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Chapter 6: Anemia, Iron Deficiency and Iron Deficiency Anemia
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CHAPTER 6. ANEMIA, IRON DEFICIENCY AND IRON DEFICIENCY ANEMIA

This chapter summarizes various indicators related to anemia, iron deficiency, and iron deficiency anemia among children 6-59 months old, non pregnant women 15-49 years of age, and men aged 18 years and older.

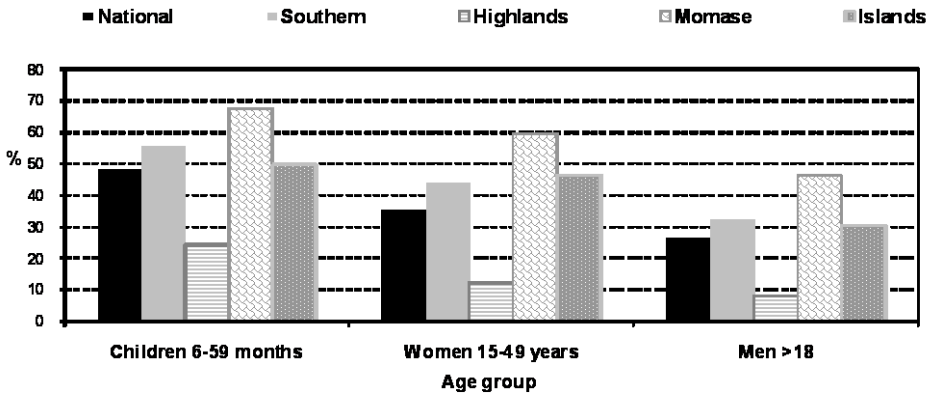
6.1 Anemia

The prevalence of anemia is based on hemoglobin data from capillary blood samples analyzed using the HemoCue instrument (HemoCue AB, Angelholm, Sweden). Anemia, defined as low Hb, is often used as a proxy indicator of iron deficiency. The Hb cut-offs for anemia, based on age and sex (WHO 2001, Nestel 2002), are presented in Table 2.14. To determine the prevalence of anemia, the individual observed Hb concentrations were adjusted based on altitude and cigarette smoking, according to (CDC1998) recommendations (Table 2.11).

6.1.1 Summary of anemia by target group

Figure 6.1 shows the prevalence of anemia by target group and by region. Children 6-59 months had the highest prevalence of anemia followed by non pregnant women (15-49 years) and then men.

Figure 6.1: Prevalence of anemia[1] by target group, National Nutrition Survey, Papua New Guinea 2005



[1] Hemoglobin (Hb) adjusted for altitude and cigarette smoking (men only). Anemia defined as Hb < 11.0 g/dL for children, Hb <12.0 for non-pregnant women and Hb <13.0 g/dL for men.

6.1.2 Anemia among children (6-59 months of age)

Of the 937 preschool children surveyed 910 (97.1%) had their hemoglobin values recorded, Table 6.1. The mean hemoglobin concentration for children 6-59 months was 10.88 g/dL (SD 1.65). Almost half of the children included in the survey were anemic. The hemoglobin distribution was shifted substantially to the left in comparison to the US

reference population of non-anemic children (figure 6.2).The prevalence of anemia was strongly associated with region. The prevalence of anemia was highest in children in Mamose region (67.5%). Children in the Highlands had the lowest prevalence of anemia (24.3%). There were no substantial differences in the prevalence according to sex or urban/rural location.

The prevalence of anemia was very high in children 6-11 months of age (69.2%). As expected the prevalence drops slightly in children 12-23 months of age and continues to decline after two years of age. Just over one third of children 48-59 months of age were anemic.

