Studies of the Nutritional Problem of Puerto Rico[1]

I. VITAMIN A DEFICIENCY IN RELATION TO DARK ADAPTATION AND OCULAR MANIFESTATIONS

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A DISCUSSION of the complicated nutritional problem of Puerto Rico should by rights be included in any program dealing with public health, since such a condition undoubtedly has an important direct or indirect bearing on the morbidity and mortality of the Island. It is unnecessary to mention here the various deficiency states prevalent in Puerto Rico, or to call attention to the obvious role that an inadequate diet plays in the high incidence of some of the infectious and parasitic diseases that are yet unsolved public health questions. However, this ever present problem of an inadequate diet—the result of poverty, ignorance and, sometimes, fads—with its possible unknown biologic effects on the population, may now become more acute during the present shipping crisis because of the diminishing importations of certain essential foodstuffs. Puerto Rico's nutritional problem, which in itself has always been varied and complex in the past, has now reached a critical point. It is not only the health and wellbeing of the civilian population which is at stake but also, and of even greater import, the health and physical fitness of those soldiers that the Island may contribute to the fight for democracy.

GENERAL CONSIDERATIONS ON THE SUBJECT

Vitamin A is derived from both animal and plant life. That vitamin A derived from the latter is known as provitamin A: the yellow carotenoid pigments, alfa, beta, gamma carotene, and cryptoxanthin. Vitamin A itself is a colorless, methylated, unsaturated, aliphatic alcohol to which a beta ionone ring is attached. There are two varieties: (1) A_1, present in the liver of marine fish and (2) A_2, found in the liver of fresh water fish. The latter contains two more carbon atoms in its aliphatic chain, but both A_1 and A_2 are optically active.

The liver is the principal reservoir for vitamin A and stores up

1. Received for publication February 11, 1943. Read before the Second Annual Meeting of the Puerto Rico Public Health Association January 30, 1943.

ninety-five percent of the amount found in the body. A normal liver contains 40,000 U.S.P. units of vitamin A per hundred grams of hepatic tissue. The choroid and retina also contain large amounts of this vitamin which aids in the formation of the visual purple, or rhodopsin.

Bitot (1863) was the first to observe that patients with xerophthalmia invariably complained of night blindness.[2] The question whether dark blindness or some degree of dysadaptation precedes the conjunctival changes, or vice versa, is still unsettled. In 1939 Bocher, Callison, and Hewston[3] asserted that "impaired dark adaptation as measured with the visual adaptometer was the earliest definite ocular abnormality observed as a result of vitamin A deficiency." Three years later Callison[4] argued that dysadaptation preceded conjunctival changes, indicating that the test for adaptation was the more reliable and the preferred routine procedure for detecting avitaminosis A. Berliner (1942)[5] pointed out that ocular lesions were disassociated with other manifestations of vitamin A deficiency, that the blood vitamin levels were as a rule not low, and that the lesions were those ordinarily ascribed to simple senile changes. On the other hand, Steininger and Roberts[6] reported in 1939 that, although there appeared to be some relationship between biophotometric readings and vitamin A nutrition, the relation was "not close enough to warrant the use of the test as a means of diagnosing subclinical vitamin A deficiency." Sometime later, and utilizing this time the Hecht and Shlaer apparatus, Oldham, Roberts, MacLennan, and Shultz[7] studied dark adaptation in children with relation to dietary levels of vitamin A. They found no correlation between adaptometer readings and the daily vitamin A intake, although a number of the subjects were apparently receiving less than 20 I. U. per kilogram daily in their diets. Kruse[8] stated that ordi-

2. J. Mandelbaum, "Vitamin A. Some Clinical Considerations," *M. Clin. North America*, 26:965, 1942.

3. L. E. Bocher, E. C. Callison, and E. M. Hewston, "Experimental Determination of Minimum Vitamin A Requirements of Normal Adults," *J. Nutrition*, 17:317, 1939.

4. E. C. Callison, "Consideration of Adequacy of Biomicroscopy as Method of Detecting Mild Cases of Vitamin A Deficiency," *Science*, 95:250, 1942.

5. M. L. Berliner, "Regarding Early Detection of Avitaminosis A by Gross or Biomicroscopic Examination of Conjunctiva," *Am.J.Ophth.*, 25:302, 1942.

6. G. Steininger and L. J. Roberts, "Biophotometer Test as Index of Nutritional Status f Vitamin A," *Arch.Int.Med.*, 64:1170, 1939.

7. H. Oldham, L. J. Roberts, K. MacLennan, and F. W. Shultz, "Dark Adaptation of Children in Relation to Dietary Levels of Vitamin A," *J.Pediat.*, 20:740, 1942.

8. H. D. Kruse, "Methods of Detecting Mild Cases of Vitamin A Deficiency," *Science*, 95:2477, 1942.

narily xerosis conjunctivae preceded night blindness and recommended the biomicroscope examination as a "simple, conventional, objective method of detecting avitaminosis A." He found gross or microscopic changes in the conjunctivae of one hundred patients showing no impaired adaptation. Other authors such as Yarborough and Dann[9] and Lewis, Bodansky, and Haig[10] claimed that the most promising single method for determining deficiency was by the study of the vitamin A level in the blood.

There is often an undoubtedly poor correlation between the biophotometric tests, blood vitamin A level, and the dietary history of patients. For instance, thyroid extract, or a-dinitrophenol, administered to patients with delayed or poor dark adaptation not only lowered the plasma vitamin A and carotenoid levels but also "simultaneously increased the speed and extent of dark adaptation."[11] Vitamin A content of the blood is probably only a rough index of the amount stored in the liver, although Brenner, Brookes, and Roberts[12] found that, in the absence of liver stores, vitamin A was still present for several weeks in the blood and eyes in amounts equal to those found in stock rats of weaning age.

In spite of the many unsettled points associated with the problems of deposition, mobilization, and distribution of vitamin A, it is an accepted fact that night blindness, when due to avitaminosis A, responds in hours or a few days to vitamin A therapy, with complete recovery in two to four weeks. Anatomical lesions of the skin require anywhere from ten to twenty weeks. Those lesions in the conjunctivae, described by Kruse and others as indicative of early vitamin A deficiency, take months and years of intensive therapy for their partial or total disappearance.

