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ECONOMIC INFLUENCES ON CHILD GROWTH STATUS, FROM THE CHILDREN'S HEALTHY LIVING PROGRAM IN THE US-AFFILIATED PACIFIC REGION

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Abstract

Mean obesity level of the 2–8-year-old children in the region was 14.4%, 14.1% were overweight, 2.7% were underweight, 1.4% were stunted, and 6.8% were stunted at birth. Acanthosis nigricans prevalence was 5%, an indicator of pre-diabetes. Sixty-one percent of the children were Native Hawaiian or Pacific Islander and 20% were of more than one race. Food insecurity was common. It was especially high in the Federated States of Micronesia and the Republic of the Marshall Islands at over 70%. Twenty-five percent of households in the region earned less than $10,000 per year. World Bank-defined upper middle-income jurisdictions had relatively high levels of both undernutrition and obesity. Jurisdiction income level was the most important factor influencing growth status in multivariate models. Policies and strategies for jurisdiction economic development and improvement of child growth status should protect local food systems and active living during economic transition. The terms of the renegotiated compact of free association with the United States, especially in the upper middle-income countries (Palau and the Republic of the Marshall Islands) that are experiencing a dual burden of undernutrition and overnutrition, are expected to play a key role in the future health of residents of these jurisdictions.

JEL Classification: I10, I12

Contents

1. INTRODUCTION

The growth status and health of children of the United States-affiliated Pacific region (USAP) has not been extensively studied. There is particular concern for a high level of obesity and noncommunicable diseases among adults of the region (Hawley and McGarvey 2015), who have among the highest levels of obesity and noncommunicable diseases in the world. The mortality from these noncommunicable diseases is highest in lower and lower middle income countries, approaching 80%.

This chapter will examine obesity and underweight in children of the USAP, a region of lower middle to upper income jurisdictions. The obesity and underweight status of children gives us insight into the future health status of the region.

Economic development is generally associated with improved health and well-being. Yet the transition from less developed to developed jurisdictions has been shown to cause a shift from underweight to obesity. The USAP, while affiliated with the US, is highly diverse in the nature of political affiliation with the US, and in coverage from US health and data systems, and surveys. Household income and caregiver education are also considered as important to child growth and well-being.

This chapter provides an examination of jurisdiction and household socioeconomics (jurisdiction income level, household income, and household money for food) in the USAP, a highly diverse set of jurisdictions and economies, and their relation to child underweight and obesity.

There are over 12,000 islands in the USAP, with about 1,000 that are populated with a total of 2.5 million people, yet the populations are relatively small and the region diverse and far flung, creating multiple challenges for economic and health systems (Hawley and McGarvey 2015). Importantly, the populations continue to grow, though many migrate to the United States of America (US). Indeed, remittances from the US are an important part of island economies.

The cultural ancestry in the USAP region is also diverse, though race in the US is captured under the category of Native Hawaiian and Pacific Islander. There is evidence for racial disparity in obesity and health among minority groups, and among Native Hawaiians and Pacific Islanders in particular. Yet none of these groups are described in US national surveys.

This chapter focuses on the growth status young Native Hawaiian and Pacific Islander children, ages 2–8 years, who are also not well described in either US or global literature. Children's growth status is recognized as a key marker of both individual health and societal well-being.

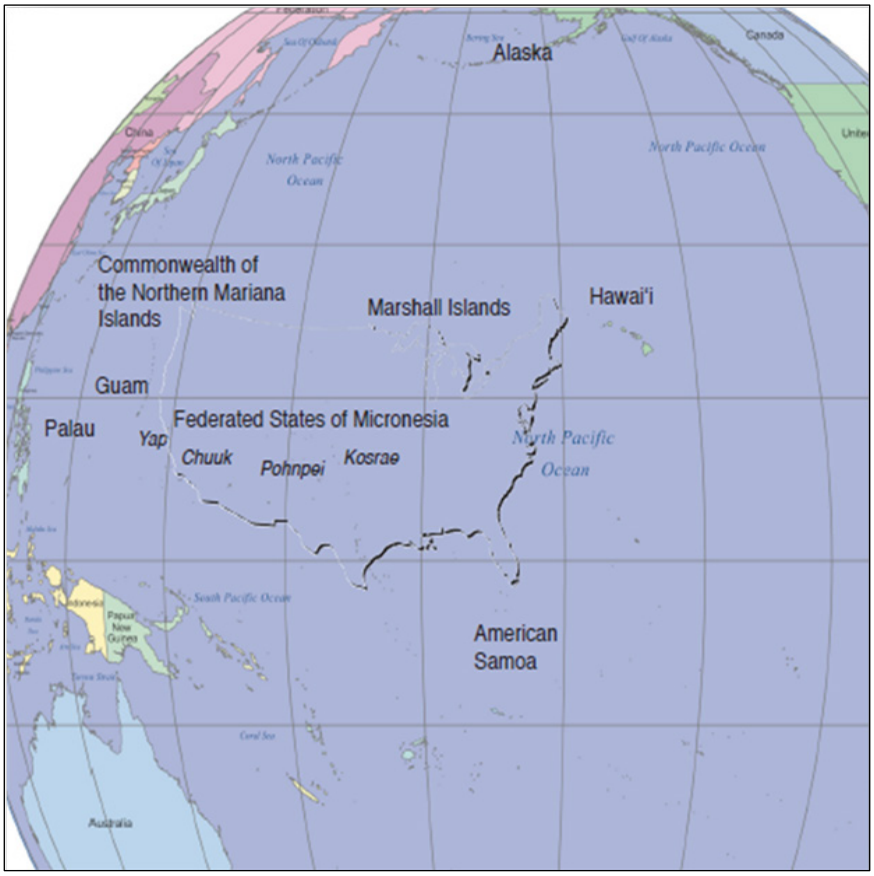
This chapter will address the following primary questions:

- What is the prevalence of food insecurity (household money running out for food), child stunting, child underweight, and child obesity in the USAP?
- What are the relationships among household money for food, household income level, parent/caregiver education level, and jurisdiction income level with child underweight and child obesity, adjusting for child sex and child age, clustering of communities, and jurisdiction strata?

USAP jurisdictions have varied political affiliations with the US, which has a relationship to food assistance programs and economic policies that may have a bearing on child growth status. Affiliations include two US states (Alaska, Hawaii), two US territories (American Samoa, Guam), and one US Commonwealth (Commonwealth of

the Northern Marianas). Three countries are in a compact of free association (Republic of Palau; Republic of Marshall Islands; and the Federated States of Micronesia, which include Yap, Pohnpei, Kosrae, and Chuuk states) (Novotny et al. 2015). The USAP is a larger geographic area than the continental US and covers seven time zones and the international dateline (Figure 1).

Figure 1: Map of the Pacific Region Indicating Locations of Hawaii, the United States Affiliated Pacific Islands, and Alaska, compared with the Size of the Contiguous US



United States Affiliated Pacific Islands = American Samoa, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Guam, Republic of the Marshall Islands, and the Republic of Palau.

Note: The overlay of the contiguous US, set between Hawaii and Guam, indicates that the distance width of the contiguous US at its widest point is just 400 miles short of the distance between these two Pacific islands.

Source: Adapted from Novotny et al. 2015.

Food is a basic human right and need, and food security is a worldwide goal as articulated by the United Nations (UN) *(*United Nations 2016*).* However, we should aim higher than food security—we should aim for nutrition security and health security, that is, nutrition, health, and well-being for all. For children, growth is a good indicator of overall health status.

A priority of US public policy, especially in the latter half of the 20th century, has been to assure that all have enough to eat. Food insecurity, defined as having limited or uncertain access to enough nutritious food, is recognized as an important problem in the developed world (Coleman-Jensen 2014; Foley et al. 2010). Nutrition security goes farther than food security, referring to access to a variety of nutritious foods and

potable drinking water; knowledge, resources, and skills for healthy living; prevention, treatment, and care for diseases affecting nutrition status; and safety-net systems during crisis situations, such as natural disasters or social and political events (Nordin et al. 2013*).* The UN's 2015–2030 Sustainable Development Goals include two goals that are particularly relevant to food and nutrition security: (i) end hunger, achieve food security, and improve nutrition and promote sustainable agriculture; and (ii) ensure healthy lives and promote well-being for all, at all ages.

According to the 2013 report from the Economic Research Service (ERS) of the United States Department of Agriculture (USDA), among households with children under age 18 years, 19.5% were food insecure at some time during the year (Coleman-Jensen et al. 2014*).* Prevalence of food insecurity was higher in households with children that were headed by a single woman (34.4%) or a single man (23.1%), in households headed by Black non-Hispanics (26.1%) and Hispanics (23.7%), and in households with incomes below 185% of the US poverty threshold (34.8%). Pacific Islanders were not included in this study. There was evidence that food insecurity was associated with higher body mass index (BMI) (weight in kilograms/height in meters squared) and rates of overweight or obesity (Coleman-Jensen, Gregory, and Singh 2014; Foley et al. 2010). Food insecurity rates were positively associated with poverty (Coleman-Jensen et al. 2014; Foley et al. 2010; Chi et al. 2014; Rose 1999; Willows 2008). Poor nutrition occurs at both ends of the spectrum—with undernutrition (underweight and stunting) and with overnutrition (overweight and obesity).

