

Dual Burden of Stunting and Obesity Among Elementary School Children on Majuro, Republic of Marshall Islands

Erin Passmore DrPH and Tanner Smith BSN

Abstract

Limited data are available on the dual burden of under- and over-nutrition among children in the Republic of Marshall Islands (RMI). This study aimed to identify the prevalence of stunting and obesity among elementary school students on Majuro, RMI. A cross-sectional study was conducted in public and private elementary schools on Majuro in 2017 – 2018. Anthropometric data were collected for 3,271 children, 4-16 years of age. The main outcome measures were prevalence of stunting and obesity. Differences by gender, age, and school type (public or private) were assessed using chi-squared tests. Overall, 5.1% (95% CI 4.4-5.9) of children were obese, and 23.6% (95% CI 22.2-25.1) of children were stunted. Obesity prevalence was higher among boys (6.3%; girls 3.9%; $P=0.002$) and children attending private schools (11.8%; public schools 2.9%; $P<0.001$), and increased with age (4-6 years 3.3%; 10-12 years 7.1%; $P<0.001$). Stunting prevalence was higher among children attending public schools (28.8%; private schools 8.0%) and increased with age (4-6 years 20.6%; 10-12 years 27.5%; $P<0.001$). Prevalence of stunting and obesity observed in this study support the need for interventions to improve nutrition and promote healthy lifestyles among children, both to address current undernutrition, and to intervene early to prevent the onset of obesity.

Keywords

Pacific, childhood obesity, stunting, Republic of Marshall Islands, chronic disease

Introduction

Understanding the prevalence of undernutrition and obesity among children is of critical importance for public health policy, as both are associated with lifelong adverse effects. Childhood undernutrition is associated with impaired cognitive development, reduced school achievement, and increased risk of obesity and reduced economic productivity in adulthood.^{1,2} Obesity among children adversely affects their psychological, musculoskeletal, cardiovascular and respiratory health.^{3,4} Furthermore, obese children are likely to remain obese as adults,⁵ placing them at increased risk of diabetes, hypertension, cardiovascular morbidity and premature mortality.⁶

While childhood obesity is receiving increased attention globally, undernutrition – which includes wasting (low weight-for-height), stunting (low height-for-age) and underweight (low weight-for-age) – continues to be a public health problem in many low- and middle-income countries. Many countries are experiencing a nutrition ‘dual burden’, characterised by the co-existence of undernutrition and micronutrient deficiencies, along with obesity and diet-related non-communicable diseases.⁷⁻⁹

One such country is the Republic of Marshall Islands (RMI), where evidence suggests high rates of underweight and stunting among young children, coupled with high rates of obesity in adulthood. A nutrition survey conducted in 2017 found 12% of Marshallese children aged under 5 were underweight and 35.3% stunted.¹⁰ While the same study found only 4% of children under 5 were overweight or obese, obesity emerges as an issue in adolescence and adulthood, with obesity prevalence of 26% among adolescents¹¹ and 32% of adults in RMI.¹²

RMI is located in the central Pacific Ocean and comprises five islands and 29 scattered and remote atolls, a land area of just 181 square kilometers spread over 1.9 million square kilometers of ocean. The estimated population of RMI (as of 2018) is 53,000 people, with the majority (77%) living in the densely-populated urban areas of Majuro and Kwajalein.¹³ The unique geography of RMI poses a significant challenge to food security, a key factor driving the nutrition dual burden in RMI. RMI was traditionally dependent on fishing and subsistence agriculture, however increasing urbanization and limited availability of agricultural land has led to high dependence on imported foods. Climate change, drought, and contamination with radioactive wastes have further affected both agricultural production and household food security with resultant impact on health, nutrition, water, sanitation and education status of the population.

The RMI Ministry of Health and Ministry of Education are implementing a range of initiatives in school settings to address childhood under- and over-nutrition. One such project is the Majuro Youth Lifetime Health Program,¹⁴ implemented in public elementary schools on Majuro in partnership with Canvasback Missions. The program started in July 2017, and has multiple components including (1) development of teaching materials about healthy diet and lifestyle targeting kindergarten and elementary school students, (2) building teachers’ capacity to use these materials in the classroom, (3) training of school food vendors to provide healthier school lunches, and (4) building schools’ capacity to provide physical activity classes and create safe areas for physical activity. While the program focusses on obesity prevention, the nutrition aspects of the program also have potential to address undernutrition – particularly supporting provision of healthier school lunches, engaging with parents and communities. This report presents baseline data on the prevalence of obesity and stunting among elementary school students living on Majuro.