Vitamin A deficiency occurs as a recurring episode of deficiency, interrupted by periods of relative sufficiency and partial recession of the lesions of the deficiency. It is the cause of one form of night blindness, or hemeralopia, and of those diseases of the eye known as xerosis conjunctivae, Bitot's spots, xerophthalmia, and keratomalacia. Epithelial metaplasia in the skin, that is, keratosis follicularis, or Darier's disease, and epithelial proliferation, stratification, and

9. M. E. Yarborough and W. J. Dann, "Dark Adaptometer and Blood Vitamin A in North Carolina Nutrition Survey," *J.Nutrition*, 22:597, 1941.

10. J. M. Lewis, O. Bodansky, and C. Haig, "Level of Vitamin A in Blood as Index of Vitamin A Deficiency in Infants and Children," *Am.J.Dis.of Child.*, 62:1129, 1941.

11. Steininger and Roberts, *op. cit.*

12. S. Brenner, M. C. H. Brookes, and L. J. Roberts, "Relation of Liver Stores to the Occurrence of Early Signs of Vitamin A Deficiency in the White Rat," *J.Nutrition*, 23:459, 1942.

keratinization in certain internal organs are also evidences of avitaminosis A. Latent or subclinical deficiencies may exist presenting no clearly recognizable clinical signs or symptoms but detectable by instrumental or by ante- or post-mortem histological examination.

TABLE 1[a]

Per Capita Consumption of Foods in Puerto Rico and Some Areas of the United States

(Figures are expressed in pounds)

Class of Food	*Puerto Rico*	*North Atlantic (843 White Families)*	*South East Central (282 White Families)*	*Southern Cities (222 Negro Families)*
Total, all foods	982.6	1,289.0	1,145.7	886.10
Meats	33.4	113.6	70.5	85.6
Eggs	4.4	32.9	33.2	15.7
Milk (fresh)	67.7	261.4	151.8	24.8
Milk (processed)	14.3	31.2	98.0	58.2
Cheese	1.6	7.7	4.6	2.3
Butter	.4	21.0	8.4	6.6
Fats	20.0	22.8	54.3	63.4
Fish	21.7	20.9	12.2	40.2
Codfish	16.0	——	——	——
Fish, fresh	2.5	12.9	4.7	23.4
Green and leafy vegetables	58.4	155.4	170.1	136.3
Rice	144.6	3.9	4.4	15.1
Wheat	51.0	177.9	149.5	123.4
Beans	29.2	4.3	8.8	8.2
Starchy vegetables	283.7	156.8	100.5	91.4
Fruits and nuts	134.8	150.2	134.5	63.6
Sugar and coffee	——	——	——	——

[a] E. B. Hill and J. R. Noguera, "The Food Supply of Puerto Rico," Bulletin 55, Agricultural Experiment Station, Río Piedras, P. R., 1940.

THE NUTRITIONAL PROBLEM IN PUERTO RICO

Table 1 demonstrates the per capita consumption of green and leafy vegetables in Puerto Rico, where a consumption of 58.4 pounds per capita yearly is compared with 155.4 pounds per capita for North Atlantic families, 170.1 for those in the Southeast Central States, and 136.3 pounds for 222 southern Negro families.

Per capita consumption of fresh milk on the Island is only 67.7 pounds yearly as compared with 261.4 pounds per capita for 843

