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Cardiometabolic Risk Factor Correlations between Parents and Children in Guam: Insights from the Pacific Islands Cohort on Cardiometabolic Health Study

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Abstract

The Western Pacific region, including Guam, reports some of the highest rates of prediabetes and type 2 diabetes mellitus (T2DM), both of which are linked to metabolic syndrome (MetS), a cluster of preventable risk factors. Offspring of parents with MetS are at elevated risk of developing MetS themselves. However, the prevalence of MetS in Guam and its impact on children are not well documented. This study utilized data from the Pacific Islands Cohort on Cardiometabolic Health (PICCAH) to assess MetS among adults and MetS risk among children. Adult MetS was defined using International Diabetes Federation (IDF) criteria, while child risk was determined based on age- and sex-specific waist circumference percentiles for abdominal obesity. MetS Z-scores were calculated, and associations between MetS indicators and lifestyle factors—including physical activity and sleep for both parents and children, sedentary behavior and stress for parents, and screen time for children—were analyzed. Linear regression evaluated relationships between adult and child MetS Z-scores, revealing direct correlations within parent–child dyads. The high adult MetS prevalence underscores the need for interventions targeting both parents and children. Further research incorporating additional lifestyle factors, such as dietary patterns, is needed to inform family-centered prevention strategies.

Keywords: Pacific islanders, Type 2 diabetes mellitus, Metabolic syndrome, MetS

Introduction

The global prevalence of metabolic syndrome (MetS) has been rising steadily, representing a combination of risk factors that increase the likelihood of cardiovascular disease (CVD), type 2 diabetes mellitus (T2DM), and stroke [1–4]. According to U.S. National Health and Nutrition Examination Survey (NHANES) data, MetS prevalence among adults increased from 25.3% in 1988–1994 to 34.2% in 2007–2012 [5]. NHANES does not include data from Hawai'i, Alaska, or U.S. territories due to its mobile examination centers, limiting information for Pacific Islander populations [6].

The International Diabetes Federation (IDF) reported in 2021 that the Western Pacific region has the highest global prevalence of prediabetes and T2DM, indicative of elevated blood glucose levels [7]. In Guam, an unincorporated U.S. territory, 11.7% of adults were diagnosed with diabetes, and 67.7% were overweight or obese (OWOB) in 2019, both exceeding U.S. averages of 10.8% and 67.0 percent, respectively [8]. Among youth, 39.3% of children aged 4–19 were OWOB during 2010–2014, and 33.8% of children aged 2–8 had abdominal

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obesity [9, 10]. These findings highlight a need for comprehensive assessment of MetS prevalence in Guam. The IDF defines MetS in adults as abdominal obesity plus any two of the following: elevated triglycerides (≥150 mg/dL) or treatment for dyslipidemia, low HDL cholesterol (<40 mg/dL for males, <50 mg/dL for females) or treatment for dyslipidemia, high blood pressure (systolic ≥130 mmHg or diastolic ≥85 mmHg) or treatment for hypertension, and elevated fasting glucose (≥100 mg/dL) or T2DM diagnosis [11]. For children, MetS is assessed according to age: ages 6–<10 are considered at risk if waist circumference exceeds the 90th percentile; ages 10–<16 are diagnosed using IDF cutoffs, requiring abdominal obesity plus two or more clinical features; children ≥16 years follow adult criteria [11].

Lifestyle behaviors including physical activity, sedentary behavior, sleep duration, stress management, and diet are key modifiable risk factors for MetS [12, 13]. In Guam, most children aged 2–8 years did not meet recommendations for sleep (59.6 percent), sedentary screen time (83.1%), fruit intake (58.7%), vegetable intake (99.1%), or sugar-sweetened beverage consumption (73.7%) [10]. Diets high in saturated fat and low in monounsaturated and polyunsaturated fatty acids are linked to dyslipidemia [14]. Children and adults consuming such diets in Guam face higher risks for MetS, especially in combination with elevated BMI [9, 10, 12, 15]. Socioeconomic status (SES) and parent–child metabolic inheritance are additional determinants of MetS risk [14, 16–19]. Low SES is associated with higher MetS prevalence [18, 20], and food insecurity affects over half (51.5%) of children, whose families report running out of food funds at month's end [10]. Children with one or both parents having MetS are at greater risk of developing the condition [20–22].