Methods

Study Design and Sample

This was a cross-sectional study, with data collected between September 2017 and January 2018. All elementary schools on Majuro (11 public schools, 7 private schools) were invited to participate via letter to the school principal. Nine public schools and 7 private schools agreed to participate.

Ethics Approval and Consent

This study was conducted with the approval of the RMI Ministry of Health and Human Services, Ministry of Education, and the school principal at each participating school. Parents and children were advised that the study was taking place, that participation was voluntary and they could opt out at any time; however no parents or children decided to opt out of the study.

Data Collection

One day of data collection was conducted at each school, with anthropometry data collected from all students attending school that day. Demographic information (students' name, school grade, gender and date of birth) was provided by school administrators at each participating school. Each child's current height and weight were measured according to standard procedures¹⁵ by a team of eight trained staff, using standard equipment (Perspective Enterprises Stadiometer model PE-AIM-101, Seca scale Model 876). Middle upper arm circumference was also measured for Kindergarten students in some schools; these data are not presented here due to the small sample size.

Analysis

Weight status was categorized using age-specific body mass index percentiles (BMI-for-age) based on US Centers for Disease Control and Prevention child growth charts.¹⁶ BMI-for-age was classified as follows: underweight (under 5th percentile), healthy weight (5th to 84th percentile), overweight (85th to 94th percentile), and obese (95th percentile and above). Stunting was defined as current height-for-age more than 2 SDs below the mean of World Health Organization child growth standards.¹⁷ Biologically implausible values for height (<80cm), BMI-for-age (<-4 or >5 standard deviations according to CDC growth charts), and height-for-age (<-6 or >6 standard deviations according to WHO growth standards) were excluded from analysis. Prevalence and 95% confidence interval (CI) for each BMI-for-age category and stunting were calculated overall and stratified by gender, age group, and school type (public or private). Prevalence was compared between groups using chi-squared tests. *P*-values less than .05 were considered statistically significant. Analysis was conducted using SPSS Statistics Version 21 (IBM: Armonk, New York).

Results

Of the 4,551 children enrolled in participating schools, anthropometric data were collected for 3,383 children. Data for 112 children were excluded due to missing data [gender (*n*=1), date of birth (*n*=104)] and implausible anthropometry values (*n*=7), leaving a total of 3,271 children included in the analysis (Table 1). This represented 71.9% of children enrolled in participating schools.

Children were in school grades Pre-Kindergarten to 6th grade, ranging from 4 to 16 years of age. Seventy-five percent of children attended public schools (Table 1). Weight status of participating children is shown in Table 2. Overall, 5.1% of children included in the study were obese. The prevalence of obesity in boys (6.3%) was significantly higher than in girls (3.9%) ($\chi^2=9.319$, *P* = .002). The prevalence of obesity in private school students (11.8%) was significantly higher than in public school students (2.9%) ($\chi^2=99.01$, *P* < .001). Prevalence of obesity was higher among older aged children. Obesity prevalence was similar for children aged 4-6 years (3.3%) and 7-9 years (4.4%) ($\chi^2=1.60$, *P*=0.21), but was significantly higher among children aged 10-12 years (7.1%, $\chi^2=13.01$, *P* < .001, ref 4-6 years), and 13 and over (7.9%, $\chi^2=4.62$, *P* = .031, ref 4-6 years).

The overall prevalence of stunting was 23.6% (Table 3). There was no significant difference in the prevalence of stunting between boys (22.9%) and girls (24.3%) ($\chi^2=0.95$, *P* = .33). The prevalence of stunting was significantly lower in private school students (8.0%) than in public school students (28.8%) ($\chi^2=145.50$, *P* < .001). The prevalence of stunting also varied by age group. Following the same pattern as obesity, stunting prevalence was similar for children aged 4-6 years (20.6%) and 7-9 years (19.8%) ($\chi^2=0.18$, *P* = .67), but was significantly higher among children aged 10-12 years (27.5%, $\chi^2=12.28$, *P* < .001, ref 4-6 years), and 13 years and over (58.4%, $\chi^2=62.8$, *P* < .001, ref 4-6 years).