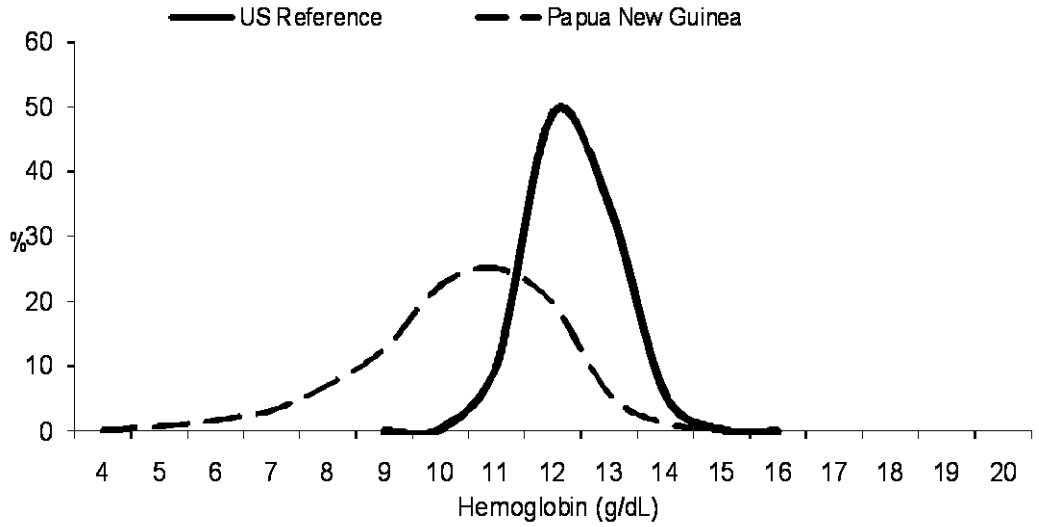
According to WHO a prevalence of >40.0% anemia in the population represents a severe problem in a population (WHO/UNICEF/UNU, 2001). [The problem of anemia in Mamose, Islands and the Southern region is classified as severe].

Table 6.1 Prevalence of anemia and mean hemoglobin levels among children (6-59 months), PNG National Nutrition Survey 2005

Demographic Characteristics	N	Prevalence of anemia[1] (%)	CI 95%	Mean[2] hemoglobin (g/dl ± SD)
National	**910**	**48.1**	**42.7, 53.5**	**10.8 ± 1.6**
Region				
Southern	207	55.6	45.3, 65.3	10.6 ± 1.5
Highlands	206	24.3	16.2, 34.7	11.78± 1.4
Mamose	252	67.5	54.5, 78.2	10.2 ± 1.8
Islands	245	49.8	42.2, 57.4	10.8 ± 1.4
Residence				
Urban	173	41.1	28.7, 54.8	11.1 ± 1.5
Rural	737	49.7	43.6, 55.9	10.9 ± 1.7
Age Group (months)				
6-11	101	69.2	58.3, 78.3	10.2 ± 1.4
12-23	219	58.2	50.0, 65.9	10.6 ± 1.6
24-35	230	42.8	35.6, 50.4	10.9 ± 1.6
36-47	196	44.3	36.3, 52.6	10.1 ± 1.7
48-59	164	33.7	25.6, 42.9	11.4 ± 1.7
Sex				
Male	492	47.8	41.4, 54.2	10.8± 1.8
Female	415	48.3	42.1, 54.6	10.9± 1.6

Weighted analysis to account for complex survey design
[1] Anemia cut-off for preschool children is Hb <11.0 g/dL. Hemoglobin (Hb) measured by Hemocue™ and adjusted for altitude
[2] Means are weighted and standard deviations (SDs) calculated assuming simple random sampling

Figure 6.2 Hemoglobin distributions of preschool children (6-59 months) in Papua New Guinea 2005, compared to iron sufficient children in US



6.1.3 Anemia among non-pregnant women of childbearing age

Of the 783 non-pregnant women participating in the survey 760 had their hemoglobin values recorded. The mean hemoglobin concentration was 12.6 g/dL (SD=1.9). Just over one third of non-pregnant women were anemic. Rural women were almost twice as likely to be anemic compared to urban women.