Guam's ethnically diverse population—including CHamorus, Filipinos, Micronesians, and other Asian groups—combined with historical colonization and migration, may contribute to increased metabolic disease prevalence [23, 24]. Migration across U.S.-Affiliated Pacific Islands (USAPI) further amplifies health burdens. Despite high T2DM and OWOB rates, MetS prevalence and contributing risk factors remain underexplored.

The Pacific Islands Cohort on Cardiometabolic Health (PICCAH) study gathered multi-generational health and lifestyle data from parent–child dyads in Guam, Pohnpei, and Palau, allowing examination of familial associations in MetS [25]. This study aimed to: (1) quantify MetS prevalence among adults and children aged 3–9 in Guam; (2) investigate modifiable lifestyle factors associated with MetS indicators; and (3) assess correlations between parent and child MetS risk.

Materials and Methods

Study design

This cross-sectional analysis utilized data from the Pacific Islands Cohort on Cardiometabolic Health (PICCAH) study. The study design and rationale of PICCAH have been detailed previously [25]. This analysis represents the first examination of parent–child associations for metabolic syndrome (MetS) risk factors in Guam, covering data collected from 2018 to 2019. Participants included parent–child dyads, comprising 338 adults aged 21–50 years and 214 children aged 3–9 years who completed at least one assessment during Visits 1 or 2.

The PICCAH study received approval from the University of Guam Committee on Human Research Subjects (CHRS/IRB#19–171 and #20–100). After providing informed consent, adults completed demographic and lifestyle questionnaires for themselves and their children during Visit 1. Anthropometric measurements—including waist circumference (WC, cm), height (cm), weight (kg), and blood pressure (mmHg)—were obtained for both parents and children during Visit 1 after consent and assent. During Visit 2, biospecimens (HDL cholesterol, triglycerides, and fasting glucose) were collected from all participants who had provided consent and assent. Detailed data collection methods have been previously described [25].

Study participants

This analysis focused on children aged 3–9 years, in line with PICCAH's original objectives. Adults identified as primary caregivers (N = 338) were grouped by ethnicity: CHamoru, Filipino, Other Micronesian (including Carolinian, Chuukese, Kiribati, Kosraean, Palauan, Pohnpeian, Yapese, or Marshallese), and Other Race/Ethnicity (including non-Micronesian Pacific Islanders, Other Asian, White, or multiracial participants). Adult ages were categorized as 18–24, 25–34, 35–44, and 45–54 years.

Household income was reported by adult participants and used to classify both adult and child income categories based on previously published thresholds [8, 10]. Only the parent's highest level of education, self-reported as years of schooling completed, was included. Cultural identity was determined using Ethnic Group Score (ECS) and U.S. Mainland Score (UCS) scales, as applied in prior studies [24]. Based on these scores, participants were classified as traditional (≤12 ECS, >12 UCS), integrated (12 ≤ ECS ≤ 12 UCS), assimilated (>12 ECS, ≤12 UCS), or marginalized (>12 ECS, >12 UCS) [10, 26].

Food insecurity was assessed using one question from the USDA Core Food Security Module: “In the past 12 months, how often does money for food run out by the end of the month?” [27]. Households responding “Sometimes,” “Most times,” or “Always” were classified as food insecure, while “Never” or “Seldom” responses were considered food secure.

Study measures

Lifestyle factors related to MetS were assessed using parent–child physical activity and sleep questionnaires (both parent and child), the International Physical Activity Questionnaire (IPAQ) and Depression Anxiety Stress Scales (DASS) for adult sedentary behavior and stress, and a screen time questionnaire for children.

Physical activity (parent and child): Adults reported weekly hours of physical activity, summed and classified as “more active” or “less active” based on meeting the 2.5-hour-per-week guideline using the Baecke Physical Activity Questionnaire [28]. Parents reported children’s activity through two questions on free-time and organized activity participation, coded 0–3 for each response. The mean of these responses was calculated, with values 0–2 categorized as “less active” and higher values as “more active.”

Sedentary behavior (parent): Parents reported average daily hours spent sitting (e.g., commuting, work, meals, TV). Hours ≥9 per day were categorized as “more sedentary.”

