

# Comprehensive Review of Preschool Age Anemia in the Pacific Island Jurisdictions

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## Abstract

*Anemia can be an indicator of poor nutrition and health, and it can have significant consequences. Children are disproportionately affected by anemia. This comprehensive review summarizes the available literature on anemia prevalence in young children in the islands of the Oceania region. The anemia prevalence, the criteria used for diagnosis, the date the data was reported, and the types of samples collected were reviewed. Anemia prevalence estimates were reported for eighteen of the Pacific Island Jurisdictions. From the fifteen data sources that were evaluable, anemia prevalence ranged from 12.3% to over 70%. A major limitation in the data is a lack of representative primary data from many of the jurisdictions in the region. Prevalence estimates reported for those jurisdictions are estimated by regression analysis from the World Health Organization (WHO). Moreover, the primary data available does not use standardized reporting criteria. Nevertheless, this review serves as a new baseline for further investigations on the prevalence of anemia and a baseline for evaluating public health prevention and treatment measures to detect and improve anemia prevalence in the Pacific.*

## Keywords

*anemia, Pacific Islands, preschool age anemia, iron deficiency*

## Introduction

Anemia is a medical condition that can be an indicator for overall health.<sup>1</sup> It is characterized by a low concentration of hemoglobin, which serves as the transport system of oxygen to the body and brain. The World Health Organization (WHO) defines anemia as a hemoglobin concentration less than 11.0 g/dl in children aged 6 months to 5 years (defined as “preschool age children”), less than 11.5 g/dl for those between the ages of 5 and 12 years, and less than 12.0 g/dl in children above 12 and less than 15 years old. The WHO estimates that anemia affects at least one quarter of the world’s population<sup>1</sup> with a global prevalence of 42.6% in patients aged 6 months to 59 months.<sup>2</sup>

Reducing prevalence of anemia is a global goal because anemia can have significant long-term health and social consequences. Anemia impairs physical capacity and work performance in all age groups. In children, anemia affects cognitive and motor development because of the need for adequate oxygen carrying capacity during the critical first few years of life when mental and physical growth are occurring at their fastest.<sup>1</sup> Developmental delay or learning delay caused by anemia is compounded by decreased overall energy capacity, leading to difficulties with paying attention in school or attending school. Moreover, maternal anemia during pregnancy is associated with prematurity and low birth weight, which are also independently linked to cognitive and motor delays.<sup>3</sup> Worldwide, the World Health Assembly Resolution 65.6 advocates for an improvement in maternal, infant, and child nutrition. Specifically related to anemia, there is an objective of a 50% reduction of anemia in

women of reproductive age by 2025. In children under the age of 5, the objective calls for a 40% reduction in stunting, which is related to anemia.<sup>4</sup>

The first step to ameliorating this generational cycle of decreased mental and physical performance in children in any region is to determine the amount of anemia present. This paper sought to do so for the jurisdictions of the Pacific, which span about 6000 nautical miles from Papua New Guinea in the west to Easter Island in the east, and covers more than a quarter circumference of the Earth. This large surface area contains the member states of the Oceania Region as defined by the United Nations. Although the data from Australia and New Zealand make up the bulk of the available data for Oceania, they likely are not representative of the rest of the region because of the economic disparities as well as ethnic differences in comparison with the island jurisdictions. Regardless, this United Nations region is significantly underrepresented in international data. This article is a review of the literature to update and consolidate the data from the Oceania region, specifically regarding the Pacific island jurisdictions, but excluding Australia and New Zealand, as a first step toward improving anemia in this area of the world as well as encouraging data dissemination in this region.

## Methods

In order to conduct this comprehensive review, several databases were accessed (Figure 1). First, a Medline/Pubmed search was conducted for peer-reviewed articles with text containing anemia, iron deficiency, national survey data, prevention and control, and nutrition deficiency in the Pacific (see Supplemental Material for search strategy). Specifically, articles including Micronesia, Melanesia, or Polynesia were searched. After this initial search, Web of Science and the repository of the Secretariat of the Pacific Community were utilized with similar search criteria to query additional databases. Google Scholar was used lastly as an adjunct to specifically address deficiencies in data from the various Pacific jurisdictions that had no data identified in the prior searches. The Google Scholar search strategy included the aforementioned terms in conjunction with specified names of the jurisdictions missing data. A search for French articles was conducted using “Polynésie française” and “Nouvelle-Calédonie” to include the two French collectivities in the Pacific. Data from New Zealand and Australia, which are part of Oceania but were not part of the Pacific Island research question, were excluded. Literature included only articles published prior to 2016. The primary source data was

not available for review. The reference section for each relevant article found was checked for additional sources, perpetuating an iterative search.