The ERS/USDA report does not include data for the vast USAP region and currently there are no official figures on food insecurity rates for this region. The prevalence of food insecurity in the USAP region is likely greater than in the US mainland due to geographic isolation, low soil fertility, low household income, import and aid dependence, urbanization, reduced agricultural activity, and reduced traditional food hunting and gathering (Hughes and Lawrence 2005; Jansen, Parkinson, and Robertson 1990; Ahlgren et al. 2014; Connell 2014; Kuhnlein et al. 2004; Barnett 2011; Locke 2009; Duffy 2011; Coyne 2000).

Traditionally, a "meal" in the Pacific region was comprised of a starchy local vegetable (e.g., yam, taro, breadfruit, pandanus) accompanied by cooked or raw seafood, a diet that is nutritious and, specifically, rich in fiber, vitamins, and minerals *(*Parkinson 1982; Coyne 2000). The present-day diet in the Pacific has shifted to the consumption of imported, refined, less nutritious energy-dense foods, such as white rice and foods high in fat, salt, and sugar (Corsi 2008; Plahe 2013), a consequence of colonization, westernization, and economic development, in particular since World War 2. The nutrition transition has been reported among indigenous people elsewhere, including Australia and Canada (Popkin 2012; Kuhnlein 2004; Egeland 2011). The shift from a high-quality subsistence diet based on local foods to a nutrient-poor market diet with predominantly imported food has contributed to a decline in diet quality, nutritional status, and nutrition security among indigenous people as they are exposed to western societies (Nordin 2013; Kuhnlein 2004; Thow and Snowdon 2010; Egeland et al. 2011). The nutrition transition, along with other lifestyle changes, such as reduced agricultural activities and a more sedentary lifestyle, has contributed to the increased prevalence of obesity and obesity-related noncommunicable diseases in the region, causing health officials to declare a health emergency (Coyne 2000; Thow and Snowdon 2010).

Also, as countries develop economically, they modernize and urbanize, which results in more mechanized farming and transportation practices. Food becomes more processed, and transportation less active. Diseases shift from infectious to chronic, accompanied by less undernutrition and more obesity (Popkin 2001*).*

Many Pacific islands now import much of their food. Imported foods are often of poor quality (including fatty cuts of meat like turkey tails and lamb flaps that are often considered waste in their countries of origin), instant noodles, and highly processed, high-sugar snack foods that have come to represent prestige and cultural capital. The wide availability of these foods at very low cost means that traditionally high-status local foods are now more expensive (Hawley and McGarvey 2015).

Early fetal and infant undernutrition, measured by birth and infant growth, predisposes children to metabolic programming that results in overweight, obesity, and noncommunicable diseases in adult life, a phenomenon referred to as the "Barker hypothesis" (Barker 2010). This phenomenon plays an important role in the causes and prevention of obesity in the USAP and other developing regions. To intervene, it is important to focus on "the circumstances in which women are pregnant and children develop," and to recognize that "babies come from society" and "are record keepers of societal decisions" (Winett et al. 2016). In short, the environment affects child growth. As a society, focus is needed on the community and environmental context, when intervening, and child growth status indicators illustrate the state of the society.

Pacific island countries, including the USAP island jurisdictions, are experiencing some of the highest rates of adult obesity in the world, in part due to substantial dietary changes that mirror changes in the regional food supply (Thow and Snowdon 2010; Thow 2011). Modernization, migration, and urbanization have impacted traditional social structures and driven a transition from subsistence to market-based economies, which in turn have dramatically impacted dietary intake, physical activity, and therefore obesity and noncommunicable disease prevalence in the islands.

Though data are limited, nine of the ten countries in the world with the most adult obesity are Pacific island countries; for example, American Samoa has a prevalence of 74.6% among adults (Central Intelligence Agency 2016). The US National Health and Nutrition Examination Survey (NHANES), however, does not collect data on either adults or children in the USAP. Some data on adult obesity are available from the World Health Organization (Parry 2010). Overall, particularly few data are available on growth status of children in the USAP.

The Children's Healthy Living (CHL) program for remote underserved minority populations of the Pacific fills this gap with a range of data describing the jurisdiction, community, household and child environments, and child growth status in the USAP, and among US-affiliated Pacific Islanders (Novotny et al. 2013). In this chapter, CHL authors specifically examine the role of the jurisdiction level and of household indicators of education and economic status on child growth status, including food insecurity (money running out for food), providing insight into jurisdiction economic development and the nutrition transition in the USAP.

2. CHILDREN'S HEALTHY LIVING (CHL) PROGRAM

The CHL program can be described as a coalition that emerged to address child health. The coalition was built from a base of collaboration in the land grant colleges in the USAP. The extension (translating science for practical application), research, and training missions of these colleges were leveraged as a means to engage communities and build capacity. This integrated platform was used to gather research data, to intervene to improve the environment for health, and to build the capacity of people and institutions in the region (Novotny et al. 2013). The CHL program was funded by a United States Department of Agriculture National Institute for Food and Agriculture Competitive Grant (2011-68001-30335, Novotny PI). For the research components,

human studies approval was obtained from the University of Hawaii (UH), University of Alaska, University of Guam, Palau Ministry of Health, or ceded to UH.

The CHL program included 11 jurisdictions of the US-affiliated Pacific, a region ranging from lower middle income to high income, all of which have ties to the US (World Bank 2016). Over 5,000 young children (n = 5,558) 2–8 years old were surveyed in 2013 in the 11 USAP jurisdictions as part of the CHL program. Child's age, sex, and race/ethnicity (Novotny et al. 2016; Wilken et al. 2013) and household information were collected by questionnaire that was completed by a parent or other caregiver.

2.1 Characteristics of the CHL Sample

Child Race/Ethnicity

A child's race/ethnicity was categorized according to the United States Office of Management and Budget (OMB) definition, which is used for federal reporting. This OMB definition has six categories: American Indian/Alaska Native (AIAN), Black, Asian, Native Hawaiian/Other Pacific Islanders (NHPI), White, and More than One Race. Due to the remarkable diversity of and interest in specific ethnic groups among Pacific Islanders of the region, and disparities among groups, we collected additional ethnic information under each OMB race. For example, under NHPI, there were 14 ethnic groups to choose from (Chamorro, Carolinian, Chuukese, Kiribati, Kosraen, Marshallese, Native Hawaiian, Palauan, Pohnpein, Samoan, Tongan, Other (please describe) _____, Tokelaun, Tahitian, Yapese) allowing for examination and description of particular Pacific Islander groups and their mixes as well.

Table 1 displays CHL race/ethnicity distribution according to OMB. Since there is a high correlation between Pacific race and jurisdiction, for the purposes of this paper, we focused on jurisdiction rather than race/ethnic difference. When important for interpretation, we use the OMB race variable in regression models. Using the OMB categories, 61% of the sample was Native Hawaiian or Pacific Islander. Nine percent of the population was Asian and 2% was American Indian or Alaska Native. The African American/Black population was a mere 0.3%.

Table 1: Race/Ethnicity of Child Participants (2–8 Years) in the Children's Healthy Living Program according to the US Office of Management and Budget Categories

Race/Ethnicity	n	Percent
American Indian/Alaska Native	124	2.2
Asian	489	8.8
Black	16	0.3
Native Hawaiian/Pacific Islander	3,389	61.2
White	419	7.6
More than one race	1,102	19.9

Note: n = 5,539. Race/ethnic information missing on some participants.

Other demographic characteristics are described in Table 2. The sample was 51% male. There were more children in the 2–5-year-old age group than the 6–8-year-old age group; age is therefore adjusted for in analyses.

Differences in CHL program activities occurred in the different jurisdictions, accounting for different sample sizes across the jurisdictions; yet the sampling methods were similar, and measurement methods were identical in all jurisdictions (Wilken et al. 2013). To account for differences in sample size, population size is weighted in prevalence analyses.

Jurisdiction Income by World Bank Income Classification (World Bank 2016)

Jurisdiction income level was categorized into three groups according to the World Bank Income Classification (Table 2). Lower middle income (LMI) jurisdictions participating in CHL included the states of the Federated States of Micronesia (Yap, Chuuk, Pohnpei, and Kosrae) while upper middle income (UMI) jurisdictions included American Samoa, the Republic of the Marshall Islands, and Palau. Guam, the Commonwealth of the Northern Mariana Islands, and the US states of Hawaii and Alaska were classified as high income (HI). This classification of the world's economies was based on estimates of gross national income (GNI) per capita for the previous year. Lower middle income economies were those with a GNI per capita between $1,026 and $4,035; upper middle-income economies were those with a GNI per capita between $4,036 and $12,475; high-income economies were those with a GNI per capita of $12,476 or more (World Bank 2016).