Sleep (parent and child): Sleep duration was reported by parents for their children, including naps, and by adults for nighttime sleep. Sleep was compared to recommended age-specific guidelines [29].

Stress (parent): Adult stress was measured using the DASS-21, focusing on seven stress-related items with responses coded 0–3 (“Never” to “Almost Always”) [30]. Total scores were categorized as “Less Stressed” (normal to moderate) or “More Stressed” (severe to extremely severe).

Screen time (child): Parents reported children’s average weekday screen time, categorized as “Never or Rarely” (0–2 h), “Sometimes” (3–5 h), “Often” (6–8 h), or “Very Often/Always” (9+ h). Weekday and weekend times were combined into a composite score: 0 = 0–1 h, 1 = 2–4 h, and 2 = ≥5 h.

MetS (parent) and MetS risk (child): Adult MetS and child MetS risk were determined using IDF criteria [6, 11] **(Table 1)**. For adults, Europid WC thresholds were applied due to the absence of Pacific Islander-specific cutoffs. Children with WC above the 90th percentile for age and sex were considered at risk for MetS [11, 29]. Specific cutoffs for ages 3–5 were: males 55.3, 59.7, 61.6 cm; females 54.2, 58.1, 64.2 cm for ages 3, 4, and 5, respectively [31].

Table 1. International Diabetes Federation (IDF) criteria for metabolic syndrome (MetS) in adults and MetS risk in children

IDF Criteria[1]	MetS Risk (Children, 6–<10 y)	MetS (Adults)
Waist Circumference (WC)[2]	>90th percentile by sex **Males:** 6 y: >68 cm, 7 y: >72.5 cm, 8 y: >77.4 cm, 9 y: >85.3 cm **Females:** 6 y: >68 cm, 7 y: >73.5 cm, 8 y: >78.0 cm, 9 y: >77.3 cm	**Male:** >94 cm **Female:** >80 cm
Additional Criteria (any 2 of the 4 below)	No established criteria for this age group	Required for MetS diagnosis in adults
Triglycerides	Not defined	≥150 mg/dL or receiving treatment for dyslipidemia
HDL Cholesterol[3]	Not defined	**Males:** <40 mg/dL or treated for dyslipidemia **Females:** <50 mg/dL or treated for dyslipidemia
Blood Pressure	Not defined	Systolic ≥130 mmHg or diastolic ≥85 mmHg or receiving treatment for hypertension
Fasting Blood Glucose	Not defined	≥100 mg/dL or diagnosed T2DM

Notes:

1. IDF criteria adapted from the 2021 International Diabetes Federation guidelines.
2. Adult WC thresholds used Europid cutoffs due to lack of Pacific Islander-specific values. Child WC values are based on the 90th percentile from ages 2–19, National Health and Nutrition Examination Survey 2015–2018.
3. HDL: high-density lipoprotein cholesterol.

Statistical methods

Metabolic syndrome (MetS) Z-scores for both adults and children were derived using established equations developed by DeBoer and Gurka, specifically tailored for non-Hispanic White adults and adolescents [29, 31–33]. Key demographic characteristics and modifiable behavioral factors—including sleep duration, sedentary time, physical activity levels, and perceived stress—were assessed. Associations between MetS status and individual demographic variables were examined through chi-square tests for independence.

Sex-specific equations were applied to compute the MetS Z-score as follows:

For adults:

- Females: 7.2591 + 0.0254 × Waist Circumference − 0.0120 × HDL + 0.0075 × SBP + 0.5800 × ln(Triglycerides) + 0.0203 × Glucose
- Males: −5.4559 + 0.0125 × Waist Circumference − 0.0251 × HDL + 0.0047 × SBP + 0.8244 × ln(Triglycerides) + 0.0106 × Glucose

For children:

- Females: −4.3757 + 0.4849 × BMI Z-score − 0.0176 × HDL + 0.0257 × SBP + 0.3172 × ln(Triglycerides) + 0.0083 × Glucose
- Males: −4.9310 + 0.2804 × BMI Z-score − 0.02557 × HDL + 0.0189 × SBP + 0.6240 × ln(Triglycerides) + 0.0140 × Glucose

Average values of core MetS components—such as the MetS Z-score, waist circumference (cm), triglycerides (mg/dL), HDL cholesterol (mg/dL), and fasting glucose (mg/dL)—were compared between groups defined by lifestyle risk factors via independent t-tests.