Women in Mamose region had a much higher prevalence of anemia than women in the other regions and women in the Highlands region had a very low prevalence of anemia. Age and education were not significantly associated with anemia prevalence or mean hemoglobin levels among non-pregnant women.

Using the WHO criteria for defining anemia as a public health problem, the public health significance of the prevalence of anemia among non-pregnant women of child bearing age is moderate.

Table 6.2 Prevalence of anemia and mean hemoglobin levels among non-pregnant women of childbearing age (15-49 years), PNG National Nutrition Survey 2005.

Demographic Characteristics	N	Prevalence of anemia[1] (%)	95 % CI	Mean hemoglobin[2] (g/dl ± SD)
National	**760**	**35.7**	**31.0, 40.7**	**12.6 ± 1.9**
Region				
Southern	244	44.2	34.0, 54.9	11.9 ± 2.0
Highlands	180	12.2	7.3, 19.8	13.6 ± 1.5
Mamose	174	59.8	49.1, 69.6	11.7 ± 1.7
Islands	162	46.3	36.0, 56.9	12.0 ± 1.6
Residence				
Urban	182	20.7	13.3, 30.9	12.9 ± 1.9
Rural	578	39.4	33.8, 45.2	12.4 ± 1.8
Age Group (years)				
15-19	134	34.5	26.7, 43.3	12.6 ± 1.8
20-29	278	34.5	28.9, 40.6	12.2 ± 1.9
30-39	207	37.4	29.5, 45.9	12.3 ± 1.8
40-49	141	36.6	27.4, 46.8	12.4 ± 2.1
Years of education				
None	167	43.1	34.2, 52.5	12.6 ± 1.9
1-3	425	36.1	30.9, 41.7	12.3 ± 1.9
4+	140	33.3	24.4, 43.7	12.3 ± 1.8

Weighted analysis to account for complex survey design
[1] Anemia cut-off for non-pregnant women is Hb <12.0 g/dL. Hemoglobin (Hb) measured by Hemocue™ and adjusted for altitude and smoking
[2] Means are weighted and standard deviations (SDs) calculated assuming simple random sampling

6.1.4 Anemia among men 18 years and older

Of the 804 men participating in the survey 778 had their hemoglobin values recorded. The mean hemoglobin concentration was 14.2 g/dL (SD 1.96) (Table 6.3). Overall 26.3% of men were anemic. Rural men had a significantly higher prevalence of anemia than urban men. Men in Mamose region had the highest prevalence of anemia, at 46.4%, while men in the Highlands region had the lowest prevalence at 8.3%. There was no difference in the prevalence of anemia by age or educational status. Using the WHO classification in PNG, the public health significance of the prevalence of anemia among men nationally is moderate, but the problem is severe in the Mamose region.

Table 6.3 Prevalence of anemia and mean hemoglobin levels among men (18> years), PNG National Nutrition Survey 2005

Demographic Characteristics	N	Percent anemic	95 % CI	Mean hemoglobin (g/dl ± SD)
National	**778**	**26.3**	**21.5, 31.9**	**14.2 ±1.9**
Region				
Southern	203	32.6	21.8, 45.6	13.8 ± 2.1
Highlands	205	8.3	4.1, 16.1	15.2 ± 1.6
Mamose	192	46.4	33.6, 59.6	13.3 ± 1.8
Islands	178	30.3	20.9, 41.8	13.8 ± 1.7
Residence				
Urban	134	10.8	6.0, 18.9	14.9 ± 1.6
Rural	644	29.6	24.0, 35.9	14.1 ± 1.9
Age Group (years)				
18-29	273	21.9	15.4, 30.1	14.4 ± 1.9
30-39	200	28.6	20.6, 38.2	14.2 ± 1.8
40-49	145	24.5	18.0, 32.5	14.2 ± 2.1
50-59	95	31.1	22.1, 41.8	13.9 ± 1.8
60+	64	35.1	22.8, 48.3	13.7 ± 1.2
Grade of education				
None	124	22.9	16.1, 31.6	14.4 ± 2.1
1-3	83	22.2	12.8, 35.7	14.3 ± 1.9
4+	552	27.9	22.5, 34.0	13.9 ± 1.9