Child Characteristics	N	%	95% CI
Gender			
Boys	1620	49.5	47.8-51.2
Girls	1651	50.5	48.8-52.2
Age			
4-6 years	845	25.8	24.4-27.4
7-9 years	1246	38.1	36.4-39.8
10-12 years	1091	33.4	31.8-35.0
13 years +	89	2.7	2.2-3.3
School Type			
Public	2466	75.4	73.9-76.8
Private	805	24.6	23.2-26.1
Total	3271		

Table 2. BMI-for-Age Status of Elementary School Children on Majuro, Republic of Marshall Islands														
	Underweight			Healthy Weight			Overweight			Obese			χ ² Results for Obesity Prevalence	
	n	%	95% CI	n	%	95% CI	n	%	95% CI	n	%	95% CI	χ ²	P-Value
Overall	149	4.6	3.9-5.3	2686	82.1	80.8-83.4	269	8.2	7.3-9.2	167	5.1	4.4-5.9		
Gender														
Boys	81	5.0	4.0-6.1	1290	79.6	77.6-81.5	147	9.1	7.7-10.5	102	6.3	5.2-7.6	Ref	
Girls	68	4.1	3.2-5.2	1396	84.6	82.8-86.2	122	7.4	6.2-8.7	65	3.9	3.1-5.0	9.319	.002
Age														
4-6 Years	34	4.0	2.9-5.5	724	85.7	83.2-87.9	59	7.0	5.4-8.8	28	3.3	2.3-4.7	Ref	
7-9 Years	55	4.4	3.4-5.7	1035	83.1	80.9-85.1	101	8.1	6.7-9.7	55	4.4	3.4-5.7	1.60	.21
10-12 Years	51	4.7	3.5-6.0	859	78.7	76.2-81.1	104	9.5	7.9-11.4	77	7.1	5.9-8.7	13.01	<.001
13 Years +	9	10.1	5.1-17.6	68	76.4	66.8-84.3	5	5.6	2.2-11.9	7	7.9	3.6-14.8	4.62	.031
School Type														
Public	127	5.2	4.3-6.1	2104	85.3	83.9-86.7	163	6.6	5.7-7.6	72	2.9	2.3-3.6	Ref	
Private	22	2.7	1.8-4.0	582	72.3	69.1-75.3	106	13.2	11.0-15.6	95	11.8	9.7-14.2	99.01	<.001

Table 3. Stunting Status of Elementary School Children on Majuro, Republic of Marshall Islands								
	Not stunted			Stunted			χ ²	P-Value
	n	%	95% CI	N	%	95% CI		
Overall	2498	76.4	74.9-77.8	773	23.6	22.2-25.1		
Gender								
Boys	1249	77.1	75.0-79.1	371	22.9	20.9-25.6	Ref	
Girls	1249	75.7	73.5-77.7	402	24.3	22.3-26.5	0.95	.33
Age								
4-6 Years	671	79.4	76.6-82.0	174	20.6	18.0-23.4	Ref	
7-9 Years	999	80.2	77.9-82.3	247	19.8	17.7-22.1	0.18	.67
10-12 Years	791	72.5	69.8-75.1	300	27.5	24.9-30.2	12.28	<.001
13 Years and Over	37	41.6	31.7-51.9	52	58.4	48.1-68.3	62.8	<.001
School Type								
Public	1757	71.2	69.4-73.0	709	28.8	27.0-30.6	Ref	
Private	741	92.0	90.0-93.8	64	8.0	6.2-10.0	145.50	<.001

Discussion

Overall, the study found that 23.6% of elementary school children on Majuro were stunted, and 5.1% were obese. The prevalence of obesity was higher among boys, children attending private school, and older children. The prevalence of stunting was similar for boys and girls, but higher among children attending public school and older children.