The association between parental and child MetS Z-scores among participants in the PICCAH study in Guam was investigated through linear regression modeling. Analyses included both crude (unadjusted) and multivariable-adjusted models. The adjusted models accounted for possible confounding variables, namely parental education and household income as well as child age, yielding adjusted regression coefficients (B), 95% confidence intervals, p-values, and correlation coefficients (R). Statistical significance was set at $p < 0.05$.

Results and Discussion

Among the 214 children included in the analysis, slightly more than half were boys (51.87%), with roughly comparable representation across the 3–6-year (55.14%) and 7–9-year (55.86%) age categories. The adult participants (primarily parents) were overwhelmingly female (99.22%), with the largest ethnic groups being CHamoru (52.10%) followed by Other Micronesian (26.65%). Most parents fell within the 25–35-year age range (46.09%), reported annual household incomes below USD 20,000 (30.89%), had completed high school (49.1%), and identified with an integrated cultural orientation (62.69%). The highest prevalence of MetS was observed in the CHamoru group (47.1%). A statistically significant association was found between parental ethnicity and MetS presence ($p < 0.05$), as detailed in **Table 2**.

Table 2. Demographic and socioeconomic characteristics of PICCAH adult participants by metabolic syndrome (MetS) status

Adult Characteristic	No MetS[1] n (%)	MetS[1] n (%)	p-Value*	Total N
Age group (years)			0.107	
18–24	10 (76.9)	3 (23.1)		13
25–35	78 (66.1)	40 (33.9)		118
35–44	58 (58.0)	42 (42.0)		100
45–54	11 (44.0)	14 (56.0)		25
Ethnicity			0.005	
CHamoru	92* (52.9)	82* (47.1)		174
Filipino	42* (76.4)	13* (23.6)		55

Other Micronesian	61* (68.5)	28* (31.5)		89
Other Race/Ethnicity[2]	5* (50.0)	5* (50.0)		10
Household income (USD)			0.692	
<20,000	51 (63.8)	29 (36.3)		80
20,000–34,999	37 (55.2)	30 (44.8)		67
35,000–59,999	29 (63.0)	17 (37.0)		46
≥60,000	42 (63.6)	24 (36.4)		66
Education level			0.095	
Less than high school	4 (40.0)	6 (60.0)		10
High school	92 (56.1)	72 (43.9)		164
College (1–3 years)	44 (67.7)	21 (32.3)		65
College (4+ years)	64 (67.4)	31 (32.6)		95
Household food security[3]			0.753	
Yes	94 (58.4)	67 (41.6)		161
No	92 (60.1)	61 (39.9)		153

Notes:

1. Metabolic syndrome (MetS) defined according to the 2021 IDF adult criteria.
2. "Other Race/Ethnicity" includes non-Micronesian, non-CHamoru, and non-Filipino participants.
3. Household food security was assessed using one USDA Core Food Security Module question: "In the past 12 months, how often did money for food run out before the end of the month?" Responses "Never" or "Seldom" were categorized as food secure (Yes), and "Sometimes," "Most times," or "Always" were considered food insecure (No).
4. *Chi-square tests were used to determine statistical significance at $p < 0.05$.

A large proportion of adults (92.3%) exhibited abdominal obesity. Among participants, the prevalence of specific MetS indicators was as follows: elevated serum triglycerides were observed in 18.93% of adults and 2.34% of children, while high fasting blood glucose affected 25.44% of adults and 0.93% of children. In adults, 31.66% had elevated blood pressure, and 60.65% had low HDL cholesterol levels. Based on the IDF criteria [29], 39.05 percent of adults met the definition for MetS, and 7.69 percent of children were identified as being at risk for MetS, as summarized in **Table 3**.