Weighted analysis to account for complex survey design
[1] Anemia cut-off for men is Hb <13.0 g/dL. Hemoglobin (Hb) measured by Hemocue™ and adjusted for altitude and smoking
[2] Means are weighted and standard deviations (SDs) calculated assuming simple random sampling

6.2 Anemia and infection

Anemia has many contributing factors including malaria, helminth infection, diet and infection. Data on infection were combined with hemoglobin values to determine the percentage in each target group who were anemic. For this analysis, only the most vulnerable population groups (children 6-59 months and women) were assessed for infection as a contributing factor to anemia.

6.2.1 Anemia and infection in children 6-59 months

Of the 910 children who had hemoglobin values, 874 also had values for C-reactive protein (CRP) and α1-acid glycoprotein (AGP). The prevalence of anemia was higher in children with a marker of inflammation (either CRP or AGP) compared to those with no indication of inflammation (Table 6.4).

Table 6.4 Prevalence of anemia among those with markers of inflammation (CRP >5mg/L and AGP >1.2 mg/L) in children 6-59 months of age, PNG National Nutrition Survey 2005

Demographic Characteristics	N	Prevalence of Anemia[1] (%)	95% CI
Indicator of infection	**Elevated CRP >5mg/L)**		
National	283	66.3	59.2, 72.8
Southern	73	68.5	51.8, 81.5
Highlands	46	45.7	26.7, 65.9
Mamose	87	81.6	69.7, 89.6
Islands	77	61.0	52.9, 68.6
Indicator of Infection	**Elevated AGP (>1.2 mg/L)**		
National	282	61.3	54.0, 68.2
Southern	74	66.2	51.3, 78.5
Highlands	61	41.0	28.1, 55.2
Mamose	88	72.7	56.2, 84.7
Islands	59	71.2	56.2, 82.6
No indicator of infection			
National	494	39.2	33.6, 45.1
Southern	100	50.0	40.5, 59.5
Highlands	121	15.7	9.2, 25.4
Mamose	124	60.5	45.7, 73.6
Islands	149	41.6	32.1, 51.8

Weighted analysis to account for complex survey design

[1] Anemia cut-off for preschool children is Hb <11.0 g/dL. Hemoglobin (Hb) measured by Hemocue™ and adjusted for altitude

6.2.2 Anemia and helminth infection in children 6-59 months of age

Stool was collected from 363 children between the ages of 24-59 months during the survey. Various parasites were identified in the stool but as only hookworm and round worm are thought to contribute to anemia stools were only examined for these two parasites. These helminths were only found in 4.9% of the stool samples. There was no

difference in the prevalence of anemia in children with or without hookworm or roundworm.

6.2.3 Anemia and infection in women 15-49 years

Of the 760 women who had hemoglobin values 756 also had values for CRP and 756 for AGP. There appeared to be an important difference in the prevalence of anemia in women with infection compared to those without an elevation of their acute phase proteins (APP). The prevalence of anemia is still severe in Momase region irrespective of infection (Table 6.5).

