THE INFLUENCE OF IMPROVED DIET ON CERTAIN BLOOD CONSTITUENTS OF MEN AND WOMEN WITH ACTIVE TUBERCULOSIS

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THE INFLUENCE OF IMPROVED DIET ON CERTAIN BLOOD CONSTITUENTS OF MEN AND WOMEN WITH ACTIVE TUBERCULOSIS

By

Eva Yen-hwa Wang

AN ABSTRACT

Submitted to the School of Graduate Studies of Michigan
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THESIS ABSTRACT

The influence of an improved diet on the fasting blood content of hemoglobin, serum total protein, vitamin A, carotene, ascorbic acid and alkaline phosphatase of 19 women and 34 men with moderately advanced, and far advanced, active tuberculosis was studied.

The average daily dietary intake was calculated and the fasting blood constituents of hemoglobin, total serum protein, vitamin A, carotene, ascorbic acid and serum alkaline phosphatase were determined for each subject during a seven-day control period. Modifications were made in the regular hospital diets of the subjects so that a generous intake of nutrients was supplied to all subjects during the experimental period which lasted for four months and was divided into three periods of six weeks each. A vitamin supplement containing vitamin A, ascorbic acid, thiamine, riboflavin, and niacin was given daily during the experimental periods. At the end of each period, a seven-day food record was obtained from each patient and the dietary intake was calculated. Also at the end of each period a blood sample from each patient was analyzed for hemoglobin, serum protein, vitamin A, carotene, ascorbic acid and alkaline phosphatase.

Statistical analysis indicated that there was an increase in the concentration of hemoglobin in the blood of men and women patients with far advanced, active tuberculosis during the experimental period in comparison with the control period. Mean blood hemoglobin values of patients with moderately advanced, active tuberculosis were comparable to that of healthy adults in the control period and there was no

significant change during the experimental period. There was no change in mean serum protein values in the experimental periods as compared with the control period.

The average mean serum vitamin A values for all groups were comparable to those of healthy adults in the control period although there was wide individual variations. No difference between the control and the experimental periods was found for any group except for the women with moderately advanced, active tuberculosis; the mean serum vitamin A for women with moderately advanced, active tuberculosis was significantly higher in the experimental periods than in the control period.

The daily dietary supplement of 150 milligrams of ascorbic acid during the experimental periods resulted in a statistically significant increase of serum ascorbic acid values in comparison with the control period.

There was not a significant difference between the mean serum alkaline phosphatase values in the control period and the experimental periods for any group except for the women with moderately advanced, active tuberculosis; this group had a higher mean serum alkaline phosphatase in the control period than in the experimental periods.

There was an increase during the experimental period in the concentration of the particular blood constituent for patients who had low initial values of blood hemoglobin, serum vitamin A and/or serum ascorbic acid. There was also a reduction in serum alkaline phosphatase activity during the experimental period for those patients whose initial values were higher than for healthy adults. The concentration of the various blood constituents at the end of the experimental period was similar to that of healthy adults for all patients.

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TABLE OF CONTENTS

PAGE

LIST OF TABLES

TABLE PAGE

LIST OF TABLES - Continued

LIST OF FIGURES

THE INFLUENCE OF IMPROVED DIET ON CERTAIN BLOOD CONSTITUENTS OF MEN AND WOMEN WITH ACTIVE TUBERCULOSIS

Although a well balanced diet has long been considered an aid for the treatment of patients with active tuberculosis, few controlled studies of the relationship of diet to tuberculosis have been reported.

Different approaches to the study of nutritional status of tuberculous patients have been used in research at the Ingham County Sanatorium by the Foods and Nutrition department at Michigan State College. In a study of the dietary habits of women with active and arrested tuberculosis, Brewer and co-workers (1949) found that a high percentage of patients with active and arrested tuberculosis had average intakes of nutrients less than the amounts recommended by the Food and Nutrition Board of the National Research Council (1953). The metabolism of thiamine, riboflavin, calcium, phosphorus and nitrogen of tuberculous patients also has been reported from this laboratory. The utilization of nitrogen, phosphorus, riboflavin and thiamine by women with moderately advanced, active tuberculosis was similar to that of healthy women, but a higher calcium intake was required for calcium equilibrium by the tuberculous patients than by healthy women (Brewer, et al., 1949; 1954).

Biochemical analysis of the blood has been used as a tool for evaluation of the nutritional status of tuberculous patients by Getz and co-workers (1941, 1943, 1944). These workers observed that tuberculous patients had lower blood values for ascorbic acid, serum albumin, hemoglobin, vitamin A, carotene and serum calcium than healthy persons. Getz et al.

(1951) also studied the relation of nutrition to the development of tuberculosis over a period of five years and reported that all cases of clearly active disease occurred in persons who had markedly low blood values of vitamin A and ascorbic acid before the development of tuberculosis.

Shaw and co-workers (1950) studied the dietary intake and blood content of hemoglobin, vitamin A, carotene, ascorbic acid, alkaline phosphatase and total protein of 25 tuberculous patients and found an inverse correlation between severity of the tuberculous symptoms and the amounts of these constituents in the blood. However, there was little correlation between the food intake of the patients and blood values of vitamin A and ascorbic acid.

Although various workers have found low blood values for ascorbic acid, vitamin A, serum protein and hemoglobin among tuberculous patients, existing evidence does not indicate whether the low blood values may be associated with the disease process or whether the low blood values reflect only the nutritional status of the patients. This study was planned to investigate the possible influence of an improved diet on the amount of ascorbic acid, vitamin A, serum protein, hemoglobin and alkaline phosphatase in the blood of tuberculous patients.

REVIEW OF LITERATURE

Nutrition in tuberculosis

It is universally accepted that poor nutrition is one of the major factors in the development of tuberculosis. The well known study of Faber (1938) indicated that there was an increase in mortality from tuberculosis in Denmark following the first world war, and that the nutrient which was most generally lacking in the diet was protein.

Protein nutrition plays an important part in building resistance against infectious diseases including tuberculosis (Cannon,1945). Sako (1942) and Dubos et al. (1948) found that mice kept on low protein diets showed a marked decrease in survival time after inoculation with mammalian tubercle bacilli. The disturbance of the protein fraction in the blood of tuberculous individuals is another evidence of the relationship between protein nutrition and tuberculosis. According to Siebert et al. (1947) and Marche et al. (1950), a decrease of serum albumin is usually accompanied by a rise in serum globulin, and a lowering of the albumin-globulin ratio in serum is observed frequently in tuberculous patients. Johnston (1947) stated that the diminishing ability of the adolescent to retain nitrogen may result in the lessening of resistance to tuberculosis when the nitrogen intake is not adequate.

The inactivity of the individual at bed rest may also be a factor which influences the protein metabolism of the tuberculous patient. From nitrogen balance studies of six healthy adults at bed rest for short periods of time, Miller and co-workers (1945) concluded that bed rest alone caused a negative nitrogen balance in a healthy person even when the caloric intake was adequate and the protein intake was reasonably high. It is true that the subjects studied by Miller and co-workers were studied for only short periods of time and there was no indication whether adaptation would result after prolonged bed rest. In a study of activity in relation to the retention of nitrogen and calcium in adolescence, Johnston (1950) found that nitrogen retention of six tuberculous children without fever declined after prolonged bed rest but was improved when the children were permitted moderate activity.

McCann (1922) studied the nitrogen metabolism of tuberculous patients and found that nitrogen equilibrium occurred at about the same intake of dietary protein for moderately advanced, active tuberculous patients as for healthy persons. Similar findings were reported by Brewer et al. (1949) who recommended a daily intake of 80 grams of protein per day for women with moderately advanced, active tuberculosis as an intake which would permit some retention of nitrogen and still represent an amount of food acceptable to the patients. According to Sedgwick (1946), an intake of 85 to 125 grams of protein daily was recommended by the California State Department of Public Health for tuberculous patients. Pottenger and Pottenger (1946) advocated an even higher intake of 225 grams of protein daily for tuberculous patients.

Calcium metabolism also appears to be of particular importance in tuberculosis. Getz and co-workers (1944) reported low values of calcium and phosphorus in the blood of advanced tuberculous patients. Brewer and co-workers (1954) concluded, from their study of the calcium metabolism of six moderately advanced, active tuberculous women, that the daily calcium intake required for calcium equilibrium for tuberculous patients was greater than that required for equilibrium by healthy women. Johnston (1947, 1950) stated that the diminishing ability of the adolescent to retain calcium may result in the lessening of resistance to tuberculosis and in turn, may retard the healing of tuberculosis when the intake of calcium is not adequate.

Considerable information relative to vitamin A nutrition in tuberculosis has resulted from the studies of Getz and co-workers. Getz (1939) found that 53 percent of a group of tuberculous patients had vitamin A deficiency as measured by a biophotometer. In 1943 and 1944 he reported that vitamin A deficiency, as evidenced by low blood content, was positively related to the severity of the tuberculosis. An inverse relation between the development of tuberculosis and the blood concentration of vitamin A was reported by Getz in 1951. Recently, Getz (1954) stated that night blindness is common among tuberculous patients and that the total content of vitamin A in blood is always lowered in advanced tuberculosis, although not necessarily in minimal cases of tuberculosis. A possible explanation of low vitamin A blood values in tuberculosis may be poor adsorption of vitamin A in the intestinal tract of tuberculous patients, particularly when intestinal tuberculosis also is present. Breese, Watkins and McCoord (1942) studied 17 patients with active pulmonary tuberculosis and intestinal symptoms and found that the ability of experimental patients to absorb vitamin A was low. When a known amount of vitamin A in the form of concentrated fish liver oil was given to the patients orally, the maximum rise of vitamin A in their blood was approximately one-half that of healthy individuals. The conversion of carotene to vitamin A may be depressed in tuberculosis since Getz (1954) stated that a low content of vitamin A usually accompanied a relatively high content of carotene in the blood of tuberculous patients.

Relatively little research has been directed toward the metabolism of factors of the vitamin B complex in tuberculosis. Farber and Miller (1943) found that 25 percent of their 400 patients with active tuberculosis had riboflavin and niacin deficiencies and there appeared to be a correlation between the nutritional status of the patients and the severity of the disease. The advanced tuberculous patients frequently had multiple vitamin deficiencies such as vitamin A, vitamin K, ascorbic acid, niacin and riboflavin although thiamine deficiency was rare. Conversely, however, Higgins and Feldman (1943) found that diets which contained significantly low amounts of thiamine and riboflavin did not affect the resistance of white rats to the infection of avian tubercle bacilli. Also, Brewer et al. (1949) studied the riboflavin, thiamine and nitrogen metabolism of six women with moderately advanced, active pulmonary tuberculosis and found that the thiamine and riboflavin metabolism of the tuberculous patients was similar to that of the healthy college women. It is possible that the occurrence of riboflavin deficiency in the patients studied by Farber and Miller reflected a poor nutritional state of patients from low socio-economic levels rather than a metabolic disturbance which resulted from the disease.

A combination of vitamin C deficiency and active tuberculosis caused a significant shortening of the survival period in guinea pigs and a decrease in body weight (Greene and co-workers, 1936) from that of healthy animals. The lowering of resistance was possibly due to a reduction of phagocytic activity of blood leucocytes in vitamin C deficiency (Cottingham and Mills, 1947). According to Chiang and Lan (1940), the tuberculous patients in China had lower blood and urinary ascorbic acid values than healthy persons. These workers found also that some of the advanced cases showed evidence of diminished amounts of ascorbic acid in body tissues by saturation tests. Similar results have been found in this country; Heise _et al_. (1936) and Sweany _et al_. (1941) showed, by means of tissue saturation tests with patients with tuberculosis, that there was a correlation between severity of the disease and degree of tissue saturation with vitamin C. Kaplan and Zonnis (1940) studied ascorbic acid blood values of 240 patients with tuberculosis. They found a correlation between stage of disease and ascorbic acid in the blood. Getz _et al_. (1944) also found low blood values of ascorbic acid in tuberculous persons. However, the values they reported indicated little correlation between stage of disease and ascorbic acid deficiency. No correlation between the severity of tuberculosis and the degree of ascorbic acid deficiency was reported by Roy _et al_. (1941) and Hurford (1948). Webb and co-workers (1946) determined the blood ascorbic acid content of 150 patients with all stages of tuberculosis who were on a supplement of 100 milligrams of ascorbic acid daily. Again there was no correlation between serum content of ascorbic acid and degree of tuberculosis. With this amount of dietary

supplement, however, the average blood ascorbic acid values for all patients were well above 1.0 milligrams per 100 milliliters of serum. Brewer (1949) reported that the urinary excretion of ascorbic acid following a test dose by women with active tuberculosis was similar to that by healthy women when a dietary supplement of 100 to 300 milligrams of ascorbic acid was given daily. In contrast, the urinary excretion of a test dose of ascorbic acid by women with active tuberculosis was very low when there was no dietary supplement of ascorbic acid. Getz (1954) stated that tuberculous patients with fever had low average ascorbic acid values in the blood and that it was almost impossible to bring body tissues to the saturated state even with a large amount of ascorbic acid. He also stated that ascorbic acid has been found repeatedly in the urine of tuberculous patients in combination with various degradation materials and products of tissues destruction. A high ascorbic acid intake may therefore be necessary for the detoxification of toxic materials from the disease organisms.

Gorden and Flanders (1931) reported from a dietary survey, that tuberculous patients consumed about 1,400 calories in comparison with 2,500 calories daily for a healthy person. Brewer and co-workers (1949) studied food habits of women patients with active tuberculosis and found that the caloric intake of the patients was less than that of healthy women. Since the body weight of the tuberculous patient may decrease considerably during the development of the disease, the diet should supply enough calories to provide for weight gain for the underweight patients and also to protect the utilization of protein by all of the patients.

In general, dietary practices for the tuberculous patients have been based on studies of the food requirements of healthy people since there has not been sufficient research to support quantitative estimations of the nutritional requirements of tuberculous patients. The need for generous quantities of protein, calcium, vitamin A and ascorbic acid in the diets of tuberculous people, however, has been stressed (Getz, 1954; Brewer, 1954). Dietary allowances which have been recommended by the California State Department of Public Health for tuberculous patients include 85-125 grams of protein, 0.8 grams of calcium, 12 milligrams of iron, 5,000 International units of vitamin A, 1.5 milligrams of thiamine, 2.2 milligrams of riboflavin, 15 milligrams of niacin and 100 to 125 milligrams of ascorbic acid and an intake of 2,500 calories (Sedgwick, 1946).

Blood constituents in healthy individuals and in tuberculosis

It has been only in recent years that microchemical methods have been developed for the measurement of blood constituents. These methods have provided further information concerning the nutritional status of groups of people and have aided in the identification of cases of border line nutrition. For example, a definite relationship between the clinical picture of an early deficiency and laboratory determination of vitamin content in the blood has been reported by Ruffin, Cayer, and Perlzweig (1944). A consistently significant relationship between ascorbic acid intake and blood content was found by Putnam et al. (1949). Also, Morrow and co-workers (1952) reported that the relationship between intakes and serum values of ascorbic acid, vitamin A and carotene was highly significant. Thus, the concentration of certain substances in blood, urine and other biological fluids reflect the recent dietary intake of related dietary factors.

Hemoglobin. Hemoglobin concentration in the blood is a widely used index of nutritional status. A number of dietary components including iron, cobalt, copper, various amino acids and factors of the vitamin B complex are required simultaneously to maintain normal functioning of the hematopoietic system (Cartwright, 1947). Storvick et al. (1951) found that there was a highly significant relationship between vitamin A in the blood and the hemoglobin concentration of the blood of selected population groups of adolescents in Oregon.

Blood hemoglobin values may be affected by various factors other than diet. These include age, sex, diurnal variations, seasonal variations and socio-economic factors.

An average of 14 grams of hemoglobin per 100 milliliters of blood for adult females and 16 grams for adult males has been used as standards for healthy people (Osgood, 1935; Wintrobe, 1946; McAllister et al., 1947; Beck et al., 1951, and Megee et al., 1952). Pedly (1944) and Ohlson et al. (1944) found that the average concentration of hemoglobin for healthy college women was 13.5 grams per 100 milliliters of blood. Haworth and co-workers (1952) reported that the mean hemoglobin value was 13.58 grams per 100 milliliters of blood for young college women on an institutional diet. Sheets and co-workers (1944) found that the average hemoglobin value for men was 14.6 grams per 100 milliliters of blood and that the average hemoglobin value for women was 12.4 grams per 100 milliliters of blood in the study of hemoglobin concentration of college men and women. A lower average value of 13.5 grams of hemoglobin per 100 milliliters of blood for men and 12.7 grams of hemoglobin per 100 milliliters of blood for women was reported by Pett et al. (1948) in a study of 3,148 people in Canada.

Hemoglobin values of 10.1 to 12.0 grams per 100 milliliters of blood were considered to be indicative of moderate or slight nutritional anemia and hemoglobin concentrations below 10.0 grams per 100 milliliters were considered indicative of severe anemia by Kaucher et al. (1948).

The influence of age on hemoglobin was reported by several investigators. Guest (1938) found that infants have a high mean level of hemoglobin from birth to ten days, 19.0 grams per 100 milliliters of blood. At two months of age, the mean was only 12.1 grams, and at one year of age the mean hemoglobin value had fallen to 11.0 grams per 100 milliliters. Thereafter, the mean hemoglobin value increased. Mugrage and Andresen (1936) Mack et al. (1941) and Kaucher et al. (1948) found an increase in mean hemoglobin values for boys and girls from 11.6 grams per 100 milliliters of blood at one year to 14.5 grams per 100 milliliters of blood in the twelfth or thirteenth year. Thirteen years is the age at which hemoglobin values for males and females begin to diverge. Girls maintain relatively constant values into womenhood. Hemoglobin values for boys increase continuously to a mean concentration of 16.6 grams per 100 milliliters of blood at ages of seventeen to nineteen years.

Diurnal variations in hemoglobin were studied by Brown and Goodall (1946) who found the hemoglobin values varied as much as 1.0 grams per 100 milliliters of blood for an individual during the period between 9:00 A.M. and 6:00 P.M. The average variation during this time was 0.54 grams per 100 milliliters of blood. Johnston (1945) however found that the blood hemoglobin concentrations varied relatively little during the course of the day.

Mack et al. (1941) and Megee et al. (1952) have demonstrated that people from a higher socio-economic level tend to have higher hemoglobin concentrations than those from a lower socio-economic level.

Tuberculous patients have been found to have a lower content of hemoglobin in the blood than healthy individuals; this has been particularly true for patients with far advanced, active tuberculosis (Getz et al., 1944, 1949; Shaw et al., 1950). According to Getz et al. (1944), approximately 40 percent of the male tuberculous patients which he studied had hemoglobin values less than 12.4 grams per 100 milliliters of blood. Getz et al. (1944) also reported that statistically significant relationships were observed between hemoglobin and other blood constituents including plasma vitamin A, ascorbic acid, carotene, serum albumin, albumin-globulin ratio and serum phosphatase. Getz found too that hemoglobin values were related to the severity of tuberculosis. Thus, other nutritional deficiencies may be expected to be associated with low hemoglobin values in the tuberculous patient.

Serum protein. The range of total serum protein for healthy adults has been found to be from six to eight grams per 100 milliliters of serum.

Values for serum albumin range from 4.0 to 5.5 grams and values for serum globulin range from 2.0 to 2.5 grams (Bruckman et al., 1930; Youmans et al., 1943; Adamson et al., 1945; Milan et al., 1946). The concentration of total serum protein is influenced by the albumin and globulin content in the blood. Peters and Eisenman (1933) stated that the measurement of the total serum protein was not as significant as measurements of the serum albumin and serum globulin for evaluation of protein nutrition since, in certain diseases, an increase in serum globulin may mask a corresponding reduction in serum albumin.

In a study of 1,200 subjects, Youmans et al. (1943) found that 89 percent of the subjects with hypoalbuminemia had a concentration of total serum protein within the range from six to eight grams per 100 milliliters of serum. There was no correlation between the dietary intake of calories or protein and serum protein. This study indicated that the concentration of serum protein may be relatively constant for a long period of time even under conditions of dietary deficiency.