Table 3. Prevalence of Metabolic Syndrome (MetS) and its components among adult and child participants in the PICCAH study

MetS Components[1]	**Adult (Parent)**			**Child**		
	n	%	95% CI	n	%	95% CI
Abdominal Obesity[2]	312[a]	92.31	(89.47, 95.15)	15	7.69	(3.95, 11.43)
Lipid Profile						
Low HDL-Cholesterol	205[a]	60.65	(55.44, 65.86)	33[d]	15.42	(10.54, 20.30)
Elevated Triglycerides	64[a]	18.93	(14.76, 23.11)	5[d]	2.34	(0.30, 4.38)
Glucose Metabolism						
Elevated Fasting Glucose	86[a]	25.44	(20.80, 30.09)	2[d]	0.93	(0.00, 2.22)
Elevated Hemoglobin A1c	50[b]	15.02	(11.18, 18.85)	1[e]	0.47	(0.00, 1.39)
Elevated Blood Pressure	107[a]	31.66	(26.70, 36.62)	1[f]	0.47	(0.00, 1.38)
Metabolic Syndrome (Adults)[2]	132[a]	39.05	(33.85, 44.25)	–	–	–
At Risk for MetS (Children)[3]	–	–	–	15[c]	7.69	(3.95, 11.43)
Waist Circumference Z-Score (Mean)	0.48 [a]	(0.31, 0.65)	−0.52 [d]	(−0.62, −0.43)		

[1] Based on International Diabetes Federation (IDF) criteria for metabolic syndrome (2021). [2] Metabolic syndrome in adults was defined as the presence of central (abdominal) obesity plus at least two of the four remaining risk factors according to the 2021 IDF criteria. [3] Children were

classified as “at risk for MetS” if their age- and sex-specific waist circumference exceeded the 90th percentile (indicating abdominal obesity); all child participants were younger than 10 years.
[a] Total adults with available data for determining MetS and its components, N = 338. [b] Total adults with available data for this specific component, N = 333. [c] Total children with available data for determining at-risk status, N = 195. [d] Total children with available data for this component, N = 214. [e] Total children with available data for this component, N = 211. [f] Total children with available data for this component, N = 215.

Both adults and children were assessed for lifestyle-related risk factors, and no statistically significant differences were observed, as presented in **Table 4**.

Table 4. Metabolic Syndrome (MetS) Components (Mean ± Standard Deviation) among adult and child participants stratified by lifestyle risk factors

Lifestyle Factor	Category	Waist Circumference (cm)	MetS Z-Score (Adults) / Waist Circumference Z-Score (Children)	HDL Cholesterol (mg/dL)	Triglycerides (mg/dL)	Fasting Blood Glucose (mg/dL)
Adult Behaviors						
Physical Activity[1] (h/week)	Less active	101.24 ± 16.09	0.15 ± 1.17	48.50 ± 11.62	107.11 ± 58.35	95.21 ± 37.69
	More active	103.19 ± 16.48	0.54 ± 1.64	48.61 ± 12.06	109.87 ± 76.67	107.54 ± 60.89
Sedentary Time[2] (h/day)	Less sedentary	102.33 ± 17.22	0.44 ± 1.51	49.85 ± 12.31	111.81 ± 67.91	105.09 ± 56.08
	More sedentary	102.09 ± 15.62	0.27 ± 1.33	52.56 ± 10.85	103.21 ± 59.13	97.88 ± 43.64
Sleep Duration	<8 hours	102.27 ± 17.26	0.46 ± 1.52	48.06 ± 11.32	108.52 ± 74.71	105.21 ± 58.10
	≥8 hours	103.98 ± 16.47	0.63 ± 1.74	48.87 ± 12.67	110.02 ± 74.73	111.70 ± 64.28
Perceived Stress[3]	Lower stress	102.82 ± 15.98	0.44 ± 1.50	48.75 ± 11.99	108.95 ± 70.18	104.18 ± 52.95
	Higher stress	103.71 ± 20.80	0.87 ± 2.27	47.94 ± 12.25	116.06 ± 109.01	123.44 ± 94.91
Child Behaviors						
Physical Activity[4]	Less active	58.25 ± 13.37	−0.56 ± 0.74	49.60 ± 11.47	68.95 ± 34.89	79.26 ± 9.53
	More active	57.90 ± 8.25	−0.48 ± 0.65	52.10 ± 12.70	63.58 ± 25.85	81.58 ± 8.29
Screen Time (h/day)	<2 hours	57.76 ± 10.12	−0.32 ± 0.76	47.77 ± 8.30	75.36 ± 45.74	79.36 ± 11.46
	≥2 hours	58.15 ± 11.64	−0.54 ± 0.69	50.67 ± 12.25	66.73 ± 30.06	80.14 ± 8.71
Sleep Recommendation[5]	Met	57.64 ± 7.10	−0.53 ± 0.69	50.17 ± 10.48	66.87 ± 32.26	78.43 ± 8.81
	Not met	58.34 ± 13.64	−0.51 ± 0.71	50.43 ± 13.04	68.37 ± 31.46	81.42 ± 9.27