Table 2: Characteristics of Child Participants with Anthropometric Measurements in the Children's Healthy Living Program

Child Characteristics	n	Percent
Sex (n = 5,523)[a]		
Male	2,825	51.1
Female	2,698	48.9
Age (n = 5,558)		
2–5 years old	3,659	65.8
6–8 years old	1,899	34.2
Jurisdiction and Jurisdiction Income Classification[b]		
Alaska – HI	666	12.0
American Samoa – UMI	972	17.5
CNMI – HI	911	16.4
Guam – HI	865	15.6
Hawaii – HI	944	17.0
Republic of Palau – UMI	193	3.5
Republic of Marshall Islands – UMI	214	3.9
Chuuk – LMI	197	3.5
Pohnpei – LMI	200	3.6
Kosrae – LMI	193	3.5
Yap – LMI	203	3.6

bHI = high income, UMI = upper middle income, LMI = lower middle income according to World Bank Classification; CNMI = Commonwealth of the Northern Mariana Islands.

Note: n = 5,558. Based on participants with age reported Sex information missing on some child participants.

Education of Caregivers

Caregiver self-reported education level is shown in Table 3. Twenty-two percent of the population had less than a high school education and 39% had more than a high school education, with the majority having a high school education in the USAP region.

Table 3: Education Level of Caregiver of the Child Participant, Children's Healthy Living Program

Education Level	Frequency	Percent
Never attended school or only attended kindergarten	105	1.9
Grades 1 to 8 (elementary to middle school)	344	6.2
Grades 9 to 11 (some high school)	790	14.3
Grade 12 or GED (high school graduate)	2,131	38.4
College or technical school (1 year to 3 years)	1,349	24.3
College 4 years or more	826	14.9
Total	5,545	100.0

Note: n = 5,545.

Household Economic Measures (Income and Food Insecurity)

Household food security was assessed by one question from the US Department of Agriculture's Core Food Security Module: "In the past 12 months how often does money for food run out before the end of the month?" (Coleman et al. 2015; Centers for Disease Control 2011). The respondent, the child's parent or caregiver, chose 1 from the 7 options: Never, Seldom, Sometimes, Most Times, Always, Don't Know, or No Response. In this study, options of "Don't Know" or "No Response" were treated as missing values. Household food insecurity was defined as present if the respondent answered that money for food runs out sometimes, most times, or always before the end of the month. This method may have overestimated the prevalence of food insecurity as we used only one question modified from the USDA Core Food Security Module. This question only assessed whether the household's money for food ran out by the end of the month. It also does not assess other food resources such as subsistence living, which is common in some of the Pacific jurisdictions, like the Federated States of Micronesia. Additional metrics are needed to quantify the economic contribution of subsistence living to child growth status, risk for disease, and health.

Household income was measured by a questionnaire of caregivers, which provided for 6 categories and no response for the household's income. The USAP household income distribution is found in Table 3. Twenty-five percent of households earned less than $10,000 per year. Even if there were only one person in the household, this income level would be below poverty level in the US in 2013 (US Census 2013). Median household income for the US in 2013 was $53,718 (Proctor et al. 2016). Clearly household income levels in the USAP were much lower.

Table 3: Annual Household Income in the United States Affiliated Region, Adjusted for Clustering in 51 Communities and 11 Jurisdictions in the Children's Healthy Living Program

Annual Household Income (US dollars)	n (%)
<$10K	1,818 (25.0%)
$10K–<$20K	866 (16.6%)
$20K–<$35K	633 (17.4%)
$35K–<$60K	501 (19.1%)
$60K–<$75K	171 (7.9%)
$75K or more	339 (14.0%)

Note: n = 4,328.

2.2 Child Growth Status in the US-Affiliated Pacific

CHL child growth analyses used survey sampling techniques (Kish et al. 1995) that weighted the sample to the young child population size in each jurisdiction, based on census data, and accounted for the clustering of participants in communities within jurisdictions. Prevalence of food security and growth parameters were estimated, with 95% confidence intervals (CI), overall and by sex, age group (2–5 or 6–8 years old), race/ethnicity, and jurisdiction income level. Prevalence was compared between groups by a chi-square test.

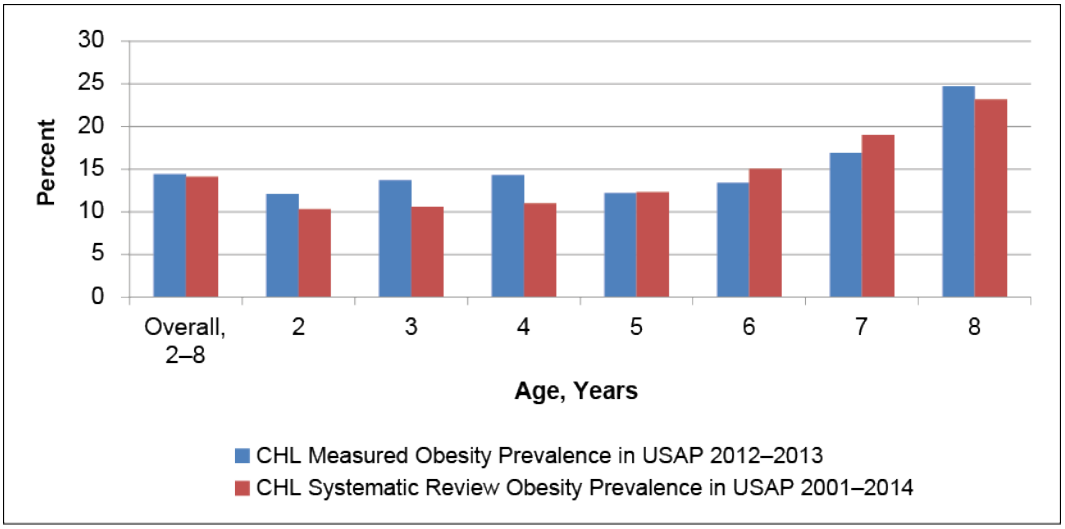
Growth for 2–8-year-olds was assessed with measured weight and height, and all measurers were standardized to obtain regional reliability and reproducibility (Li et al. 2015), and the same type of equipment was used at all sites. Growth data were expressed as percentile of body mass index [weight (kg)/height (m^2)] for age (months) for age and sex as described by the Centers for Disease Control (CDC 2016) using the SAS program provided by the CDC (CDC 2016). This assessment was based on US CDC reference data and cut-points for body mass index for age and sex where > 95th percentile were obese, 85th to < 95th percentile were overweight, 5th to < 85th percentile were healthy weight, and < 5th percentile were underweight. Birth weight and length data were obtained by questionnaire of caregiver. Stunting was defined as < 2 standard deviations of height for age and sex using CDC data for current (2–8-year-old) stunting and using World Health Organization data to determine stunting at birth, as recommended by the CDC (CDC 2016).

Overall, among the 2–8-year-old children in the USAP, 68% of children were healthy weight, 15% were overweight, 14% were obese, 3% were underweight, 1% were stunted, and 7% were stunted at birth (Novotny et al. 2016; Novotny et al. 2015). US data from the contiguous US states from 2013–2014, using the same reference data and cut points for determining obesity, showed that, among 2–5-year-old US children, the rate of obesity was 10%, and among 6–11-year-old children, the rate was 17% (Ogden et al. 2016). Thus, the rate found in the USAP was comparable, on average. However, notable differences among subgroups will be described below.

Obesity prevalence increased across the 2–8-year-old age groups (Figure 2), with variation among the jurisdictions, and with no obesity in the Republic of the Marshall Islands, and a high of 22% obesity in American Samoa (Figure 3). Obesity and stunting prevalences also varied by World Bank income level (Figure 4). Stunting, an important indicator of long-term population nutrition status and well-being, decreased with increased World Bank income level, indicating improved population growth in height with improved economic status, as would be expected. Population obesity prevalence

increased from lower middle to upper middle income World Bank income level, but dropped off in the high income groups. The data reflect a shift in the nutritional and other resources available to jurisdictions. The data also show that, in the upper middle income group, both undernutrition and overnutrition are present, whereas in the high income group those resources have allowed for healthier growth status at both ends of the nutrition spectrum.

Figure 2: Child Obesity by Age in the Children's Healthy Living Program

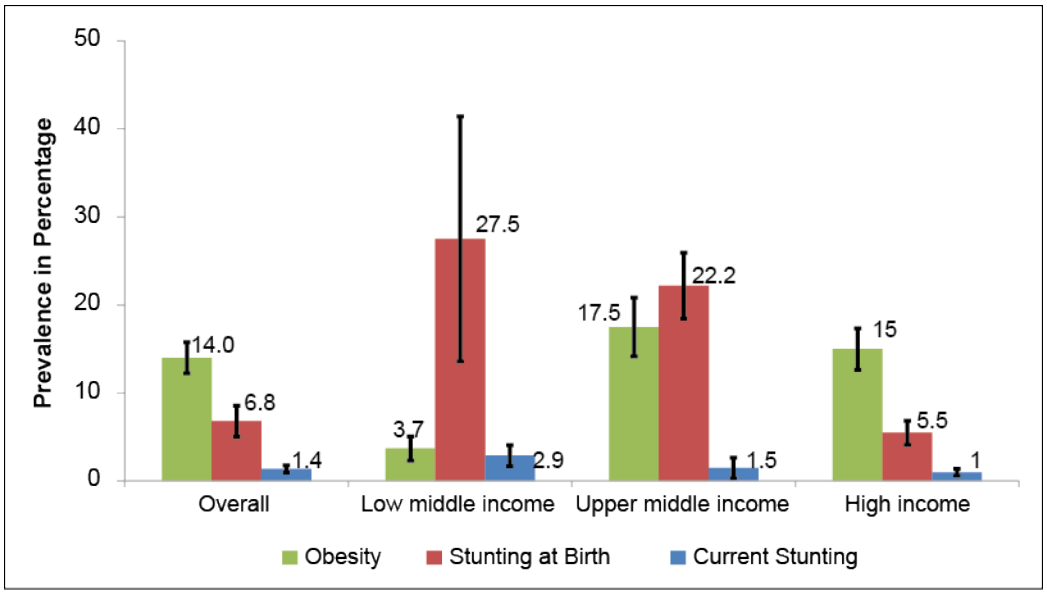


USAP = United States Affiliated Pacific.