The disturbance of the protein fraction in the blood of a tuberculous individual was observed by Seibert et al. (1947) and Marche et al. (1950). A slight rise of gamma-globulin in the serum and a decline in serum albumin occurred in the early stages of tuberculosis. As the disease progressed the alpha-globulin fraction simultaneously increased. In the mean time, the serum albumin showed a further decrease. These changes were more intensified in far advanced tuberculosis.

There was no difference in the blood of the healthy person and the tuberculous patient as far as the total serum protein is concerned

(Getz et al., 1944; Shaw et al., 1950). However, a considerable reduction in the albumin-globulin ratio has been found in tuberculous patients. If the disease is well advanced, a decrease of total serum protein might be expected also (Getz et al., 1949).

Vitamin A and carotene. Ranges of 40 to 200 International units of vitamin A and 50 to 400 micrograms of carotene per 100 milliliters of plasma have been reported for healthy people (Kimble 1939; Abel et al., 1941; Youmans et al., 1944; Adersbery et al., 1945; Anderson and Milam, 1945; Harris et al., 1946; and Yiengst and Shock, 1949). Bessey et al. (1946) has suggested that a range of 30 to 70 micrograms of vitamin A per 100 milliliters of serum represented an adequate nutritional state with respect to vitamin A. In the interpretation of his data, Getz et al., (1944) selected 110 International units of vitamin A per 100 milliliters of plasma and 110 micrograms per 100 milliliters of plasma for carotene as "normal" values.

A sex difference in vitamin A and carotene content of the blood was reported by Kimble in 1939. In general, the average value for vitamin A in the blood of males was higher than the average value for females. The average for the males was 127 International units per 100 milliliters of plasma; the average value for the females was 91 International units per 100 milliliters of plasma. On the other hand, the average carotene content of the plasma for males, 166 micrograms per 100 milliliters, was considerably less than the average carotene content of 187 micrograms per 100 milliliters of plasma which was found for females. Sex differences in vitamin A and carotene values of the blood were reported also by Abels *et al.* (1941) and Storvick *et al.* (1951). Anderson *et al.* (1945) found that the vitamin A values in blood of negro people were less than the vitamin A values of blood of white persons of both sexes. No age differences in serum content of vitamin A were found by Yiengst (1949).

The vitamin A content of the blood is fairly stable and is not affected by the addition of small amounts of vitamin A and carotene in the diet; however, blood carotenoids decrease rapidly over a period of one week when a diet low in carotene and vitamin A is given (Brenner and Roberts ,1943). Malnourishment and febrile disorders have been associated frequently with low serum vitamin A. May and co-workers (1940) found that low blood values of both vitamin A and carotene occurred in cases of acute infection associated with fever. A positive correlation between serum vitamin A and other blood constituents such as carotene, ascorbic acid and hemoglobin was found by Storvick *et al.* (1951) in studies of selected population groups of adolescent in Oregon.

Getz *et al.* (1941, 1943) stated that in blood of recently diagnosed tuberculous patients, vitamin A was lower than in the blood of those who have been receiving treatment for some time. The percentage of tuberculous patients who had blood vitamin A values which were considered to be within a pathological range (less than 30 micrograms per 100 milliliters of serum) was greatest for the patients with far advanced, active tuberculosis and least for the group with minimal tuberculosis.

Moore (1937) found that low vitamin A values in plasma occurred in tuberculous patients with fever. But Getz (1944) stated that the average vitamin A in plasma was only slightly decreased in the tuberculous patients because of fever.

A low plasma carotene in the tuberculous patients is not often found unless the stage of the disease is far advanced. Values of carotene in the blood similar to those for healthy people may be maintained in the tuberculous patients even when the values of vitamin A in the blood are abnormally low (Getz, 1954). This condition would indicate that the ability of the body to convert carotene to vitamin A is affected.

Ascorbic acid. Much research has been done on blood ascorbic acid, and there is perhaps better knowledge of the ranges of blood ascorbic acid in health and in disease than of other vitamins. Youmans (1949) found that the concentration of ascorbic acid in blood of healthy persons was above 0.7 milligram in 100 milliliters of serum. Values in the range of 0.4 to 0.7 milligram per 100 milliliters were considered to represent borderline nutrition with respect to ascorbic acid. Values below 0.5 or 0.4 milligram per 100 milliliters of serum indicated that tissue stores of the ascorbic acid were deficient. Similar interpretations of ranges of blood ascorbic acid values have been reported by Gyorgy (1942) and Johnson (1945).

The dietary intake of ascorbic acid has been found to be related significantly to the blood content of ascorbic acid (Kyhos et al., 1944; Johnston et al. 1946; Putnam et al. 1949). A rise in serum ascorbic acid occurred immediately following a test dose of ascorbic acid; the peak value was reached about three hours after the test dose (Kyhos et al. 1944).

According to Johnston (1946), a marked change in the intake of ascorbic acid is also reflected in the fasting blood plasma ascorbic acid content in a period of only one or two weeks.

Values for ascorbic acid, vitamin A and carotenoids in the serum were significantly correlated in the study reported by Storvick et al. (1951). No correlation was found between ascorbic acid and hemoglobin concentration by McMellan et al. (1946), Moyer et al. (1948) and Storvick et al. (1951).

Low blood ascorbic acid values have been found in tuberculous patients by numerous investigators. Getz et al. (1941 and 1951) found that 75 percent of their tuberculous patients had less than 0.6 milligram of ascorbic acid in 100 milliliters of blood. In a study of 240 patients with chronic pulmonary tuberculosis, Kaplan (1940) showed a correlation between the degree of ascorbic acid deficiency and the stage of development of the disease. The average values of ascorbic acid in 100 milliliters of plasma from control, moderately advanced, active and far advanced, active tuberculous patients were 0.78 milligrams, 0.70 milligrams of 0.42 milligrams respectively. Similar results also were reported by other workers who have found that the depression of ascorbic acid in the blood of tuberculous patients was related to the severity of the disease (Hiese and Martin, 1936; Sweany et al., 1941 and Chang and Lan, 1940). According to Getz (1941), tuberculous patients who had received treatment usually had a higher content of ascorbic acid in the blood than recently diagnosed cases of tuberculosis. Webb, Storvick and Olson (1946) on the other hand, did not find that the serum content of ascorbic acid was related to the degree

or extent of tuberculosis. Kaplan (1940) found that the concentration of ascorbic acid in blood plasma in most of the patients could be raised to "normal" values by oral administration of synthetic ascorbic acid with a dosage of 200 milligrams daily from one to six months.

No significant difference in the ascorbic acid content of blood of negro and of white persons has been found in tuberculous patients (Getz, 1941). Female patients of both negro and white people showed a higher serum ascorbic acid than male patients. In regard to the overweight patients, it has been reported that 26 out of 37 subjects showed low ascorbic acid in the plasma (Getz, 1941). Low ascorbic acid values in blood were found in the tuberculous patients with fever and softening of lung tissue and it was found to be almost impossible to saturate the tissues of these patients even with large quantities of ascorbic acid (Getz, 1954).

<u>Serum alkaline phosphatase</u>. The function of serum alkaline phosphatase is the release of inorganic phosphorus from organic phosphoric acid esters (Bodansky, 1934). Robison and Soames (1924) believed that serum alkaline phosphatase was important in promoting ossification through deposition of calcium phosphate from soluble calcium salts of phosphoric ester which was present in blood. High serum alkaline phosphatase values are observed in early rickets and hypovitaminosis D, and the serum alkaline phosphatase is probably diffused from the osseous tissue (Bodansky, (1934).

The range of serum alkaline phosphatase in the human adult has been reported as 0.8 to 2.3 nitrophenol units (Bessey and Lowry, 1946) or

1.5 to 4.0 Bodansky units (Bodansky and Jaffe, 1934); in children, the range of serum alkaline phosphatase had been reported as 2.8 to 7.7 nitrophenol units (Bessey and Lowry, 1946) or five to 14 Bodansky units (Bodansky and Jaffe, 1934).

No significant change in serum alkaline phosphatase in healthy persons after 18-hour fasting and a high protein diet or a high fat diet has been found by Bessey et al. (1946). Getz et al. (1949) and Shaw et al. (1950) reported that the concentration of serum alkaline phosphatase in the blood of tuberculous patients was similar to that of healthy persons.

EXPERIMENTAL PROCEDURE

Subjects

The subjects in this study consisted of 53 hospitalized patients with active tuberculosis; thirty-one of the subjects were patients at the Ingham County Sanatorium, Lansing, Michigan and 22 were patients at the Michigan State Sanatorium, Howell, Michigan. The subjects, classified according to the degree of tuberculosis were: ten men and twelve women with moderately advanced, active tuberculosis and eight men and one woman with far advanced, active tuberculosis at the Ingham County Sanatorium; twelve men and four women with moderately advanced, active tuberculosis and four men and three women with far advanced, active tuberculosis at the Michigan State Sanatorium.

According to age and sex, the subjects were as follows: thirty-four male subjects ranging in age from 16 to 68 years and 19 female subjects from 15 to 55 years. Among 53 subjects, there were seven negroes (four males and three females) and 46 white persons. All patients who were selected as subjects had positive sputum reactions. An attempt was made to select only those patients as subjects who were expected to require sanatorium care for at least four months. Prior to the beginning of this study, streptomycin had been given to all subjects; however, four individuals were allergic to the drug and the treatment had been discontinued for them. Streptomycin was continued for the rest of the patients throughout the study. Chest x-rays were taken at three-month intervals. During this time, three subjects received thoracoplasty and lobectomies were performed on six subjects.

Experimental plan

This investigation was begun in October, 1952 at Ingham County Sanatorium and in May, 1953 at the Michigan State Sanatorium. The study was terminated in December, 1953.

A personal history of food likes and dislikes and the customary pattern of eating was obtained during the first interview with each patient. A seven-day diet record also was collected from each subject. During this seven-day period, blood samples were obtained from the subject in the fasting state for the analysis of blood hemoglobin, total serum protein, vitamin A, carotene, ascorbic acid and alkaline serum phosphatase. Thus, the food intake and blood constituents were determined for each patient on the customary hospital routine. This represented the control period for the individual patient. After the control period, modifications were made in the diet to improve the dietary intake of individual patients. All subjects were encouraged to eat all protein foods such as meat and cheese which were served on the hospital tray. One or more eggs for breakfast and at least four glasses of milk were provided for each patient daily. Vitamin tablets[1] which contained 5,000 International units of vitamin A, 1,000 International units of vitamin D, 2.5 milligrams of thiamine, 2.5 milligrams of riboflavin, 50 milligrams

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[1] Abdol, No. 218, Parke, Davis & Co., Detroit

of ascorbic acid, 20 milligrams of nicotinamide, five milligrams of pantothenic acid, 0.5 milligrams of pyridoxine, one microgram of vitamin B_{12}, and 100 milligrams of ascorbic acid were also given to each subject daily. One serving of beef liver was added to the usual hospital diet weekly throughout the study. Two subjects who could not eat meat and liver were given a protein supplement[1] and twelve milligrams of iron[2] daily. At six-week intervals, seven-day food records and fasting blood samples were obtained from each subject for a period of four months. Patients were visited by the author once a week during this time and a dietary recall record was obtained for the day previous to the visit. The medical history of each subject was examined at the end of the experimental period.

Certain irregularities developed during the process of the experiment. One of the women with moderately advanced, active tuberculosis transferred from Ingham County Sanatorium to Michigan State Sanatorium at the end of period I and another was discharged to her home in period III. Of the 15 women in this group who commenced the study, 13 continued throughout the three experimental periods.

There were four women patients with far advanced, active tuberculosis at the beginning of the investigation. One patient died immediately after period I. This was the patient who formerly had been studied at Ingham County Sanatorium as a patient with moderately advanced, active

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[1] Protenum, Mead Johnson & Co., Evansville, Ind.

[2] Ferrous sulfate, No. 7, Eli Lilly & Co., Indianapolis

tuberculosis and then transferred to Michigan State Sanatorium. When this study was initiated at Michigan State Sanatorium, the degree of tuberculous involvement for this patient was classed as far advanced. She participated again in the experiment and was studied during another control period and the first period preceding her death.

Of 22 moderately advanced, active tuberculous men patients, 16 cooperated throughout the entire study. Two of the other patients had surgical treatment in period I; one of these cooperated during period II but left the sanatorium in period III. Two patients left the sanatorium against medical advice in period II. Another patient had an operation in period II but resumed cooperation with the experiment in period III.

Of 12 men patients with far advanced, active tuberculosis, only seven were able to participate continuously until the end of this investigation. One patient had an operation in period I but rejoined the experiment in period III. Two men left the sanatorium against medical advice in period II, and two left the sanatorium against medical advice in period III.

Dietary records

The nutritive values of the diets were calculated according to the table of food values published by Donelson and Leichsenring (1951).

Blood sampling

A fasting venous blood sample was taken from the forearm of each subject by venipuncture; the blood was drawn into a syringe and then transferred to a fifteen milliliters centrifuge tube. Samples for the determination of hemoglobin were taken immediately and the remaining blood was allowed to clot for thirty minutes. The blood then was centrifuged and the serum was removed. In order to protect the ascorbic acid from possible destruction, an aliquot of serum was frozen with dry ice, taken from the hospital to the laboratory in the frozen state, and kept in frozen storage for the determination of vitamin A, carotene, ascorbic acid and serum alkaline phosphatase. Another aliquot of serum, which was not in the frozen state, was used for the determination of serum protein as soon as the serum samples reached the laboratory. Blood hemoglobin was determined within four hours after the sample was collected.

Chemical method

The blood hemoglobin values were determined by the alkaline hematin method (Sanford and Sheard, 1930) with the use of a photelometer.[1] Duplicate blood samples of twenty cubic millimeters were diluted with ten milliliters of 0.1 percent sodium carbonate in a fifty milliliter flask. The percent transmission was measured on the photelometer; the photelometer was adjusted to 100 percent transmission with distilled water.

Serum protein concentration was measured from a ten cubic millimeters serum sample by the method of Lowry and Hunter (1945) which applies the gradient principle for the measurement of specific gravity. The specific gravity of the serum was determined from a graph showing the position of rest of droplets of potassium sulfate solutions of known densities.

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[1] Cenco-Sheard-Sanford photelometer, Central Scientific Co.

The carotene and vitamin A values of the serum sample were determined by the micro-method of Bessey, Lowry and Brock (1946). The blood serum was saponified with alcoholic potassium hydroxide and the carotene and vitamin A were extracted with a mixture of one volume of kerosene and one volume of xylene. The optical density of carotene was measured at a wave length of 460 millimicrons with a spectrophotometer,[1] and the optical density of vitamin A was measured at a wave length of 328 millimicrons. The sample then was removed to a soft glass tube and irradiated under an ultra violet lamp[2] in order to destroy the spectral absorption of vitamin A at 328 millimicrons; the optical density of the irradiated solution was measured at 328 millimicrons to obtain an estimate of the compounds which interfere with vitamin A at this wave length. The concentration of carotene and vitamin A was expressed as micrograms per 100 milliliters of serum. Analyses of carotene and vitamin A were made in triplicates and 200 cubic millimeters of serum was used for each sample. Standard solutions of vitamin A acetate and beta-carotene were used to check the procedure for the determination of serum vitamin A and serum carotene respectively.

Ascorbic acid was determined by the micro-method of Lowry, Lopez and Bessey (1945, 1947). This method depends upon the quantitative development of a colored product of phenylhydrazone when dinitrophenylhydrazin reacts with oxidized ascorbic acid (dehydroascorbic acid). One hundred cubic millimeters of serum were used for each determination.

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[1] Beckman spectrophotometer, Model DU, Central Scientific Co.

[2] B-H4 lamp, General Electric Co.

The optical density of the phenylhydrazone was measured at a wave length of 520 millimicrons and the concentration of ascorbic acid in the sample was estimated from a standard curve prepared from known concentrations of ascorbic acid which were treated in a manner similar to the serum.

The activity of serum alkaline phosphatase was determined by the method of Bessey, Lowry and Brock (1946), using sodium para-nitrophenyl phosphate as the substrate for the enzyme. The optical density of the enzyme-released para-nitrophenol was measured by using a spectrophotometer[1] at a wave length of 410 millimicrons. One nitrophenol unit is defined as the amount of phosphatase activity per liter of serum which is required to liberate one millimole of nitrophenol per hour from sodium para-nitrophenyl phosphate under the specific conditions of the test. A ten cubic millimeters serum sample was used in each determination.

Clinical records

Information was obtained concerning body weight, and height, fluctuation in body temperatures and X-ray findings from the clinical records and medical histories of the patients.

[1] Beckman spectrophotometer, Model DU, Central Scientific Co.

RESULTS AND DISCUSSION

Food intake of subjects: Control period

The nutritive value of the seven-day dietary records was calculated according to the table of food values published by Donelson and Leichsenring (1951). Although the calculated values are not as accurate as determination of food value by direct chemical analyses, this method has been used satisfactorily by several nutritional research laboratories (Ohlson et al., 1948; Brewer et al., 1949; Dieckmann et al., 1951) for estimation of the food intake of groups of individuals.

The average food intake of patients from Ingham County Sanatorium was comparable to that of the patients from Michigan State Sanatorium during the control period. Statistical analyses by the Fisher "t" test indicated that there were no significant differences between the two sanatoria in the average intake of any of the calculated nutrients for either men or women patients. The comparison of the average food intake of patients from the two sanatoria is shown in Table 22 of the Appendix. On the basis of this analysis, patients from the two sanatoria were grouped together as follows: women with (a) moderately advanced, active tuberculosis and (b) far advanced, active tuberculosis; men with (a) moderately advanced, active tuberculosis and (b) far advanced, active tuberculosis.