Table 6.5 Prevalence of anemia among those with markers of inflammation (CRP >5mg/L and AGP >1.2 mg/L) 15-49 years of age, PNG National Nutrition Survey 2005

Demographic Characteristics	N	Prevalence of Anemia (%)	95% CI
Indicator of Infection	**Elevated CRP >5mg/L)**		
National	76	46.9	34.4, 59.7
Southern	23	51.1	22.2, 79.3
Highlands	18	27.8	12.5, 50.8
Mamose	14	78.6	47.0, 93.8
Islands	21	47.6	25.9, 70.3
Indicator of Infection	**Elevated AGP (>1.2 mg/L)**		
National	63	57.8	42.9, 71.3
Southern	28	61.8	36.8, 81.8
Highlands	15	40.0	17.9, 67.0
Mamose	12	83.3	49.6, 96.2
Islands	8	62.5	29.4, 87.0
No indicator of infection			
National	638	34.2	29.5, 39.2
Southern	204	42.0	33.2, 51.4
Highlands	147	10.2	5.5, 18.3
Mamose	150	57.3	46.8, 67.3
Islands	137	46.0	35.9, 56.4

Weighted analysis to account for complex survey design
[1] Anemia cut-off for non-pregnant women is Hb <12.0 g/dL. Hemoglobin (Hb) measured by Hemocue™ and adjusted for altitude and smoking

6.3. Iron deficiency

6.3.1 Iron deficiency among children 6-59 months

Of the 937 children who participated in the survey, TfR was measured in 872 children. The prevalence of iron deficiency (>8.0 µg/l) was 27.8%. Iron deficiency was highest in the Southern region (44.6%) and lowest in the Highlands (10.8%). Children in the 6-11 month group had a higher prevalence of iron deficiency than children in the other age groups (Table 6.6 and Figure 6.3).

Table 6.6 Prevalence of iron deficiency among children (6-59 months), PNG National Nutrition Survey 2005

Demographic Characteristics	N	Prevalence (%) of Iron Deficiency[1]	95% CI	Mean TfR ± SD
National	**872**	**27.8**	**23.4, 32.7**	**7.3 ± 4.9**
Region				
Southern	195	44.6	33.8, 56.0	8.7 ± 5.2
Highlands	195	10.8	6.6, 17.0	5.3 ± 3.1
Mamose	238	34.0	25.0, 44.5	8.1 ± 6.3
Islands	244	29.9	20.6, 41.2	6.9 ± 3.5
Residence				
Urban	164	23.1	14.1, 35.5	6.5 ± 3.7
Rural	708	28.9	23.8, 34.6	7.2 ± 5.1
Age Group (months)				
6-11	95	39.7	28.8, 51.7	8.2 ± 4.7
12-23	209	37.0	29.5, 45.3	7.9 ± 4.6
24-35	219	24.2	18.1, 31.7	7.1 ± 4.5
36-47	189	25.5	19.1, 33.1	6.9 ± 4.5
48-59	157	15.8	10.5, 23.1	5.9 ± 5.3
Sex				
Male	465	29.4	24.4, 34.8	7.26 ± 4.9
Female	404	25.8	20.6, 31.8	6.90 ± 4.8

Weighted analysis to account for complex survey design
[1]Iron deficiency is TfR> 8.0 µg/l

6.3.2 Iron deficiency among non- pregnant women 15-49 years

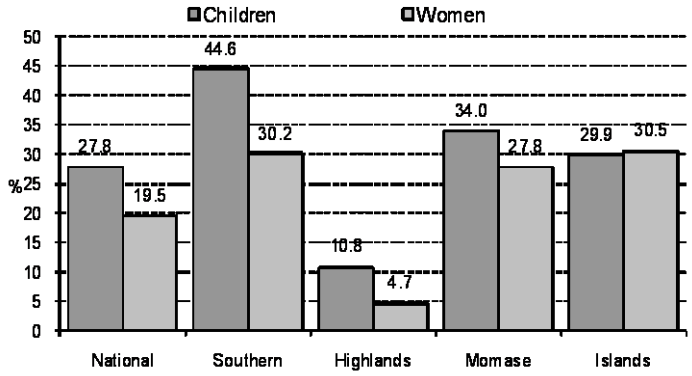
Of the 753 women with TfR results, the prevalence of iron deficiency (>8.0 µg/l) was 14.9%. Iron deficiency was highest in the Southern region (24.4%) and the Islands (23.0%) (Table 6.7).

