Interactions among micronutrient deficiencies and undernutrition in the Philippines

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Data gathered from the 1987 National Nutrition Survey in the Philippines provided the opportunity to study the interactions among micronutrient deficiencies and undernutrition in different age groups as a basis for program targeting. A randomly selected subset of 50% of the households (3,200) covered by the national survey served as source of subjects. Results showed that there was a greater proportion of anaemia among the undernourished (as judged by weight -for-age in children and weight-for-height in adults (66.0%) than among the adequately nourished (54.6%) alpha=0.01). However, the observed differences in the proportion of serum vitamin A deficiency and of goitre among the undernourished compared to the adequately nourished were not significant. Also not significant were the observed higher prevalence of anaemia among subjects with acceptable serum vitamin A levels for both adequately nourished and undernourished, and the higher prevalence of vitamin A deficiency among the non-anaemic. Again there were no significant difference in the prevalence of anaemia among goitrous and non-goitrous subjects, as well as the prevalence of goitre among anaemic and non-anaemic subjects. Neither were there significant differences in the prevalence of vitamin A deficiency among goitrous and non goitrous subjects, but there were significant differences in the prevalence of goitre among vitamin A deficient and non-vitamin A deficient subjects among the 7-14 year olds and among pregnant and lactating women. The study concludes that at the national level there is apparently an interaction between anaemia and protein-energy undernutrition and possibly also between goitre and vitamin A deficiency in the high risk age groups, but not between anaemia on the one hand and goitre and vitamin A deficiency in another, perhaps because of clustering in the latter conditions not found in anaemia and general undernutrition. These findings may be useful in targeting communities with high prevalence of micronutrient deficiencies by using prevalence of underweight and goitre as indicators for high prevalence of anaemia and vitamin A deficiency, respectively.

Introduction

Micronutrients are assuming new importance as their wider roles in health and development become better understood. Deficiencies in micronutrients particularly vitamin A, iron and iodine are among the most common especially in developing countries. Iron deficiency anaemia is the most widespread in the world, afflicting an estimated one billion people principally infants, pre-school age children, pregnant and lactating women. In Asia alone, corneal lesions due to vitamin A deficiency register an estimated 700,000 new cases every year (WHO, 1985), or 6 to 7 million new cases per year of children with vitamin A deficiency. Likewise in Asia, 400 million children and adults are affected with iodine deficiency. In the Philippines, vitamin A deficiency, iron deficiency anaemia and iodine deficiency disorders remain as public health problems[1,2].

Vitamin A deficiency in children damages the eyes and lowers the resistance to common childhood diseases such as infectious diarrhoea, measles and respiratory tract infections by reducing the effectiveness of the immune system. Even moderate levels of deficiency will lead to stunted growth, increased severity of infection and higher death rates.

Iron deficiency in infancy and childhood can impair learning and the ability to resist disease. Anaemia contributes to high maternal mortality rates and contributes greatly to low birth weight and infant mortality.

Iodine is needed to produce thyroid hormones necessary for the development and normal functioning of the brain and the nervous system. It also regulates body heat and energy. A low level of thyroid hormones can reduce both physical and mental capacity. In pregnant women, iodine deficiency can cause miscarriages and still births. It may lead to irreversible brain damage in the fetus or newborn and cause mental retardation in children[1].

Results of the Philippine Nationwide Nutrition Survey done in 1987[3] revealed various degrees of malnutrition assessed through clinical, dietary, anthropometric and biochemical measurements. The survey likewise indicated a worsening prevalence of anaemia among Filipinos, with the prevalence rising from 26.67% in 1982 to 37.2%. In 1987. Greatly affected in the populations similar to past surveys, were the 6-11 month old infants with a prevalence rate of 70.4% Following next in decreasing order were elderly males, pregnant and lactating women. In contrast to anaemia, the over-all prevalence of vitamin A and iodine deficiencies of 0.8 % and 3.5%, respectively, were not as

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alarming as shown by both clinical and biochemical assessments. It is possible that the problem of vitamin A deficiency is predominant in isolated and highly localised areas, like urban slums and remote rural areas, as have been shown by others[4] and that regional and national surveys do not reflect the true severity of the problem at the community level. Iodine deficiency as shown by goitre among female members of the population, however, was found to be quite alarming wherein pregnant and lactating women were mostly affected. In 1987, more than 10 out of every 100 pregnant and lactating women had goitre. Compared with the 1982 data, a greater number of goitre cases was recorded in the 1987 survey.