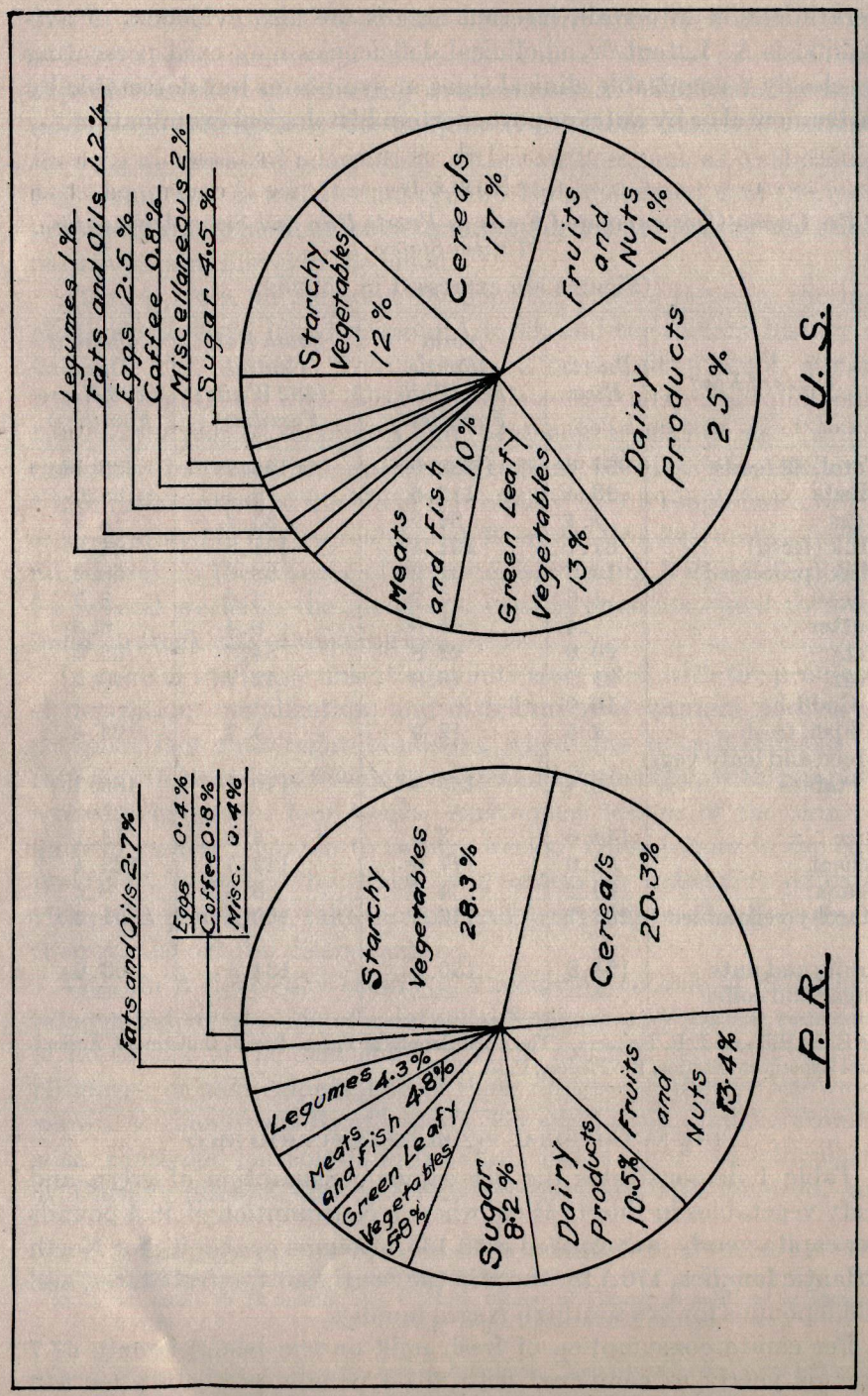


CHART COMPARING LOCAL AND CONTINENTAL CONSUMPTION OF FOODS RICH IN VITAMIN A AND IN CAROTENE

white families of the North Atlantic States and 24.8 pounds for the 222 Negro families mentioned in the preceding paragraph. On the other hand, these Negro families consumed per capita 58.2 pounds of processed milk, while consumption in Puerto Rico was only 14.3 pounds. Local consumption of cheese and butter is also ridiculously low as can be seen by this table. However, rice is consumed at the rate of 144.6 pounds per capita per year as compared with 3.9 pounds for North Atlantic families and 15.1 for the 222 Negro families. Starchy vegetables represent almost twice the consumption of the North Atlantic families—283.7 pounds for Puerto Rico and 156.8 pounds for the latter.

Chart 1 shows schematically the apparent difference between local and continental consumption of foods rich in vitamin A and in carotene. Dairy products make up only 10.5 percent of the local daily ration compared with 25 percent for the United States. Green and leafy vegetables form 13 percent of the continental diet and only 5.8 percent of Puerto Rico's, while eggs make up 2.5 percent of the former and 0.4 percent of the latter.

It may be of interest to point out that deficiency in foods rich in vitamin A and carotene was more pronounced among families of rural areas than in those studied in twenty-two towns and in San Juan. Table 2 shows that families of the rural areas studied consumed only 4 pounds of tomatoes per capita yearly, while those of San Juan and other towns consumed 22 and 24 pounds, respectively. Similar relative figures were obtained for such vegetables as peppers, lettuce, cabbage; also for tomato sauce. Fresh milk was consumed at the rate of 195 pounds per capita in San Juan, while the year's consumption per capita in the rural districts amounted to only 94 pounds. Cheese totaled 3 pounds in San Juan and 0.5 pound in the rural areas; butter 5 pounds in San Juan, 2 pounds in the other towns, and only 0.3 of an ounce among the rural families.

Cook, Axtmayer, and Dalmau[13] showed conclusively in a comparative study of the continental and Puerto Rican caterer and country diets that both these Puerto Rican diets were wholly deficient in vitamin A. Out of a diet of 2,400 calories the country family received only 1,220 Sherman units daily; those using the caterer diet acquired 2,419 units, as contrasted with 7,895 units from the continental diet.

13. D. H. Cook, J. H. Axtmayer, and L. M. Dalmau, "Nutritional Studies of Foodstuffs Used in the Puerto Rican Dietary. VII. A Comparative Study of the Nutritive Value of Three Diets of Frequent Use in Puerto Rico," *Puerto Rico J.Pub.Health & Trop.Med.*, 16:3, 1940.

TABLE 2[a]

Yearly Per Capita Consumption of Important Foods, Puerto Rico, by Surveyed Areas

Food	San Juan (2,645 Families, 1937)	22 Towns (1,901 Families, 1938)	Rural Area (439 Families, 1939)
	pounds	*pounds*	*pounds*
Cereals	132	152	146
Rice	43	44	20
Bread	—[b]	9	19
Corn meal			
Starchy vegetables	16	38	86
Sweet potatoes	71	54	22
Potatoes	76	66	34
Plantains	27	39	27
Taniers (yautía)	8	10	10
Yams (ñame)	—[c]	3	6
Cassava (yuca)			
Green and leafy vegetables	22	24	4
Tomatoes	10	9	2
Peppers	7	7	—[c]
Lettuce	6	11	1
Cabbage	12	7	1
Tomato sauce			
Legumes	42	45	38
Beans			
Sugar	57	59	52
Milk and equivalents	195	190	94
Fresh milk	3	2	—[c]
Cheese	5	2	—[c]
Butter	12	4	1
Evaporated milk			
Oleomargarine	1	3	—[c]
Lean meats, and fish	56	35	2
Fresh beef	11	10	4
Fresh pork	18	10	4
Poultry	10	8	1
Fresh fish	9	16	19
Codfish			
Eggs	19	17	6
Coffee, ground	12	13	13

[a] S. L. Descartes, S. Díaz Pacheco, and J. R. Noguera, "Food Consumption Studies in Puerto Rico," Bulletin 59, Agricultural Experiment Station, Río Piedras, P. R., 1941.

[b] Not included in this study.

TABLE 3[a]

Weights of Each of the Diets Needed to Supply 2,400 Net Calories, Grams of Nutrients and the Caloric Value of Each

Diet		Protein	Fat	Carbohydrates	Ca	P	Fe	Vitamin A Sherman Units	Cal./Gm.	Total Weight of Diet
Continental	Grams	55.27	98.79	321.33	0.352	1.29	0.021	7,895		1,579
	Calories	221.08	889.11	1,285.32					1.52	
Caterer	Grams	85.91	76.24	340.17	0.277	1.49	0.028	2,419		1,935
	Calories	343.64	686.16	1,360.68					1.24	
Country Family	Grams	58.78	61.70	400.54	0.291	0.734	0.032	1,220		1,743
	Calories	235.12	555.30	1,602.16					1.38	

[a] D. H. Cook, J. H. Axtmayer, and L. M. Dalmau, "Nutritional Studies of Foodstuffs Used in the Puerto Rican Dietary. VII. A Comparative Study of the Nutritive Value of Three Diets of Frequent Use in Puerto Rico," *Puerto Rico J. Pub. Health & Trop. Med.*, 16:3, 1940.

In a comparative study made of the physical measurements of 15,493 Puerto Rican agricultural laborers, Morales Otero and Pérez[14] showed that these men were 2.5 inches shorter and weighed 18 pounds less than a similar group in continental United States, with an average height of 64.8 inches and an average weight of 123.45 pounds for the former. The nutritional study of Cook, Axtmayer, and Dalmau[15] proved that laboratory rats fed solely on a Puerto Rican country diet showed poor growth response. It is sincerely hoped that the people of the Island may be more fortunate in spite of this daily diet.