[1] Adult physical activity guideline: ≥150 minutes (2.5 hours) per week. Participants reported activity in whole-hour intervals; a rounded cutoff of 3.0 hours per week was applied to categorize groups. [2] Adult sedentary time recommendation: <9 hours per day. Sedentary time was reported in whole-hour intervals. [3] Stress levels in adults were dichotomized using the Depression, Anxiety and Stress Scale (DASS-21): “lower stress” (normal to mild) versus “higher stress” (moderate, severe, or extremely severe). [4] Child physical activity was assessed as the average of two Likert-scale items (1 = never, 2 = almost never, 3 = very often, 4 = always); averages of 1–2.9 were classified as “less active” and 3–4 as “more active.” [5] Recommended minimum sleep duration: ≥10 hours for ages 3–5 years and ≥9 hours for ages 6–12 years.

Children’s MetS Z-scores were significantly linked to their parents’ MetS Z-scores (Pearson correlation = 0.288, $p < 0.001$). In a multiple regression analysis accounting for parental education, income, and child age, the parent’s MetS Z-score remained a significant predictor of the child’s MetS Z-score ($p = 0.001$), with a one-unit increase in the parent score associated with a 0.126 rise in the child's score **(Table 5)**.

Table 5. Association between adult MetS Z-score and child at-risk MetS Z-score among PICCAH participants.

	Unadjusted Linear Regression				Adjusted Linear Regression *			
	B	95% CI	*p*-Value	R	B	95% CI	*p*-Value	R
Adult MetS Z-score	0.128	(0.068, 0.188)	<0.001	0.288	0.126	(0.065, 0.186)	0.001	0.297

* Adjusted for parent's education level and income and child's age.

The current research provides the first detailed examination of MetS prevalence among adults in Guam, a population that has been largely understudied. The findings align with prior research indicating elevated rates of T2DM and overweight/obesity (OWOB) among adults in Guam [7, 15]. Our results indicate that 39.05% of adults in Guam have MetS, exceeding the 34.2% prevalence reported for U.S. adults between 2007 and 2012 [8]. The 2019 IDF criteria for adult central obesity use sex- and ethnicity-specific waist circumference (WC) thresholds for groups such as Europids, South Asians, Chinese, Japanese, Ethnic South and Central Americans, Sub-Saharan Africans, and populations from the Eastern Mediterranean and Middle East, yet Pacific Islanders and the US-Affiliated Pacific region are not included [29]. While the IDF applies lower WC cut-offs for South and East Asian populations, WC thresholds of 90 cm for men and 80 cm for women in the Asia–Pacific region have been widely used and were applied in this study [34].

Guam's heterogeneous population includes Native Hawaiian and Other Pacific Islander (NHOPI) and Asian individuals, groups often underrepresented in U.S. national reports due to aggregated data and exclusion of geographically isolated states and territories, such as those in NHANES. For federal reporting purposes, NHOPI individuals are defined as those originating from Hawaii, Guam, Samoa, or other Pacific Islands [35]. This population faces disproportionately high risks for cardiovascular disease, T2DM, and obesity compared to other U.S. groups [36]. By disaggregating the NHOPI category, this study identified additional health disparities, highlighting the burden of NCDs among CHamorus, Other Micronesians, and Filipinos in Guam [37, 38]. Established MetS risk factors include advanced age, lower household income, and education at the high school level or below [36, 38, 39]; in this study, education level was significantly associated with MetS, whereas other demographic factors were largely consistent across participants.