Note: n = 5,463 CHL measured sample; n = 246 data points for CHL meta-analysis.

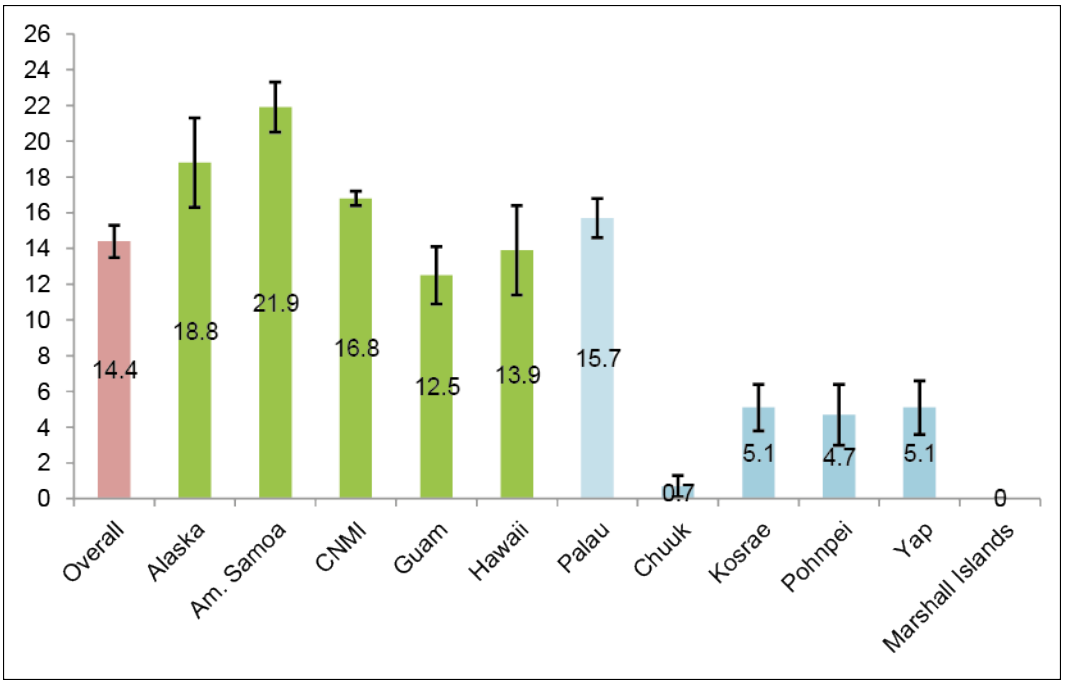
Source: Novotny et. al. 2015 and Novotny et. al. 2016.

Figure 3: Prevalence of Obesity, Stunting at Birth, and Current Stunting by Jurisdiction Income Level in the Children's Healthy Living Program (n = 5,461)



Note: All anthropometric measures differed significantly by jurisdiction income level ($p<0.05$, Chi-square test).

Figure 4: Obesity Prevalence (Percent) by United States Affiliated Pacific Jurisdiction in the Children's Healthy Living Program



Am Samoa = American Samoa, CNMI = Commonwealth of the Northern Mariana Islands.

Note: n = 5,461. Error bars show 95% confidence interval. BMI ≥ 95th percentile, weighted for population size and adjusted for community clustering. 14.1% overweight (85th to 94th percentile) overall.

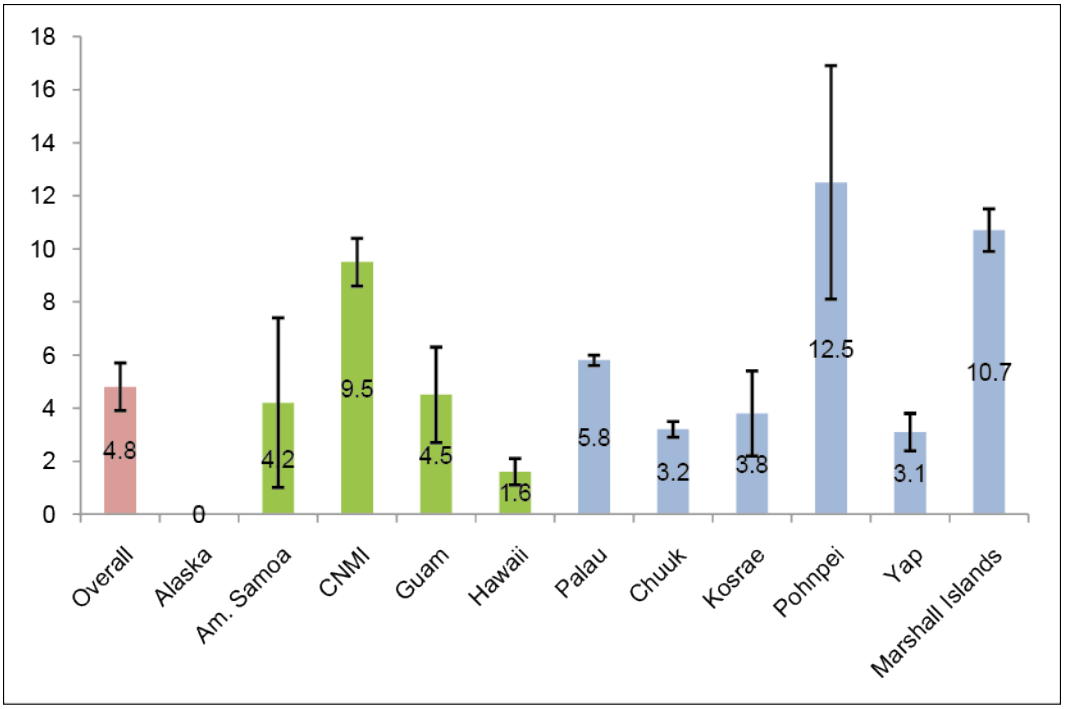
Source. Novotny, et. al. 2016.

Prevalence or occurrence of the acanthosis nigricans condition in the population averaged 5% (Novotny et al. 2016, Figure 5) across the USAP region. Any acanthosis nigricans is unexpected and indicates metabolic risk for diabetes. Acanthosis nigricans was highly associated with obesity (Novotny et al. 2016) as would be expected, and as has been found in a similar study among Native Americans (Hearst et al. 2011). This finding highlights that obesity is a health concern, beginning in childhood in this population.

Prevalence of food insecurity (money running out for food by the end of the month, sometimes or always) was high in the region at 53% overall (Figure 6), and it was higher among households with older children, and among households with boys. The higher level of food insecurity with older children may reflect that fewer food assistance programs are available to this age group, as compared with the 0–5-year-old age group. The 0–5-year-old age group has early child education programs, including the Headstart program, which provides a meal in Alaska, American Samoa, Hawaii, Guam, and CNMI; and the Supplemental Feeding Program for Women, Infants, and Children, which provides supplemental foods to take home and is available in some of the USAP jurisdictions (Alaska, Hawaii, Guam, and CNMI). Elementary school meal programs are also available in some jurisdictions (Alaska, Hawaii, Guam, American Samoa, CNMI). Food assistance programs aim to provide healthy food and may help improve child nutritional status directly and may also help stretch available resources toward healthier lifestyles in other ways. Why food insecurity is higher in households with boys is difficult to explain. Boys may be more active and consume more food. Or perhaps households spend more money on other expenses for boys than girls, leaving less for

food. Or there may be social or cultural beliefs or traditions resulting in boys being more obese than girls. This should be further explored.