For each relevant article the criteria for participant selection and diagnostic testing methods were evaluated. If available, the following details were collected from each paper: the type of study done, population size analyzed, method of population selection, method of data collection, age of participants, criteria used by the paper for diagnosis of anemia, and time frame of data collection. To compare the strength of the data in these reports in terms of how they address the question of prevalence of anemia amongst preschool age children, we developed a numerical rubric. (Table 1) This rubric gives maximum credit (10 points) to those reports that relied on data from direct, random patient sampling, sampling between the preschool age range, the use of hemoglobin of less than 11.0 g/dl in that age range as the definition of anemia, and the use of data collected after 2010. Duplicate data from any single jurisdiction was reviewed and the data that is reported here are those with sources with the highest rubric score.

These data were compiled into a table and sorted by prevalence estimate. Completeness of the review was crosschecked with the list of member states in the WHO Oceania region in this purposive sampling of the literature.

## Results

The results of the Medline/Pubmed search conducted in February 2016 revealed 522 potential sources. Additional databases were searched as described in the methods (Figure 1). Only fifteen distinct sources containing prevalence estimates of anemia were identified. The remaining sources were excluded because they either did not report prevalence estimates of anemia or did not report on anemia in the region of interest or did not include pediatric aged patients.

The age ranges, the number of participants, time period for data collection, and the cutoff value for diagnosis of anemia were not always available in some of the sources. Some reported on the prevalence of anemia in the overall population whereas some included children only. Two of these fifteen sources were the WHO global reports of anemia, published using data from up to 2005 and also data from up to 2011.<sup>2,3</sup> The majority of the data obtained from the WHO reports were estimates based on regression analysis, using known covariates of anemia such as mean weight-for-age z-scores, or surveys or estimates reported by departments of public health directly to the WHO.

Anemia prevalence estimates for young children were found for a total of 18 jurisdictions, but were not found for six of the jurisdictions (Table 2). Results are graphically reported in Figure 2. Data from the United States is included for comparison and is represented graphically over the Hawaiian Islands. Data from the Federated States of Micronesia (FSM) was separated into three jurisdictions based on the available state-specific data.

Anemia is defined as a moderate public health problem when the prevalence is between 20% and 40% and defined as a severe public health problem when the prevalence is over 40%.<sup>1</sup> Results suggest that anemia in preschool age children is at least a moderate public health problem in seventeen (94.4%) of these 18 jurisdictions with reported anemia prevalence estimates. In seven of these Pacific jurisdictions, anemia is a severe public health problem.<sup>1</sup>

The rubric scores from evaluation of the sources of data are reported in Table 3. Only the demographic and health survey conducted by the Samoa Bureau of Statistics and financed largely by the Samoan government received the maximum 10 point score.<sup>12</sup> Data reported by the WHO from regression analysis calculations received 5 points on the rubric due to the assumption that the data was on preschool age patients using criteria defined by the WHO (2 points each) plus 1 point for regression analysis data. The range of rubric scores is from 1 to 10, with the majority receiving a rubric a score of 5.

### Supplemental Material

Search Criteria for MEDLINE/Pubmed: ((national) AND (survey)) OR ((population) AND (prevalence))) AND ((iron status) OR (iron deficiency) OR (anemia) OR (anaemia) OR (ferritin) OR (hemoglobin) OR (haemoglobin) OR (low iron level) OR (transferrin receptor) OR (insufficient iron)) OR ((pediatric) OR (infant) OR (children) OR (preschool age)) AND ((oceania) OR (pacific island) OR (pacific) OR (micronesia) OR (melanesia) OR (polynesia))

Search Criteria for Web of Science: Search terms: prevalence or rate, anemia or anaemia or iron deficiency and oceania or pacific or Micronesia or Melanesia or Polynesia