The nutritional problem becomes more gloomy when one notes that in normal times the Island produced only 65 percent of its already inadequate diet (Table 4). All sugar and coffee consumed locally was of course raised in Puerto Rico, but the Island had to import 100 percent of the fat and 99 percent of its cereals, 89 percent of the fish and 18 percent of green and leafy vegetables (the latter in the form of canned and dried vegetables such as onions), and sauces. About 62 percent of the meat consumed was produced on the Island but 38 percent had to be imported. Thirty-four percent of the dairy products were also imported.

Axtmayer and Cook[16] studied the vitamin A content of some of the native fruits and vegetables and found them to be rich sources of vitamin. Of the foodstuffs studied, the annato seed contained 45,000 units per ounce, the *mamey* (mammee apple) 1,140, the mango, 810, the pumpkin, 560, and the green plantain, 570. However, even if the Island could raise all the green vegetables needed, there would still remain a weak point in its dietary—that of having to depend entirely upon carotene for its vitamin A intake. While vitamin A is readily absorbed from the intestine, a considerable portion of the provitamin carotene is lost in the stools. In addition a low fat diet decreases the absorption, as do steatorrhea, celiac disease, biliary obstruction, pancreatic dysfunction, and other such diarrheal states so frequent in the tropics. Incidentally, mineral oil interferes with the absorption of carotene, but not of vitamin A.

One of the richest natural sources of vitamin A is the West Indies

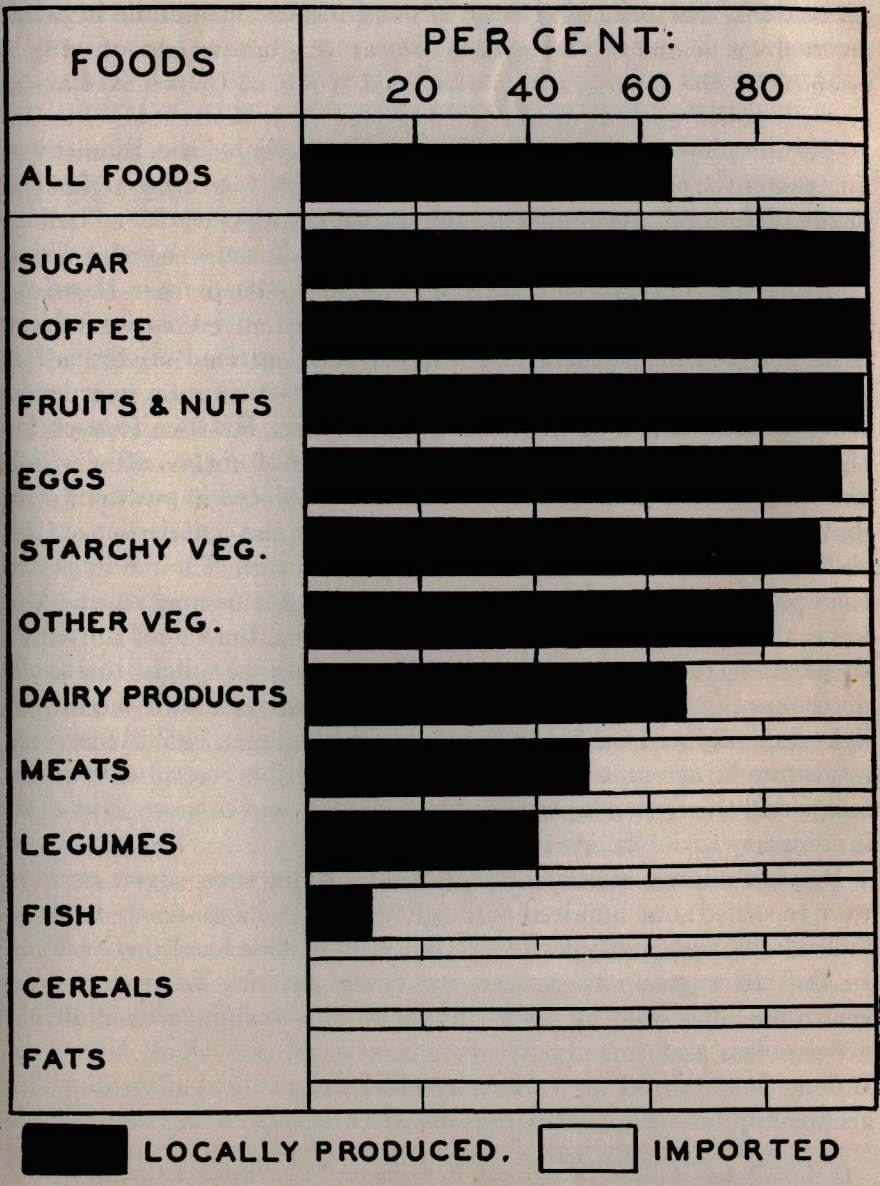
14. P. Morales Otero and M. Pérez, "Health and Socioeconomic Studies in Puerto Rico. III. Physical Measurements of Agricultural Workers," *Puerto Rico J.Pub.Health & Trop. Med.*, 14:450, 1939.

15. Cook *et al*, *op. cit.*

16. J. H. Axtmayer and D. H. Cook, "Estudios sobre el Valor Nutritivo de las Substancias Alimenticias en la Dieta Ordinaria de Puerto Rico," *Puerto Rico J.Pub.Health & Trop.Med.*, 8:407, 1933.

TABLE 4[a]

SHOWING PERCENTAGE OF FOODSTUFFS LOCALLY PRODUCED AND IMPORTED



[a] E. B. Hill and J. R. Noguera, "The Food Supply of Puerto Rico," Bulletin 55, Agricultural Experiment Station, Río Piedras, P. R., 1940.

shark liver oil. Asenjo, Dalmau, and Axtmayer[17] found that it contained 13,000 to 14,000 units per gram as compared to only 800 to 1,000 units per gram in cod liver oil. On the other hand, cod liver oil contains 200 units of vitamin D per gram to the 50 units in shark liver oil.