Figure 5: Prevalence (Percent) of Acanthosis Nigricans in the Children's Healthy Living Program, United States Affiliated Pacific



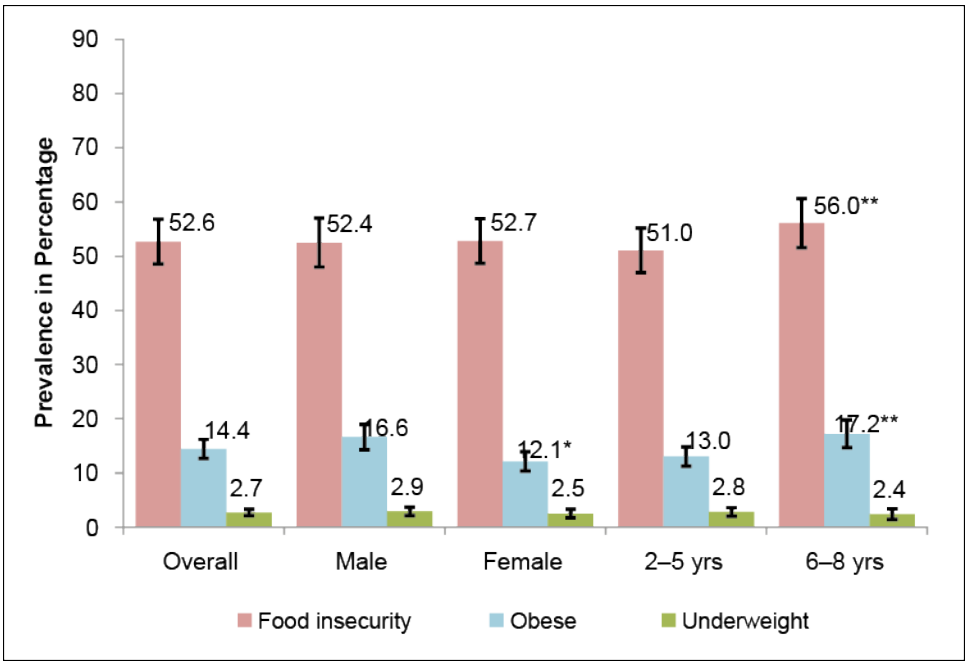
Am Samoa = American Samoa, CNMI = Commonwealth of the Northern Mariana Islands.

Note: n = 4,625. Any presence of acanthosis nigricans, weighted for population size and adjusted for community clustering.

Source: Novotny, et. al. 2016.

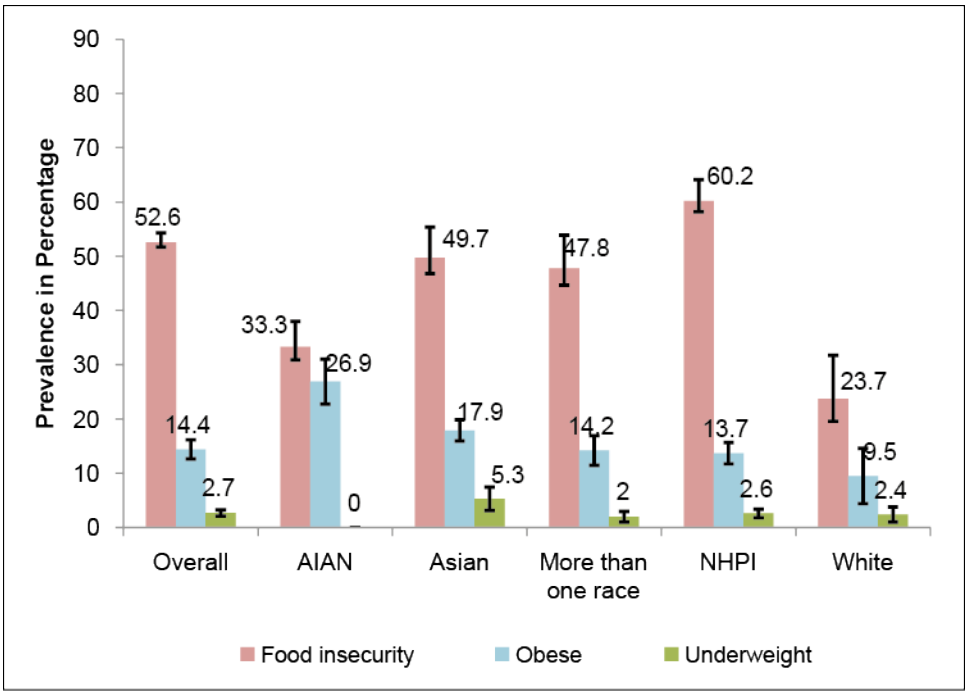
Money for food was reported to have run out by the end of the month at least sometimes for 31% of households, most of the time for 11% of households, and all of the time for 6% of households. There was wide jurisdiction variability in the prevalence of food insecurity: Alaska, 31%; American Samoa, 59%; CNMI, 54%; Guam, 51%; and Hawaii, 41%. Clearly food insecurity is an important issue for this region. Food insecurity also varied by race, where it was highest among Native Hawaiians and Pacific Islanders at 60% (Figure 7) and lowest among Whites at 24%. These rates are high even for the White group, higher than the 20% found in the contiguous US as an average (Coleman, Gregory, and Singh 2014), though the CHL methodology could overestimate this. Additionally, CHL has estimated that food costs in the region well exceed those in the contiguous US (Greenberg et al. 2015).

Figure 6: Prevalences of Food Insecurity, Obesity, and Underweight Overall, and by Sex and Age Group in the Children's Healthy Living Program



Note: n = 5,461. Significant difference from other group by Chi-square, p<0.05. Error bars show 95% confidence interval.

Figure 7: Food Security, Underweight, and Obesity Prevalences in the Children's Healthy Living Program by United States Office of Management and Budget Race Grouping

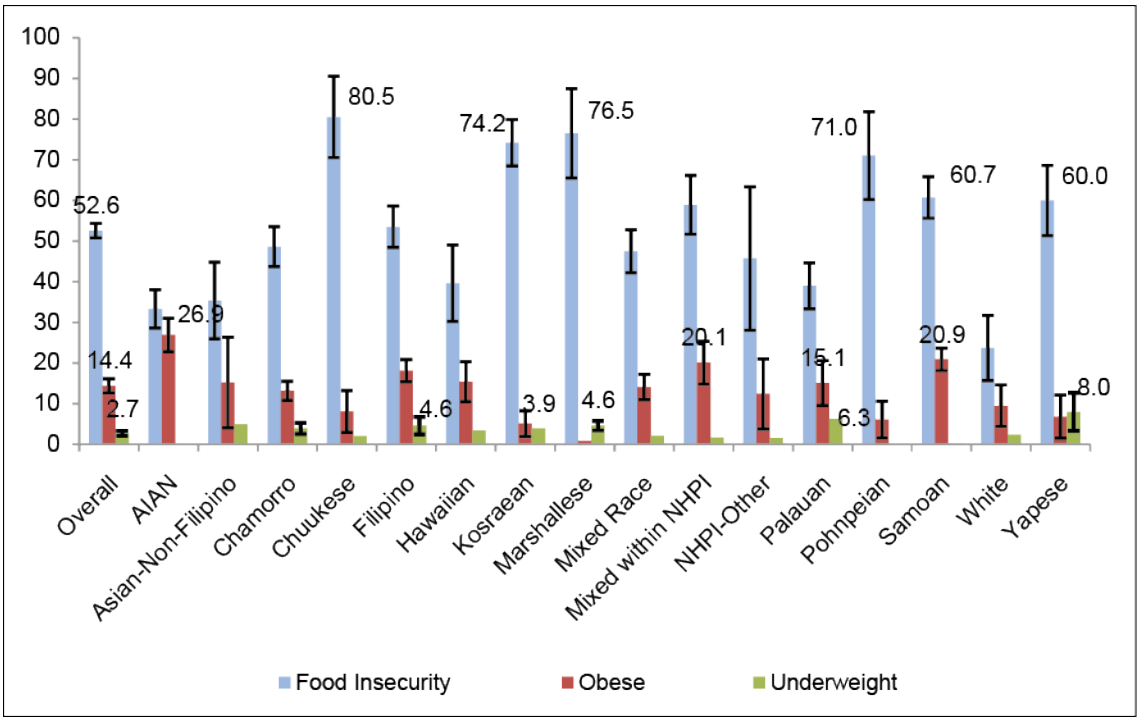


AIAN = American Indian/Alaska Native, NHPI = Native Hawaiian/Pacific Islander.

Note: n = 5,461. Significant differences in prevalence of food insecurity (p<0.001), obesity (p<0.0001), and underweight (p = 0.02) among the jurisdictions.

The highest prevalence of food insecurity was among those of Chuukese (81%), Marshallese (76%), Kosraean (74%), Pohnpeian (71%), and Yapese (60%) race/ethnicities (Figure 8).

Figure 8: Food Insecurity, Obesity, and Underweight by Pacific Race/Ethnicity Categories in the Children's Healthy Living Program



AIAN = American Indian/Alaska Native; NHPI = Native Hawaiian/Pacific Islander.

Note: n = 5,461.

2.3 Factors Influencing Child Obesity and Underweight

Hierarchical regression models (Tables 4–19) with a logistic link of child obesity or underweight were fit to assess the relationship with food insecurity (money for food), parent education, household income, and jurisdiction income level; controlling for age group (2–5 years or 6–8 years), sex, and race/ethnicity (OMB). These models account for the community as a clustering variable and jurisdiction as a strata variable. Regression estimates, odds ratios, and 95% CI were reported from the models.

Food insecurity (running out of money for food) was marginally protective for obesity (p=0.07, Table 4) and not related to risk of underweight (Table 8). All race groups except Black had a higher risk for obesity compared to White. Both Black and American Indian Alaska Native children were less likely to be underweight as compared to White (Table 12). Older children and male children had a higher risk for obesity than younger children and female children (Table 8). These variables were not significantly related to underweight status.

Jurisdiction income level was strongly related to risk for obesity (p = 0.0001, Table 5) with higher risk in lower middle compared to upper middle income countries. Yet jurisdiction income level was also protective for underweight in upper middle income countries (p = 0.001, Table 13), but not in high income countries.