Based on the findings of the 1987 surveys therefore, micronutrient deficiencies are indeed public health problems in some regions of the Philippines that need immediate nutritional intervention. To date, however, no local study of interactions/ relationship of single micronutrient deficiency with undernutrition or on prevalence of multiple micronutrient deficiency in relation to undernutrition have been carried out. Thus this study was undertaken to assess the prevalence of single and multiple micronutrient deficiencies in Philippine populations using a subset of clinical and biochemical data gathered in the 1987 Philippine Nationwide Nutrition Survey. Specifically, the study aimed to assess the extent and distribution of single and multiple micronutrient deficiencies among different age groups; and among undernourished and adequately nourished cases in the sample population. Likewise, the study aimed to determine the implications of these findings for programmatic strategies of micronutrient deficiency prevention and control.

Methodology

1. Sampling Design and Subjects

The subjects for this study were derived from those covered by the 1987 National Nutrition Survey. Fifty percent of the total number of households (3,200), randomly selected on the basis of a stratified three-stage sampling design described by Villavieja et al[5], were covered by this study. Anthropometric measurements based on methods by Jelliffe[6] were gathered by trained medical technologists and nutritionists, while the clinical assessment was done by physicians[3]. Blood samples were collected and analysed by members of the Nutritional Standards and Requirements Division[7].

Assessment of vitamin A deficiency was done on household members aged 6 months to 19 years old, pregnant and lactating women. Clinical signs suggestive of vitamin A deficiency were looked for among family members. Elder members of the family were interviewed if they have difficulty seeing at night. Mothers were asked if they had a child who had the same problem or who bumped into things or groped in the dark or refused to play in the dark. These findings help identify the presence of nightblindness, often the first symptom of xerophthalmia. Eyes were examined in bright light or window light for the presence of characteristic eye lesions of xerophthalmia. Blood samples were collected to determine serum vitamin A using TFA method by Neeld and Pearson[8] by members of the Nutritional Standards and Requirements Division. The results of serum vitamin A analysis were interpreted based on the cut-off points set by WHO/IVACG/HKI in 1982 [9].

All the members of the households were included in haemoglobin determination using the Cyanmethaemoglobin method. Out of these households, only those aged 6 months to 19 years old, pregnant and lactating were targeted as subjects in this study. They were classified in terms of age, sex, micronutrient deficiency and degree of malnutrition using anthropometric methods.

Thyroid gland examination was done on household members aged 7 years old and over. Any enlargement of the thyroid gland was graded using the World Health Organization classification[10].

2. Data Processing

Data were submitted to the Infrastructure Computer Center (ICC) for computerisation. Survey data and information were entered into a master tape wherein validation of updated programs was applied to create a master data file; from this file a secondary tape was produced whose contents were used as inputs to generate for the Statistical Package for the Social Sciences (SPSS).

3. Data Analysis

Weight-for-height data were compared with the National Center for Health Statistics (NCHS) standards, with the cut-off point for undernourished of -2 standard deviations[11]. Recommended weight-for-height table for Filipinos[12] was used to classify the nutritional status of the pregnant and lactating women.

Result and Discussion

A. Single micronutrient deficiencies in relation to undernutrition iron deficiency anaemia

The analysis of single micronutrient deficiencies in relation to undernutrition showed that anaemia was more prevalent among the undernourished than the adequately nourished. This was true for all age groups in both sexes with the exception of females belonging to the 5-14 years of age and pregnant women. Statistical test on the difference of proportions between the adequately nourished and undernourished groups showed significant result at $p<0.01$ level of significance (Table 1). This indicates a correlation between anaemia and undernutrition.

