakau en pohnpei**		
36. **Betel Nut** (chewing)		
37. **Tobacco use**		

F. 24-hour Recall Form

Mand 24-Hour Recall Form for Mother or Head of Selected Household

DATE: _____ Interviewer Name: _____ ID NUM #_____

Name of Mother/Household head: _____

Are you pregnant now? Yes No Are you lactating now? Yes No

What did you eat and drink after you woke up yesterday morning? What was the time? Where did you eat that food? What did you have next, and when and where was that?

Time or Common Activity	Place	Description of Food or Drink: Name of food, ripeness, variety as for banana, drink, dish, ingredients, cooking methods, brand names of packaged/tinned foods	Amount (household measures)	Amount (grams)

Listen as I read what I've recorded. Is there a mistake or omission? Yes No *If yes, change*
Did you have alcoholic drinks? Yes No Did you eat anything in the night? Yes No
Did you take any vitamin or mineral supplements? Yes No
If yes, what kind_____. May I see the label? *write label*_____
Was this a normal day for you? Yes No Explain below. Did you go to a funeral? Yes No Explain
Or did you eat any food that you/someone brought from a funeral or party? Yes No
THANK YOU!

G. Participant's Results Slip from Health Assessment

Name: _____ ID#: ____ FASTING: Yes No

July 7, 2007

Weight: ____._ kg Height: ____._ cm

underweight healthy weight overweight obese

Waist circumference: _____._ cm

*at risk: Males ≥102cm Females ≥88cm

Fasting Blood Sugar: ____

* at risk for Diabetes: ≥ 126mg/dl

Blood Pressure: ____ / ___

* at risk >140 / 90

For follow-up, please contact Dr. Elizabeth Keller at Diabetes Control Program, Public Health, 320-7843

'Mand Project' Evaluation – Summer 2007

Activity	1. Have you heard about _____?	2. Did you take part in it?	3. Did anyone else in your HH take part in it? *[record name & relation]*	4. What do you think about it?	5. *If #2 YES,* What was the most important thing you learned?
a. Mand Working Group Meetings	YES NO Doesn't know	YES NO	Participant = _____ _____	Positive Response Negative Response Comments: _____	
b. Planting Material distribution (Pilot Farm, other)	YES NO Doesn't know	YES NO	Participant = _____ _____	Positive Response Negative Response Comments: _____	
c. Planting and Weight Loss Competition	YES NO Doesn't know	YES NO	Participant = _____ _____	Positive Response Negative Response Comments: _____	
d. Cooking Training by Welsy and Miriam	YES NO Doesn't know	YES NO	Participant = _____ _____	Positive Response Negative Response Comments: _____	
e. Charcoal Oven Training and Distribution	YES NO Doesn't know	YES NO	Participant = _____ _____	Positive Response Negative Response Comments: _____	
f. Container Gardening with Kiped and Gibson Santos	YES NO Doesn't know	YES NO	Participant = _____ _____	Positive Response Negative Response Comments: _____	
g. US Ambassador's Potluck dinner	YES NO Doesn't know	YES NO	Participant = _____ _____	Positive Response Negative Response Comments: _____	
h. Breastfeeding Club	YES NO Doesn't know	YES NO	Participant = _____ _____	Positive Response Negative Response Comments: _____	
i. Mand School Training on Bananas with Sohse (Youth-to-Youth)	YES NO Doesn't know	YES NO	Participant = _____ _____	Positive Response Negative Response Comments: _____	....your child learned?
j. Mand Drama club with Mr.Rohaizad	YES NO Doesn't know	YES NO	Participant = _____ _____	Positive Response Negative Response Comments: _____	....your child learned?

'Mand Project' Evaluation - Summer 2007

Materials	6. Have you seen ____?	7. Where have you seen this?	8. What does it mean to you?
a. Bananas poster	YES NO	_____	
b. Blue Food Poster (FAO/CINE)	YES NO	_____	
c. Go Local Billboard	YES NO	[*circle responses*] Mand School Causeway Hospital Other:	
d. heard about the Mand Project in the news (radio, newspaper)	YES NO	_____ _____	

9. Did you hear about the Mand Study results from 2005? YES NO
   If YES, what do you recall about the results?
   [*circle response themes*]

Mand local foods	reliance on imported food
overweight/obesity	diabetes
other: _____	