By providing recent data from a large sample of children on Majuro, our study has made a significant contribution to the literature of childhood stunting and obesity in RMI, particu-

larly for children over 5 years of age for whom limited recent data are available. Only three previous studies have assessed prevalence of obesity and/or stunting among children in RMI. A 2017 national nutrition survey found stunting prevalence of 35% and obesity prevalence of 4% among children under 5 years of age in RMI.¹⁰ Another recent survey conducted as part of the Children's Healthy Living Program found stunting prevalence of 35% among children 2-8 years of age, and no obese children.¹⁸ Finally, a 2003 survey conducted in 6 locations in RMI, ranging from urban and peri-urban conditions to remote atolls, found 35.5% of children 1-5 years of age, and 36.3% of children 5-10 years of age, were stunted.¹⁹

The prevalence of obesity identified in our study (5%) is similar to that reported among children under 5 in the recent national nutrition survey.¹⁰ While the Children's Healthy Living Program found no obese children aged 2-8 years, this may be due to the study's small sample size (214 children).¹⁸ The obesity prevalence identified in our study is substantially lower than that reported in other United States-affiliated Pacific islands. For example, previous studies have reported obesity prevalence of 47% of children aged 8 years in American Samoa, and 23.0% of children aged 6-11 years on Guam.^{20,21} While obesity prevalence was much lower in our study, the pattern of higher prevalence of obesity among boys, and in older children, is consistent with that reported in USAPIs^{18,20} and internationally.^{22,23}

The current study identified a high prevalence of stunting (23.6%) among elementary school children on Majuro, indicating that childhood undernutrition continues to be a significant public health issue on Majuro. While this is lower than the prevalence reported in previous studies^{10,18,19} (approx. 35%), comparisons must be made with caution due to the different age groups, sampling methods and locations of the studies. Nevertheless, the observed prevalence of 23.6% is "very high" according to WHO classifications - in a well-nourished population we would expect only 2.3% of children to be stunted.¹⁷

The high prevalence of stunting in RMI, - and undernutrition more broadly - has been attributed to a complex range of factors including household food insecurity, limited availability of nutritious local foods, poor maternal nutrition during pregnancy, unhealthy household environments (eg, lack of clean water, poor sanitation), a presence of micronutrient deficiencies throughout infancy and young childhood, and poor child feeding practices (eg, limited breastfeeding, poor complementary feeding practices).¹⁰ The nutrition situation is further exacerbated by the ready availability, and aggressive marketing, of imported processed foods that are high in calories.^{19,24} The recent national nutrition survey in RMI found that poorer households were more likely to experience food insecurity, and that children under 5 in the poorest households were more likely to be stunted than children from higher wealth quintiles.¹⁰ Similarly, the higher prevalence of stunting in public school students than private school students reported here strongly suggest food insecurity as a challenge on Majuro. While previous research in RMI has mainly focussed on children under 5, future research may seek to further explore the complex associations between food security, nutrition and stunting among older children.

The study supports the need for interventions to improve nutrition and promote healthy lifestyles among elementary school-aged students, both to address the existing high rates of stunting in this age group, and to intervene early to prevent the onset of obesity. The WHO highlights the importance of 'double-duty actions' - interventions, programs, and policies that simultaneously address both undernutrition, as well as obesity and diet-related non-communicable diseases.²⁵ School-based nutrition programs have been identified as a potential area for double-duty action, and in addition to addressing undernutrition and obesity among school children may also be a potential entry point for engaging with parents and communities.²⁶ The Majuro Youth Lifetime Health Program, by promoting healthy lifestyles and nutrition for elementary school students, has potential for double-duty action. Beyond school-based education and wellness programs, there is also a need to increase the affordability and accessibility of healthy foods, for example through free in-school breakfast and lunch programs, as well as national legislation and policy. Our finding that private schools had higher obesity prevalence and lower stunting prevalence than public schools suggests that interventions in RMI may need to be tailored by school type, with greater emphasis on undernutrition in public schools and overnutrition in private schools.