Adequate body iron depends on sufficient stores at birth, and an ample supply of available iron in the diet[13]. Although the iron intake among the households was reportedly not very low (91.5% of RDA)[5], a significant number of anaemic among the undernourished groups was noted. Considering that 90% of the iron in the diet comes from vegetables sources[5], iron deficiency was prevalent possibly because of inefficient absorption. Another possible factor that may contribute to high prevalence of anaemia is the high prevalence of intestinal parasitism. In the 1982 nutrition survey[14], hookworm infection was 13.8% among subjects of all age groups.

1. Vitamin A Deficiency

The combination of the nutritional status and the biochemical levels provides a more accurate estimation of the prevalence of vitamin A deficiency. The prevalence of Vitamin A deficiency (biochemical) among the

undernourished (8.5%) and adequately nourished (8.8%) were about the same as shown in Table 2.

Table 1. Prevalence of anaemia among adequately nourished and undernourished subjects, Philippines, 1987

Population Group	Total Subjects Examined	Adequately Nourished	Under Nourished
		Percentage of subjects	
6-11months			
Male	128	70.8	84.4
Female	145	73.6	79.5
1-4 years			
Male	1068	39.2	52.4
Female	1006	42.9	51.5
5-14 years			
Male	2459	61.3	63.3
Female	2359	60.3	59.7
15-19 years			
Male	947	61.5	70.5
Female	909	28.0	93.5
Pregnant	287	49.2	46.5
Lactating	554	54.0	60.7
Total	**9862**	**54.6****	**66.0****

*Used NCHS Standards: W/H Classification (Cut-off Point -250)
**0.01 Level of significance

Table 2. Prevalence of vitamin A deficiency among adequately nourished and undernourished subjects: Philippines, 1987.

Population Group	Total Subjects Examined	Serum Vitamin A Levels: Adequately Nourished		Undernourished	
		Deficient	Low	Deficient	Low
		Percentage of Subjects			
6-11 months					
Male	73	1.9	11.3	-	-
Female	76	1.8	3.6	-	-
1-4 years					
Male	678	0.9	4.5	2.2	3.0
Female	641	3.1	3.1	3.6	4.5
5 - 14 years .					
Male	1081	4.4	6.9	5.0	3.6
Female	1047	3.8	6.3	4.4	6.2
15-19 years					
Male	310	2.7	6.3	4.6	8.0
Female	295	5.5	8.8	1.8	12.3
Pregnant	144	4.3	3.4	-	7.1
Lactating	359	1.1	2.5	-	8.9
Total	**4704**	**3.2**	**5.6**	**3.5**	**5.0**

*Used NCHS Standards: W/H Classification (Cut-off point -250); Used Philippine W/H Standard for Filipino Pregnant and Lactating Women.

The same pattern of distribution for deficient and low serum vitamin A level, in the undernourished and adequately nourished was seen except among pregnant women and male 5-14 years of age . There was no apparent association between undernutrition and vitamin A deficiency. There may be an association with morbidity and mortality rather than nutritional status based on weight for age.

Based on the 1987 dietary consumption survey, the Filipino diet is still inadequate in both protein and fat which are very important in the conversion of β-carotene to active vitamin A, as well as absorption, transport, and storage[21]. High prevalence of infectious diseases such as respiratory diseases, measles, diarrhoea and parasitic infections could be some of the possible reasons why in spite of adequate nutrition, vitamin A deficiency continue to be manifested . The study of Sommer et al[22] likewise showed that children with mild xerophthalmia were more likely to develop respiratory disease and diarrhoea than non- xerophthalmic children, and this increased risk was more closely associated with their vitamin A status than with their general nutritional status.

2. Goitre

As a whole, goitre was apparently more prevalent among adequately nourished than the undernourished, as shown in Table 3, although the differences were not significant. This was true in all age groups examined except among the 15-19 years old. There is no apparent association between undernutrition and goitre.