The average food intakes of women patients with moderately, advanced and far advanced, active tuberculosis on the customary hospital routine and after modifications were made to improve the dietary intake are given in Table 1. Intakes of nutrients by the individual subjects are given in Tables 23 to 27 of the Appendix. In the control period, the average daily caloric intake for the fifteen women with moderately advanced, active tuberculosis was 1,764 calories with a range of 1,131 to 2,466 calories per day. The distribution of these patients according to the range of the food intake is presented in Table 2. There were three patients in the range from 1,000 to 1,399 calories with an average intake of 1,254 calories per day; five patients in the range from 1,400 to 1,799 with an average intake of 1,658 calories per day and six patients in the range of 1,800 to 2,199 with an average intake of 1,989 calories per day. The distribution of women patients with far advanced, active tuberculosis according to graded nutrient intakes is given in Table 3. The average daily caloric intake of the four women patients with far advanced, active tuberculosis was 1,646 calories, with a range of 1,067 to 2,556 calories. Two of these patients had daily caloric intakes in the range of 1,000 to 1,399 calories. The other two patients had daily caloric intakes of 1,823 and 2,556 calories, respectively. Caloric intakes for 17 of the women were less than the recommended allowance of 2,300 calories established by the Food and Nutrition Board of the National Research Council (1953) for a woman weighing 55 kilograms. Recently, however, dietary surveys have indicated that the recommendations for calories may be overestimated (Winter _et al._, 1945; Ohlson _et al._, 1948). Moreover, with continued bed rest, it may be difficult for the

Table 1. The Average Food Intakes of Women Patients With Active Tuberculosis

Period	Degree of Tuberculosis	No. of Subjects	Calories	Protein (gm.)	Fat (gm.)	Carbohydrate (gm.)
Control	Mod. adv.	15	1764± 90*	73± 3.2	77± 5.7	180± 8.6
	Far adv.	4	1646± 127	59± 14.4	68± 14.5	194± 42.3
I	Mod. adv.	15	1954± 114	89± 6.8	89± 5.8	180± 9.6
	Far adv.	4	1636± 306	80± 14.6	70± 15.0	177± 25.3
II	Mod. adv.	14	1865± 130	86± 6.0	89± 7.9	190± 10.5
	Far adv.	3	1819± 284	96± 11.6	78± 15.4	182± 26.2
III	Mod. adv.	13	1844± 99	82± 3.4	90± 5.8	176± 11.7
	Far adv.	3	1944± 334	112± 26.8	84± 35.3	194± 26.9

* Standard error of the mean

Table 1 continued

Calcium (gm.)	Phosphous (gm.)	Iron (mg.)	Vitamin A (I.U.)	Ascorbic Acid (mg.)	Thiamine (mg.)	Riboflavin (mg.)	Niacin (mg.)
1.22 ± 0.03	1.30 ± 0.03	8.71 ± 0.42	13742 ± 1071	101 ± 15.3	2.54 ± 0.71	3.42 ± 0.69	20.3 ± 5.33
1.00 ± 0.20	1.16 ± 0.22	9.22 ± 1.54	5613 ± 1873	116 ± 49.2	1.04 ± 0.17	1.79 ± 0.36	7.2 ± 2.25
1.61 ± 0.14	1.56 ± 0.14	9.78 ± 0.36	16520 ± 1368	228 ± 9.3	3.83 ± 0.03	5.49 ± 0.17	31.3 ± 0.54
1.07 ± 0.25	1.26 0.28	9.25 ± 2.27	16598 ± 2125	295 ± 56.7	6.12 ± 2.53	6.33 ± 1.97	34.3 ± 1.41
1.53 ± 0.10	1.60 ± 0.03	11.84 ± 0.94	15839 ± 1850	274 ± 41.1	4.61 ± 0.59	5.97 ± 0.40	35.0 ± 4.03
1.07 ± 0.28	1.30 ± 0.17	11.49 ± 2.70	14932 ± 2247	268 ± 69.2	6.36 ± 2.98	6.97 ± 2.54	33.7 ± 4.87
1.38 ± 0.02	1.47 ± 0.02	9.72 ± 0.86	12036 ± 1199	262 ± 33.7	4.39 ± 0.55	5.57 ± 0.52	35.6 ± 4.46
1.18 ± 0.20	1.53 ± 0.17	11.06 ± 2.73	12846 ± 2233	226 ± 17.6	5.95 2.26	6.35 ± 0.95	32.7 ± 6.81

Table 2

The Distribution of Women with Moderately Advanced, Active Tuberculosis, According to the Range of Food Intake

Food Intake	No. of Subject	Control Period Range	Control Period Mean	Mean for Period I	Mean for Period II	Mean for Period III
Calories	3	1000 - 1399	1254	2032	1616	1725
	5	1400 - 1799	1658	1731	1571	1630
	6	1800 - 2199	1989	1955	2037*	1973**
	1	2200 - above	2466	2831	3220	2762
Protein	1	Less than 50gms.	45	89	85	62
	2	50 - 64	57	87	68	73
	8	65 - 79	74	87	82	83*
	4	80 - above	85	94	111*	96*
Calcium	1	Less than 0.8gm.	0.52	1.34	1.33	1.07
	8	0.8 - 1.21	1.06	1.48	1.34	1.28*
	6	1.22 - above	1.56	1.81	1.86*	1.56*
Vitamin A	0	Less than 3500	-	-	-	-
	0	3500 - 4999	-	-	-	-
	15	5000 - above	13742	16520	15839*	12036**
Ascorbic acid	1	Less than 50mg.	49	182	172	170
	4	50 - 74 mg.	64	209	345	299
	6	75 - 99 mg.	86	232	267*	277**
	4	100 and above	174	254	237	234
Thiamine	1	Less than 0.8mg.	0.77	3.70	11.06	8.72
	8	0.8 - 1.19	1.00	3.68	3.25*	2.72**
	6	1.2 - above	4.89	4.05	4.58	4.44
Riboflavin	0	Less than 1.0mg.	-	-	-	-
	2	1.0 - 1.49 mg.	1.34	5.76	5.34*	4.50*
	1	1.5 - 1.99 mg.	1.74	6.43	9.25	9.52
	12	2.00 and above	3.91	5.36	5.75	5.31*

* One subject dropped out of experiment.

Table 3

The Distribution of Women with Far Advanced, Active Tuberculosis, According to the Range of Food Intake.

Food Intake	No. of Subject	Control Period		Mean for Period		
		Range	Mean	I	II	III
Calories	2	1000 - 1399	1103	1222	1261*	2613*
	0	1400 - 1799	-	-	-	-
	1	1800 - 2199	1823	1600	2005	1584
	1	2200 - above	2556	2281	2190	1735
Protein	2	Less than 50 gms.	36	50	77*	176*
	0	50 - 64	-	-	-	-
	1	65 - 79	77	98	94	73
	1	80 - above	91	122	117	86
Calcium	1	Less than 0.8	0.59	0.41	0.53	2.23
	2	0.8 - 1.21	0.96	1.14	1.26*	0.90*
	1	1.22 - above	1.50	1.58	1.43	1.23
Vitamin A	1	Less than 3500	1715	13986	12354	8923
	1	3500 - 4999	3735	19865	-	-
	2	5000 - above	8502	16271	16220	14008
Ascorbic acid	1	Less than 50 mg.	29	172	171	193
	1	50 - 74 mg.	67	414	402	253
	0	75 - 99 mg.	-	-	-	-
	2	100 and above	185	296	231*	232*
Thiamine	1	Less than 0.8	0.66	3.06	3.17*	3.59*
	1	0.8 - 1.19	0.84	3.58	-	-
	2	1.2 - above	1.33	8.92	7.9	7.12
Riboflavin	0	Less than 1.0 mg.	-	-	-	-
	2	1.0 - 1.49 mg.	1.24	4.13	3.85*	5.90*
	0	1.5 - 1.99 mg.	-	-	-	-
	2	2.00 and above	2.34	8.63	8.53	6.57

* One subject died during the experiment.

patients to consume sufficient food to provide the recommended allowance for calories for healthy individuals.

Weight, height and age data are given for the individual women subjects in Tables 28 and 29 of the Appendix. Ten of the fifteen women patients with moderately advanced, active tuberculosis were considered underweight; body weights of these subjects were ten percent or more under the average weight according to standard tables of weight in relation to height and age (Cooper, 1947). The average caloric intake of the ten underweight patients during the control period was 1,684 calories per day. The average caloric intake of the five subjects whose body weights ranged from -6 to +5 percent of standard weight was 1,844 calories per day. All of the four patients with far advanced tuberculosis were underweight. Body weights ranged from 97 to 120 pounds and the deviations from "ideal" bodyweight were -7 to -20 percent.

The average protein intake of the moderately advanced, active tuberculous women patients in this study was 73 grams with a range of 45 to 93 grams. Although the average daily protein intake compared favorably with the daily allowance recommended by the Food and Nutrition Board of the National Research Council in 1953 for women, it was somewhat less than the value of 80 grams of protein per day suggested by Brewer et al. (1949) to provide for nitrogen retention by tuberculous women patients. One patient had an intake less than 50 grams per day; daily intakes of two patients were in the range of 50 to 64 grams with an average of 57 grams; eight patients had intakes in the range of 65 to 79 grams with an average of 74 grams and four patients had intakes which were higher than 80 grams per day.

The protein intake of the four women with far advanced, active tuberculosis ranged from 32 to 91 grams per day, with an average of 59 grams. Two of the patients had protein intakes less than 50 grams per day.

The average daily calcium intake of the women patients with moderately advanced, active tuberculosis was 1.22 grams during the control period; this was similar to the calcium intake which was predicted by Brewer et al.. (1954) for calcium equilibrium of women with active tuberculosis. The range of daily calcium intake of patients in this group was from 0.52 to 1.75 grams. Nine patients had average daily intakes less than 1.22 grams of calcium per day. One of these patients had an intake of only 0.52 grams calcium per day. The range of daily calcium intake for the four women with far advanced tuberculosis was from 0.59 to 1.50 grams, with an average of 1.16 grams. Two patients had calcium intakes less than 1.22 grams per day, with an average of 1.16 grams. The patient who had the lowest calcium intake (0.59 grams per day) drank no milk.

The average daily phosphorus intake of the patients was 1.30 grams with a range from 0.75 to 1.80 grams. Brewer and co-workers (1954) found that 1.38 grams of phosphorus daily provided for phosphorus equilibrium for women with moderately advanced, active tuberculosis; this amount is usually supplied by a diet which is adequate in protein and calcium. Intakes of seven patients in this study were less than 1.38 grams phosphorus per day. The range of phosphorus intake for the women with far advanced tuberculosis was 0.70 to 1.33 grams, with an average of 1.16 grams per day.

No studies of the iron metabolism of tuberculous patients have been found in the literature. Estimations of the iron requirement of tuberculous patients thus have been based on recommendations for healthy people and the intakes required for the maintenance of adequate amounts of hemoglobin in the blood of the patients. The average daily iron intake for the women with moderately advanced, active tuberculosis was 6.71 milligrams. Only one patient had a daily iron intake over 12.00 milligrams which is the allowance for iron recommended by the Food and Nutrition Board of the National Research Council for healthy women (weight, 55 kilograms). In comparison with this allowance, the average iron intake of the patients was considered to be low. The iron intake of three of the women with far advanced, active tuberculosis also was low. The average for this group was 9.22 milligrams per day. One patient however had a daily intake of 13.30 milligrams.

A daily allowance of 5,000 International units of vitamin A has been recommended by the Food and Nutrition Board of the National Research Council for diets of healthy men and women. The accumulation of data in the literature which indicate a disturbance of vitamin A metabolism in tuberculosis indicates also that the vitamin A requirement for tuberculous patients is considerably higher than for healthy persons, although quantitative requirements have not been established. The average intake of the women with moderately advanced, active tuberculosis was 13,742 International units, with a range of 8,765 to 21,472 International units daily. The highest daily vitamin A intake of 21,472 International units resulted because one of the subjects received a vitamin supplement which

contained vitamin A. Thus, the average intake was more than twice the recommended daily allowance for healthy people. The average daily vitamin A intake of women with far advanced, active tuberculosis was lower than for the women with moderately advanced, active tuberculosis. The average daily intake of vitamin A for the far advanced tuberculous patients was 5,613 International Units, with a range of 1,715 to 10,332 International units. There were two patients with relatively low intakes of 1,715 and 3,735 International units of vitamin A per day, respectively.

The average daily ascorbic acid intake of the patients in the control period was 101 milligrams with a range of 49 to 288 milligrams. The average daily ascorbic acid intake was similar to the ascorbic acid intake recommended by Webb et al. (1946) but less than the amount (average of 200 milligrams) which was suggested by Brewer et al. (1949) as a desirable supplement to the hospital diet for women with active tuberculosis. One patient had an ascorbic acid intake which was less than 50 milligrams per day; four patients had daily intakes in the range of 50 to 75 milligrams of ascorbic acid; six patients had ascorbic acid intakes of 75 to 99 milligrams and four patients had intakes which were more than 100 milligrams per day. One patient with far advanced tuberculosis had an ascorbic acid intake of only 29 milligrams per day. This patient did not accept citrous fruits or other fruits which supply appreciable amounts of ascorbic acid. Since the patient was a recent admission to the sanatorium, the physician had not prescribed an ascorbic acid supplement so that she might be used as a subject for this study. One woman with far advanced, active tuberculosis had an average daily intake of 67 milligrams. The other two patients in this group had average daily intakes which were higher than 100 milligrams.

The average thiamine intake of the women patients with moderately advanced, active tuberculosis was 2.54 milligrams with a range of 0.77 to 8.74 milligrams. The higher thiamine intakes represented the dietary intakes of patients who received vitamin supplements. One patient had a daily thiamine intake which was less than 0.8 milligrams; eight patients had thiamine intakes which were in the range of 0.8 to 1.19 milligrams and six patients had more than 1.2 milligrams of thiamine per day. One patient with far advanced tuberculosis had an intake of only 0.66 milligrams per day; one woman had an intake of 0.84 milligrams and the other two patients with far advanced tuberculosis had 1.33 milligrams or more per day. There are insufficient data in the literature to provide an estimate for the thiamine requirement of tuberculous patients. Brewer and co-workers (1949) reported that the metabolism of thiamine by tuberculous women was found to be similar to that of healthy women. From that it would appear that an intake equivalent to or slightly above that of the requirement for healthy women should be adequate for the tuberculous patient.

The riboflavin intake of the women with moderately advanced, active tuberculosis averaged 3.42 milligrams with a range of 0.86 to 3.93 milligrams per day. Only three of the fifteen patients had intakes which were less than 2.00 milligrams of riboflavin daily. Brewer et al. (1949)

reported that an intake of 2.6 milligrams appeared to be adequate for women with moderately advanced, active tuberculosis. Six of the fifteen patients had intakes of 2.6 milligrams per day or more. Two of the women patients with far advanced tuberculosis had intakes of 2.6 milligrams or more per day. One patient received only 0.8 milligrams and another patient with far advanced, active tuberculosis had an average daily intake of 1.49 milligrams of riboflavin.

The average daily niacin intake for the women with far advanced, active tuberculosis ranged from 1.2 to 12.0 milligrams with an average of 7.2 milligrams. This was considerably lower than the intake of the women with moderately advanced, active tuberculosis which averaged 20.3 milligrams per day, and was also less than the allowance of 12 milligrams per day which has been recommended by the Food and Nutrition Board of the National Research Council (1953) for a healthy woman, twenty-five years of age, and weighing 55 kilograms.

Few studies of the nutritional requirements of men with tuberculosis have been found in the literature. Evaluation of the adequacy of the diets of tuberculous men who acted as subjects in this study has been made on the basis of the recommended allowances of the Food and Nutrition Board of the National Research Council (1953) with the realization that additional amounts of protein, calcium, ascorbic acid and vitamin A are desirable for tuberculous patients.

The average food intakes of men patients with moderately advanced and far advanced, active tuberculosis in the control and experimental periods are given in Table 4. Intakes of nutrients by the individual subjects are given in Tables 30 to 33 of the Appendix. The distribution

Table 4. Average Daily Food Intake of Men With Active Tuberculosis In Control and Experimental Periods

Period	Degree of Tuberculosis	No. of Subjects	Calories	Protein (gm)	Fat (gm)	Carbohydrate (gm)
Control	Mod. adv.	22	2071± 131*	89± 3.8	99± 7.4	206± 9.4
	Far adv.	12	1748± 123	79± 6.0	76± 6.4	184± 10.8
I	Mod. adv.	20	2037± 30	89± 4.4	87± 5.8	207± 77.3
	Far adv.	11	1978± 108	86± 4.9	92± 5.5	191± 15.3
II	Mod. adv.	19	2039± 83	89± 3.7	96± 6.3	199± 10.0
	Far adv.	9	2042± 119	90± 7.0	94± 5.6	205± 12.6
III	Mod. adv.	18	1952± 105	86± 5.0	95± 7.0	197± 10.9
	Far adv.	8	1797± 159	82± 9.2	83± 8.0	188± 18.9

* Standard error of the mean

Table 4 - Continued

Calcium (gm)	Phosphorus (gm)	Iron (mg)	Vitamin A I.U.	Ascorbic Acid (mg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)
1.59± 0.10	1.61± 0.03	10.48± 0.63	7293± 1144	75± 8.3	1.71± 0.35	3.00± 0.33	14.1± 2.71
1.31± 0.16	1.40± 0.14	10.71± 0.94	7917± 242	76± 5.1	1.15± 0.08	2.54± 0.46	10.7± 0.74
1.76± 0.17	1.72± 0.10	11.26± 0.71	13,173± 1542	207± 4.4	3.70± 0.10	5.10± 0.20	29.1± 0.45
1.62± 0.16	1.70± 0.12	10.25± 0.35	13,462± 1040	224± 6.1	3.78± 0.06	5.36± 0.25	31.0± 0.48
1.87± 0.90	1.96± 0.17	13.67± 1.45	14,662± 921	214± 6.0	3.80± 0.14	5.55± 0.20	29.6± 0.99
1.66± 0.17	1.75± 0.14	10.68± 0.42	13,166± 2087	209± 7.5	3.78± 0.08	5.20± 0.40	31.4± 0.57
1.65± 0.14	1.66± 0.10	12.45± 1.18	11,583± 886	206± 4.3	3.68± 0.10	5.29± 0.25	30.4± 0.06
1.49± 0.22	1.66± 0.17	10.15± 1.27	11,797± 1125	228± 5.8	3.99± 0.33	4.91± 0.40	30.2± 0.88

of the patients according to graded intakes of nutrients is given in Tables 5 and 6.

The average daily caloric intake of 22 men with moderately advanced, active tuberculosis during the control period was 2,071 calories, with a range of 1,340 to 2,961 calories. There were two patients whose caloric intakes were in the range of 1,000 to 1,399 calories with an average of 1,288 calories. Four patients had an average daily caloric intake of 1,624 calories, with a range of 1,400 to 1,799 calories; eight patients had an average daily caloric intake of 1,972 calories, with a range of 1,800 to 2,199 calories. The other eight patients in this group had daily caloric intakes above 2,200 calories.

The average daily caloric intake for the 12 men with far advanced, active tuberculosis was 1,748 calories, with a range of 1,035 to 2,647 calories. Ten of the 12 patients had caloric intakes less than 2,200 calories per day (Table 6).

Weight, height and age data are given for the individual male subjects in Tables 35 and 36 of the Appendix. Ten of the 22 men patients with moderately advanced, active tuberculosis were evaluated to be underweight. The average caloric intake of these ten patients in the control period was 1,925 calories per day. The 12 subjects whose bodyweights ranged from -9 to +16 percent of "ideal" weight had an average intake of 2,217 calories per day. Nine of the 12 men with far advanced, active tuberculosis were considered underweight; the average caloric intake of these subjects was 1,391 calories per day during the control period. The average caloric intake of the three subjects whose bodyweights ranged

Table 5

The Distribution of Men with Moderately Advanced, Active Tuberculosis According to the Range of Food Intake

Nutrient	No. of Subject	Control Period Range	Control Period Mean	Mean for Experimental Period I	II	III
Calories	2	1000-1399	1268	1635	1721*	1745*
	4	1400-1799	1624	1861*	2033*	1795*
	8	1800-2199	1972	2019	1834*	1892**
	8	2200-above	2586	2270*	2261	2081
Protein	1	Less than 60 gms	57	71	--*	--*
	4	60-74 gms	67	79	82*	74
	7	75-89 gms	84	83*	85	84**
	10	90-above	105	99*	95*	92*
Calcium	0	Less than 0.8 gms	—	--	--	--
	6	0.8-1.21 gms	1.07	1.38	1.37**	1.14**
	16	1.22-above	2.05	2.17**	2.23*	1.94**
Vitamin A	2	Less than 3500 I.U.	3118	8015	9472	7717
	6	3500-4999 I.U.	4151	14,946*	17,326*	13,429**
	14	5000-above	9242	13,592*	14,416**	11,612**
Ascorbic acid	5	Less than 50 mg.	40	193	186*	194*
	9	50-74 mg.	63	209	197*	185*
	5	75-99 mg.	85	216*	263	216**
	3	100 and above	157	216*	209*	219
Thiamine	1	Less than 0.8 mg.	0.58	3.65	3.72	3.66
	8	0.8-1.19 mg.	1.07	3.45*	3.88*	3.52**
	13	1.2-above	2.19	3.85*	3.44**	3.75**
Riboflavin	0	Less than 1.0 mg.	--	--	--	--
	1	1.0-1.49 mg.	1.48	4.39	--*	--*
	0	1.5-1.99 mg.	--	--	--	--
	21	2.00 and above	3.06	5.43**	5.55**	5.29***

* Subjects dropped out of experiment

Table 6

The Distribution of Men With Far Advanced, Active Tuberculosis According to the Range of Food Intake

Food Intake	No. of Subject	Control Period Range	Control Period Mean	Mean For Experimental Period I	II	III
Caloric	1	1000-1399	1035	1985	1791	--*
	8	1400-1799	1617	1829*	1944***	1753**
	1	1800-2199	2006	1720	1707	1400
	2	2200-above	2496	2625	2583	2467*
Protein	2	Less than 60 gms	49	91	58*	--**
	5	60-74	70	76*	66*	73
	3	75-89	81	80	86*	81*
	2	90-above	126	117	117	125*
Calcium	1	Less than 0.8	0.62	1.78	1.33	--*
	7	0.8-1.21	1.10	1.40*	1.53***	1.39**
	4	1.22-above	1.65	1.92	1.87	1.67*
Vitamin A	1	Less than 3500	2571	10,084	10,129	--*
	1	3500-4999	4247	6,186	9,740	9,102
	10	5000-above	8619	14,649*	14,090***	12,182***
Ascorbic acid	1	Less than 50 mg	39	194	193	--*
	4	50-74 mg	66	169*	99**	174*
	5	75-99 mg	80	221	219*	219*
	2	100 and above	103	241	210	249*
Thiamine	1	Less than 0.8	0.67	3.54	3.39	--*
	6	0.8-1.19	1.00	3.73*	3.70***	3.56**
	5	1.2-above	1.41	3.88	3.91	4.43*
Riboflavin	1	Less than 1.0 mg	0.86	--*	--*	5.32
	1	1.0-1.49 mg	1.16	5.51	4.00	--*
	3	1.5-1.99 mg	1.79	5.11	5.37*	4.34*
	7	2.00 and above	3.30	5.45	4.58*	3.61**

* Subjects dropped out of experiment

from -4 to +8 percent of "ideal" weight was 2,105 calories per day.