There were several limitations to this study. First, although the eight members of the data collection team received anthropometry training, there was no formal standardization of the data collection team. Although erroneous data were minimised by excluding extreme values for height, BMI-for-age, and height-for-age, measurements may still be subject to measurement error. Second, the findings may not be representative of all children in RMI, as the sample did not include children from islands other than Majuro, children not enrolled in school, children who were home-schooled, and children not attending school on the day of the survey - all of whom may have different growth status to the children included in our study. However, the large sample size and high participation rate (data were collected for 72% of children in participating schools) suggests the sample is likely to be representative of Majuro elementary school students. Finally, no data were collected on children's ethnicity. In other USAPIs, prevalence of childhood obesity has been found to vary by ethnicity;²⁰ it would have been of interest to know whether this is also the case on Majuro.

In conclusion, the dual burden of undernutrition and obesity is a significant public health challenge in RMI. The rates of stunting and obesity observed in this study highlight elementary schools as an important setting for taking integrated double-duty actions to address the nutrition dual burden in RMI.

Conflict of Interest

None of the authors identify any conflict of interest.

Acknowledgements

The authors gratefully acknowledge the staff and students of the schools that participated in this project. We also express our thanks to the following people for their contributions: Wildur Heine, Minister, Ministry of Education, RMI; Kanchi Hosia, Commissioner, Ministry of Education, RMI; Eonmita Rakinmeto, Health Specialist, Ministry of Education, RMI; Kalani Kaneko, Minister, Ministry of Health and Human Services, RMI; Julia Alfred, Secretary of Health, Ministry of Health and Human Services, RMI; Leilani Perren, Tobacco Control Coordinator, Ministry of Health and Human Services, RMI; Shra Kedi, Non-Communicable Disease Coordinator, Ministry of Health and Human Services, RMI; Paul Alee, Director Nutrition and health promotion program, Ministry of Health and Human Services, RMI; Tolina Tomeing, Coordinator, Racial and Ethnic Approaches to Community Health (REACH); Dr. Koh Ming Wei, Ec literacy Senior Specialist, Pacific Resources for Education and Learning; Yun-Ting Hsu (Nicki Hsu), Coordinator, Taiwan Health Center, RMI; Russell Langrine, NCD Specialist, Majuro Atoll Local Government; Ladie Jack, Mayor, Majuro Atoll Local Government; Elder & Sister Craig Preston, Senior Health Coordinators, Church of Jesus Christ of Latter-Day Saints; Pete John Biscarra, Nutrition Consultant, UNICEF; Michael Sharp, Economic Advisor, Pacific Community; Dr Si Thu Win Tin, NCD Team Leader, Pacific Community.

Authors' Affiliations:

- Public Health Division, Pacific Community (SPC), Suva, Fiji (EP)
- Canvasback Missions, Benicia, CA (TS)

Correspondence to:

Erin Passmore DrPH; Public Health Division, Pacific Community (SPC), Private Mail Bag, Suva, Fiji; Email: passmoreerin@yahoo.com.au