Table 3. Prevalence of goitre among adequately nourished and undernourished subjects, Philippines, 1987

Population Group	Total Subjects Examined	Adequately Nourished	Under-nourished*
		Percentage of Subjects	
7-14 years			
Male	1907	0.8	0.4
Female	1840	2.9	0.9
15-19 years			
Male	931	0.2	0.4
Female	890	6.4	7.0
Pregnant	277	14.0	11.9
Lactating	543	11.5	9.4
Total	**6388**	**3.9**	**1.9**

*Used NCHS Standards: W/H Classification (Cut-off Point -250)

This study is similar to other studies. Medeiros-Neto have documented that there was no relationship whatsoever between nutritional indices and prevalence of goitre among school children[23]. A study in Zaire did not reveal an association between malnutrition and goitre[23]. A study in Bangladesh, however, found the prevalence of goitre was inversely related to underweight and wasting after controlling for the effect of socioeconomic status[24]. One reason for a greater prevalence of goitre among the adequately nourished could be the crude assessment of goitre.

B. Multiple micronutrient deficiencies and undernutrition anaemia and vitamin A deficiency

In the analysis of multiple micronutrient deficiencies among the adequately nourished it was shown that anaemia was more prevalent among subjects with acceptable vitamin A levels both in the undernourished and adequately nourished with the exception of adequately nourished infants and pregnant women. This indicates no apparent association between anaemia and vitamin A deficiency (Table 4). Although there was a higher (43.6%) prevalence of anaemia among the undernourished with acceptable serum vitamin A in comparison to their adequately nourished counterparts (31.4%), this was not significant for sub-groups.

Table 4. Prevalence of anaemia among vitamin A deficiency and non-vitamin A deficiency by nutritional status: Philippines, 1987

Population Group	Total Subjects Examined	Adequately Nourished		Undernourished	
		VAD*	Non-VAD**	VAD	Non-VAD
6 - 11 Months					
Male	73	57.1	54.3	-	80.0
Female	76	66.7	66.0	-	70.0
1 - 4 Years					
Male	677	29.2	34.5	33.3	50.0
Female	641	32.0	39.8	38.9	50.5
5 - 14 Years					
Male	1082	29.9	36.5	30.6	36.6
Female	1047	21.8	33.2	10.7	31.3
15 - 19 Years					
Male	309	-	23.6	30.0	39.0
Female	299	20.6	32.2	75.0	44.9
Pregnant	145	55.6	43.5	-	50.0
Lactating	360	45.58	51.9	57.1	68.1
Total	4709	27.2	37.2	31.4	43.6

*VAD = Serum vitamin A < 10-19 ug/dL (ICNND, 1963)
**Non-VAD = Serum vitamin A ≥ 20-50 ug/dL.

Table 5. Prevalence of vitamin A deficiency among anaemic and non-anaemic by nutritional status: Philippines, 1987

Population Group	**Total Subjects Examined**	**Adequately Nourished**		**Undernourished**	
		Anaemic	Non-Anaemic	Anaemic	Non-Anaemic
6-11 months					
Male	73	13.8	12.5	-	-
Female	76	5.4	5.3	-	-
1-4 years					
Male	677	4.6	5.8	3.5	6.8
Female	641	4.9	6.7	6.3	9.7
5-14 years					
Male	1082	9.7	12.6	7.3	9.4
Female	1047	6.9	11.6	3.8	12.9
15-19 years					
Male	309	-	10.9	9.1	13.0
Female	299	9.5	16.1	21.4	6.9
Pregnant	145	9.6	6.2	-	13.3
Lactating	360	3.4	4.4	7.6	11.5
Total	**4709**	**6.6**	**10.0**	**6.2**	**10.1**

Table 5 shows there was apparently a higher prevalence of vitamin A deficiency among non-anaemic than anaemic both in the adequately nourished and undernourished groups. This was true for all age groups examined except among infants, pregnant women and the 15-19 years of age females who were found to be adequately nourished. The differences, however, were not statistically significant. Also noted in Table 5 was the high prevalence of vitamin A deficiency among female adolescents (21.4%) who were anaemic, and undernourished and their non-anaemic counterparts who were found to be adequately nourished as well (16.1%). In addition, the non-anaemic female undernourished 5-14 years showed a high prevalence rate of 12.9%.