Table 6.7 Prevalence of iron deficiency among women (15-49 years), as measured by DBS TfR, National Nutrition Survey, and PNG 2005

Demographic Characteristics	N	Prevalence (%) of Iron Deficiency [1] (DBS TfR)	95% CI	Mean TfR ± SD
National	**753**	**19.5**	**15.9, 23.5**	**6.06 ± 4.8**
Region				
Southern	247	30.0	21.7, 40.0	7.50 ± 5.5
Highlands	173	4.7	2.3, 8.9	4.43 ± 2.2
Mamose	169	27.8	20.1, 37.1	6.80 ± 4.0
Islands	164	30.5	20.8, 42.2	7.19 ± 6.0
Residence				
Urban	187	13.5	8.2, 21.6	5.36 ± 3.4
Rural	566	20.9	16.6, 26.0	6.24 ± 5.3
Age Group (years)				
15-19	133	29.7	21.8, 38.9	7.4 ± 5.6
20-29	274	17.7	13.2, 23.4	6.6 ± 5.2
30-39	203	16.5	11.3, 23.4	6.1 ± 3.8
40-49	136	16.5	10.3, 25.4	5.9 ± 4.0
Grade of education				
None	162	14.5	9.4, 21.9	6.5 ± 4.9
1-3	424	21.3	17.3, 25.9	6.8 ± 5.3
4+	139	19.7	12.8, 29.0	6.2 ± 3.9

Weighted analysis to account for complex survey design
[1]Iron deficiency is TfR> 8.0 µg/l

Figure 6.3 Prevalence of iron deficiency in children 6-59 months and non-pregnant women 15-49 years by region, PNG National Nutrition Survey 2005.



6.4 Iron deficiency anemia

Iron deficiency anemia was assessed by forming a combination indicator, elevated TfR (iron deficiency) and low hemoglobin (anemia).

6.4.1 Iron deficiency anemia in children 6-59 months of age

The prevalence of iron deficiency anemia in preschool children is 22.8% (Table 6.9). Nationally, iron deficiency accounts for almost 50% of the anemia among children 6-59 months. In children, a higher prevalence of iron deficiency anemia (IDA) was found in the Southern region. The prevalence of iron deficiency anemia was very high in children 6-11 months and dropped in each successive age group. There was little difference in the prevalence of IDA by sex or by residence.

Table 6.8 Prevalence of iron deficiency anemia among children (6-59 months), PNG National Nutrition Survey 2005

Demographic Characteristics	(TfR) and Hemoglobin (Hb) [1]		
	N	Prevalence of iron deficiency anemia (%)	95% CI
National	**868**	**22.8**	**18.8, 27.4**
Region			
Southern	194	35.6	26.4, 45.9
Highlands	195	7.7	4.6, 12.7
Mamose	236	31.4	22.1, 42.4
Islands	243	21.8	14.7, 31.1
Residence			
Urban	164	19.1	11.0, 31.2
Rural	704	23.7	19.1, 29.0
Age Group (months)			
6-11	95	36.6	26.4, 48.1
12-23	209	28.6	22.0, 36.3
24-59	219	18.9	13.7, 25.3
36-47	188	22.5	16.2, 30.3
48-59	157	12.8	7.8, 20.2
Sex			
Male	464	24.2	19.6, 29.5
Female	401	20.8	16.2, 26.4

Weighted analysis to account for complex survey design
[1]Iron deficiency anemia is TfR> 8.0 µg/l and Hb <11.0 g/dl.) Hb measured by Hemocue™ and adjusted for altitude

6.4.2 Iron deficiency anemia in non-pregnant women 15-49 years of age

The prevalence of iron deficiency anemia in non-pregnant women 15-49 years of age is 15.0% (Table 6.9). Nationally iron deficiency accounted for almost 50% of the anemia among non pregnant women 15-49 years of age.