VITAMIN A DEFICIENCY IN RELATION TO DARK ADAPTATION

The biophotometer, model G, manufactured by the Biomedical Instrument Company of Chagrin Falls, Ohio, was utilized for the study of dark adaptation. This apparatus is equipped with a "ballast light" that maintains a constant electrical load on the rheostat which controls the voltage. The accuracy of the instrument is therefore unimpaired, even though the voltage of the outlet varies widely from one test to another. The test may be described briefly as follows: the patient rests his eyes in the dark for ten minutes in order to eliminate the effects of previous light exposure. He then focuses for three minutes on the bright light in the biophotometer, after which time this light is shut off and the test shutter placed in position. The dial reading at which the patient can just see the center spot on the shutter is recorded every minute for ten minutes. The readings are then plotted on the chart and compared with the normal curve—the lower the curve the poorer the dark adaptation; the higher the curve the better the dark adaptation. In making the light-threshold determination with this instrument one commences with the lowest light intensity and travels on upward to the highest. Should a reverse procedure be attempted, there would be a possible error due to after-image and the dark adapted eye would be exposed to more light than is necessary to determine the threshold.

Biophotometric studies of two hundred and sixty-seven persons were recorded: one hundred and eighty-five were apparently healthy individuals and eighty-two were patients of two local institutions. In the latter group there were six cases suffering from the sprue syndrome, one case of severe hypochromic anemia plus multiple deficiencies, and seventy-five beneficiaries of the U. S. Veterans' Bureau hospitalized for various surgical and medical ailments. The group of apparently healthy persons was made up of the professional,

17. C. F. Asenjo, L. M. Dalmau, and J. H. Axtmayer, "The Vitamin A Content of West Indian Shark (*Carcharinus sp.*) Liver Oil," *Puerto Rico J.Pub.Health & Trop.Med.*, 11:158, 1935.
C. F. Asenjo, D. H. Cook, and J. H. Axtmayer, "The Vitamin Content of West Indian Shark Liver Oils. II. The Vitamin D Content of the Liver Oil of the Small Blue Shark," *Puerto Rico J.Pub.Health & Trop.Med.*, 12:358, 1937.

technical, and secretarial personnel of the two institutions and by the entire population of one hundred and nine inmates of the Insular Charity School for Girls. Of the total number only one complained of night blindness.

The normal curve for the biophotometer started at 55 and showed a gradual rise up to 100 at the end of ten minutes. Only two cases of the series reached the normal level of dark adaptation and six additional cases could well be considered within the normal range, making a possible total of eight. It is interesting to point out that when five of the persons, showing the highest dark adaptation curve were given vitamin A orally in 100,000 unit doses daily, all of them showed some degree of improvement in their light threshold. A composite curve of these five cases began at 49 and finished at 83; after taking the vitamin concentrate for 48 hours, the curve began at 56 and ended at 87. This experiment suggested that even well-to-do persons, who are receiving an apparently adequate diet, are far from the state of vitamin A saturation.

All sprue cases showed dysadaptation which was most noticeable in two of them; one was suffering from nyctalopia. The average curve for the six sprue cases began at 26 and ended at 53; the highest began at 40 and finished at 82. The dramatic response of the case suffering from night blindness is evidenced in the following explanation: his original biophotometric curve started at 20. Eight minutes later it went up to 28 and by the end of the test was down to 25. Vitamin A was administered orally in 100,000 unit doses daily and forty-eight hours later, when only 150,000 units had been given, his curve jumped up to an initial reading of 40; ten minutes later the reading was 72. Twenty-four hours later these figures were 55 and 81, respectively. Clinical improvement was as marked and as rapid as the rise of the curve.

The average or composite curve of the forty-six apparently healthy persons studied at one of the institutions, the School of Tropical Medicine, began at 42 and reached only the 72 level at the end of the test. The highest curve in this group began at 49 and ended at 87; the lowest began at 33 and ended at 49.

The average curve for a similar group of thirty-one individuals studied with the biophotometer at Mimiya Hospital began at 39 and went up to 75. The highest reading began at 54 and finished at 93, the lowest at 32 finishing at 57.

One hundred and nine girls, ranging in ages from eight and a half years to eighteen years, were studied at the Insular Charity School.

The composite curve for the group began at 36 and went up to 67; the highest started at 56 and went up to 90, but the lowest commenced at 29, ran an irregular course, reached 42 in five minutes and came down to 35 in seven more minutes to rise again to 39 in nine minutes, coming down to 35 by the end of the test. The dietitian of this institution supplied menus that furnished a relatively well balanced diet and stated that the underweight and undernourished girls received an extra glass of milk with soya beans daily and, in addition, a plate of soup every day. In November all the inmates were given cod liver oil once a day. (These biophotometric studies were recorded before November.)

The records of the seventy-five U. S. Veterans' Bureau beneficiaries, all veterans of World War I, revealed a low average curve which began at 28 and ended at 59. One who had lived in the United States for a good many years and gave a good nutritional history had the highest—an almost normal curve. It started at 51, went up to 73 in three minutes, down again to 70 on the fourth minute, stayed at the same level for one minute more, and then went up steadily to the end of the test at 94. The lowest curve was very irregular, beginning at 0, going up to 16, and finishing at 10. With few exceptions this group of patients was poor and undernourished; their ages fluctuated between 42 and 77 years.

It is a known fact that the threshold for red perception of dim light rises definitely with age. Nevertheless, the older age group described above exhibited a lower dark adaptation curve than the group at the Insular Charity School.

A case suffering from severe hypochromic anemia and clinical evidences of multiple deficiencies showed definite improvement under vitamin A therapy. His original dark adaptation curve began at 25 and ended at 68 but went up to an initial light threshold of 41 and 44 after forty-eight and seventy-two hours, respectively, finishing at 79 on both occasions.

VITAMIN A DEFICIENCY IN RELATION TO OCULAR MANIFESTATIONS

Jollife and Stern[18] have described five gradations of conjunctival manifestations due to vitamin A deficiency, wherein the normal eye shows a bluish white sclera, smooth conjunctiva, only mild vascularization and a pale pink, unswollen plica semilunaris. As the

18. N. Jollife and M. Stern, "Objective Manifestations of Nutritional Deficiency Diseases," *Clinics*, 1:282, 1942.

deficiency increases, the blue white of the sclera turns white, then muddy, with brownish or yellowish pigmentation. The conjunctiva thickens irregularly; there appears a rough, wrinkled surface with increased vascularization and the plica becomes engorged and swollen. As the conjunctiva continues to thicken and become heaped up, a Bitot's spot forms at the corneal-scleral junction, at the meridian of the cornea. In grade 5, which is a very late stage, this process encroaches on the cornea.