Plasma retinol levels are not necessarily related to anaemia and PEM among subjects in this survey. In health, about 90% of the vitamin A in the body is stored in the liver. A healthy person would have several months' supply of vitamin A. It is possible therefore, that a person manifesting anaemia may still show adequate vitamin A levels. Besides, vitamin A does not work in isolation. Protein, fat and bile enhance the digestion and absorption of carotenoids and retinol esters. In a study done by Smith, et al[25] among children with kwashiorkor, low plasma retinol was associated with low RBP and pre-albumin levels. All components increased after a diet high in protein and energy but without vitamin A.

1. Anaemia and Goitre

Among the adequately nourished, anaemia was more prevalent among the non-goitrous subjects except among 7-14 year old males and lactating women although the differences were not statistically significant (Table 6). However the reverse was seen among the undernourished wherein anaemia is more prevalent among the goitrous with the exception of the 7-14 year old males. The differences were not statistically significant.

Table 6. Prevalence of anaemia among goitrous and non-goitrous by nutritional status: Philippines, 1987

Population Group	**Total Subjects Examined**	**Adequately Nourished**		**Undernourished**	
		Goitrous	Non-Goitrous	Goitrous	Non-Goitrous
7-14 years					
Male	1906	100.0	70.2	66.7	70.6
Female	1841	57.5	69.4	100.0	68.2
15-19 years					
Male	930	-	61.4	100.0	69.9
Female	890	67.3	69.7	75.0	70.0
Pregnant	277	28.1	49.8	60.0	43.6
Lactating	541	62.5	51.9	72.7	59.4
Total	**6385**	**58.7**	**66.2**	**75.0**	**68.5**

Table 7 shows that the differences between proportions were not statistically significant in the prevalence of goitre among anaemic and non-anaemic both in the adequately nourished and undernourished. Slightly more goitre cases were seen among anaemic undernourished than non-anaemic in all age groups except male 7-14 years of ages although differences were not statistically significant. However, among adequately nourished, there was slightly higher prevalence of goitre among non-anaemic but again the difference was not significant. As noted previously, there was higher prevalence of goitre among pregnant and lactating women and among adolescents.

Results support the earlier discussion that goitre prevalence was not related to anaemia and nutritional status among the subjects of the survey.

2. Vitamin A Deficiency and Goitre

Highly significant difference was seen (= 0.01) in the proportion of vitamin A deficiency among adequately nourished goitrous cases compared to their non-goitrous counterpart (Table 8). This was true for all subjects as a whole and, for males belonging to the 7-14 years of age and pregnant women. However, among the undernourished, vitamin A deficiency was more prevalent among the goitrous lactating women than the non-goitrous. The

differences between proportions were not statistically significant for the other age groups This table suggests that there may be a correlation between vitamin A deficiency and goitre among high risk groups such as pregnant and lactating women.

Table 7. Prevalence of goitre among anaemic and non-anaemic by nutritional status: Philippines, 1987

Population Group	Total Subjects Examined	Adequately Nourished		Undernourished	
		Anaemic	Non-Anaemic	Anaemic	Non-Anaemic
7-14 years					
Male	1906	1.2	-	0.4	0.5
Female	1841	2.4	4.0	1.3	-
15-19 years					
Male	930	-	-	0.5	-
Female	890	6.2	6.9	6.7	5.3
Pregnant	277	8.3	18.5	15.0	8.3
Lactating	541	13.3	9.0	11.3	6.5
Total	**6385**	**3.4**	**4.7**	**2.0**	**1.5**

Table 8. Prevalence of vitamin A deficiency among goitrous and non-goitrous by nutritional status: Philippines, 1987

Population Group	Total Subjects Examined	Adequately Nourished		Undernourished	
		Goitrous	Non-Goitrous	Goitrous	Non-Goitrous
7-14 years					
Male	720	50.0*	11.6	-	8.0
Female	694	23.5	11.0	100.0	11.4
15-19 years					
Male	303	-	8.7	-	11.9
Female	291	11.8	14.6	-	16.3
Pregnant	144	33.3**	3.1	-	8.7
Lactating	352	3.8	4.1	28.6**	6.9
Total	**2504**	**18.3****	**9.9**	**14.3**	**9.9**