The protein intake of the male patients with moderately advanced, active tuberculosis during the control period ranged from 57 to 116 grams per day; the average was 89 grams per day. Only one patient had a protein intake less than 60 grams per day. Four patients had protein intakes which ranged from 60 to 74 grams per day and seven patients had protein intakes within the range of 75 to 89 grams per day. Ten patients had daily protein intakes which were above 90 grams. Only two of the 12 men with far advanced, active tuberculosis had protein intakes above 90 grams per day. One patient had a very low intake of 43 grams per day; nine of the 12 men had protein intakes within the range of 50 to 89 grams per day. An intake of 65 grams of protein per day has been recommended as an allowance for healthy men weighing 65 kilograms by the Food and Nutrition Board of the National Research Council (1953). Getz (1949) suggested an intake of 90 grams of protein per day for tuberculous men.

Six of the men with moderately advanced, active tuberculosis had calcium intakes less than 1.21 grams per day. The average for the entire group was 1.59 grams per day, with a range of 0.85 to 3.17 grams per day. The calcium intakes of the men with far advanced, active tuberculosis was less than that of the men with moderately advanced, active tuberculosis. The average intake for this group was 1.31 grams of calcium, with a range of 0.62 to 2.45 grams per day. Eight of the patients had intakes less than 1.21 grams of calcium per day.

The average daily phosphorus intake for the men patients with moderately advanced, active tuberculosis was 1.61 grams with a range from 0.95 to 2.53 grams. The range of daily phosphorus intake for the far advanced, active tuberculous men patients was from 0.77 to 2.38 grams with an average of 1.40 grams.

The iron intake of the men with moderately advanced, active tuberculosis ranged from 4.49 to 16.30 milligrams per day; the iron intake of the men with far advanced, active tuberculosis ranged from 6.11 to 18.50 milligrams per day. Nine of the men with moderately advanced, active tuberculosis had intakes less than the average intake for the group which was 10.48 milligrams per day, and six of the men with far advanced, active tuberculosis had intakes less than 10.71 milligrams, which was the average iron intake for that group. Seventy-two percent of the men with moderately advanced, active tuberculosis and 75 percent of the men with far advanced, active tuberculosis had iron intakes less than the intake of 12 milligrams per day which has been recommended by the Food and Nutrition Board of the National Research Council for healthy men (1953).

There was a wide range of intake of vitamin A for the tuberculous men. The average for men with moderately advanced, active tuberculosis was 7,293 International Units, with a range of 4,016 to 28,269 International Units of vitamin A per day. Six of these patients had intakes less than 5,000 International Units of vitamin A per day. The range of vitamin A intake for the men with far advanced, active tuberculosis was 2,571 to 13,495 International Units per day, with an average intake of 7,917 International Units. Only two of the twelve patients, however, had intakes which were less than 5,000 International Units per day.

The average daily ascorbic acid intake for men with moderately advanced, active tuberculosis was 75 milligrams with a range of 33 to 186 milligrams per day. Only three of the 22 patients were in the upper range of ascorbic acid intake, that is, with intakes above 100 milligrams of ascorbic acid per day. Five of the patients had ascorbic acid intakes which were less than 50 milligrams per day.

Only two of the men with far advanced, active tuberculosis had intakes of ascorbic acid above 100 milligrams per day. Five patients had daily intakes less than 75 milligrams of ascorbic acid. The average for the group was 76 milligrams, with a range of 39 to 105 milligrams of ascorbic acid per day.

Nine men with moderately advanced, active tuberculosis had thiamine intakes less than 1.2 milligrams per day. The average for the group, 1.7 milligrams per day, appeared to be high since one of the men received a vitamin supplement which contained thiamine. The range of thiamine intake for the group was from 0.58 to 8.55 milligrams per day. Seven of the men with far advanced tuberculosis had thiamine intakes which were less than 1.2 milligrams per day. The average for the group was 1.15 milligrams with a range of 0.67 to 1.73 milligrams of thiamine per day. The intake allowance for thiamine for a healthy man with a bodyweight of 65 kilograms and an age of 25 years which has been recommended by the Food and Nutrition Board of the National Research Council (1953) is 1.6 milligrams per day. There is no evidence that there is an increased requirement by tuberculous patients. If this amount is used as a basis for evaluation of the adequacy of the diets of these patients, it would appear that about 79 percent of the men with active tuberculosis had intakes of thiamine which were inadequate, during the control period.

The average daily riboflavin intake was 3.00 milligrams, with a range of 1.46 to 4.04 milligrams. The relatively high riboflavin intakes resulted from a high consumption of milk. All of the patients in this group had daily riboflavin intakes above 2.00 milligrams except for one patient whose riboflavin intake was 1.50 milligrams per day. One male patient with far advanced, active tuberculosis had an average daily riboflavin intake of only 0.86 milligrams during the control period. One patient had 1.16 milligrams of riboflavin per day. Three patients had riboflavin intakes within the range of 1.50 to 2.00 milligrams per day and seven of the patients received 2.00 milligrams or more per day. The average for the group was 2.54 milligrams, with a range of 0.86 to 6.73 milligrams of riboflavin per day.

The daily intake of niacin for the moderately advanced, active tuberculous men patients ranged from 4.4 to 69.8 milligrams with an average of 14.1 milligrams. For the far advanced, active tuberculous men, the average daily niacin intake was 10.7 milligrams with a range from 6.5 to 17.1 milligrams. The average niacin intakes of both groups were less than the allowance of 16 milligrams per day which has been recommended by the Food and Nutrition Board of the National Research Council (1953) for healthy men, 25 years of age, and weighing 65 kilograms.

Blood constituents: Control period.

The average concentration of the blood constituents of women and men with moderately advanced and far advanced, active tuberculosis in the control period are given in Table 7. Individual values for the blood constituents are presented in the Appendix in Tables 37 to 46.

The average blood hemoglobin concentration of the 15 women patients with moderately advanced, active tuberculosis was 13.60 grams per 100 milliliters of blood with a range of 11.25 to 16.00 grams per 100 milliliters of blood. The range of values compared favorably with the range reported by Ohlson and co-workers (1944) for healthy college women, that is, 11.08 to 15.72 grams per 100 milliliters of blood. Blood hemoglobin values for the women with far advanced, active tuberculosis were somewhat lower. The average for this group was 11.88 grams per 100 milliliters of blood, with a range of 11.25 to 12.50 grams. Values for the four women with far advanced, active tuberculosis, however, all were within the range of values reported by Ohlson et al. (1944) for healthy college women.

The correlation coefficient between blood hemoglobin and the calculated iron intake of the tuberculous women in the control period was 0.015. This was not statistically significant. The correlation coefficient between blood hemoglobin and the calculated protein intake of the tuberculous women in the control period was 0.154. There was not a statistically significant relationship between blood hemoglobin and dietary protein.

Concentrations of total serum protein in the blood of the women with moderately advanced, and far advanced, active tuberculosis all were within the range of six to eight grams per 100 milliliters of serum, which has been considered a satisfactory range of serum protein for healthy

Table 7

The Average Blood Constituents of Women and Men With Active Tuberculosis in the Control Period

Subjects	No. of Subjects	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mcg/100 ml.	Serum Carotene mcg/100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
Women with moderately advanced active tuberculosis	15	13.60±0.14*	6.63±0.10	33±3.41	100±10.64	0.93±0.10	2.12±0.20
Women with far advanced active tuberculosis	4	11.88±0.36	6.64±0.10	38±2.48	165±72.24	0.78±0.22	1.78±0.17
Men with moderately advanced, active tuberculosis	22	15.64±1.11	6.88±0.14	44±2.15	90±7.20	0.68±0.10	1.51±0.14
Men with far advanced, active tuberculosis	12	14.13±0.60	7.13±0.13	52±5.15	108±14.55	0.48±0.05	2.35±0.26

people by various investigators (Bruckman et al., 1930; Youmans et al., 1943; Adamson et al., 1945; and Milan et al., 1946).

The average serum vitamin A concentration for the women with moderately advanced, active tuberculosis was 33 micrograms per 100 milliliters of serum, with a range of 11 to 59 micrograms per 100 milliliters of serum. Six out of the 15 women in this group had serum vitamin A values less than 30 micrograms per 100 milliliters of serum, the amount suggested by Bessey et al. (1946) as an adequate concentration of vitamin A in the serum of healthy persons. The average vitamin A intake of these women was estimated by dietary calculation to be 12,647 International units (range, 2,821 to 28,369 International units) per day. None of the four women with far advanced, active tuberculosis had serum vitamin A values less than 30 micrograms per 100 milliliters of serum.

The women with moderately advanced, active tuberculosis had an average serum carotene concentration of 100 micrograms per 100 milliliters of serum with a range of 42 to 208 micrograms per 100 milliliters of serum. Since the serum carotene concentration is not significant without reference to the concentration of vitamin A in the serum, the concentration of serum carotene is therefore necessarily evaluated in comparison with the serum vitamin A concentration. The average serum carotene concentration was 76 micrograms per 100 milliliters of serum for the six moderately advanced, active tuberculous women patients whose serum vitamin A concentration was less than 30 micrograms per 100 milliliters of serum. One of the six patients had a low serum carotene of 42 micrograms per 100 milliliters of serum. The other five had serum carotene values (range, 68 to 101 micrograms) within the range of 50 to 400 micrograms per 100 milliliters of plasma which was found by various investigators (Kimble, 1939; Abel *et al.*, 1941; Adersbery *et al.*, 1945; Anderson and Milam, 1945; Harris *et al.*, 1946; and Hengst and Shock, 1945) for healthy people. The average serum carotene concentration of the far advanced, active tuberculosis was 165 micrograms per 100 milliliters of serum with a range from 60 to 374 micrograms per 100 milliliters of serum. One patient, Subject HU had a relatively high concentration of 374 micrograms carotene per 100 milliliters of serum and a relatively low vitamin A concentration of 32 micrograms per 100 milliliters of serum. This was the only patient in this group whose serum values of carotene and vitamin A indicated that there may have been a disturbance of the mechanism for conversion of carotene to vitamin A.

The average serum ascorbic acid value for the women with moderately advanced, active tuberculosis was 0.93 milligrams per 100 milliliters of serum, with a range of 0.28 to 1.73 milligrams per 100 milliliters of serum. Two of the 15 patients had serum ascorbic acid values less than 0.50 milligrams per 100 milliliters of serum, and two of the patients had serum ascorbic acid values which were within the range of 0.50 to 0.70 milligrams per 100 milliliters of serum. Thus, 26 percent of this group had serum ascorbic acid values less than the concentration which is usually associated with adequate ascorbic acid nutrition, that is, 0.70 milligrams per 100 milliliters of serum (Gyorgy, 1942 and Johnson, 1945). One woman with far advanced, active tuberculosis had a serum ascorbic acid value of only 0.28 milligrams per 100 milliliters. This patient had received an average intake of 29 milligrams of ascorbic acid per day during the control period. One of the four patients had serum ascorbic acid values within the range of 0.50 to 0.70 milligrams per 100 milliliters of serum; two patients had serum ascorbic acid values above 0.70 milligrams per 100 milliliters of serum. The average for the four women was 0.78 milligrams of ascorbic acid per 100 milliliters of serum.

The correlation coefficient between serum ascorbic acid and ascorbic acid intake for the tuberculous women during the control period was 0.473. This was statistically significant ($P \leq 0.05$).

Bessey and Lowry (1946) suggested that concentrations of serum alkaline phosphatase up to 2.30 nitrophenol units per 100 milliliters of serum were satisfactory for healthy individuals. Six of the 15 women patients with moderately advanced, active tuberculosis had serum alkaline phosphatase values which were greater than 2.30 nitrophenol units, but all of the values were within the range of 0.90 to 3.40 nitrophenol units. Since there have been relatively few studies of serum alkaline phosphatase in disease conditions other than rickets, and since it is relatively difficult to compare measurements of enzyme activity from one laboratory to another, it is difficult to interpret the significance of the values which were above 2.30 nitrophenol units. Macy and co-workers (1954) have reported that the average alkaline phosphatase concentration of non-pregnant white women was 1.36 nitrophenol units which was slightly lower than the average of 2.12 nitrophenol units for moderately advanced, active tuberculous women in this study. All four of the women with far advanced, active tuberculosis had serum alkaline phosphatase values which were less than 2.30 nitrophenol units per 100 milliliters of serum. The average was 1.78 nitrophenol units.

There was a wide range of blood hemoglobin concentrations among the tuberculous men. The range of values for men with moderately advanced, active tuberculosis was from 12.50 to 19.60 grams per 100 milliliters of blood with an average of 15.64 grams per 100 milliliters of blood. The range of blood hemoglobin values for the men with far advanced, active tuberculosis was from 12.00 to 18.50 grams per 100 milliliters of blood, with an average of 14.14 grams. The correlation coefficient between blood hemoglobin and the calculated iron intake of the tuberculous men during the control period was 0.269. This was not statistically significant. There also was not a significant relationship between blood hemoglobin and dietary protein (correlation coefficient, 0.297).

The concentrations of total serum protein for men with moderately advanced and far advanced, active tuberculosis were within the range of six to eight grams per 100 milliliters of serum for all but two of the men with moderately advanced, active tuberculosis. Values for these two patients were 5.17 and 8.10 grams per 100 milliliters of serum, respectively.

Only two men with moderately advanced, active tuberculosis and one man with far advanced, active tuberculosis had serum vitamin A values which were less than 30 micrograms per 100 milliliters. The calculated vitamin A intakes of these men ranged from 2,821 to 28,369 International Units per day. The average serum vitamin A for the group of men with moderately advanced, active tuberculosis was 44 micrograms per 100 milliliters of serum with a range of 26 to 77 micrograms. The average serum vitamin A for the men with far advanced, active tuberculosis was 52 micrograms per 100 milliliters, with a range of 19 to 78 micrograms per 100 milliliters.

In general, the men patients had lower serum carotene values than the women patients. The average concentration of carotene values in the serum of the men with moderately advanced, active tuberculosis was 90 micrograms with a range of 31 to 130 micrograms per 100 milliliters. Two patients, SE and M.Y, who had low serum vitamin A values (26 and 29 micrograms per 100 milliliters of serum) also had relatively low serum carotene values of 103 and 31 micrograms of carotene per 100 milliliters of serum, respectively. Serum carotene values for men with far advanced, active tuberculosis averaged 108 micrograms, with a range of 34 to 192 micrograms per 100 milliliters. Subject B.H who had a low serum vitamin A value of 19 micrograms per 100 milliliters of serum also had a low serum carotene value (34 micrograms per 100 milliliters of serum).

Serum ascorbic acid values for the men also were lower than for the women. The average serum ascorbic acid of the men with moderately advanced, active tuberculosis was 0.68 milligrams per 100 milliliters of serum and the range of values was from 0.08 to 1.94 milligrams per 100 milliliters. Fifteen of the 22 men had serum ascorbic acid values less than 0.70 milligrams per 100 milliliters of serum. Eleven of the 12 men with far advanced, active tuberculosis had serum ascorbic acid values less than 0.70 milligrams per 100 milliliters of serum. The average value for this group was only 0.48 milligrams per 100 milliliters of serum, and the range of values was from 0.25 to 0.76 milligrams.

There was a statistically significant relationship between the calculated dietary intake of ascorbic acid and the serum ascorbic acid during the control period. The correlation coefficient was 0.375 (P _ 0.05).

Three of the men with moderately advanced, active tuberculosis and five of the men with far advanced, active tuberculosis had serum alkaline phosphatase values which were above 2.30 nitrophenol units.

Recommended dietary modifications

The range of higher intakes of the various nutrients in the diets of both men and women patients indicated that an adequate amount of the essential nutrients was supplied in the diets of the two sanatoria, in so far as the diets could be judged by available information concerning requirements in tuberculosis and the results of the blood analyses during the control period. The lower intakes of various nutrients by certain of the patients probably can be attributed to rejection of food because of individual food likes and dislikes. It was felt that this could be improved by encouragement and education. The low blood values for ascorbic acid, vitamin A and carotene which were obtained for some of the patients indicated that an increased intake of these nutrients was desirable.

Modifications in the diet were therefore recommended to each of the subjects with the support and cooperation of the medical director and the dietitian of the two sanatoria. These modifications which were described in the previous section were planned to (a) provide adequate protein in the diet; each patient was asked to eat all meat, fish, poultry and eggs which were served on the hospital tray, (b) increase the iron intake; one or more eggs for breakfast and one serving of beef liver weekly was added to the usual hospital diet, (c) maintain the adequate amount of calcium and phosphorus in the diet; four glasses of milk or more were provided for each patient daily, (d) assure the daily intake of vitamins; one vitamin tablet[1] and 100 milligrams of ascorbic acid were given to each patient daily for the three experimental periods, (e) supply adequate calories to provide for gains in weight for the underweight patients; underweight patients were encouraged to eat all of the food that was served to them.

Influence of improved diet on food intake

Evaluation of the dietary intakes for each experimental period has been made from the calculated food intakes of the seven-day diet records which were obtained at the end of each period. The one day dietary recall records which were collected each week were evaluated to indicate how carefully the patients followed the dietary regime, and to provide a basis for advising the patients during the experiment. Dietary intakes estimated from the recall diets were not included in the estimates of average intakes of the patients for the three experimental periods.

The average daily food intakes of the women with moderately advanced, active tuberculosis in the control and in the three experimental periods were given in Table 1, and the graded intakes of the nutrients were given

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[1] Abdol, No. 218, Parke, Davis & Co., Detroit.

in the Table 2. The average daily caloric intake of the women in this group was 1,954 calories for period I, 1,865 calories for period II and 1,844 calories for period III, in comparison with an average intake of 1,764 calories in the control period. The cooperation of the patients throughout the entire study was quite good and those patients who were in the lowest range of caloric intakes in the control period had the highest increase in daily caloric intakes. Subjects MO and HS limited the amount of fat and carbohydrate foods in the diet to prevent further gain in weight, and subjects MCO and FA did not accept the dietary regime in periods II and III as well as in period I. Subject DCO had thoracoplasty once in period II, and twice in period III. Subject AS had lobectomy in period II. Subject LA had asthma during periods II and III. Lower caloric intakes for these patients occurred during these periods. For these reasons, the average caloric intake was lower for the entire group during periods II and III than in period I.