No significant relationship was found between household income and obesity or household income and underweight (Tables 6 and 14). Caregiver education was associated with increased risk for obesity (Tables 7, 9, 10) but was attenuated when jurisdiction income level was added to models (Table 11). Caregiver education was not related to underweight (Tables 15–19). Household income and jurisdiction income level were both important to predict obesity (Tables 8 and 9) though jurisdiction income level was highly significant compared to other variables in full models in explaining risk of obesity (Table 11).

Table 4: Obesity Model 1. Core Model of Food Insecurity and Risk of Obesity in the Children's Healthy Living Program

					95% CI	95% CI
Parameter	Estimate	SE	p-value	OR	Lower	Upper
Intercept	–2.5274	0.198	<.0001			
Food Insecurity vs. Secure	–0.1847	0.1011	0.0677	0.831	0.682	1.014
American Indian Alaska Native vs. White	1.2809	0.3112	<.0001	3.6	1.956	6.625
Asian vs. White	0.7604	0.2323	0.0011	2.139	1.357	3.373
Black vs. White	0.984	0.9053	0.2771	2.675	0.454	15.775
More than one Race vs. White	0.5042	0.2155	0.0193	1.656	1.085	2.526
Native Hawaiian or Pacific Islander vs. White	0.4622	0.2014	0.0217	1.588	1.07	2.356
6–8 year old vs. 2–5 year old	0.3443	0.1007	0.0006	1.411	1.158	1.719
Male vs. female	0.3711	0.0986	0.0002	1.449	1.195	1.758

Note: Food insecurity is defined as running out of money for food monthly, sometimes, most times, or always. n = 4,930.

Table 5: Obesity Model 2. Core Model (Table 1) plus Jurisdiction Income Level

					95% CI	95% CI
Parameter	Estimate	SE	Pr > ChiSq	OR	Lower	Upper
Intercept	–3.9411	0.3087	<.0001			
Food insecure vs. Secure	–0.1259	0.1025	0.2194	0.882	0.721	1.078
American Indian Alaska Native vs. White	1.2755	0.3104	<.0001	3.58	1.949	6.579
Asian vs. White	0.7454	0.2323	0.0013	2.107	1.337	3.322
Black vs. White	1.0397	0.9097	0.2531	2.828	0.476	16.821
More than one race vs. White	0.5196	0.216	0.0161	1.681	1.101	2.567
Native Hawaiian Pacific Islander vs. White	0.5493	0.2097	0.0088	1.732	1.148	2.612
6–8 year olds vs. 2–5 year olds	0.3333	0.1016	0.001	1.396	1.144	1.703
Male vs. Female	0.3815	0.0994	0.0001	1.465	1.205	1.78
Medium vs. Low Income Jurisdictions	1.5594	0.2324	<.0001	4.756	3.016	7.501
High vs. Low Income Jurisdictions	1.3979	0.2296	<.0001	4.047	2.58	6.347

Table 6: Obesity Model 3. Core Model (Table 1) plus Household Income Level

					95% CI	95% CI
Parameter	Estimate	Error	Pr > ChiSq	OR	Lower	Upper
Intercept	–2.512	0.235	<.0001			
Food Insecure vs. Secure	–0.1934	0.1113	0.0824	0.824	0.663	1.025
American Indian Alaska Native vs. White	1.4091	0.3279	<.0001	4.092	2.152	7.782
Asian vs. White	0.7075	0.2527	0.0051	2.029	1.236	3.329
Black vs. White	1.473	0.9092	0.1052	4.362	0.734	25.919
More than one race vs. White	0.5311	0.2296	0.0207	1.701	1.084	2.668
Native Hawaiian Pacific Islander vs. White	0.582	0.2239	0.0093	1.79	1.154	2.776
6–8 year old vs. 2–5 year old	0.3238	0.1076	0.0026	1.382	1.119	1.707
Male vs. Female	0.3906	0.1057	0.0002	1.478	1.201	1.818
Household Income ≥ US $35,000 vs. < $35,000	–0.0475	0.1427	0.7391	0.954	0.721	1.261

Table 7: Obesity Model 4. Core Model (Table 1) plus Education of Caregiver

Parameter	Estimate	SE	p-value	OR	95% CI Lower	95% CI Upper
Intercept	–3.0785	0.2523	<.0001			
Food Insecure vs. Secure	–0.157	0.102	0.1235	0.855	0.7	1.044
American Indian Alaska Native vs. White	1.3115	0.3151	<.0001	3.712	2.001	6.883
Asian vs. White	0.7703	0.2323	0.0009	2.16	1.37	3.406
Black vs. White	0.9623	0.9075	0.289	2.618	0.442	15.502
More than one race vs. White	0.524	0.2176	0.016	1.689	1.102	2.587
Native Hawaiian Pacific Islander vs. White	0.5323	0.2077	0.0104	1.703	1.133	2.559
6–8 year old vs. 2–5 year old	0.3772	0.1014	0.0002	1.458	1.195	1.779
Male vs. Female	0.3879	0.0992	<.0001	1.474	1.213	1.79
High School vs. < High School	0.5977	0.1498	<.0001	1.818	1.355	2.439
College vs. < High School	0.5426	0.1531	0.0004	1.72	1.275	2.322

Table 8: Obesity Model 5. Core Model (Table 1) plus Jurisdiction Income Level and Household Income Level

Parameter	Estimate	SE	p-value	OR	95% CI Lower	95% CI Upper
Intercept	–3.7252	0.3424	<.0001			
Food Insecure vs. Secure	–0.1495	0.1121	0.1822	0.861	0.691	1.073
American Indian Alaska Native vs. White	1.4005	0.3272	<.0001	4.057	2.137	7.704
Asian vs. White	0.6846	0.2528	0.0068	1.983	1.208	3.254
Black vs. White	1.5827	0.8833	0.0732	4.868	0.862	27.492
More than one race vs. White	0.5302	0.2294	0.0208	1.699	1.084	2.664
Native Hawaiian Pacific Islander vs. White	0.6107	0.2298	0.0079	1.842	1.174	2.889
6–8 year old vs. 2–5 year old	0.3239	0.1086	0.0029	1.383	1.118	1.71
Male vs. Female	0.405	0.1065	0.0001	1.499	1.217	1.847
$35K,000+ vs. < $35,000 Household Income	1.3953	0.2512	<.0001	4.036	2.467	6.604
Medium vs. Low Income Jurisdiction	1.2108	0.2498	<.0001	3.356	2.057	5.476
High vs. Low Income Jurisdiction	–0.0728	0.1434	0.6118	0.93	0.702	1.232

Table 9: Obesity Model 6. Core Model (Table 1) plus Jurisdiction Income Level and Education of Caregiver

Parameter	Estimate	SE	p-value	OR	95% CI Lower	95% CI Upper
Intercept	–4.391	0.3419	<.0001			
Food Insecure vs. Secure	–0.1032	0.1033	0.3177	0.902	0.737	1.104
American Indian Alaska Native vs. White	1.3089	0.3138	<.0001	3.702	2.001	6.847
Asian vs. White	0.7562	0.2326	0.0011	2.13	1.35	3.36
Black vs. White	1.023	0.9066	0.2592	2.781	0.47	16.443
More than one race vs. White	0.545	0.2182	0.0125	1.725	1.125	2.645
Native Hawaiian Pacific Islander vs. White	0.6335	0.2173	0.0036	1.884	1.231	2.885
6–8 year old vs. 2–5 year old	0.3618	0.1023	0.0004	1.436	1.175	1.755
Male vs. Female	0.3938	0.0999	<.0001	1.483	1.219	1.803
High School vs. < High School Education	0.4837	0.1515	0.0014	1.622	1.205	2.183
College vs. < High School Education	0.5013	0.1548	0.0012	1.651	1.219	2.236
Medium vs. Low Income Jurisdiction	1.4993	0.2341	<.0001	4.478	2.831	7.085
High vs. Low Income Jurisdiction	1.3585	0.232	<.0001	3.89	2.469	6.13

Table 10: Obesity Model 7. Core Model (Table 1) plus Household Income Level and Education of Caregiver

Parameter	Estimate	SE	p-value	OR	95% CI Lower	95% CI Upper
Intercept	–2.8432	0.283	<.0001			
Food Insecure vs. Secure	–0.184	0.112	0.1005	0.832	0.668	1.036
American Indian Alaska Native vs. White	1.4225	0.3305	<.0001	4.147	2.17	7.927
Asian vs. White	0.7005	0.2515	0.0053	2.015	1.231	3.298
Black vs. White	1.4419	0.9103	0.1132	4.229	0.71	25.182
More than one race vs. White	0.5306	0.2296	0.0208	1.7	1.084	2.666
Native Hawaiian Pacific Islander vs. White	0.5964	0.2257	0.0082	1.816	1.167	2.826
6–8 year old vs. 2–5 year old	0.3403	0.1081	0.0016	1.405	1.137	1.737
Male vs. Female	0.4007	0.1063	0.0002	1.493	1.212	1.839
High School vs. < High School	0.3959	0.1678	0.0183	1.486	1.069	2.064
College vs. < High School	0.3478	0.169	0.0396	1.416	1.017	1.972
$35K + vs. < $35K	–0.0774	0.145	0.5936	0.926	0.697	1.23