*0.05 level of significance
**0.01 Level of significance

Again, goitre was apparently more prevalent among vitamin A deficient than non-vitamin A deficient subjects (Table 9). For the adequately nourished the same pattern of distribution was evident for all subjects examined except among the adolescent female and lactating mothers, and the differences between proportions were found to be highly significant. Twice as many cases of goitre was seen among the vitamin A deficient adequately nourished than undernourished. Highly significant difference was seen in the prevalence of goitre among vitamin A deficient undernourished lactating mothers compared to non-vitamin A deficient cases.

Table 9. Prevalence of goitre among vitamin A deficient and non-vitamin A deficient by nutritional status: Philippines, 1987

Population Group	Total Subjects Examined	Adequately Nourished		Undernourished	
		VAD	Non-VAD	VAD	Non-VAD
7-14 years					
Male	720	3.8**	0.51	-	0.8
Female	694	6.7**	2.8	5.0	-
15-19 years					
Male	303	-	-	-	-
Female	291	5.9	7.4	-	12.8
Pregnant	144	66.7**	11.2	-	19.2
Lactating	352	9.1	9.5	28.6**	6.9
Total	**2504**	**8.1**	**4.1**	**4.4**	**2.9**

**0.01 Level of significance

Conclusions

Based on the results of the 1987 National Nutrition Survey conducted in the Philippines, there is apparently an interaction between anaemia and protein-energy malnutrition and possibly between goitre and vitamin A. It is possible that vitamin A deficiency and goitre status cluster in certain geographic areas while anaemia and PEM do not, mapping interaction at the national level between anaemia and PEM on the one hand and vitamin A deficiency and goitre on the other. These interactions or lack of interactions need to be tested at the local level in a variety of nutrition situations. The implication for programming is that we may be able to use prevalence of PEM in the locality as a good indicator for the prevalence of anaemia, but not for prevalence of vitamin A or goitre. On the other hand it may be possible to use goitre prevalence as an indicator of prevalence of vitamin A deficiency in high risk groups.

The need to have more in-depth analysis to study interactions in the presence of clustering of vitamin A and goitre is warranted. Moreover, because of the apparent lack of interaction at the individual level (as shown before), use of prevalence rates at the community level may be warranted for the assessment of micronutrient deficiencies.

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菲律賓人微量營養素缺乏和營養不良間的相互影響

摘要

從菲律賓 1987 年營養調查收集的數據，提供了不同年齡組微量營養素缺乏和營養不良間相互影響的研究基礎。該研究對象是從 1987 年全國營養調查的對象中選出。結果顯示營養不良者（兒童用年齡一體重評定，成人用身高一體重評定）貧血比率大於營養充足的人群，分別爲 66% 和 54.6%（$\alpha = 0.01$）。比較營養不良和營養充足的人群，其維生素 A 缺乏和甲狀腺腫發病率沒有明顯差異，在可接受的血清維生素 A 水平時，其貧血發病率也沒有顯著差異，但非貧血人群中，維生素 A 缺乏較高。再者，甲狀腺腫和非甲狀腺腫對象中，其貧血發病率亦沒有明顯差異，同時，貧血與非貧血對象中，其甲狀腺腫發病率亦沒有明顯差異。在甲狀腺腫和非甲狀腺腫病人中，維生素 A 缺乏和發病率沒有區別，但是在缺乏維生素 A 和非缺乏維生素 A 的 7—14 歲兒童、孕婦和授乳婦人中，其甲狀腺腫發病率有明顯差異。作者得出結論，在全國範圍內，貧血和蛋白質一能量營養不良之間有明顯的相互影響，或許在高發病年齡組，甲狀腺腫和維生素 A 缺乏之間也有明顯的相互影響。這些發現，也許對製訂計劃分別去研究貧血、維生素 A 缺乏和體重過輕、甲狀腺腫的相互影響是有用的。

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