Six of the ten women patients who were underweight (-10 percent or more of desirable weight) at the beginning of the study were still underweight at the end of the study although there was an average gain in weight of eight pounds per patient. The average daily caloric intakes of the ten women were 2,173, 1,760, and 1,862 calories in periods I, II and III, respectively, in comparison with an average daily intake of 1,684 calories in the control period. Only one person in this group was considered to be 20 percent less than the average weight for her age and height at the end of the study whereas six of the patients were at least 20 percent underweight at the beginning of the study. Weight losses were observed for two of the patients; these losses in weight may be explained in part at least by the fact that it was necessary for the patients to have surgical treatment during the study. Gains in weight for the group ranged from two to 26 pounds during the experimental periods.

Two of the women in this group did not complete the three experimental periods. Subject KN was discharged to her home after period II and subject MU transferred from the Ingham County Sanatorium to the Michigan State Sanatorium at the end of period I. When this study was initiated at the Michigan State Sanatorium five months later, the patient again was selected as a subject. At this time the degree of tuberculosis was classed as far advanced.

The average daily food intakes of the women with far advanced, active tuberculosis in the control and in the three experimental periods were given in Table 1, and the graded intakes of the nutrients were given in Table 3. The average daily caloric intakes were1,636 calories for period I, 2,190 calories for period II and 1,944 calories for period III in comparison with an average of 1,646 calories in the control period. Subject HO had a gastro-intestinal disturbance during period I. Her caloric intake was only 856 calories per day; for this reason, the average daily caloric intake in this group was less in period I than in the control period. Subject ME who had an average intake of 2,556 calories per day in the control period desired to control her body weight by reducing the quantity of fat and carbohydrate in the diet and the average intakes in the experimental periods were less for this subject than in the

control period. Subject RO decreased her caloric intake from 2,005 calories in period II to 1,584 calories in period III. Subject HU, who had an infection between the lobectomic spaces, lost five pounds during the first six weeks and died after period I. The body weight of the other three patients increased from ten to seventeen pounds during the four-month period, although two of the subjects, RO and HO still were underweight for their height and age at the end of the study. The average daily caloric intakes of these three patients were 1,662, 1,819 and 1,977 in periods I, II and III, respectively.

The average daily protein intakes of the women with moderately advanced, active tuberculosis were 89, 86 and 82 grams for periods I, II and III, respectively, as compared with an average of 73 grams per day in the control period. Data for the individual subjects indicated that three of the 13 women who completed the experiment had protein intakes which averaged 80 grams or more per day for the three experimental periods. Average protein intakes of eight of the women were from five to 31 grams of protein lower in period III than in period I. Subject EH who had the lowest protein intake (45 grams per day) during the control period was able to increase her protein intake to 69 grams for period I, maintain it at 65 grams for period II but reduced it to 62 grams for period III. The sharp reduction in protein intake in the period III resulted because this subject was excited about going home the following month and could not eat.

Two of the women with far advanced, active tuberculosis had protein intakes which averaged less than 50 grams during the control period.

One of these two patients, Subject HU, died at the end of the period I. Subject HO who had a daily protein intake of 39 grams during the control period was given a protein supplement[1] during periods II and III. Average protein intakes for this subject were 33, 77 and 176 grams of protein per day for periods I, II and III, respectively. There was an increase in protein intake during periods I and II for subjects HO and ME but in both cases the protein intake during period III was less than in the control period.

The average daily calcium intake of the women with moderately advanced, active tuberculosis was 1.61 grams for period I, 1.53 grams for period II, and 1.38 grams for period III as compared with an average intake of 1.22 grams of calcium per day during the control period. The reduction in average calcium intake during periods II and III followed a pattern corresponding to the reduction in protein intake. However, seven of the 13 women who completed the experiment had calcium intakes above 1.22 grams per day in all three experimental periods.

Of the three women with far advanced, active tuberculosis who completed the experiment, only one, Subject ME, had a calcium intake which exceeded the intake of 1.22 grams per day which was predicted by Brewer et al. (1954) for calcium equilibrium for women with moderately advanced, active tuberculosis. Subject HO who had an intake of only 0.59 grams calcium per day in the control period had an even lower intake of 0.41 grams per day during period I and 0.53 grams per day during period II. The calcium intake of the patient, however, was increased to 2.23 grams

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[1] Protenum, Mead Johnson & Co., Evansville, Ind.

per day for the period III since a large amount of milk was combined with the protein supplement[1] for the patient in period III.

Mean daily intakes of phosphorus were 1.56, 1.60 and 1.47 grams in periods I, II and III, respectively, for women with moderately advanced, active tuberculosis and 1.26, 1.30 and 1.53 grams in the periods I, II and III, respectively, for the women with far advanced, active tuberculosis. There was a marked increase of the daily intake of this nutrient in the experimental periods as compared with the average daily intake in the control period of 1.30 grams for women with moderately advanced, active tuberculosis and 1.10 grams for women with far advanced, active tuberculosis.

Average daily iron intakes in periods I, II and III were 9.78, 11.84 and 9.72 milligrams for the moderately advanced, active tuberculous women patients, and 9.25, 11.49 and 11.06 milligrams for the patients with far advanced, active tuberculosis. An increase of iron intake was shown in the experimental periods as compared with the average intake in the control period of 8.71 milligrams for women with moderately advanced, active tuberculosis and 9.22 milligrams for women with far advanced, active tuberculosis.

Average daily vitamin A intakes for the moderately advanced, active tuberculous women patients were 16,520, 15,839 and 12,036 International units in periods I, II and III, in comparison with the average daily vitamin A intake of 13,742 International units in the control

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[1] Protenum, Mead Johnson & Co., Evansville, Ind.

period. The average vitamin A intake in the control period was weighted by the dietary supplement[1] which one patient received and which supplied vitamin A. There was a marked increase in the average vitamin A intake in period I for the women with far advanced, active tuberculosis. The average daily vitamin A intakes were 16,598, 14,932 and 12,846 International units for the three successive experimental periods as compared with an average intake of 5,613 International units per day during the control period. The high averages in periods I and II were influenced by the vitamin A intake of subject KO who had three vitamin tablets[1] per day, prescribed for her by the physician, during those two periods. Average intakes of ascorbic acid, thiamine, riboflavin and niacin also were influenced in periods I and II by the intakes of additional vitamins by this patient since the vitamin tablet was multi-vitamin.

Mean daily ascorbic acid intakes for the women with moderately advanced, active tuberculosis were increased to 228, 274 and 262 milligrams in the three successive experimental periods from an average intake of 101 milligrams in the control period. The high ascorbic acid intakes in periods I and II were influenced by the additional ascorbic acid supplement prescribed for two subjects after surgical treatment. The average ascorbic acid intakes from food sources alone in the three successive experimental periods were 78, 124 and 112 milligrams.

The average daily ascorbic acid intakes in the three successive experimental periods were 295, 268 and 226 milligrams for the women with

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[1] Abdol, No. 218, Parke, Davis & Co., Detroit.

far advanced, active tuberculosis. Subject MO had an additional supplement of 100 milligrams ascorbic acid from vitamin tablets[1] during periods I and II by direction of the physician. During period III, however, this patient received the same ascorbic acid supplement as the other subjects. Subject HO who had a low ascorbic acid intake of 29 milligrams per day during the control period increased her daily intake to values of 172, 171 and 193 milligrams in the three successive experimental periods. This increase was due to dietary supplement, however, since the average daily ascorbic acid intakes of this patient from food sources alone were 22, 21 and 43 milligrams for period I, II and III, respectively. Two subjects, ME and MU, had decreased ascorbic acid intakes from food sources during the experimental periods.

The diets supplied liberal amounts of thiamine throughout the study. Women with moderately advanced, active tuberculosis had average daily thiamine intakes of 3.83, 4.61 and 4.39 milligrams in period I, II and III, respectively, in comparison with 2.54 milligrams in the control period. For the women with far advanced, active tuberculosis, the average daily intakes of thiamine for the three successive experimental periods were 6.12, 6.36 and 5.95 milligrams in comparison with 1.04 milligrams in the control period.

The average daily intakes of riboflavin for the moderately advanced, active tuberculous women were 5.49, 5.97 and 5.57 milligrams in the three successive experimental periods. For the far advanced, active tuberculous

[1] Abdol, No. 218, Parke, Davis & Co., Detroit.

women patients, the average daily intakes of riboflavin in the three successive experimental periods were 6.33, 6.97 and 6.35 milligrams. In the experimental periods, all individual daily intakes of riboflavin exceeded 2.60 milligrams which has been recommended by Brewer et al. (1949) for moderately advanced, active tuberculous women. The average daily intake of riboflavin was higher in the experimental periods than in the control period.

Average daily niacin intakes in the control period and three successive experimental periods were 20.3, 31.3, 35.0 and 35.6 milligrams for the moderately advanced, active tuberculous women and 7.2, 34.3, 33.7 and 32.7 milligrams for the far advanced, active tuberculous women patients respectively.

Analysis of variance was carried out to determine whether or not statistically significant changes occurred between the food intake of the women with active tuberculosis in the control period and the experimental period. A summary of the analysis of variance is given in Table 6.

The average intakes of protein, thiamine, riboflavin and niacin were significantly higher in the experimental period than in the control period for the women patients in both groups. The intake of calories and ascorbic acid also was higher for women with moderately advanced, active tuberculosis in the experimental period than in the control period. The limited number of subjects in the group of women with far advanced, active tuberculosis and the wide variations in calories and ascorbic acid intakes of those patients may explain the fact that significant differences

Table 8

Summary of Analysis of Variance of Food Intake for Women With Active Tuberculosis Between Control and Experimental Periods

Source of Variation	F Value Obtained	Predicted F 0.05	F 0.01
Moderately Advanced Tuberculosis			
Calories	6.40**	3.17	5.01
Protein	154.00**		
Fat	1.35		
Carbohydrate	1.34		
Calcium	1.41		
Phosphorus	0.21		
Iron	2.12		
Vitamin A	0.24		
Ascorbic acid	8.13**		
Thiamine	3.90*		
Riboflavin	8.35**		
Niacin	4.40**		
Far Advanced Tuberculosis			
Calories	0.87	3.98	7.20
Protein	11.78**		
Fat	0.15		
Carbohydrate	0.40		
Calcium	0.03		
Phosphorus	0.03		
Iron	0.45		
Vitamin A	7.34**		
Ascorbic acid	3.30		
Thiamine	4.79*		
Riboflavin	4.00*		
Niacin	10.37**		

between the caloric and ascorbic acid intakes of the control period and period I were not obtained for this group.

The vitamin A intake of the women with far advanced, active tuberculosis was significantly higher in the experimental period than in the control period. This was not true for the women with moderately advanced, active tuberculosis, probably because five of the women had vitamin A intakes which exceeded 15,000 International Units in the control period.

The average daily food intakes of the men with moderately advanced, active tuberculosis in the control and in the three experimental periods were given in Table 4, and the graded intakes of the nutrients were given in Table 5.

There was considerable variation in the caloric intakes of the male patients with moderately advanced, active tuberculosis. Average daily caloric intakes of these patients in the three experimental periods were 2,037, 2,039 and 1,952 calories respectively. These caloric intakes were less than the average daily intake of 2,071 calories in the control period. However, those patients who were in the lowest range of caloric intake in the control period had a consistent increase in daily caloric intake throughout the study. Eight of the patients who had daily caloric intakes above 2200 calories in the control period had caloric intakes which were less than that of the control period in one or more of the experimental periods. Four subjects in this group did not complete the study.

Four of the eighteen men patients who completed the study were still underweight at the termination of the experiment. Weight gains for the entire group ranged from one to 19 pounds during the four-month period. Only one patient was considered overweight at the end of the four-month period; his body-weight was 20 percent above the average for his height and age.

The average daily food intakes of the men with far advanced, active tuberculosis in the control and in the three experimental periods were given in Table 4, and the graded intakes of the nutrients were given in Table 6.

The average daily caloric intake of far advanced, active tuberculous men patients increased from 1,748 calories in the control period to 1,978 calories in period I, to 2,042 calories in period II and then decreased to 1,797 calories in period III. Ten of the twelve subjects had an increase in caloric intake during period I. Of the eight who completed the experiment, only one, subject KI, had caloric intake which was consistently higher in the three experimental periods than in the control period. Three subjects had decreased caloric intakes in periods II and III and the other three subjects had lower caloric intakes only during period III. Subject BER, who received surgical treatment during periods I and II, was able to increase his caloric intake for period III above that of the control period. However, he weighed five pounds less at the end of the experiment than at the beginning. In spite of this case, gains in body weight for the seven patients who completed the experiment ranged from one to 14 pounds. Four of these seven patients were still underweight at the end of the experimental period.

Variations in protein intakes similar to these in caloric intake were observed for the men with moderately advanced, active tuberculosis. The average daily protein intakes for these patients in the three successive experimental periods were 89, 89 and 86 grams respectively. These values were similar to the average daily protein intake of 89 grams in the control period. Only five subjects consumed 90 grams or more of protein in each of three experimental periods.

The average daily protein intake for the far advanced, active tuberculous men were 88, 90 and 82 grams for the three successive experimental periods, in comparison with an average intake of 79 grams per day during the control period. There was considerable individual variation in protein intake during the experimental period. Only three subjects had protein intakes which were consistently higher in periods I, II and III than in the control period. Two subjects increased their protein intakes above that of the control period in period I and II but had a lowered intake in period III.

Average daily calcium intakes for the moderately advanced, active tuberculous men were 1.76, 1.87 and 1.65 grams in the three successive experimental periods, in comparison with 1.59 grams in the control period. For men with far advanced, active tuberculosis, the average daily calcium intakes were 1.62, 1.66 and 1.49 grams in the three successive experimental periods, in comparison with 1.31 grams in the control period. Both groups showed an increase in the average daily intake of calcium in each experimental period above that of the control period. At the end of the study, 72 percent of the men with moderately advanced, active

tuberculosis and 75 percent of the men with far advanced, active tuberculosis had daily calcium intakes above 1.22 grams.

The average daily intakes of phosphorus for the men with moderately advanced, active tuberculosis were 1.72, 1.96 and 1.66 grams in the three successive experimental periods and 1.61 grams in the control period. The average daily intakes of phosphorus for the men with far advanced, active tuberculosis were 1.70, 1.75 and 1.66 grams for periods I, II and III, respectively and 1.40 grams in the control period. The low average intakes of phosphorus in period III corresponded for both groups to the reduced caloric, protein and calcium intakes which occurred in period III.

The mean intake of iron by the men with moderately advanced, active tuberculosis was higher during the experimental periods than during the control period. The average daily intake for periods I, II and III were 11.26, 13.67 and 12.45 milligrams of iron in comparison with an average intake of 10.48 milligrams of iron in the control period. The average iron intakes in periods II and III were weighted by the iron provided as dietary supplement for four patients in period II and three patients in period III. The ferrous sulfate supplement[1] was prescribed by the physician for subjects HA and LA. Subjects HA and SC were not willing to eat liver and did not like eggs. Therefore additional iron was prescribed for them also.

The average daily iron intakes of the men with far advanced, active tuberculosis were 10.25, 10.68 and 10.15 milligrams in the three

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[1] Ferrous sulfate, No. 7, Eli Lilly & Co., Indianapolis.

successive experimental periods. These values were similar to the average daily iron intake of 10.71 milligrams in the control period.

The mean vitamin A intakes in the three successive experimental periods were 13,173, 14,662 and 11,583 International units per day for men with moderately advanced, active tuberculosis in comparison with a mean intake of 7,293 International units per day in the control period. Of the 18 subjects who completed the three periods of this experiment, 15 of the subjects had an increase in vitamin A intake for periods I, II and III in contrast to the intake for the control period. Seven of the subjects had higher vitamin A intakes in periods I and II than in the control period but a lower vitamin A intake in period III. The average amounts of vitamin A obtained from food sources alone for the control period and periods I, II and III were 6,615, 8,173, 9,662 and 6,783 International units of vitamin A per day, respectively.

The mean daily vitamin A intakes of all but two of the male patients with far advanced, active tuberculosis who completed the experiment were higher in the experimental periods than in the control period. The average daily vitamin A intakes were 7,917, 13,462, 13,166 and 11,797 International units of vitamin A for the control period and periods I, II and III, respectively. The average amounts of vitamin A from natural food sources were 8,462, 8,166 and 6,797 for period I, II and III, respectively.

Mean daily ascorbic acid intakes for the men with moderately advanced, active tuberculosis were 207, 214 and 208 milligrams in periods I, II and III in comparison with an average intake of 75 milligrams per day in the control period. The amounts of ascorbic acid which were obtained from natural food sources were 64, 57, 64 and 58 milligrams per day respectively for control period, periods I, II and III. Ascorbic acid intakes of all of the men in this group who completed the three experimental periods were greater than the average intake during the control period.

The average daily ascorbic acid intakes for men with far advanced, active tuberculosis were 224, 209 and 228 milligrams in periods I, II and III and 76 milligrams in the control period. The ascorbic acid from natural food sources averaged 74, 59 and 78 milligrams per day for the three successive experimental periods respectively. Thus the ascorbic acid supplement provided for the patients resulted in significant increases in ascorbic acid intake although the ascorbic acid intake from natural food did not increase.

The average daily thiamine intakes in periods I, II and III were 3.70, 3.80 and 3.68 milligrams for the men with moderately advanced, active tuberculosis and 1.71 milligrams per day in the control period. The amounts of thiamine from natural food in the three experimental periods and control period were 1.20, 1.30, 1.66 and 1.37 milligrams respectively.

The average daily thiamine intakesfor the far advanced, active tuberculous men were increased to 3.76, 3.78 and 3.99 milligrams in the three successive experimental periods from an average intake of 1.15 milligrams per day in the control period. The actual amount of thiamine supplied by natural food was 1.26, 1.23 and 1.49 milligrams per day for period I, II and III respectively. These values were higher than the average daily thiamine intake of 1.15 milligrams in the control period and indicated that the patients consumed a better diet with respect to thiamine during the experimental periods.

Mean riboflavin intakes from natural food sources only were 2.60, 3.05 and 2.79 milligrams in the three successive experimental periods, and 2.83 in the control period for men with moderately advanced, active tuberculosis. The average total riboflavin intakes were 5.10, 5.55 and 5.29 milligrams per day in periods I, II and III. Thus the total riboflavin intake was generous throughout the experimental periods.

The average daily riboflavin intakes for the far advanced, active tuberculous men were 5.36, 5.20 and 4.91 milligrams in the three successive experimental periods. The amounts of riboflavin from natural food sources were 2.86, 2.70 and 2.41 milligrams per day respectively in these periods, and 2.54 milligrams per day in the control period. The reduction of average daily riboflavin intake from natural food sources in period III corresponded to the reduction of protein and calcium intakes in this period.

The average daily niacin intakes for the men with moderately advanced, active tuberculosis were 29.1, 29.6 and 30.4 milligrams in the three successive experimental periods. The average daily niacin intakes (without vitamin supplement) were 9.1, 9.6 and 10.4 milligrams and 11.4 milligrams in the control period.

For the far advanced, active tuberculous men, the mean daily niacin intakes were 31.0, 31.4 and 30.2 milligrams in the three successive experimental periods. When the intakes were calculated without the addition of the vitamin supplements, the average daily niacin intakes for the three successive experimental periods were 11.0, 11.4 and 10.2 milligrams and 10.7 in the control period.

The summary of the statistical comparison by analysis of variance of the food intakes of the men with active tuberculosis in the control period and the experimental period is given in Table 9. The average daily intakes of all vitamins were significantly higher in the experimental periods than in the control period for men with both moderately advanced, and far advanced, active tuberculosis. There was not a significant difference in the average daily intake of the other nutrients between the experimental periods and the control period. The lack of a significant change for protein, calcium and phosphorus intakes may be explained by the fact that no attempt was made to increase the intake of these nutrients for those patients whose intake of protein, calcium and phosphorus appeared adequate in the control period, in so far as evidence was available to indicate the nutritional requirements of tuberculous men. Encouragement was given the patients, however, to maintain an adequate intake of these nutrients throughout the four month period.