Table 11: Obesity Model 8. Core Model (Table 1) plus Jurisdiction Income Level, Household Income Level, and Education of Caregiver

Parameter	Estimate	SE	p-value	OR	95% CI Lower	95% CI Upper
Intercept	–3.9775	0.3683	<.0001			
Food Insecure vs. Secure	–0.1433	0.1125	0.2027	0.866	0.695	1.08
American Indian Alaska Native vs. White	1.4162	0.3291	<.0001	4.121	2.162	7.855
Asian vs. White	0.6701	0.2519	0.0078	1.954	1.193	3.202
Black vs. White	1.5394	0.8793	0.08	4.662	0.832	26.122
More than one race vs. White	0.5315	0.2297	0.0206	1.702	1.085	2.669
Native Hawaiian Pacific Islander vs. White	0.6361	0.2329	0.0063	1.889	1.197	2.982
6–8 year old vs. 2–5 year old	0.3368	0.1091	0.002	1.4	1.131	1.734
Male vs. Female	0.4112	0.1069	0.0001	1.509	1.223	1.86
High School vs. < High School	0.2864	0.1703	0.0926	1.332	0.954	1.859
College vs. High School	0.3182	0.1708	0.0624	1.375	0.984	1.921
$35,000+ vs. < $35,000	–0.1167	0.1463	0.4252	0.89	0.668	1.185
Medium vs. Low Income Jurisdiction	1.3657	0.2537	<.0001	3.918	2.383	6.443
High vs. Low Income Jurisdiction	1.1921	0.2541	<.0001	3.294	2.002	5.42

Table 12: Underweight Model 1. Core Model of Food Insecurity and Risk of Underweight in the Children's Healthy Living Program

Parameter	Estimate	SE	p-value	OR	95% CI Lower	95% CI Upper
Intercept	–3.7025	0.4463	<.0001			
Food Insecure vs. secure	–0.1261	0.2141	0.5558	0.882	0.579	1.341
American Indian Alaska Native vs. White	–13.9113	0.4552	<.0001	<0.001	<0.001	<0.001
Asian vs. White	0.8508	0.5035	0.0911	2.342	0.873	6.282
Black vs. White	–13.9554	0.5544	<.0001	<0.001	<0.001	<0.001
More than one race vs. White	–0.1327	0.5035	0.7921	0.876	0.326	2.349
Native Hawaiian Pacific Islander vs. White	0.1505	0.4801	0.754	1.162	0.454	2.979
6–8 year old vs. 2–5 year old	–0.1906	0.2236	0.3941	0.826	0.533	1.281
Male vs. Female	0.1378	0.2061	0.5038	1.148	0.766	1.719

Note: n = 4,930.

Table 13: Underweight Model 2. Core Model (Table 12) plus Jurisdiction Income Level

Parameter	Estimate	SE	Pr > ChiSq	OR	95% CI Lower	95% CI Upper
Intercept	–3.3456	0.5247	<.0001			
Food Insecure vs. secure	–0.1535	0.2113	0.4676	0.858	0.567	1.298
American Indian Alaska Native vs. White	–13.9087	0.4553	<.0001	<0.001	<0.001	<0.001
Asian vs. White	0.8637	0.5037	0.0864	2.372	0.884	6.366
Black vs. White	–13.8528	0.5523	<.0001	<0.001	<0.001	<0.001
More than one race vs. White	–0.1009	0.5037	0.8412	0.904	0.337	2.426
Native Hawaiian Pacific Islander vs. White	0.2981	0.5155	0.563	1.347	0.491	3.701
6–8 year old vs. 2–5 year old	–0.184	0.2257	0.4151	0.832	0.535	1.295
Male vs. Female	0.1344	0.206	0.5142	1.144	0.764	1.713
Middle Upper Income Level vs. Lower Income	–1.1045	0.3417	0.0012	0.331	0.17	0.647
High Income Level vs. Lower Income	–0.3504	0.3128	0.2625	0.704	0.382	1.3

Table 14: Underweight Model 3. Core Model (Table 12) plus Household Income Level

Parameter	Estimate	Error	p-value	OR	95% CI Lower	95% CI Upper
Intercept	–3.6236	0.537	<.0001			
Food Insecure vs. Secure	0.0221	0.2395	0.9266	1.022	0.639	1.635
American Indian Alaska Native vs.White	–14.0892	0.4728	<.0001	<0.001	<0.001	<0.001
Asian vs. White	0.6992	0.5439	0.1986	2.012	0.693	5.843
Black vs. White	–14.2131	0.6118	<.0001	<0.001	<0.001	<0.001
More than one race vs. White	–0.3832	0.5396	0.4776	0.682	0.237	1.963
Native Hawaiian Pacific Islander vs. White	–0.2273	0.522	0.6633	0.797	0.286	2.216
6–8 year old vs. 2–5 year olds	–0.1614	0.2628	0.539	0.851	0.508	1.424
Male vs. Female	0.2638	0.2346	0.2608	1.302	0.822	2.062
$35,000 + vs. < $35,000	–0.2452	0.3355	0.465	0.783	0.405	1.51

Table 15: Underweight Model 4. Core Model (Table 12) plus Education of Caregiver

Parameter	Estimate	Error	p-value	OR	95% CI Lower	95% CI Upper
Intercept	–3.802	0.487	<.0001			
Food insecure vs. secure	–0.1289	0.2131	0.5451	0.879	0.579	1.335
American Indian Alaska Native vs. White	–13.917	0.4558	<.0001	<0.001	<0.001	<0.001
Asian vs. White	0.851	0.5027	0.0905	2.342	0.874	6.272
Black vs. White	–13.9595	0.5562	<.0001	<0.001	<0.001	<0.001
More than One Race vs. White	–0.1496	0.5045	0.7668	0.861	0.32	2.314
Native Hawaiian Pacific Islander vs. White	0.114	0.4873	0.815	1.121	0.431	2.913
6–8 year old vs. 2–5 year old	–0.1772	0.2221	0.425	0.838	0.542	1.294
Male vs. Female	0.1428	0.2063	0.4886	1.154	0.77	1.728
High School vs. < High School	0.2531	0.2807	0.3671	1.288	0.743	2.233
College vs. < High School	0.0466	0.2879	0.8713	1.048	0.596	1.842

Table 16: Underweight Model 5. Core Model (Table 12) plus Jurisdiction Income Level and Household Income Level

Parameter	Estimate	SE	p-value	OR	95% CI Lower	95% CI Upper
Intercept	–3.1273	0.5848	<.0001			
Food insecure vs. secure	–0.0283	0.241	0.9064	0.972	0.606	1.559
American Indian Alaska Native vs. White	–14.097	0.4727	<.0001	<0.001	<0.001	<0.001
Asian vs. White	0.6949	0.5432	0.2008	2.003	0.691	5.81
Black vs. White	–14.277	0.6163	<.0001	<0.001	<0.001	<0.001
More than one race vs. White	–0.3531	0.5373	0.5111	0.703	0.245	2.014
Native Hawaiian Pacific Islander vs. White	–0.0252	0.5355	0.9624	0.975	0.341	2.785
6–8 year old vs. 2–5 year old	–0.1627	0.2641	0.5378	0.85	0.506	1.426
Male vs. Female	0.262	0.2332	0.2612	1.299	0.823	2.052
$35,000 + vs. < $35,000 Household Income	–1.523	0.4326	0.0004	0.218	0.093	0.509
Middle Upper vs. Lower middle income level Jurisdiction	–0.4455	0.3697	0.2281	0.64	0.31	1.322
High Income vs. Lower middle income Level Jurisdiction	–0.3059	0.3439	0.3737	0.736	0.375	1.445

Table 17: Underweight Model 6. Core Model (Table 12) plus Caregiver Education and Jurisdiction Income Level

Parameter	Estimate	SE	p-value	OR	95% CI Lower	95% CI Upper
Intercept	–3.1273	0.5848	<.0001			
Food insecure vs. secure	–0.0283	0.241	0.9064	0.972	0.606	1.559
American Indian Alaska Native vs. White	–14.097	0.4727	<.0001	<0.001	<0.001	<0.001
Asian vs. White	0.6949	0.5432	0.2008	2.003	0.691	5.81
Black vs. White	–14.277	0.6163	<.0001	<0.001	<0.001	<0.001
More than one race vs. White	–0.3531	0.5373	0.5111	0.703	0.245	2.014
Native Hawaiian Pacific Islander vs. White	–0.0252	0.5355	0.9624	0.975	0.341	2.785
6–8 year old vs. 2–5 year old	–0.1627	0.2641	0.5378	0.85	0.506	1.426
Male vs. Female	0.262	0.2332	0.2612	1.299	0.823	2.052
$35,000 + vs. < $35,000 Household Income	–1.523	0.4326	0.0004	0.218	0.093	0.509
Middle Upper vs. Lower middle income level Jurisdiction	–0.4455	0.3697	0.2281	0.64	0.31	1.322
High Income vs. Lower middle income Level Jurisdiction	–0.3059	0.3439	0.3737	0.736	0.375	1.445