Careful gross examination was made of the eyes of one hundred and sixteen ambulatory patients none of whom complained of any type of ocular symptoms. Most of them belonged to the upper economic and well-educated strata of society. There were forty-five males and seventy-one females with twenty-seven children ranging between three and fifteen years of age. Thirteen adults and ten children, a total of twenty-three persons (19 percent) in the series of one hundred and sixteen cases, had normal conjunctivae. The remaining ninety-three cases (81 percent) showed gross evidence of vitamin A deficiency. Increased vascularity was present in five patients (5 percent), prexerosis in nineteen (19 percent), and Bitot's spots in sixty-nine cases (59 percent). Two of them showed considerable conjunctival pigmentation. The ocular manifestations were slightly more prevalent in the male sex (78 percent of males and 75 percent of females).

CONCLUSIONS

Notwithstanding the preceding findings in the studies carried out, these data are presented herein with certain reservations because the series studied is small. In addition, the part played by the climate and the effect that the ultraviolet component of sunlight may have on the conjunctivae merit additional investigation. However, the study although incomplete, proves:

1. That there exists in Puerto Rico a relatively large number of persons suffering from vitamin A deficiency.

2. That there is present in the population a chronic, latent, and subclinical stage of vitamin A subnutrition which may exhibit epidemic characteristics under intercurrent infection and the stress of existing economic and nutritional difficulties, unless measures are adopted for its control and prevention.

3. That the persistent preference shown by the people for a rice and bean diet is not contributing towards the prevention of further vitamin A deficiency.

4. That the industrialization of shark liver oil could provide, among other things, the necessary supplement of vitamin A.

5. That a campaign to raise and consume more green and leafy vegetables would be partially effective.

6. That the maintenance of a cafeteria with at least one meal of high nutritional value should be established by the government for all industrial and agricultural workers.

7. That pamphlets on nutrition from such agencies as the Bureau of Home Economics of the Department of Agriculture and Commerce should be distributed to the families of workers.

8. That priority for shipping space should be given to animal proteins, including dairy products and fats, in accordance with the recommendations of the Committee appointed by the Governor of Puerto Rico.[19]

SUMMARY

1. The majority of persons tested in a series of 267 cases showed poor dark adaptation:

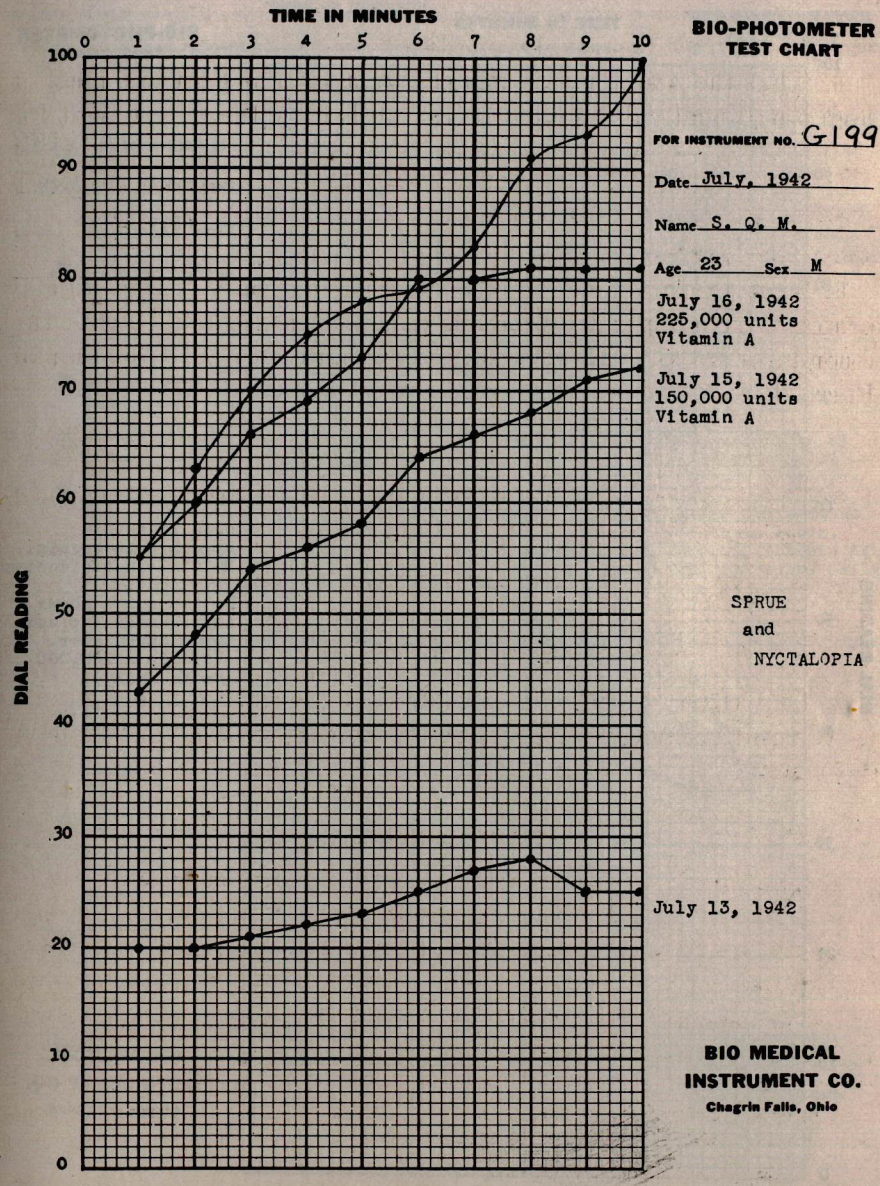
   a. Eight persons showed biophotometric curves that might be considered within normal range.
   b. Only two were absolutely normal.