Table 6.9 Prevalence of iron deficiency anemia among non-pregnant women of childbearing age (15-49 years), PNG National Nutrition Survey 2005

Demographic Characteristics	DBS (TfR) and Hemoglobin (Hb)[1]		
	N	Percent with iron deficiency anemia	95% CI
National	**742**	**15.0**	**11.8, 18.8**
Region			
Southern	242	24.5	16.6, 34.5
Highlands	171	2.3	0.7, 7.2
Mamose	168	22.6	15.3, 32.2
Islands	161	23.0	15.4, 32.8
Residence			
Urban	182	12.0	7.0, 19.9
Rural	560	15.7	11.8, 20.5
Age Group (years)			
15-19	130	20.5	13.5, 29.8
20-29	273	13.5	9.6, 18.6
30-39	203	13.6	9.0, 20.2
40-49	136	14.6	8.7, 23.5
Grade of education			
None	156	11.6	7.0, 18.7
1-3	420	15.9	12.6, 20.0
4+	139	17.2	10.5, 26.8

Weighted analysis to account for complex survey design

[1]Iron deficiency anemia is TfR> 8.0 µg/l and Hb <12.0 g/dl.) Hb measured by Hemocue™ and adjusted for altitude and smoking.

Figure 6.4 Prevalence of iron deficiency anemia in children 6-59 months of age and non-pregnant women 15-49 years by region, PNG National Nutrition Survey 2005

6.5 Iron supplementation coverage

Among the 358 women who had given birth during the previous three years prior to the survey 79.1% of women reported receiving iron supplements at some point during their pregnancy (Table 6.10). Of the women who had received supplements there were no significant regional differences. Most women, (92.3%), obtained their iron tablets from health workers from a clinic or hospital.

Table 6.10 Use of iron supplements during last pregnancy, PNG National Nutrition Survey 2005

Demographic Characteristics	N	Prevalence of women reporting use of iron supplements during their last pregnancy (within three years of the survey date) (%)	95% CI
National	**358**	**79.1**	**72.5-84.6**
Region			
Southern	102	87.3	74.0-94.3
Highlands	82	78.0	64.7-87.4
Mamose	89	71.9	59.6-81.6
Islands	85	87.1	72.8-94.4

Weighted analysis to account for complex survey design

6.6 Discussion: Anemia, iron deficiency and iron deficiency anemia

In each of the target groups there is a high prevalence of anemia. The pattern is similar in all three target groups across the 4 regions, with people in Mamose and the Southern region having the highest prevalence. The high prevalence of anemia in men suggests that iron deficiency may not be the predominant cause of anemia in Papua New Guinea. Iron deficiency anemia in women is 19.5% and in children it is highest in the 6-11 months age group (27.8%).

Infections seem to be more related to anemia in children than in women. Children with elevated acute phase proteins are much more likely to be anemic than children without signs of inflammation.

Unfortunately due to technical difficulties we were not able to determine the malaria status of the survey participants so it is difficult to know to what extent malaria might have contributed to the anemia prevalence.

More work needs to be done to determine the aetiology of anemia in PNG. Iron fortification of food vehicles such as wheat flour, may help to reduce the prevalence of iron deficiency further but based on this data there are other causes of anemia that need to be addressed, such as infection and possibly malaria control.

To address the very high prevalence of anemia among young children, the feasibility of commercial and in-home fortification (e.g. using multiple micronutrient powders) of foods for infants and young children should be explored.

These data on iron supplementation have limited use as there is no indication of how many supplements women received, at which stage or pregnancy they received supplements and how frequently they took the supplements. Furthermore the survey did not collect hemoglobin on pregnant women so there is no information on their nutritional status during pregnancy. Although these data have limitations it indicates that systems are in place for supplement delivery at some point during pregnancy for just over 75% of pregnant women in Papua New Guinea. The policy on iron supplementation of pregnant women should also continue to be routine practice in antenatal care.