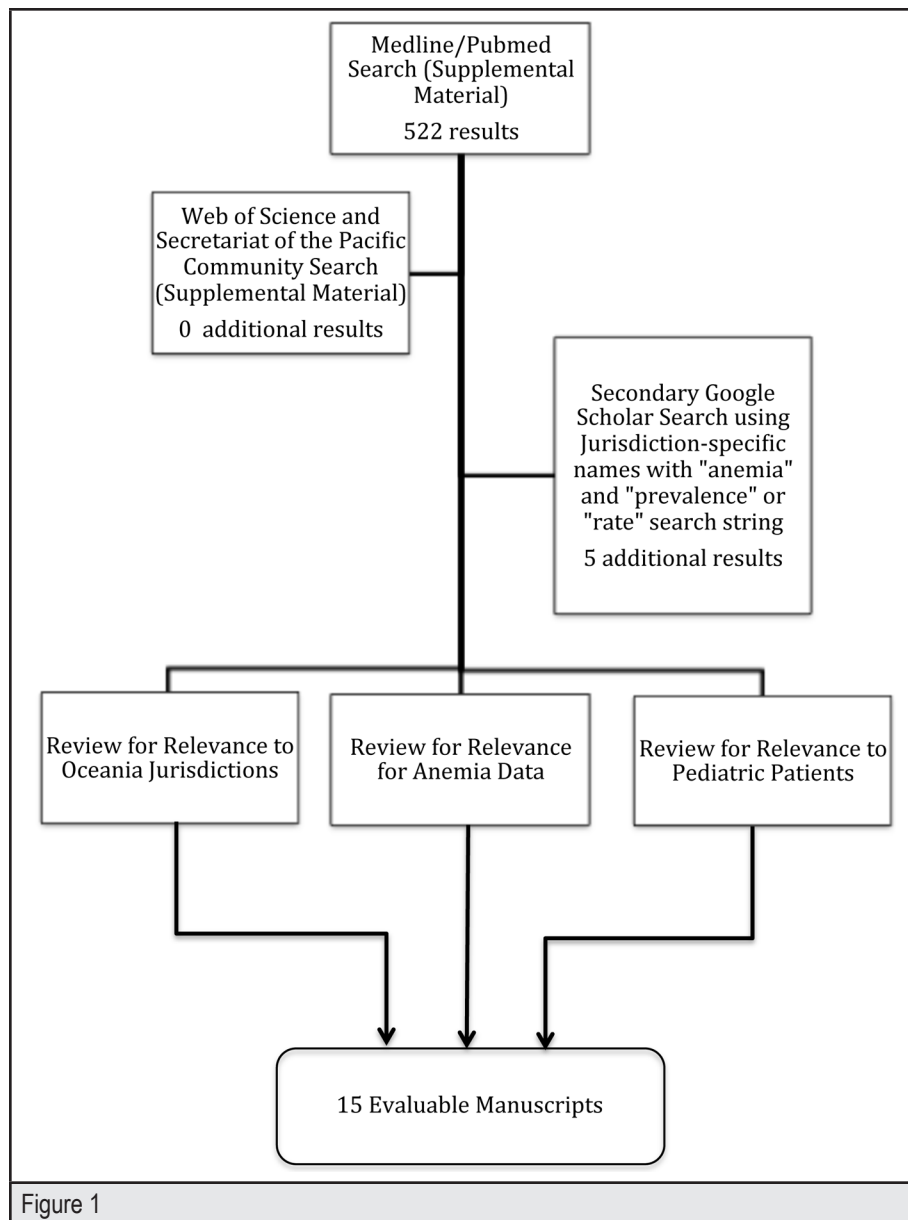


Table 1. Rubric for Comparing Anemia Reports of Preschool Age Children in the Pacific			
Points Awarded	0	1	2
Type of Data	Not reported	Regression Analysis	Direct Patient Sampling
Age Range of Patients	No delineation or not reported	Separated out pediatrics or child data from adult data	Data specifically on 'preschool age' children (6 months to 5 years per WHO)
Criteria for Anemia	Not defined or reported	Defined with different parameters than WHO	Defined as per WHO criteria
Type of Sampling	Not reported	Convenience sampling	Randomized sampling
Date Data were Collected	Prior to 2005 or not reported	2005-2010	After 2010