Parameter	Estimate	SE	p-value	OR	95% CI Lower	95% CI Upper
Intercept	–3.2339	0.6125	<0.0001			
Food insecure vs. secure	0.00961	0.2376	0.9677	1.010	0.634	1.609
American Indian Alaska Native vs. White	–14.0607	0.4593	<0.0001	<0.001	<0.001	<0.001
Asian vs. White	0.8237	0.5140	0.1091	2.279	0.832	6.242
Black vs. White	–14.1150	0.5806	<0.0001	<0.001	<0.001	<0.001
More than one race vs. White	–0.3078	0.5212	0.5548	0.735	0.265	2.042
Native Hawaiian Pacific Islander vs. White	0.0120	0.5198	0.9815	1.012	0.365	2.803
6–8 year old vs. 2–5 year old	–0.1662	0.2648	0.5304	0.847	0.504	1.423
Male vs. female	0.2693	0.2341	0.2501	1.309	0.827	2.071
High school vs. < high school	0.2152	0.3478	0.5361	1.240	0.627	2.452
College vs. < high school	–0.0739	0.3292	0.8223	0.929	0.487	1.771
Middle upper vs. Lower middle income jurisdiction	–1.5899	0.4511	0.0004	0.204	0.084	0.494
High income vs. Lower middle income jurisdiction	–0.5474	0.3605	0.1289	0.578	0.285	1.172

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Table 17 *continued*

Parameter	Estimate	SE	p-value	OR	95% CI Lower	95% CI Upper
Intercept	–3.2339	0.6125	<.0001			
Food insecure vs. secure	0.00961	0.2376	0.9677	1.01	0.634	1.609
AIAN vs. White	–14.0607	0.4593	<.0001	<0.001	<0.001	<0.001
Asian vs. White	0.8237	0.514	0.1091	2.279	0.832	6.242
Black vs. White	–14.115	0.5806	<.0001	<0.001	<0.001	<0.001
More than one race vs. White	–0.3078	0.5212	0.5548	0.735	0.265	2.042
Native Hawaiian Pacific Islander vs. White	0.012	0.5198	0.9815	1.012	0.365	2.803
6–8 year old vs. 2–5 year old	–0.1662	0.2648	0.5304	0.847	0.504	1.423
Male vs. Female	0.2693	0.2341	0.2501	1.309	0.827	2.071
High School vs. < High School	0.2152	0.3478	0.5361	1.24	0.627	2.452
College vs. < High School	–0.0739	0.3292	0.8223	0.929	0.487	1.771
Middle Upper vs. Lower Middle Income Jurisdiction	–1.5899	0.4511	0.0004	0.204	0.084	0.494
High Income vs. Lower Middle Income Jurisdiction	–0.5474	0.3605	0.1289	0.578	0.285	1.172

Table 18: Underweight Model 7. Core Model (Table 12) plus Caregiver Education and Household Income

Parameter	Estimate	SE	p-value	OR	95% CI Lower	95% CI Upper
Intercept	–3.5959	0.5548	<.0001			
Food insecure vs. secure	0.0179	0.239	0.9403	1.018	0.637	1.626
American Indian Alaska Native vs. White	–14.0981	0.4721	<.0001	<0.001	<0.001	<0.001
Asian vs. White	0.7188	0.5454	0.1875	2.052	0.705	5.976
Black vs. White	–14.1748	0.615	<.0001	<0.001	<0.001	<0.001
More than one race vs. White	–0.3874	0.5393	0.4725	0.679	0.236	1.954
Native Hawaiian Pacific Islander vs. White	–0.253	0.5226	0.6284	0.777	0.279	2.163
6–8 year old vs. 2–5 year old	–0.1621	0.2623	0.5366	0.85	0.509	1.422
Male vs. Female	0.2658	0.2344	0.2569	1.304	0.824	2.065
High School vs. < High School	0.0552	0.3442	0.8726	1.057	0.538	2.075
College vs. < High School Caregiver	–0.0954	0.3415	0.7799	0.909	0.465	1.775
$35,000+ vs. < $35,000 Household Income	–0.2086	0.3386	0.5378	0.812	0.418	1.576

Table 19: Underweight Model 8. Core Model (Table 12) plus Education, plus Household Income plus Jurisdiction Income

Parameter	Estimate	SE	p-value	OR	95% CI Lower	95% CI Upper
Intercept	–3.1468	0.6258	<.0001			
Food insecure vs. secure	–0.0283	0.2403	0.9062	0.972	0.607	1.557
AIAN vs. White	–14.103	0.4717	<.0001	<0.001	<0.001	<0.001
Asian vs. White	0.723	0.5439	0.1837	2.061	0.71	5.983
Black vs. White	–14.232	0.6178	<.0001	<0.001	<0.001	<0.001
More than one race vs. White	–0.3631	0.5368	0.4988	0.696	0.243	1.992
Native Hawaiian Pacific Islander vs. White	–0.0643	0.5356	0.9045	0.938	0.328	2.679
6–8 year old vs. 2–5 year old	–0.1558	0.2636	0.5543	0.856	0.51	1.434
Male vs. Female	0.2698	0.2337	0.2483	1.31	0.828	2.071
High School vs. < High School Caregiver	0.2157	0.3475	0.5348	1.241	0.628	2.452
College vs. < High School Caregiver	–0.0282	0.3394	0.9337	0.972	0.5	1.891
$35K + vs. < $35K	–0.2541	0.3473	0.4644	0.776	0.393	1.532
Middle Upper vs. Lower Middle Income Jurisdiction	–1.5833	0.4519	0.0005	0.205	0.085	0.498
High vs. Lower Middle Income Jurisdiction	–0.5021	0.3725	0.1776	0.605	0.292	1.256

Household income was not significantly related to obesity in regression analyses, while jurisdiction income level was strongly related. Household income has been shown to be important at the ends of the distribution of income (Jolliffe 2011), while in these jurisdictions the income is relatively homogeneous, at least in comparison to jurisdiction income level differences. Within the upper middle income jurisdictions, income may be an important predictor of obesity among those at the ends of the income distribution, yet overall other factors related to use of income (for example, purchase of imported processed foods) are likely better indicators, and are better measured by jurisdiction policies. This implies jurisdiction-level approaches can be vital in changing nutrition and health status.

Several of the jurisdictions are in compacts of free association with the US (Federated States of Micronesia [FSM], the RMI, and Palau); the compact agreement is currently up for renegotiation in Palau, and will be up for renegotiation in the RMI and the FSM in 2023 (GAO 2016). These countries are lower middle income (FSM) and upper middle income (RMI and Palau). This is a key opportunity to implement policies that will support healthy growth of children, which will impact future health statistics of the jurisdiction.

Strategies for economic development of jurisdictions in the USAP should consider the food and physical activity environment that will protect against a rapid nutrition transition from undernutrition to overnutrition. Strategies that protect the local food system and active living are vital (Sunguya et al. 2014). Advancing programs that support local foods may be helpful since local food production (i) provides incentives for entrepreneurship and innovation; (ii) expands consumer choice and fresh food access; (iii) improves negotiating power to local producers; (iv) supports rural economic revitalization; and (v) protects the food system against severe shocks, through decentralization of production (McFadden et al. 2016). This latter point is especially important in island settings where frequent cyclones devastate agriculture, requiring a planned agricultural response to avoid dependency on outside food sources. Snowdon et al. found that approximately 67% of Guam's food supply is imported from the US, the Philippines, and Japan (Snowdon et al. 2013).

Other approaches for food companies include the following: (i) align core business practices with population health goals, (ii) pledge to support a level playing field for those attempting to make the food environment healthier, (iii) share proprietary data with independent evaluators, and (iv) invest in creating a consumer base for healthy food and beverage products (Huang et al. 2015).

Sugar sweetened beverage (SSB) consumption has shown a relationship with child obesity. Indeed, SSBs (which include soda, sport drinks, fruit drinks and punches, low-calorie drinks, sweetened tea, and other sweetened beverages) are recognized as a large contributor to calorie intake, with little to no nutritional value (Kass et al. 2014). Additionally, liquid calories are less satiating than food calories. Key policy approaches to reducing intake of SSBs include taxes on SSBs, restricting sale or availability of SSBs in and around schools, and prohibiting SSB purchase on the Supplemental Food Assistance Program.

Multicomponent approaches to improve child growth status are likely needed.

3. CONCLUSIONS

The USAP region is highly diverse in economic development, food security, and child growth status, with a dual burden of over and undernutrition. Jurisdiction-level policies are needed that protect a healthy local environment and promote healthy child and jurisdiction development by preserving an active lifestyle and healthy food environment. Such policies would include food, nutrition and economic programs and policies that protect local agriculture and food production, and policies (such as transportation policies) that protect local activities such as walking and ocean activities. Food policies might support selective importation of health-promoting products and banning or taxing of unhealthy products such as sugar-sweetened beverages. Limiting the development of fast food and convenience stores may help control the quality of food consumed. Further study of the ability of child food assistance programs to protect from both undernutrition and obesity are needed. The terms of the compacts of free association with the United States will likely play a key role in determining the economic environment for promoting healthy child growth in the USAP.

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