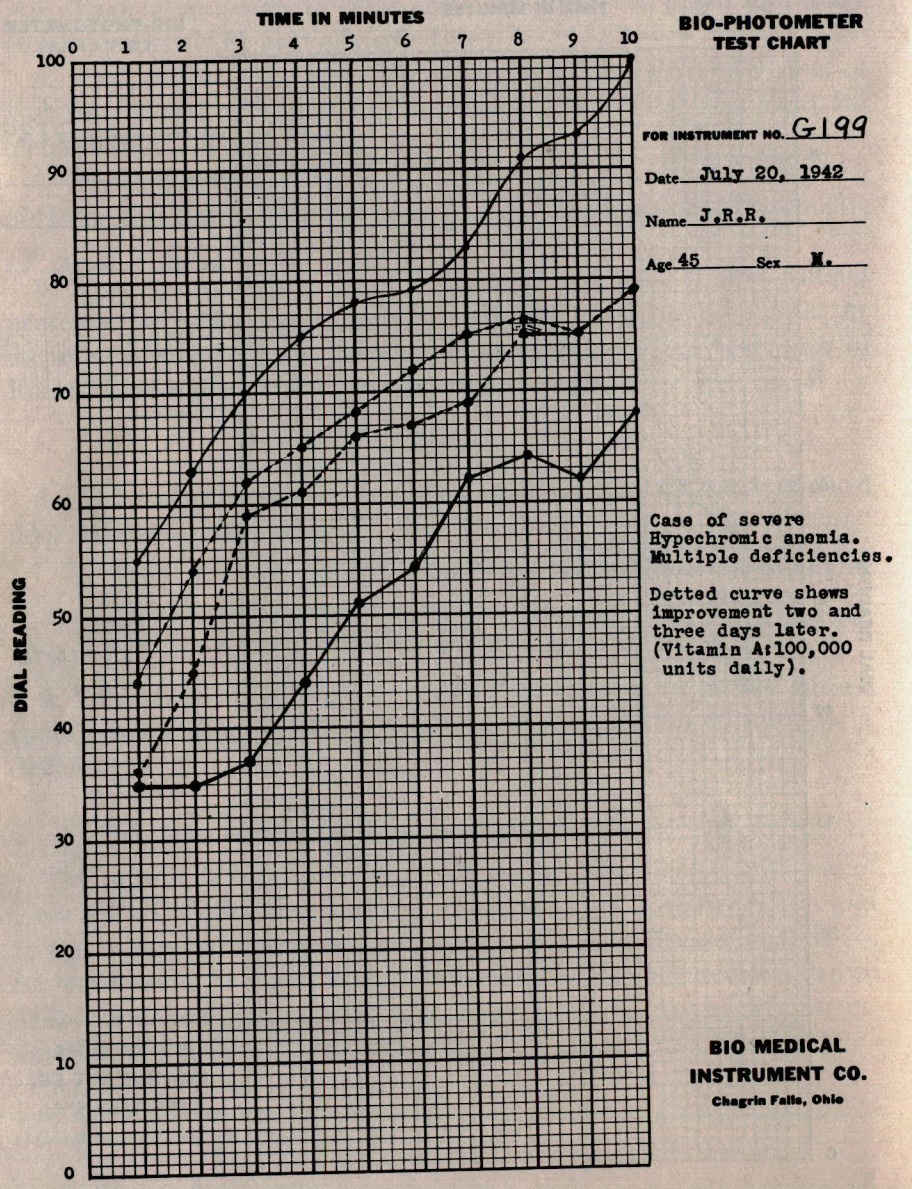
2. Of a series of 116 persons studied, 59 percent exhibited Bitot's spots besides other lesser gross ocular manifestations of vitamin A deficiency.

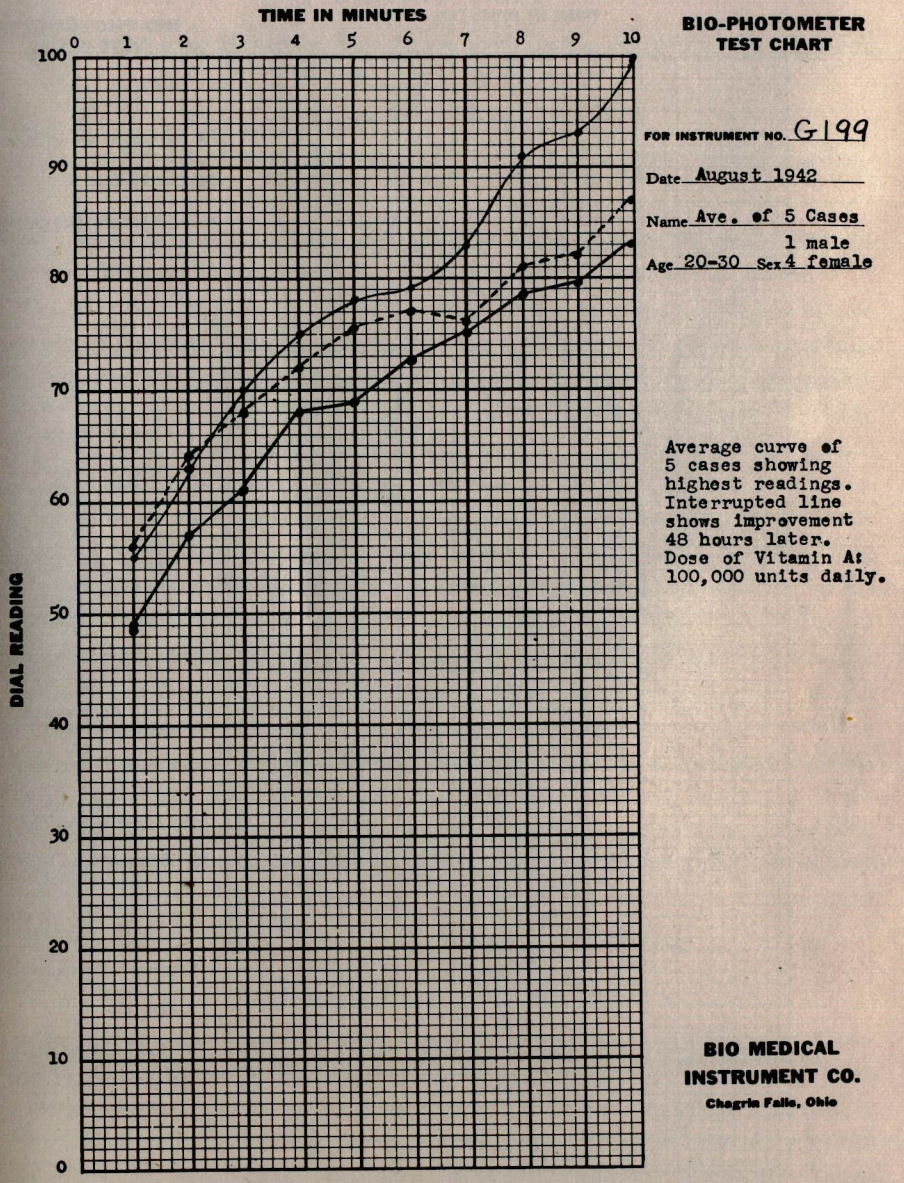
ACKNOWLEDGMENT

The author is indebted to the Winthrop Chemical Company, of New York City, for the supply of vitamin A used in these studies and to the Agricultural Experiment Station at Río Piedras, Puerto Rico, for permission to reproduce certain charts included herein; also to Miss Clemencia Benítez and Mrs. Rosario V. de Monserrate for invaluable technical assistance.