Table 2. Prevalence Estimates of Anemia in Pacific Island Jurisdictions Compared with USA		
	Island/Nation	Prevalence of Anemia
	USA <sup>5*</sup>	3.2%
	Yap + Kosrae (FSM) <sup>6</sup>	11.2%
Moderate Public Health Problem (20% – 40% Anemia)	Nauru <sup>3</sup>	20%
	Pohnpei (FSM) <sup>7</sup>	20.8%
	Niue <sup>3</sup>	21.6%
	Palau <sup>3</sup>	22.2%
	Tuvalu <sup>3</sup>	34.2%
	Tonga <sup>2</sup>	36.2%
	Marshall Islands <sup>8</sup>	36.4%
	Kiribati <sup>2</sup>	37%
	Cook Islands <sup>9</sup>	37%
	Vanuatu <sup>10</sup>	38%
Severe Public Health Problem (>40% Anemia)	Solomon Islands <sup>2</sup>	40%
	French Polynesia <sup>9</sup>	43%
	Papua New Guinea <sup>2</sup>	44%
	Samoa <sup>12</sup>	44.1%
	Chuuk (FSM) <sup>13</sup>	46.3%
	Fiji <sup>14</sup>	49.6%
	New Caledonia <sup>9</sup>	70+%
No Data Available	Guam	No data
	Commonwealth of the Northern Mariana Islands	No data
	Pitcairn Islands	No data
	Easter Island	No data
	Tokelau	No data
	Wallis and Fortuna	No data

Table 3. Quality of Data on Prevalence Estimates of Preschool-Age Anemia in the Pacific Islands					
Island/Nation	Rubric Score	Subject Age	Sample Size	Type of Sample	Year Reported
Samoa <sup>12</sup>	10	0.5-5	2765	Random Sample	2014
USA <sup>5*</sup>	9	1-5	1437	Representative Survey	2016
Fiji <sup>14</sup>	8	0.5-5	687	Random sample	2004
Yap + Kosrae (FSM) <sup>6</sup>	7	2-5	486	Random Survey	2000
Chuuk (FSM) <sup>13</sup>	6	3-7	382	Random Sample	1991
Marshall Islands <sup>8</sup>	6	1-6	904	Convenient Sample	2003
Nauru <sup>3</sup>	5	0.5-5	-	Regression Analysis	2008
Niue <sup>3</sup>	5	0.5-5	-	Regression Analysis	2008
Palau <sup>3</sup>	5	0.5-5	-	Regression Analysis	2008
Tuvalu <sup>3</sup>	5	0.5-5	-	Regression Analysis	2008
Tonga <sup>2</sup>	5	0.5-5	-	Regression Analysis	2015
Kiribati <sup>2</sup>	5	0.5-5	-	Regression Analysis	2015
Papua New Guinea <sup>2</sup>	5	0.5-5	-	Regression Analysis	2015
Solomon Islands <sup>2</sup>	5	0.5-5	-	Regression Analysis	2015
Pohnpei (FSM) <sup>7</sup>	3	2-4	355	Not reported	1993
French Polynesia <sup>9</sup>	2	1-2	Not reported	Not reported	2006
New Caledonia <sup>9</sup>	1	0-4 (hospitalized)	Not reported	Not reported	1992
Cook Islands <sup>9</sup>	1	All females with hemoglobin <12	Not reported	Not reported	1986
Vanuatu <sup>10</sup>	1	All ages	2823	Not reported	1996, 2007 <sup>11</sup>