These findings reinforce existing evidence that adults in Guam face elevated risks for cardiovascular conditions and other chronic diseases such as cancer and T2DM, many of which could be mitigated through early lifestyle interventions [37, 39]. Specifically, MetS components—including high WC, elevated fasting glucose, and hypertension—can be addressed through healthy dietary habits, regular physical activity, and stress management [40, 41]. Such interventions are particularly pertinent given recent reports of poor dietary patterns and high sedentary behavior among adults in Guam [12, 42, 43]. For instance, research in Pacific and New Zealand women found that higher dietary fiber intake was inversely related to body fat percentage and MetS risk [44]. Key dietary sources of fiber included discretionary fast foods, whole-grain breads, and cereals, reflecting the ongoing nutrition transition in the USAP region [44–47]. However, locally available high-fiber root crops and starches, such as taro, yam, tapioca, breadfruit, and plantains, could serve as culturally relevant intervention options [48, 49].

This study also represents the first attempt to assess MetS risk in children as young as three years old and to estimate overall prevalence among children in the Western Pacific. Abdominal obesity was observed in 7.69% of children, slightly lower than the 8.94% reported among 2–8-year-olds in a recent Guam study [10]. Subsequent research established optimal WC cut-offs for children aged 2–8 in the USAP region, reflecting the ethnic composition of Guam [38], underscoring the need for future studies to assess pediatric MetS risk using these population-specific criteria. Additionally, cultural identity may influence MetS risk in children in this region. A recent study found that children from families with an integrated cultural identity were twice as likely to be OWOB, which corresponds with the majority of parents in this study (62.7 percent) reporting an integrated cultural identity and may contribute to MetS risk in this population [10].

Although no significant differences in MetS indicators or MetS Z-scores were observed among parents or children based on lifestyle risk factors, parents reporting lower stress generally exhibited better MetS indicators than those experiencing higher stress, with the exception of HDL. Similarly, children who met recommended sleep guidelines showed more favorable outcomes across all examined indicators. These patterns may also reflect the familial clustering of cardiovascular risk factors [18]. A meta-analysis examining MetS risk in offspring revealed that children with at least one parent affected by MetS have a higher likelihood of developing MetS themselves, with the risk particularly pronounced in children of mothers with MetS, consistent with findings in our cohort [50]. These observations support the rationale for lifestyle interventions targeting both parents and children, aligned with the linear association identified between parent and child MetS scores.

Despite children in this study—based on 2011–2012 Guam data—having a lower prevalence of abdominal obesity compared to age-matched U.S. children [51], the elevated MetS prevalence among parents and exposure to an obesogenic environment underscores the importance of early interventions for children in Guam [52]. Interventions that engage multiple household members and a child's broader support network have been effective in improving health behaviors and outcomes [53, 54], particularly in CHamoru and Filipino families, who often rely on extended social networks and cultural practices involving food and physical activity [55, 56]. Moreover, multi-sector approaches have been shown to reduce acanthosis nigricans and obesity in young children [57], highlighting the need for studies evaluating impacts on parents and caregivers as well. Multi-component household interventions, therefore, may be a promising strategy for reducing MetS and other NCD burdens.

This study has several limitations. The sample size was limited due to incomplete data, with only a subset of adults having full bloodwork and an even smaller group of children with laboratory results. Lifestyle factors, including physical activity and sleep **(Table 4)**, were self-reported and often missing. To maximize analytic power, we did not restrict analyses to fully matched parent–child dyads, particularly for analyses focused on adults alone. The lack of complete dyadic data constrained the ability to fully examine parent–child relationships. Being the first study to assess MetS risk in early childhood, there is limited evidence on whether abdominal obesity at this age predicts future MetS risk [18, 58, 59]. Additionally, there are no validated formulas for calculating MetS Z-scores specifically for Pacific Islander children; we used the method developed by Gurka *et al*. [31], which has not been validated in this population. Future research should address this gap. Another limitation is that measured lifestyle factors did not encompass all modifiable risks, such as dietary habits, smoking, and intake of sugar-sweetened beverages or alcohol [60–62], though these data have been collected in the PICCAH study for subsequent analyses. Given the complexity of lifestyle behaviors, more comprehensive analyses are needed to identify effective intervention strategies [59, 63, 64]. As this represents the first analysis of the PICCAH dataset, future studies will further inform potential lifestyle interventions for this population.

Conclusion

Parent and child MetS risk in Guam are directly associated, with high adult MetS prevalence highlighting the urgent need for interventions that involve both generations. Expanding research to explore additional lifestyle factors, such as diet, within parent–child dyads will be essential for designing targeted and effective intervention programs.

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