References

1. Dewey KG, Begum K. Long-term consequences of stunting in early life. *Matern Child Nutr.* 2011;7(s3):5-18.
2. Barker D, Osmond C. Fetal, infant, and childhood growth are predictors of coronary heart disease, diabetes, and hypertension in adult men and women. *Env Health Perspect.* 2000;108(3):545-553.
3. Reilly JJ, Methven E, McDowell ZC, Hacking B, Alexander D, Stewart L, et al. Health consequences of obesity. *Arch Dis Child.* 2003;88:748-752.
4. Smith SM, Sumar B, Dixon KA. Musculoskeletal pain in overweight and obese children. *Int J Obes.* 2014;38:11-15.
5. Singh AS, Mulder C, Twisk JW, Van Mechelen W, Chinapaw MJ. Tracking of childhood overweight into adulthood: a systematic review of the literature. *Obes Rev.* 2008;9(5):474-488.
6. Reilly JJ, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. *Int J Obes.* 2010;35:891-898.
7. World Health Organization. Policy brief: the double burden of malnutrition. 2017 <http://apps.who.int/iris/bitstream/handle/10665/255413/WHO-NMH-NHD-17.3-eng.pdf>. Accessed September 11, 2018.
8. Novotny R, Li F, Guerrero RL, Coleman P, Tufa AJ, Bersamin A, Deenik J, Wilkens LR. Dual burden of malnutrition in US Affiliated Pacific jurisdictions in the Children's Healthy Living Program. *BMC Public Health.* 2017;17(1):483.
9. World Health Organization. The double burden of malnutrition: policy brief. 2017. <http://apps.who.int/iris/bitstream/handle/10665/255413/WHO-NMH-NHD-17.3-eng.pdf>. Accessed September 9, 2018.
10. Republic of the Marshall Islands Ministry of Health, RMI National Statistics Office and UNICEF. Republic of the Marshall Islands Integrated Child Health and Nutrition Survey 2017, Key Findings. Majuro, Republic of the Marshall Islands: Republic of the Marshall Islands Ministry of Health, RMI National Statistics Office. 2017.
11. Lippe N, Kann L, Kinchen S, Harris W, McManus T, Speicher N. Youth Risk Behavior Surveillance - Pacific Island United States Territories, 2007. *MMWR.* 2008;57(SS12):28-56.
12. Ministry of Health, Republic of the Marshall Islands. 2002. NCD Risk Factors STEPS Report. http://www.who.int/ncds/surveillance/steps/2002_Marshall_Islands_STEPS-Report.pdf. Accessed August 16, 2018.
13. UN Data. Marshall Islands profile. <http://data.un.org/en/iso/mh.html>. Accessed January 27, 2019.
14. World Diabetes Foundation. Project information: Majuro Youth Lifetime Program. <https://www.worlddiabetesfoundation.org/projects/marshall-islands-wdf16-1418>. Accessed August 20, 2018.
15. UNICEF. MICS manual for anthropometry. 2014. <https://www.google.com/search?q=unicef+anthropometry&aq=chrome.69i57j35i39j0l4.4939j0j7&sourceid=chrome&ie=UTF-8#>. Accessed August 20, 2018.
16. National Centre for Health Statistics. 2000. Growth Charts. 2000. https://www.cdc.gov/growth-charts/cdc_charts.htm. Accessed August 16, 2018.
17. World Health Organization. Child growth standards. 2006. <http://www.who.int/childgrowth/en/>. Accessed August 16, 2018.
18. Novotny R, Li F, Fialkowski MK, Bersamin A, Tufa A, Deenik J, Coleman P, Guerrero RL, Wilkens LR. Prevalence of obesity and acanthosis nigricans among young children in the children's healthy living program in the United States Affiliated Pacific. *Medicine.* 2016;95(37).
19. Gittelsohn J, Haberle H, Vastine AE, Dyckman W, Palafox NA. Macro- and microlevel processes affect food choice and nutritional status in the Republic of the Marshall Islands. *J Nutr.* 2003;133(1):310S-3S.
20. Novotny R et al. Systematic review of prevalence of young child overweight and obesity in the United States-Affiliated Pacific Region compared with the 48 contiguous states: The Children's Healthy Living Program. *Am J Public Health.* 2015;105(1):e22-e35.
21. Paulino DY, Guerrero DR, Uncangco DA, Rosadino DM, Quinene DJ, Natividad DZ. Overweight and obesity prevalence among public school children in Guam. *J Health Care Poor Underserved.* 2015;26(2):53.
22. National Center for Health Statistics. Data Brief No. 219: Prevalence of Obesity Among Adults and Youth: United States, 2011-2014. 2015. <https://www.cdc.gov/nchs/data/databriefs/db219.pdf>. Accessed August 18, 2018.
23. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, Mullany EC, Biryukov S, Abbafati C, Abera SF, Abraham JP. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet.* 2014;384(9945):766-81.
24. Food and Agriculture Organization. Policy options for improved food security in the Republic of Marshall Islands. 2014. http://www.ipcinfo.org/fileadmin/user_upload/sap/docs/Food%20Security%20Policy%20Options%20the%20Marshall%20Islands%202014.pdf. Accessed January 26, 2018.
25. World Health Organization. Policy brief: double-duty actions for nutrition. 2017. <http://apps.who.int/iris/bitstream/handle/10665/255414/WHO-NMH-NHD-17.2-eng.pdf?ua=1#page10>. Accessed September 11, 2018.
26. World Health Organization. Nutrition-friendly schools initiative. 2017 http://www.who.int/nutrition/topics/nutrition_friendly_schools_initiative/en. Accessed September 11, 2018.