<u>Influence of Improved Diet on Blood Constituents</u>

<u>Blood Hemoglobin</u>: The average hemoglobin concentration in the blood of the moderately advanced, active tuberculous women patients was 13.60 grams per 100 milliliters of blood in the control period and 13.68, 13.91 and 14.35 grams per 100 milliliters of blood in the three successive experimental periods. For the far advanced, active tuberculous women patients, the average blood hemoglobin concentration with a value of

Table 9

Summary of Analysis of Variance of Food Intake for Men With Active Tuberculosis Between Control and Experimental Periods

Source of Variation	F Value Obtained	Predicted F 0.05	Predicted F 0.01
Moderately Advanced Men			
Calories	0.12	3.11	4.88
Protein	0.02		
Fat	0.09		
Carbohydrate	0.06		
Calcium	0.32		
Phosphorus	0.65		
Iron	1.49		
Vitamin A	11.44**		
Ascorbic acid	183.24**		
Thiamine	35.56**		
Riboflavin	30.69**		
Niacin	60.40**		
Far Advanced Men			
Calories	1.04	3.25	5.21
Protein	0.51		
Fat	2.05		
Carbohydrate	0.25		
Calcium	1.16		
Phosphorus	1.65		
Iron	0.08		
Vitamin A	4.40**		
Ascorbic acid	201.21**		
Thiamine	138.63**		
Riboflavin	19.30**		
Niacin	235.17**		

11.88 grams per 100 milliliters of blood was considerably lower than the hemoglobin concentration for the moderately advanced, active tuberculous women in the control period but the concentration increased to 12.61, 14.75 and 13.88 grams of hemoglobin per 100 milliliters of blood in the three experimental periods. These data are summarized in Table 10. The average hemoglobin value for moderately advanced, active tuberculous women patients was higher than for the far advanced, active tuberculous women patients throughout the study except in period II.

Data were treated statistically by analysis of variance to determine whether or not the improvements in diet of the patients during the experimental periods may have influenced the hemoglobin values of the subjects. A summary of the analysis of variance for hemoglobin and for the other blood constituents is presented in Table 11. Since the average hemoglobin concentration for the moderately advanced, active tuberculous women was comparable to that of healthy women in the control period, it is not surprising that the averages of hemoglobin values between means of the control and experimental periods for this group were not significantly different. The results indicated that blood hemoglobin concentrations of the tuberculous women can be maintained at values comparable to those of healthy women for a four-month period by a good diet.

The average hemoglobin concentration in the blood of women with far advanced, active tuberculosis was significantly higher in the three experimental periods than in the control period ($P \leq 0.05$). This indicated that the modifications in the diet were effective in increasing the concentration of hemoglobin in the blood of patients with far

Table 10

Average Fasting Blood Constituents of Women Patients With Active Tuberculosis In Control and Experimental Period

Period	Degree of Tubercu-losis	No. of Subjects	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mcg/100 ml.	Serum Carotene mcg/100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
Control	Mod. adv.	15	13.60±0.14*	6.83±0.10	33±3.41	100±10.64	0.93±0.10	2.12±0.20
	Far adv.	4	11.88±0.36	6.64±0.10	38±2.48	165±72.24	0.78±0.22	1.78±0.17
I	Mod. adv.	15	13.68±0.39	6.75±0.10	47±5.72	116±9.88	1.12±0.10	1.48±0.18
	Far adv.	4	12.81±0.10	7.18±0.30	37±5.95	117±37.54	1.30±0.10	1.87±0.14
II	Mod. adv.	14	13.91±0.24	6.60±0.14	42±6.81	105±10.94	1.42±0.06	1.26±0.14
	Far adv.	3	14.75±0.25	6.86±0.10	45±5.23	45±19.18	1.60±0.14	1.95±0.20
III	Mod. adv.	13	14.35±0.28	6.71±0.12	45±3.62	106±11.40	1.50±0.10	1.41±0.18
	Far adv.	3	13.88±0.07	7.06±0.05	63±12.65	91±18.21	1.79±0.00	1.56±0.14

* Standard error of the mean

Table 11

Summary of Analysis of Variance of Blood Constituents for Women Patients With Active Tuberculosis Between Control And Experimental Periods

Source of Variance	F Value Obtained	Predicted F 0.05	Predicted F 0.01
Moderately Advanced Women			
Hemoglobin	0.40	3.17	5.01
Serum protein	0.30		
Vitamin A	3.67*		
Carotene	3.87*		
Ascorbic acid	6.13**		
Phosphatase	6.63**		
Far Advanced Women			
Hemoglobin	6.13*	3.98	7.20
Serum protein	0.85		
Vitamin A	0.47		
Carotene	1.08		
Ascorbic acid	6.83**		
Phosphatase	0.00		

advanced, active tuberculosis from a value which initially was less than the average hemoglobin concentration of healthy women to an average value comparable to that of healthy women (Ohlson, 1944).

The average hemoglobin value of men patients with moderately advanced, active tuberculosis in the control period was 15.64 grams per 100 milliliters of blood (Table 12); this value was similar to the average concentration of 15.40 grams per 100 milliliters of blood which was reported by Getz et al. (1944) from a study of 97 male tuberculous subjects. The average hemoglobin values for the three experimental periods were 16.19, 16.20 and 16.68 grams per 100 milliliters of blood. The average hemoglobin concentration of men with far advanced, active tuberculosis was 14.13 grams per 100 milliliters of blood in the control period and 14.28, 15.61 and 15.65 grams per 100 milliliters of blood in the three successive experimental periods; these values were somewhat lower than the values for the men patients with moderately advanced, active tuberculosis. Getz et al. (1944) also found that the hemoglobin concentration in the blood of patients with far advanced, active tuberculosis was lower than the hemoglobin concentration in the blood of patients with moderately advanced, active tuberculosis. Analysis of variance indicated that there was no difference in the hemoglobin concentration of the men with moderately advanced, active tuberculosis between the control and the experimental periods. There was a statistically significant increase in blood hemoglobin between the control and the experimental periods for the men with far advanced, active tuberculosis (Table 13).

Table 12

Average Fasting Blood Constituents of Men Patients With Active Tuberculosis In Control and Experimental Periods

Period	Degree of Tuberculosis	No. of Subjects	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mcg/100 ml.	Serum Carotene mcg/100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
Control	Mod. adv.	22	15.64±1.11*	6.88±0.14	44±2.15	90±7.20	0.68±0.10	1.51±0.14
	Far adv.	12	14.13±0.60	7.13±0.13	52±5.15	108±14.55	0.48±0.05	2.35±0.26
I	Mod. adv.	20	16.19±0.33	6.91±0.39	50±3.42	94±6.67	1.48±0.07	1.68±0.14
	Far adv.	11	14.28±0.40	7.05±0.21	59±7.65	147±16.67	1.34±0.14	1.93±0.20
II	Mod. adv.	19	16.20±0.27	6.97±0.10	46±2.55	98±10.42	1.33±0.10	1.70±0.14
	Far adv.	9	15.61±0.63	6.86±0.15	48±3.47	67±15.88	1.20±0.14	1.86±0.14
III	Mod. adv.	18	16.68±0.28	6.94±0.10	55±3.31	102±9.64	1.51±0.10	2.12±0.22
	Far adv.	8	15.65±0.76	6.92±0.24	68±8.75	115±18.74	1.52±0.13	1.88±0.13

* Standard error of mean

Table 13

Summary of Analysis of Variance of Blood Constituents for Men Patients With Active Tuberculosis Between Control And Experimental Periods

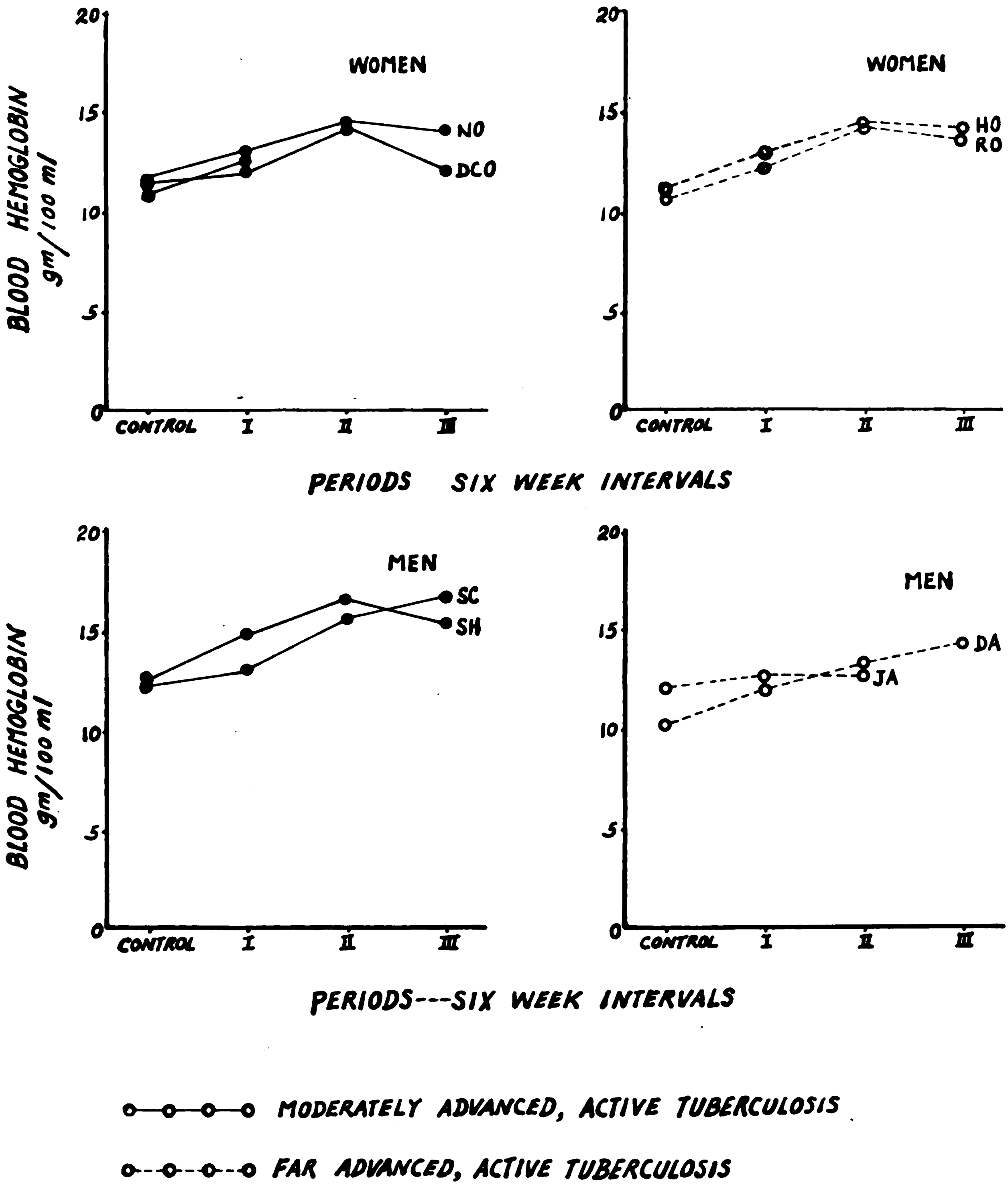
Source of Variance	F Value Obtained	Predicted F 0.05	F 0.01
Moderately Advanced Men			
Hemoglobin	1.67	3.11	4.88
Serum protein	0.06		
Vitamin A	1.72		
Carotene	0.36		
Ascorbic acid	24.94**		
Phosphatase	1.59		
Far Advanced Men			
Hemoglobin	5.53**	3.25	5.21
Serum protein	0.33		
Vitamin A	0.73		
Carotene	0.02		
Ascorbic acid	36.57**		
Phosphatase	2.19		

In both the men and women patients, therefore, the average blood hemoglobin values were lower in cases of far advanced, active tuberculosis than in the cases with moderately advanced, active tuberculosis. Increases in blood hemoglobin values to values comparable to those of healthy individuals resulted from improvements in the diet for both men and women. This would appear to indicate that the lower hemoglobin values for the patients with far advanced, active tuberculosis reflected a poorer nutritional status of these patients, rather than a condition associated with the disease process.

Blood hemoglobin values less than 12.00 grams per 100 milliliters for women and less than 12.60 grams per 100 milliliters for men were observed for nine patients during the control period. Changes in hemoglobin values for these subjects are shown in Figure 1. Subjects MO, HO, KO, SC, SH and DA showed an increased concentration of hemoglobin in the experimental period as compared with the control period. When Subject HU was studied as a patient with moderately advanced, active tuberculosis, the blood hemoglobin concentration of this patient was increased in period I above that of the control period. The initial hemoglobin value for subject HU was 11.25 grams per 100 milliliters in the control period when she was studied as a subject with moderately advanced, active tuberculosis, and 12.75 grams per 100 milliliters in period I. When the same person was studied as a patient with far advanced, active tuberculosis, the value for the control period was 12.50 grams per 100 milliliters, and 12.75 grams per 100 milliliters in period I.

Blood hemoglobin values for Subjects DCO, MO, HO, KO. and SH were less in Period III than in periods I and II. This reduction occurred in

Figure (1) Changes in blood hemoglobin of individual patients with low initial values.


WOMEN
NO
DCO
HO
RO
MEN
SC
SH
DA
JA
BLOOD HEMOGLOBIN gm/100 ml
20
15
10
5
0
CONTROL
I
II
III
PERIODS SIX WEEK INTERVALS
PERIODS---SIX WEEK INTERVALS
o—o—o—o MODERATELY ADVANCED, ACTIVE TUBERCULOSIS
o--o--o--o FAR ADVANCED, ACTIVE TUBERCULOSIS

the same period that lowered intakes of calories, protein, phosphorus and other nutrients were observed for subjects MO and MO and lowered intakes of phosphorus were observed for Subjects DCO and SH as well. Subject MO had a higher food intake in period III than in period II, but the food intake for this patient in period II was relatively low. Lower blood values for Subjects SH and DCO possibly could be attributed to incomplete recovery from loss of blood during surgical treatment.

Serum protein: The average total serum protein values for patients of both sexes were within the range of six to eight grams per 100 milliliters of serum (Tables 10 and 12). This range has been indicated as satisfactory for healthy individuals (Jessey, 1946). Differences between the serum total protein of the control period and the experimental periods were not statistically significant by analysis of variance.

Getz et al. (1944, 1950) and Shaw et al. (1950) stated that the serum total protein for patients both with moderate and far advanced tuberculosis was usually similar to that for healthy people, although the ratio of albumin to globulin is altered in the disease. When reductions in serum albumin occurred, elevations in serum globulin values usually occurred simultaneously, and, as a result, no change in the serum total protein was measurable. Thus, measurement of the serum total protein is a less critical measure of the state of protein nutrition of the tuberculous patient than measurement of protein fractions, although severely depleted protein stores may be indicated by low serum total protein values. Three patients had serum protein values which were slightly higher than 8.0 grams per 100 milliliters of serum and six patients had serum protein values slightly less than 6.0 grams per 100 milliliters of serum. The X-ray findings for these patients apparently were as satisfactory as for those who had serum total protein values within six to eight grams per 100 milliliters of serum. One patient, Subject ПМ, with far advanced, active tuberculosis had a total serum protein value of 5.65 grams per 100 milliliters of serum in period III; X-ray findings for this patient showed an extension of the cavity in the upper lung at the time of the test period and this patient died five months after the experiment. Subject HU, who died, had satisfactory serum total protein values: 6.70 grams per 100 milliliters in the control period and 7.16 grams per 100 milliliters in the period I preceding her death.

<u>Serum Vitamin A and carotene</u>: The average serum vitamin A of women with moderately advanced, active tuberculosis was 33 micrograms per 100 milliliters of serum in the control period, and 47, 42 and 45 micrograms per 100 milliliters of serum in the three successive experimental periods. The difference between the control and the experimental period was statistically significant ($P \leq 0.05$). This indicated that the average serum vitamin A was influenced by the addition of a daily supplement of vitamin A to the diets of these patients.

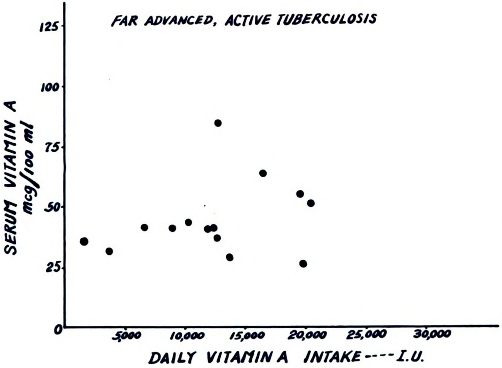
The average serum vitamin A for women with far advanced, active tuberculosis was 38 micrograms per 100 milliliters of serum in the control period and 37, 45 and 63 micrograms per 100 milliliters of serum in the three experimental periods. There was no significant difference between the control period and the experimental periods according to the analysis of variance. This was probably due to variations from period to period in the serum vitamin A values of the patients. One patient, subject KO, had a serum vitamin A value of 41 micrograms per 100 milliliters in the control period. Values for this subject increased to 52, 55 and 85 micrograms per 100 milliliters for the periods I, II and III, respectively. On the other hand, subject HO had a decrease in serum vitamin A values from 36 micrograms per 100 milliliters in the control period to 29 micrograms per 100 milliliters in the period I, although this was followed by an increase to 41 micrograms per 100 milliliters in periods II and III. Subject HU, who died after period I, had a serum vitamin A value of 32 micrograms per 100 milliliters in the control period; the concentration was lowered to 26 micrograms per 100 milliliters in the period I.

The mean concentration of serum vitamin A was higher for male patients than for the tuberculous women in both the control and the experimental periods. Average serum vitamin A values for men with moderately advanced, active tuberculosis were 44, 50, 46 and 55 micrograms per 100 milliliters of serum for the control period and periods I, II and III, respectively. Average serum vitamin A values for men with far advanced, active tuberculosis were 52, 59, 48 and 68 micrograms per 100 milliliters of serum for the control period and periods I, II and III, respectively. There was not a statistically significant difference in serum vitamin A values for the control period and the experimental periods for either the men with moderately advanced, active tuberculosis or the men with far advanced, active tuberculosis.

All serum vitamin A values for men with moderately advanced, active tuberculosis were 30 micrograms or more per 100 milliliters of serum with the single exception of Subject M.R. who had a concentration of 29 micrograms of vitamin A per 100 milliliters of blood in the period I. There was considerable variation in the serum vitamin A of Subject M.J., a male patient with far advanced, active tuberculosis. The serum vitamin A for this subject was 33 micrograms per 100 milliliters in the control period, 25 micrograms per 100 milliliters in period I, 38 micrograms per 100 milliliters in period II, and 16 micrograms per 100 milliliters in period III. This patient died following the experiment. Subject B.K., also a male patient with far advanced, active tuberculosis had a serum vitamin A value of 19 micrograms per 100 milliliters in period I; the concentration then increased to 50 micrograms per 100 milliliters for periods II and III. With these exceptions, the serum vitamin A values for the men with far advanced, active tuberculosis were consistently equal to or greater than 30 micrograms per 100 milliliters and, according to Bessey (1947), comparable to values for healthy individuals.

Evidence of previous depletion of vitamin A as reported by Getz (1954) for tuberculous patients was not apparent from the blood studies of the patients in this study. Graphs showing scatter diagrams of the vitamin A content of the serum plotted against the total vitamin A intake of the patients are given in Figure 2 for the tuberculous women and in Figure 3 for the tuberculous men. Serum vitamin A values were not linearly related to the vitamin A intake. Correlation coefficients were 0.006 for women with moderately advanced, active tuberculosis, 0.259 for

Figure (2) Graph showing relationship of serum vitamin A and daily vitamin A intake of women with active tuberculosis.


FAR ADVANCED, ACTIVE TUBERCULOSIS
SERUM VITAMIN A
mcg/100 ml
125
100
75
50
25
0
5,000
10,000
15,000
20,000
25,000
30,000
DAILY VITAMIN A INTAKE ---- I.U.