10. Why do you think people become sick with diabetes?
    [*circle responses*]

diet	hereditary
lack of exercise	don't know
other: _____	

11. What do yellow-fleshed bananas have a lot of that white-fleshed bananas do not have?
    _____

12. Have you or has someone in your household taken part in an agricultural fair? YES NO
    If YES, which ones did you participate in _____: [*circle responses*]

2005/6
World Food Day (October 2005)
Municipality Fair (November 2005)
Mand Agriculture Fair (January 1, 2006)
Education & Agricultural Fair (2006)

2006/7
World Food Day (October 2006)
Municipality Fair (November 2006)
Mand Agriculture Fair (January 1, 2007)
Education & Agricultural Fair (2007)

13. Have you received counseling on vitamin A deficiency? YES NO DOESN'T KNOW
    If YES, from where? [*circle responses*]

doctor
Mand Project - counseling with Pelihna & Amy
Public Health
Relative/Friend
other: _____

    If YES, did you apply this advice? YES NO

Crop	14. Have you planted _____ in the past 2 years?	15. How many plants of _____ have you planted in the past 2 years?	16. What varieties have you planted? *[circle varieties]*	17. Where did you get the planting materials?	18. How often do you harvest? (now, current season)	19. Do you feed your child this food?
a. banana, (*uht, wis*)	YES NO	_____	yellow-fleshed cultivars [Akadahn, Iemwahn, Ipali, Karat, Karat en Iap, Taiwang, Mangat, Sendohki, Utimwas,Utin Kerenis, Utin Iap] white-fleshed cultivars [Inahsio, Kaimana, Preisihl, Utin Lihli, Utin Menihle, Utin Pihsi, Utin Ruk] doesn't know	a. Mand Community Meetings b. Mand Community Nursery c. Pilot Farm d. Family / Friends e. Market f. Own land g. Other:_____	_____	YES NO
b. green leafy vegetables:	YES NO Is this in a container garden or raised bed? YES NO	_____	chaya / pele katuk / kangkong spinach / chinese cabbage head cabbage other:_____ Which are in a container garden or raised bed? [*write * next to these*]	h. Mand Community Meetings i. Mand Community Nursery j. Pilot Farm k. Family / Friends l. Market m. Own land n. Other:_____	_____	YES NO
c. other vegetables:	YES NO Is this in a container garden or raised bed? YES NO	_____	(What vegetable crops?) bell pepper / eggplant beans (string) / avocado cucumber / cassava sweet potato other:_____ Which are in a container garden or raised bed? [*write * next to these*]	o. Mand Community Meetings p. Mand Community Nursery q. Pilot Farm r. Family / Friends s. Market t. Own land u. Other:_____	_____	YES NO
d. calamansi citrus (*karertik*)	YES NO	_____		_____ [*fill in*]	_____	YES NO

20. Why did you decide to plant these additional crops?
[*circle responses*]
a. Wanted more local food
b. Had more time
c. Because of the importance of local food
d. Money
e. Other:_____

21. What proportion/fraction of your HH food is local food?
[*circle response*] 0-25% 26-50% 51-75% 76-100%

22. What proportion/fraction of the local food your HH consumes is home grown?
[*circle response*] 0-25% 26-50% 51-75% 76-100%

23. Every month, about how much of your family's money (salary) pays for food?
a. less than half
b. half
c. more than half
d. don't know

24. Some people think that local food production is worth preserving. Others think that the situation will take care of itself. What do you think/what is your opinion?
_____
_____

Charcoal Oven
Did you receive a charcoal oven? YES NO [If NO, Kalahngan!]

If YES,
1. How often do you use it? ___times/day ___times/month used in past never

2. What do/did you cook? [what dishes, what foods] _____

3. [*If didn't mention any local food:*] Do/did you use the oven to cook any local food? YES NO
What local food/dishes? _____

4. What do/did you use for charcoal?
coconut shells wood store-bought charcoal other: _____

5. Is making/getting charcoal a problem? YES NO Comments:_____

6. If you don't use it currently, why don't you? [*circle responses*]
takes too long to prepare charcoal lack of charcoal
don't know how to make charcoal other:_____

Ask to see the oven. Record the following:
1. Is the IFCP sticker on oven? YES NO
2. Is the oven used? *Note level of discoloration from smoke in interior.*
1 (no discoloration) 2 3 4 5 (very blackened) Comments: _____

THANK YOU! ---------)(---------- KALAHNGAN!