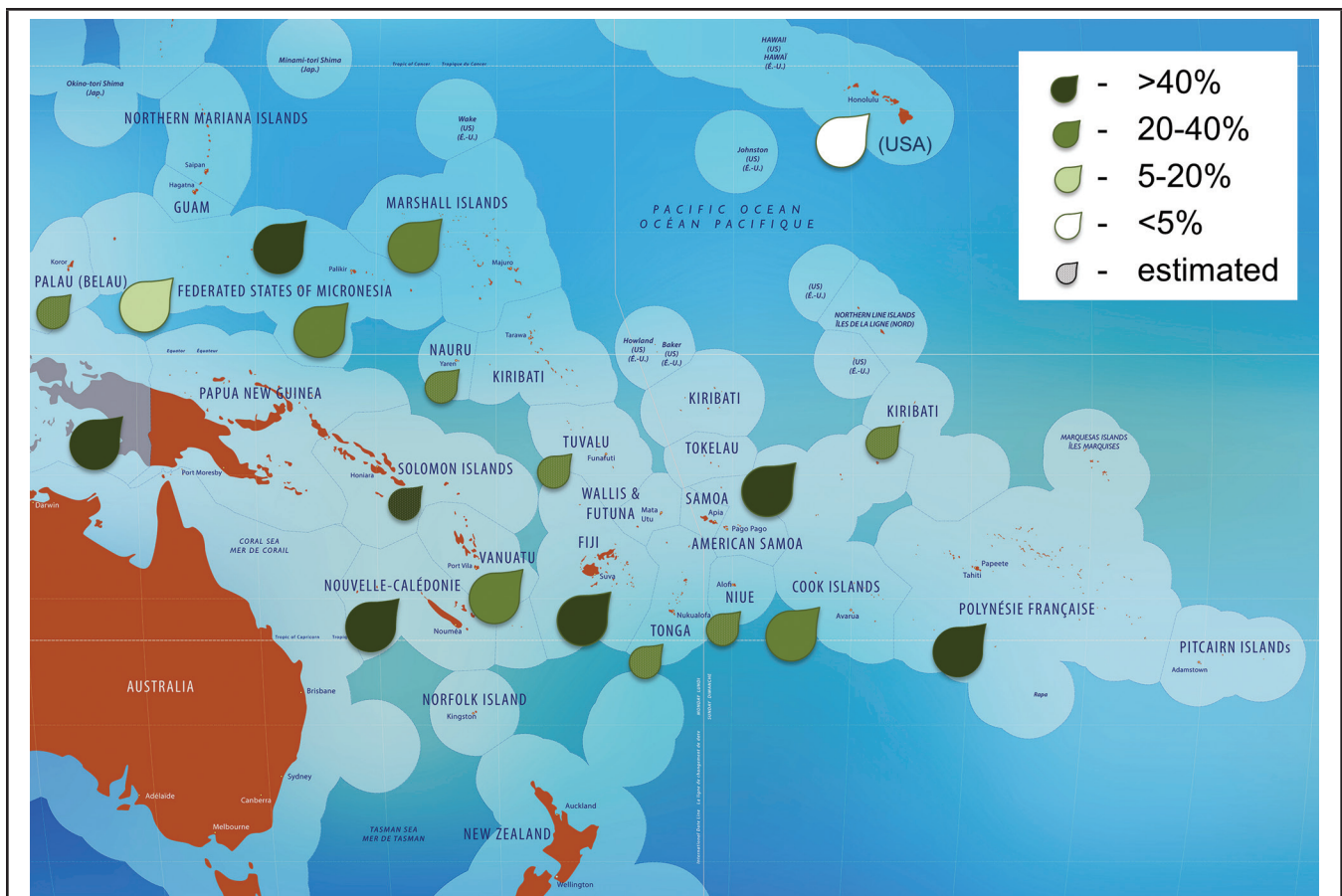


Figure 2. Prevalence Estimates of Pediatric Anemia amongst the Pacific Islands (United States is represented in the figure by the Hawaiian Islands)

## Discussion

We reviewed available published reports on the prevalence estimates of anemia inclusive of children ages 6 months to 5 years amongst the jurisdictions of Oceania. The data come from a variety of sources with variable levels of strength. The majority of the prevalence estimates of anemia reported were higher than 20%, qualifying anemia as a moderate public health problem in those jurisdictions. For seven of the island jurisdictions of which data are reported, anemia is a severe public health problem—affecting more than 40% of their preschool age population. These high prevalence estimates of anemia demonstrate the need for more efforts regarding anemia prevention and treatment in this region.