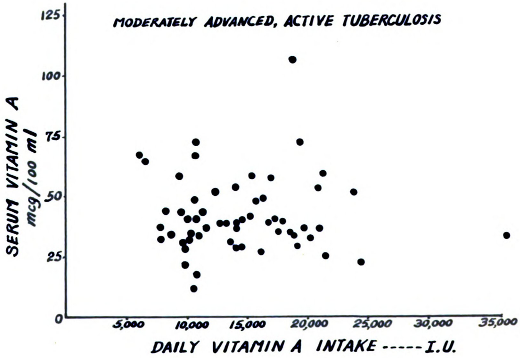
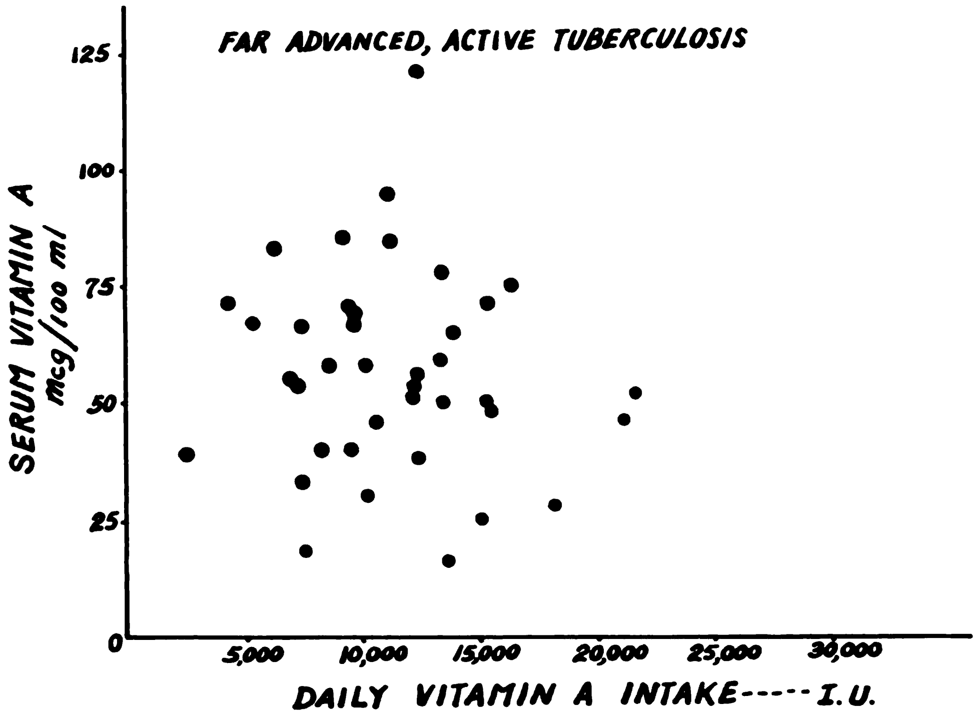
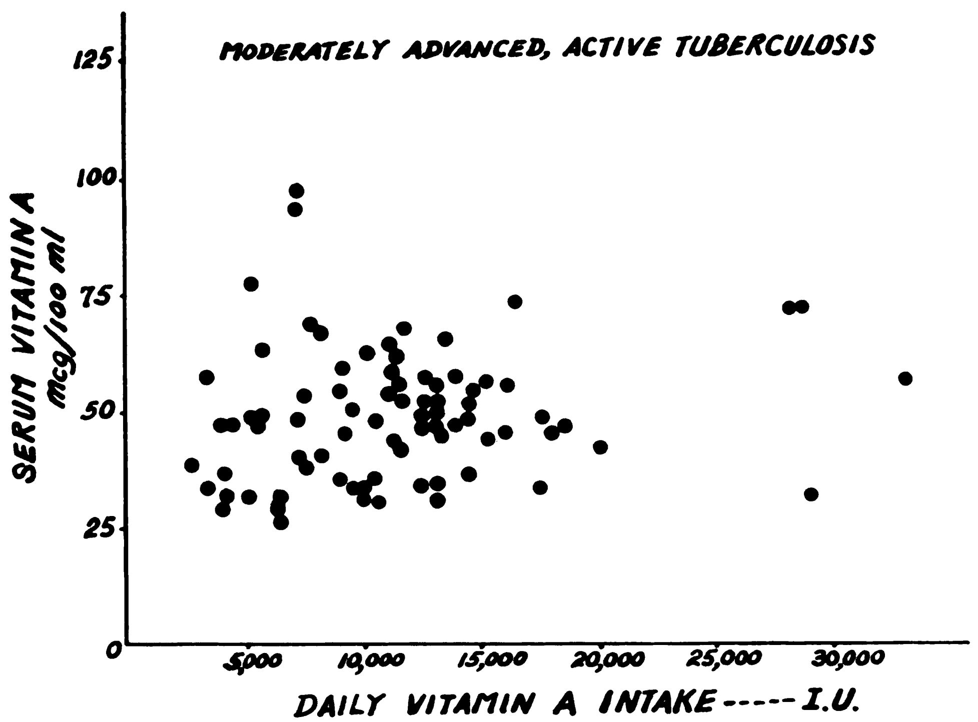

MODERATELY ADVANCED, ACTIVE TUBERCULOSIS
SERUM VITAMIN A
mcg/100 ml
125
100
75
50
25
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
DAILY VITAMIN A INTAKE ----- I.U.

Figure (3) Graph showing relationship of serum vitamin A and daily vitamin A intake of men with active tuberculosis.

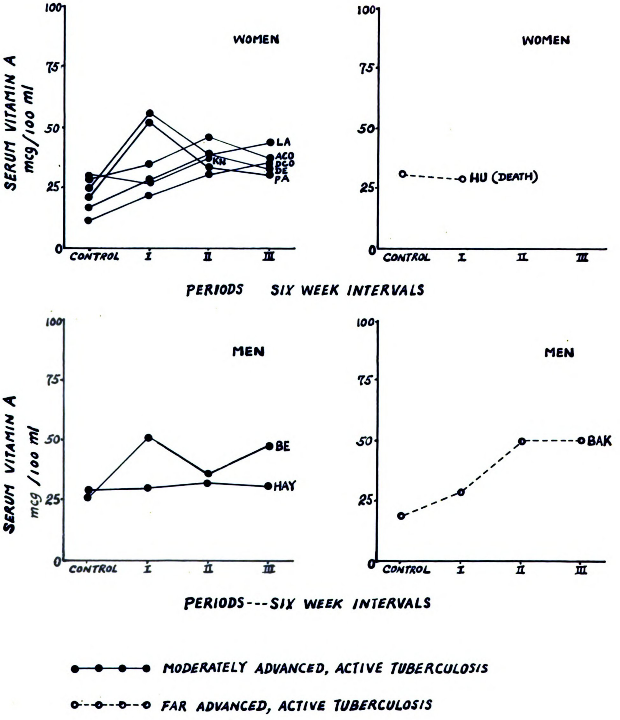

FAR ADVANCED, ACTIVE TUBERCULOSIS
125
100
75
50
25
0
SERUM VITAMIN A
mcg/100 ml
5,000
10,000
15,000
20,000
25,000
30,000
DAILY VITAMIN A INTAKE----- I.U.


MODERATELY ADVANCED, ACTIVE TUBERCULOSIS
125
100
75
50
25
0
SERUM VITAMIN A
mcg/100 ml
5,000
10,000
15,000
20,000
25,000
30,000
DAILY VITAMIN A INTAKE----- I.U.

women with far advanced, active tuberculosis, 0.217 for men with moderately advanced, active tuberculosis and 0.083 for men with far advanced, active tuberculosis.

Serum vitamin A values for nine individuals who had initial concentrations less than 30 micrograms of vitamin A per 100 milliliters and for Subject HU are shown graphically in Figure 4. Subject HU had a concentration of 32 micrograms of vitamin A per 100 milliliters of serum in the control period and 26 micrograms of vitamin A per 100 milliliters of serum in period I during the time that she was studied as a patient with far advanced, active tuberculosis. Only one of the nine individuals with low initial concentrations of serum vitamin A failed to show an increase in serum vitamin A during the experiment. Values for this patient, Subject MAY, were 29, 30, 33 and 31 micrograms of vitamin A per 100 milliliters of serum for the control period and periods I, II and III, respectively. The relatively low serum vitamin A values for this patient could not be associated with recognized factors since the patient showed favorable progress in recovery from tuberculosis during the experiment and had average intakes of 10,861 International Units of vitamin A per day in period I and 17,809 International Units of vitamin A per day in period II, although his vitamin A intake decreased to 6,694 International Units per day in period III. The sharp increase in serum vitamin A values in period I followed by a reduction in values for periods II and III which was observed for subjects DE and PA also could not be associated with other recognized factors. However, the data for this group of patients indicated that even for tuberculous patients with low serum

Figure (4) Changes in the serum vitamin A of individual patients with low initial value.


WOMEN
SERUM VITAMIN A mcg/100 ml
100
75
50
25
0
CONTROL
I
II
III
LA
ACO
DCO
DE
PA
KN
HU (DEATH)
PERIODS SIX WEEK INTERVALS
MEN
BE
HAY
BAK
PERIODS---SIX WEEK INTERVALS
MODERATELY ADVANCED, ACTIVE TUBERCULOSIS
FAR ADVANCED, ACTIVE TUBERCULOSIS

vitamin A values, supplementation of the diet with vitamin A resulted in increases in serum vitamin A concentrations to values which corresponded to those for healthy people.

The average serum carotene for moderately advanced, active tuberculous women was 100 micrograms per 100 milliliters of serum in the control period and 116, 105 and 106 micrograms per 100 milliliters in the three successive experimental periods. Analysis of variance indicated that the difference between the control and the experimental periods was statistically significant ($P \leq 0.05$) for moderately advanced, active tuberculous women (Table 11).

No particular effort was made to persuade the subjects to eat foods which were high in carotene during the experimental periods other than the request to eat all of the foods which were served to them; the increase in serum carotene during the experimental period may have reflected the interest of the subjects in the experiment and therefore, an increased intake of green and yellow vegetables.

For women with far advanced, active tuberculosis, the average serum carotene values were 165, 117, 45 and 91 micrograms during the control period and the periods I, II and III, respectively. Although these values indicated a reduction in serum carotene, analysis of variance indicated that there was not a statistically significant difference between the control period and the experimental periods. There was wide variation in individual values from period to period. It was indicated previously that Subject AU had a high serum carotene value and a relatively low vitamin A value in the control period. The serum carotene for this

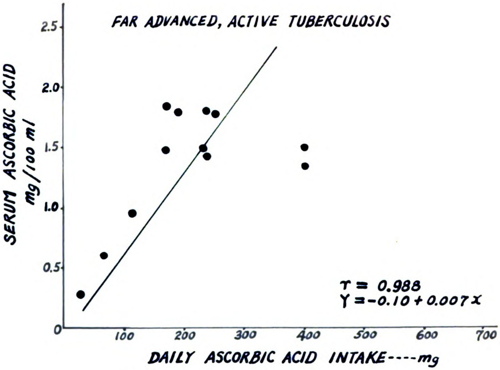
patient in period I was 219 micrograms per 100 milliliters and the serum vitamin A value was 26 micrograms per 100 milliliters. Relative vitamin A and carotene values for this subject in period I indicated further the possibility that the ability to convert carotene to vitamin A may have been disturbed for this patient.

The average values of serum carotene for men with moderately advanced, active tuberculosis in the control period were 99 micrograms per 100 milliliters of serum and 94, 98 and 102 micrograms per 100 milliliters of serum for the three experimental periods, respectively. The average value of serum carotene for men with far advanced, active tuberculosis was 108 micrograms per 100 milliliters of serum in the control period and 147, 67 and 115 micrograms per 100 milliliters of serum in the three experimental periods, respectively (Table 12). Analysis of variance showed that the differences between the control and the experimental periods were not significant for either group of patients.

Serum ascorbic acid: Serum ascorbic acid values in the experimental periods were higher than for the control period for both men and women. Women with moderately advanced, active tuberculosis had average serum ascorbic acid values of 1.12, 1.42 and 1.50 milligrams per 100 milli liters in the three experimental periods as compared with an average serum value of 0.93 milligrams of ascorbic acid in the control period. Similarly the serum ascorbic acid of the women with far advanced, active tuberculosis was increased from 0.78 milligram per 100 milliliters in the control period to values of 1.30, 1.60 and 1.79 milligrams per 100 milliliters of serum in periods I, II and III, respectively. The average serum ascorbic acid of the men with moderately advanced, active tuberculosis was 0.68 milligram per 100 milliliters in the control period; values increased to 1.46, 1.33 and 1.51 milligrams per 100 milliliters for the three experimental periods. Although the average serum ascorbic acid of men with far advanced, active tuberculosis was only 0.48 milligram per 100 milliliters of serum, the daily dietary supplement of 150 milligrams of ascorbic acid during the experimental periods resulted in an increase of serum ascorbic acid values to 1.34, 1.20 and 1.52 milligrams per 100 milliliters of serum for periods I, II and III, respectively. Analyses of variance showed that the serum ascorbic acid values of the experimental periods were significantly higher than the control period for the four groups of patients.

Serum ascorbic acid was plotted against ascorbic acid intake in scatter diagrams for tuberculous women in Figure 5 and for tuberculous men in Figure 6. Regression lines were calculated according to the predicting equation, $Y = a + bX$. There was a statistically significant relationship between ascorbic acid intake and serum ascorbic acid for all groups of patients except for the women with far advanced, active tuberculosis. The correlation coefficients were 0.701 for women with moderately advanced, active tuberculosis, 0.795 for men with moderately advanced, active tuberculosis and 0.603 for men with far advanced, active tuberculosis. When the correlation coefficient between ascorbic acid intake and serum ascorbic acid was calculated for the three women with far advanced, active tuberculosis, with the data for subject HU omitted from

Figure (5) Regression of serum ascorbic acid upon ascorbic acid intake for women patients with active tuberculosis.


FAR ADVANCED, ACTIVE TUBERCULOSIS
SERUM ASCORBIC ACID mg/100 ml
2.5
2.0
1.5
1.0
0.5
0
100
200
300
400
500
600
700
r = 0.988
Y = -0.10 + 0.007 X
DAILY ASCORBIC ACID INTAKE----mg

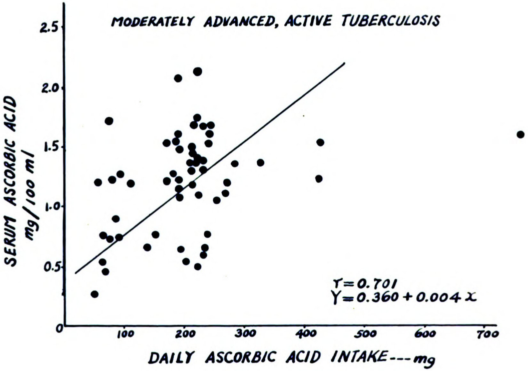
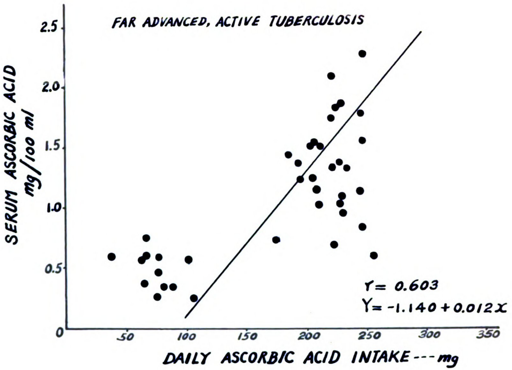
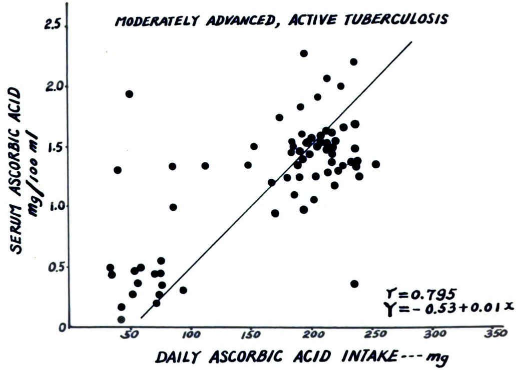

MODERATELY ADVANCED, ACTIVE TUBERCULOSIS
SERUM ASCORBIC ACID mg/100 ml
2.5
2.0
1.5
1.0
0.5
0
100
200
300
400
500
600
700
r = 0.701
Y = 0.360 + 0.004 X
DAILY ASCORBIC ACID INTAKE---mg

Figure (6) Regression of serum ascorbic acid upon ascorbic acid intake for men patients with active tuberculosis.


FAR ADVANCED, ACTIVE TUBERCULOSIS
SERUM ASCORBIC ACID mg/100 ml
2.5
2.0
1.5
1.0
0.5
0
50
100
150
200
250
300
350
r= 0.603
Y= -1.140 + 0.012X
DAILY ASCORBIC ACID INTAKE --- mg


MODERATELY ADVANCED, ACTIVE TUBERCULOSIS
SERUM ASCORBIC ACID mg/100 ml
2.5
2.0
1.5
1.0
0.5
0
50
100
150
200
250
300
350
r=0.795
Y=- 0.53+0.01X
DAILY ASCORBIC ACID INTAKE --- mg

this group, the relationship also was statistically significant ($r = 0.988$; $P \leq 0.01$). Subject HO had a decrease in serum ascorbic acid in period I in comparison with the control period.

Twenty-one out of fifty-three patients in this study had serum ascorbic acid values in the control period which were below 0.5 milligrams of ascorbic acid per 100 milliliters of serum. Concentrations of serum ascorbic acid for these patients are shown graphically for the control period and for periods I, II and III in Figures 7 and 8. Subject CZ had a final ascorbic acid concentration of 0.99 milligrams per 100 milliliters and subject DA had a final ascorbic acid concentration of 0.97 milligrams per 100 milliliters. With these exceptions (which were relatively insignificant) the final concentrations of serum ascorbic acid for all of these patients were equivalent to or greater than 1.0 milligrams per 100 milliliters of serum. There was a reduction in serum ascorbic acid concentration for subject CZ following period I which could not be associated with known factors from his medical case history or dietary history during the experiment.

The response of serum ascorbic acid concentration to the increased dietary intake appeared to be slower for two of the men, subjects DA and MA, with far advanced, active tuberculosis and one subject, MR, with moderately advanced, active tuberculosis than for other patients with low initial ascorbic acid concentrations. However the serum ascorbic acid values for these patients in period III corresponded to those of healthy persons.

Figure (7) Changes in the serum ascorbic acid of individual female patients with low initial values.