19. R. de J. Cordero, V. Medina, R. Colón Torres, R. Huyke, and S. L. Descartes, "Informe al Gobernador de Puerto Rico," *El Mundo*, July 24, 1942.




TIME IN MINUTES
0 1 2 3 4 5 6 7 8 9 10
DIAL READING
100 90 80 70 60 50 40 30 20 10 0
BIO-PHOTOMETER
TEST CHART
FOR INSTRUMENT NO. G199
Date July 20, 1942
Name J.R.R.
Age 45 Sex M.
Case of severe Hypochromic anemia. Multiple deficiencies.
Detted curve shews improvement two and three days later. (Vitamin A:100,000 units daily).
BIO MEDICAL INSTRUMENT CO.
Chagrin Falls, Ohio


TIME IN MINUTES
0 1 2 3 4 5 6 7 8 9 10
DIAL READING
100 90 80 70 60 50 40 30 20 10 0
BIO-PHOTOMETER
TEST CHART
FOR INSTRUMENT NO. G199
Date August 1942
Name Ave. of 5 Cases
1 male
Age 20-30 Sex 4 female
Average curve of 5 cases showing highest readings. Interrupted line shows improvement 48 hours later. Dose of Vitamin A: 100,000 units daily.
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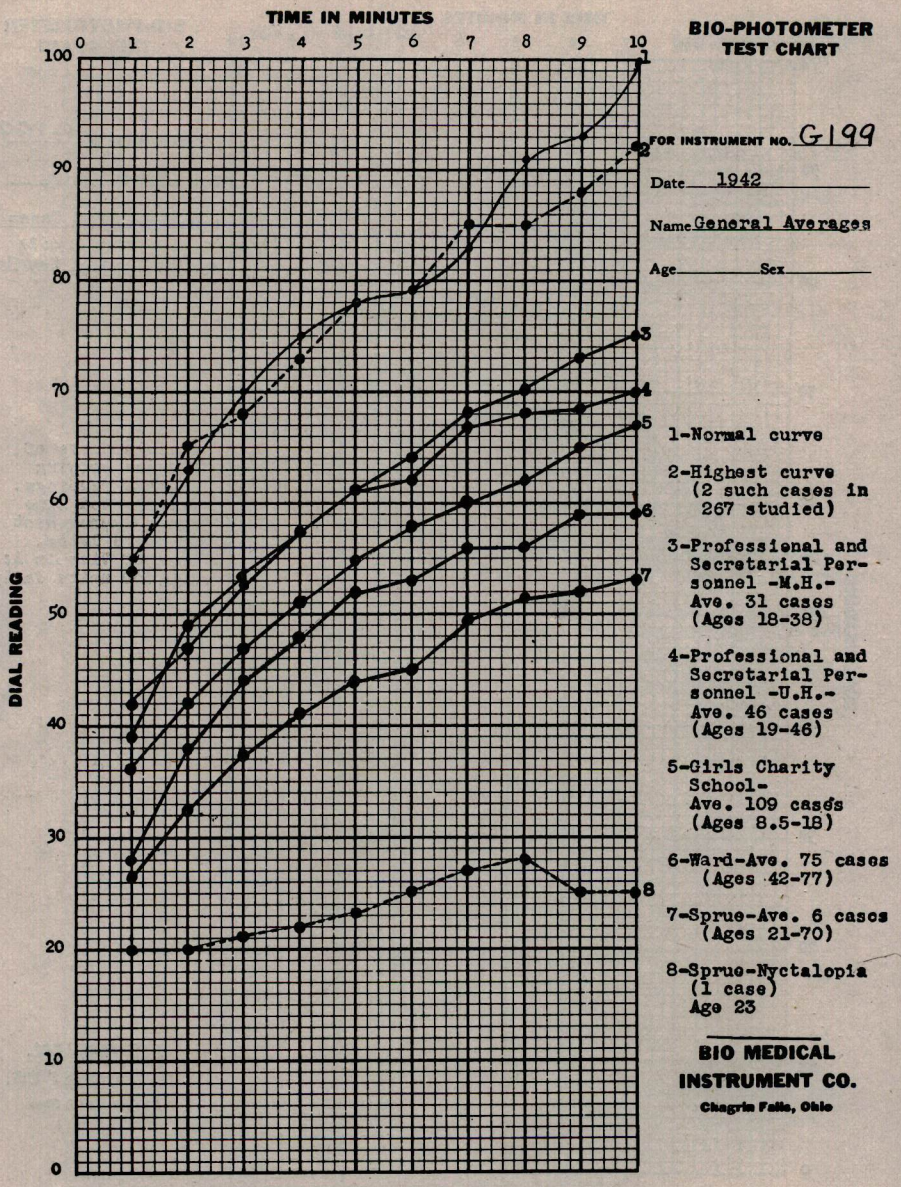
TIME IN MINUTES
0 1 2 3 4 5 6 7 8 9 10
DIAL READING
100 90 80 70 60 50 40 30 20 10 0
BIO-PHOTOMETER TEST CHART
FOR INSTRUMENT NO. G199
Date 1942
Name General Averages
Age Sex
1-Normal curve
2-Highest curve (2 such cases in 267 studied)
3-Professional and Secretarial Personnel -M.H.- Ave. 31 cases (Ages 18-38)
4-Professional and Secretarial Personnel -U.H.- Ave. 46 cases (Ages 19-46)
5-Girls Charity School- Ave. 109 cases (Ages 8.5-18)
6-Ward-Ave. 75 cases (Ages 42-77)
7-Sprue-Ave. 6 cases (Ages 21-70)
8-Sprue-Nyctalopia (1 case) Age 23
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