The main limitation to a thorough summary of anemia prevalence in this region is the lack of primary data. Ten of the eighteen island jurisdictions had anemia prevalence estimates reported from primary data, whereas the remaining only had prevalence estimated from regression analysis performed by the WHO secondary to the lack of subnational or national data. Specifically for the island jurisdictions of Nauru, Niue, Palau and Tuvalu, the WHO did not report on their estimated prevalence of anemia in the 2011 report due to a lack of updated

covariate data for the regression analysis, so regression analysis data from 1993 to 2005 were used.<sup>2</sup> For these estimates from regression analysis, the total population covered, and exact ages of the patients from whom the covariate data included, were not available. This paucity of primary data suggests that increased reporting alone as a first step could help start directing resources appropriately for anemia intervention throughout Oceania.

The lack of primary data was only one contributor to the lack of quality data as measured by rubric criteria (Table 3). Of the ten reports using primary data, only one used the standard WHO-defined “preschool age” range of 0.5 to 5 years. Four of these ten reports used WHO-defined cutoffs for anemia for the age group they sampled. Of the ten primary sources, only five (50%) had grades higher than a level of 5 on the 10 point rubric scale. The mean score, both when the WHO regression analysis results were included and excluded, was less than 5 indicating that a majority of the data was of poor quality with significant limitations for use in analysis.

The use of convenience sampling instead of representative sampling is another important limitation. Preschool age anemia is particularly important to address in light of its occurrence during a crucial stage of development. Convenience sampling

for anemia data can often miss preschool age children because samples are harder to obtain from young children. Yet, the prevalence of anemia is usually highest amongst preschool age children because of the shift in their diet source to solid foods and their increased susceptibility to infectious complications. For example, a Samoan community health project was conducted to update anemia prevalence, but out of a total of 165 pediatric patients evaluated, only one patient was under the age of 5.<sup>15</sup> (The data reported in Table 2 though is a more recent report from Samoa<sup>12</sup> that includes a separate category for children age 6 months to 5 years.) Thus, difficulties with sampling may underestimate prevalence of anemia in the preschool age population.

A third limitation was that the majority of the data available for the Oceania region was reported prior to 2005. The most updated primary source data included data collected as far back as 1988 from Chuuk.<sup>13</sup> Each jurisdiction's anemia prevalence reported here was based on a single data source without any additional sources to validate these findings. Through the years, as dietary composition changes and increased migration occurred throughout the region, changes in the prevalence of anemia due to both nutritional and hereditary causes might have changed as well. To understand the current prevalence of preschool age anemia from these jurisdictions requires updated testing and reporting.

Our review underscores the lack of quality data on the prevalence of anemia in Oceania with what has been reported showing a significant amount of preschool age anemia. The World Health Organization's 2011 Global Prevalence of Anemia noted that the Oceania Region anemia prevalence estimates were reported based on only 5.4% population coverage by surveys of anemia prevalence whereas other regional prevalence estimates are based on at least 85% coverage.<sup>2</sup> This disparity between the population coverage from Oceania compared to the other regions' preschool age anemia data coverage has been noted since the WHO's report on anemia from 1993-2005.<sup>4</sup> While there are no global recommendations for universal anemia screening, having a baseline set of national or subnational data on prevalence of anemia can help to guide local recommendations for screening. The implementation of anemia screening as a public health surveillance measure can utilize the resources that are already in place for other non-communicable diseases to collect, analyze and disseminate data. For example, some of these jurisdictions have routine national census collections that can be used to canvas the community. Alternatively, some of the jurisdictions have funded nutritional supplement programs (such as Women, Infant and Children funded by the United States' Department of Agriculture) that already do routine screening for anemia in preschool age children. In addition, many medical providers also follow the American Academy of Pediatrics recommendation for routine universal screening of toddlers because of the known risk of anemia at that age group. These existing anemia screening programs within the Pacific island jurisdictions may provide more valid data on which to base estimates of the prevalence of anemia.

Data from a complete data set from screening programs can provide a valid and accurate prevalence of anemia amongst this specific age group. Next steps would be to ensure that data that is being collected defines anemia according to WHO criteria, includes pediatric patients, is based on direct patient sampling, and has been performed within the last decade of reporting. In line with the global goals for anemia control, obtaining this data will be important for future public health interventions for decreasing anemia.

## Conflict of Interest

None of the authors identify any conflicts of interest.

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