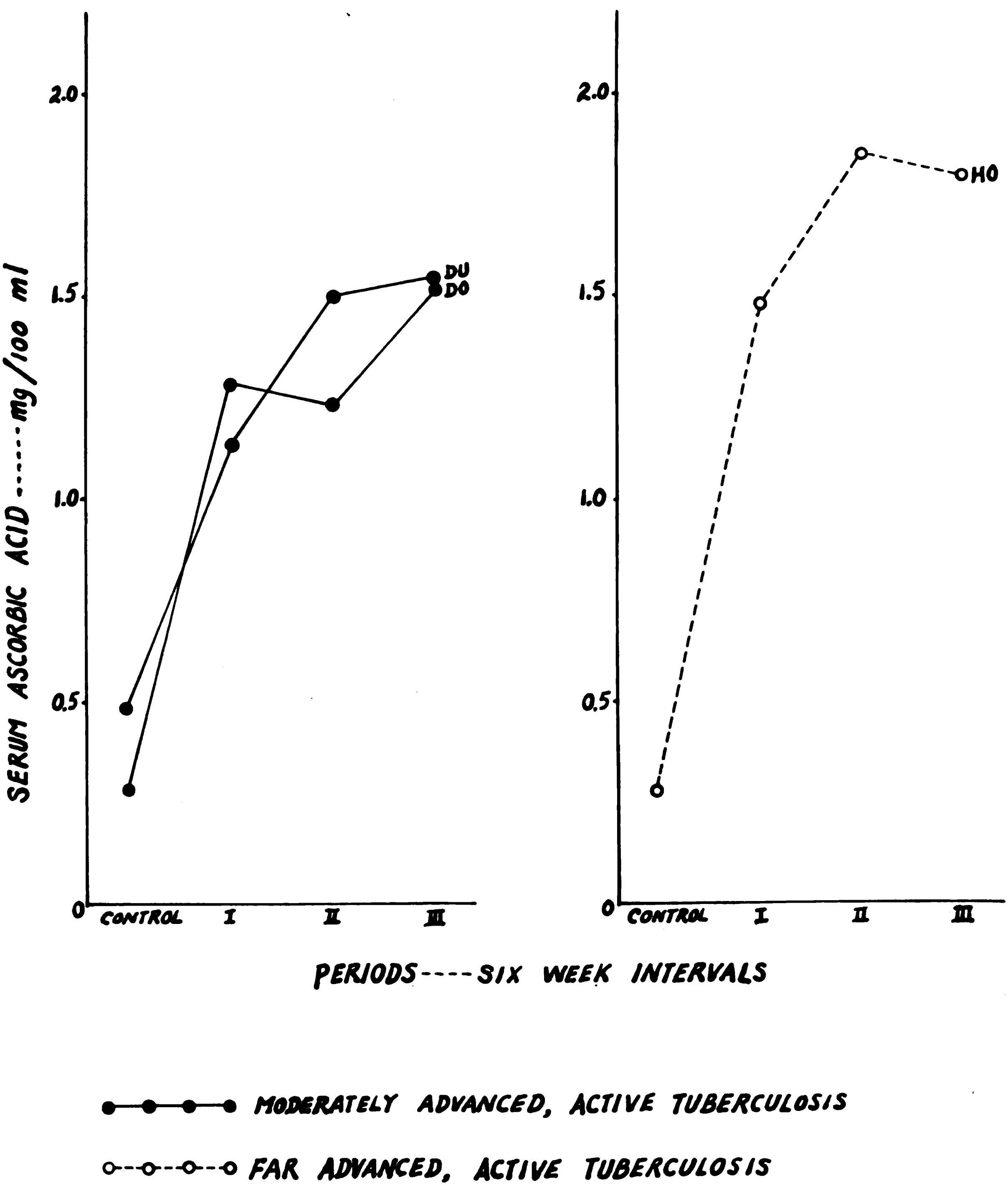
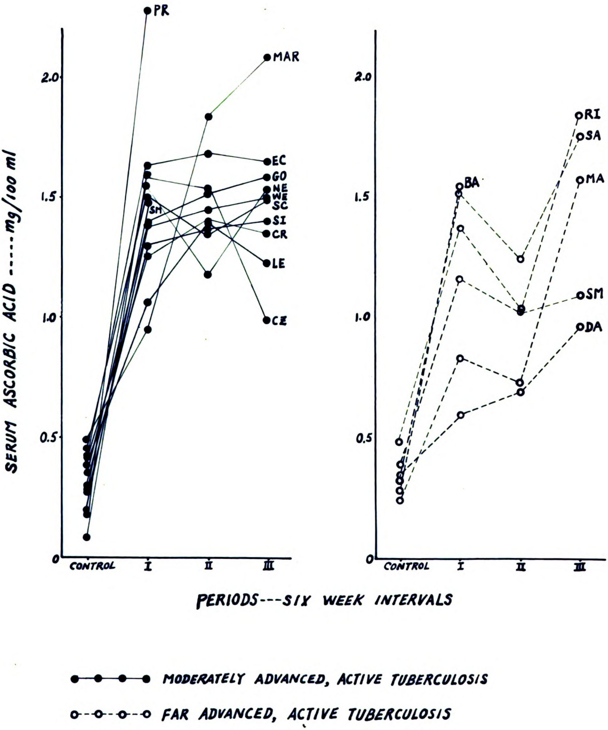

2.0
1.5
1.0
0.5
0
SERUM ASCORBIC ACID ------ mg/100 ml
DU
DO
CONTROL
I
II
III
2.0
1.5
1.0
0.5
0
HO
CONTROL
I
II
III
PERIODS----SIX WEEK INTERVALS
MODERATELY ADVANCED, ACTIVE TUBERCULOSIS
FAR ADVANCED, ACTIVE TUBERCULOSIS

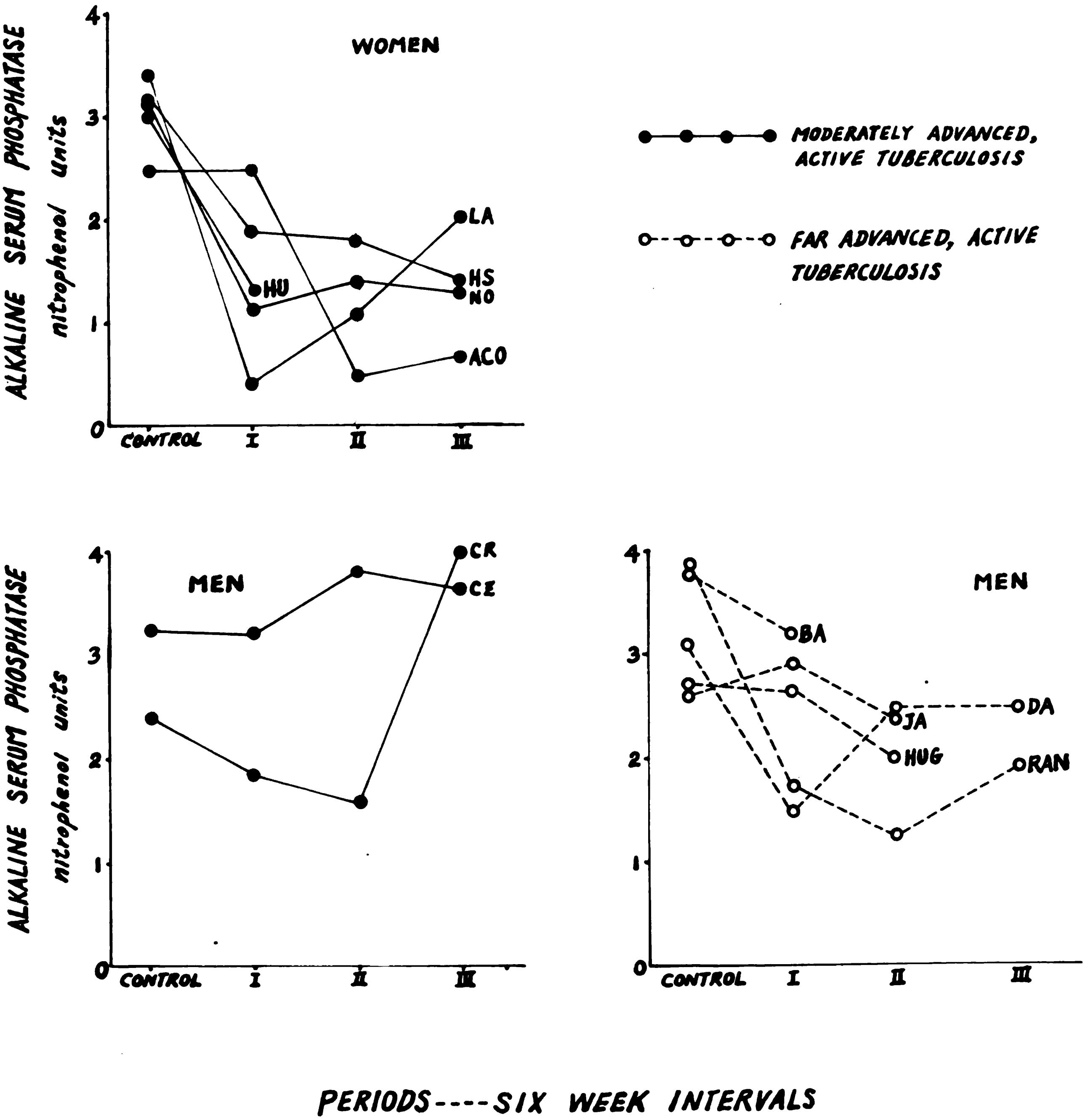
Figure (c) Changes in the serum ascorbic acid of individual male patients with low initial value.


SERUM ASCORBIC ACID ----- mg/100 ml
2.0
1.5
1.0
0.5
0
CONTROL
I
II
III
PR
MAR
EC
GO
NE
WE
SC
SI
CR
LE
CE
SM
RI
SA
MA
BA
SM
DA
PERIODS---SIX WEEK INTERVALS
MODERATELY ADVANCED, ACTIVE TUBERCULOSIS
FAR ADVANCED, ACTIVE TUBERCULOSIS

Serum alkaline phosphatase: A range of 0.8 to 2.3 nitrophenol units has been reported by Bessey, et al. (1946) for healthy adults. Four of the adult women with moderately advanced, active tuberculosis, two of the men with moderately advanced, active tuberculosis and five of the men with far advanced, active tuberculosis had values which exceeded 2.3 nitrophenol units in the control period. The alkaline serum phosphatase values for these patients in the control period and in periods I, II and III are shown graphically in Figure 9.

Subject DU was a fifteen year old girl. Her serum alkaline phosphatase value was 2.50 nitrophenol units. This value is slightly below the range of 2.8 to 7.7 nitrophenol units reported by Bessey et al. (1946) for healthy adolescents; values for this subject were not shown in Figure 9. Alkaline phosphatase values for subject DU for the experimental periods were 2.36, 2.25 and 2.68 nitrophenol units for periods I, II, and III, respectively. Subject PA also was a fifteen year old girl. The initial serum phosphatase value for this patient was 1.50 nitrophenol units and the values remained low throughout the study. Serum alkaline phosphatase values for the six adult women with moderately advanced tuberculosis who had initial values greater than 2.30 nitrophenol units were less than 2.30 nitrophenol units at the end of the experiment. The greatest fluctuation in values was apparent for Subject LA whose serum alkaline phosphatase dropped from an initial value of 3.40 nitrophenol units to 0.45 in period I, increased to 1.10 in period II and increased further to 2.01 nitrophenol units in period III. Serum alkaline phosphatase values for Subjects HS and MO dropped

Figure (9) Changes in the serum alkaline phosphatase of individual patients with high initial value.


WOMEN
ALKALINE SERUM PHOSPHATASE
nitrophenol units
4
3
2
1
0
CONTROL
I
II
III
LA
HU
HS
NO
ACO
MODERATELY ADVANCED, ACTIVE TUBERCULOSIS
FAR ADVANCED, ACTIVE TUBERCULOSIS
MEN
CR
CE
MEN
BA
DA
JA
HUG
RAN
PERIODS----SIX WEEK INTERVALS

considerably in period I and then remained relatively constant for periods II and III. None of the four women with far advanced, active tuberculosis had serum alkaline phosphatase values greater than 2.30 nitrophenol units at any time during the experiment.

Subject CZ was a male patient with moderately advanced, active tuberculosis. Serum alkaline phosphatase values for this patient were high throughout the entire period. Subject CK, also a male patient with moderately advanced, active tuberculosis, had a reduction in serum alkaline phosphatase in periods I and II but there was a considerable rise from 1.60 nitrophenol units in period II to 4.20 nitrophenol units in period III.

Forty percent of the men with far advanced, active tuberculosis had serum alkaline phosphatase values higher than 2.3 nitrophenol units in the control period. Subject BA had a reduction in serum alkaline phosphatase values from 3.80 nitrophenol units in the control period to 3.22 nitrophenol units in period I; this subject left the sanatorium at this time and additional values were not obtained. Reduction in serum alkaline phosphatase also occurred for subjects DA and RMN in period I as compared with the control period. The value for subject DA was increased in period II; no further increase occurred in period III. The value for serum alkaline phosphatase for subject RMN was lower in period II than in period I but was increased in period III. Subjects JA and HUG also withdrew from the sanatorium after period II and values for period III were not obtained for these subjects. A reduction from the initial value in serum alkaline phosphatase had occurred by the end of period II for these two subjects.

Diet and tuberculosis.

The state of Michigan has an active program for the detection of tuberculosis; many cases of tuberculosis are detected in the minimal stage of the disease. In addition, antibiotic therapy in the treatment of tuberculosis is effective in early reversal of the positive sputum reaction of many patients with moderately advanced and even far advanced, active tuberculosis. The number of patients for selection of subjects based on positive sputum reaction, probable cooperation of the subjects with the experimental plan, and an anticipated sanatorium stay of four months or longer was limited; therefore the number of subjects varied among the groups.

There was not the prevalence of low values for serum vitamin A, carotene and blood hemoglobin among these patients that Getz et al. (1941, 1944) and Shaw et al. (1950) reported previously for patients with active tuberculosis. It was not possible to limit patients for this study to recent admission cases as would be desirable to obtain a better evaluation of the relation of concentration of blood constituents to dietary habits of patients previous to their entering the sanatorium. Intakes of vitamins actually were lowered for a few patients who previously had received rather large amounts of vitamins as dietary supplement. Since the hospital diets of the sanatoria supplied liberal amounts of protein, calcium and phosphorus, intakes of these nutrients were not

necessarily increased for patients who already accepted foods as milk, cheese, meat, eggs, poultry and fish. Thus, the concept of improved diet as defined in the plan for the study was not achieved uniformly for all patients; that an improved diet with respect to certain nutrients was achieved for many of the patients was indicated by the analyses of variance which have been discussed previously. The dietary plan for the experiment did appear to accomplish the maintenance for the four-month experimental period of a diet which supplied generous intakes of nutrients. There were a few patients who did not cooperate fully with the experiment; surgical treatment also interrupted the experiment for certain other patients. Mean values for blood hemoglobin, serum vitamin A, carotene, protein, ascorbic acid and alkaline phosphatase at the end of the experimental period were comparable to those of healthy individuals. This appeared to indicate that low blood values among tuberculous patients such as have been reported previously, may be associated with the plane of nutrition of the individual, rather than representing a condition which is obligatory with tuberculosis.

Intakes of the various essential nutrients during the experimental period were generous and allowed a liberal "margin of safety" over the allowances for healthy individuals recommended by the Foods and Nutrition Board of the National Research Council (1953). However, the intakes of nutrients were less than have been reported by certain other investigators in studies of nutrition in tuberculosis. For example, Getz (1949) supplied vitamin A supplements of 150,000 International units per day in his work; Pottenger has advocated the intake of 225 grams of protein, 3,840 calories, 3,007 milligrams of phosphorus, 29 milligrams of iron, and 48 milligrams of niacin per day for tuberculous patients.

Insofar as could be judged by the concentration of certain blood constituents and the clinical progress of the patients, the mean dietary intakes supplied during the experimental period were adequate. There would not appear to be an advantage for increased intakes and there is the possible disadvantage of imposing stress on the body of the tuberculous patient by "over-loading" with nutrients.

However, higher intakes of vitamin A and ascorbic acid are necessary for tuberculous patients than healthy individuals for the maintenance of blood concentrations of these vitamins at values comparable to those of healthy adults. It is uncertain whether this reflects increased retention of these vitamins in tuberculosis or possibly greater destruction of the vitamin in the metabolism of the tuberculous individual.

Influence of other factors on blood constituents

Age: The possible influence of age on the concentration of the various blood constituents was investigated in an effort to determine whether or not the observations which were made in relation to the influence of dietary intake on blood constituents were influenced by the age of the patients. For this purpose, the subjects were divided, according to age, into three classes: 15 to 24 years of age, 25 to 49 years of age and 50 to 74 years of age.

The average concentration of blood constituents for the women with moderately advanced, active tuberculosis according to age is presented in

Table 14. A high hemoglobin concentration was found for women patients from the age of 50 to 79 years throughout the entire study. The higher hemoglobin concentration in the older women patients probably was related to the cessation of menstruation. Vitamin A and serum alkaline phosphatase values also were higher for the older age group than for the two groups of younger patients. The serum ascorbic acid in the control period was higher for patients in the age ranges of 15 to 24, and 25 to 49 years than for the older patients. The mean serum carotene values for the control period and the experimental period were less for patients in the age range of 15 to 24 years than for the other subjects. There was no apparent difference in serum protein values which was related to the age of the patients.

The average concentration of blood constituents for the women with far advanced, active tuberculosis is presented in Table 15. However, there were only four patients in this group and the age range was from 23 to 43 years. The data have been presented to facilitate comparisons with other groups but no attempt has been made to associate age with concentrations of blood constituents in this group.

The average concentration of blood constituents for men with moderately advanced, active tuberculosis according to three age ranges is presented in Table 16. There was only one subject in the age range of 15 to 24 years. Blood values for this subject were similar in the control period to values for other subjects. Mean hemoglobin values for subjects, 25 to 49 years of age, were higher in the control and experimental periods than the mean values for subjects, 50 to 74 years of age.

Table 14

The Average Concentration According to Age of Certain Blood Constituents of Women With Moderately Advanced, Active Tuberculosis

Age of Subjects and Period	No. of Subjects	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mcg./100 ml.	Serum Carotene mcg./100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
15 to 24 years							
Control Period	4	13.56	7.12	28	86	0.91	2.21
Period I	4	13.16	6.75	46	101	1.29	1.52
Period II	4	14.06	6.51	37	86	1.52	1.56
Period III	4	14.06	6.80	43	72	1.52	1.61
25 to 49 years							
Control Period	8	13.44	6.66	34	99	0.99	1.78
Period I	8	13.48	6.76	44	127	1.05	1.35
Period II	7	13.75	6.63	42	113	1.36	1.06
Period III	6	13.96	6.67	43	120	1.63	1.25
50 to 74 years							
Control Period	3	14.17	6.87	38	123	0.77	2.92
Period I	3	15.00	6.71	59	107	1.06	1.78
Period II	3	14.33	6.83	47	108	1.40	1.66
Period III	3	15.5	6.95	51	109	1.44	1.90

* Nitrophenol Units

Table 16

The Average Concentration According to Age of Certain Blood Constituents of Men With Moderately Advanced, Active Tuberculosis

Age of Subjects and Period	No. of Subjects	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mcg./100 ml.	Serum Carotene mcg./100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol units
16-24 years							
Control Period	5	16.00	6.80	37	[illegible]	0.39	1.55
Period I	5	16.35	6.[illegible]5	44	69	1.33	1.[illegible]
Period II	4	16.85	6.95	40	76	1.0[illegible]	1.60
Period III	4	17.06	6.[illegible]5	43	71	1.46	1.[illegible]
25-49 years							
Control Period	12	15.40	[illegible].89	45	118	0.[illegible]	1.[illegible]
Period I	10	[illegible]	[illegible]	51	103	1.40	1.57
Period II	11	16.37	6.94	47	98	1.51	1.61
Period III	10	16.83	6.90	56	96	1.55	2.04
50-75 years							
Control Period	5	15.87	7.41	48	107	0.57	1.[illegible]0
Period I	5	15.70	6.36	54	101	1.30	1.74
Period II	4	15.06	7.10	49	121	1.61	2.04
Period III	5	16.10	7.10	62	135	1.49	2.[illegible]

However, the mean values of serum alkaline phosphatase were higher in both the control and the experimental periods for subjects aged 50 to 74 years than for subjects aged 25 to 49 years. There were no apparent differences in mean values of the other blood constituents between the two age groups, 25 to 49 years and 50 to 74 years.

Mean concentrations of blood constituents for men with far advanced, active tuberculosis grouped according to age are presented in Table 17. Mean values for hemoglobin, serum protein, vitamin A, carotene and ascorbic acid were higher in corresponding periods for the men aged 25 to 49 years than the men aged 50 to 74 years. There was not a consistent difference in mean values of serum alkaline phosphatase with age.

The number of subjects within each age range was too small for the various groups to justify a more precise evaluation of the relationship of age to the concentration of blood constituents. Since difference in blood values corresponding to differences in age were not consistent among the groups, it is doubtful that the apparent differences were truly differences associated with age.

Body temperature. The possible influence of body temperature on the concentration of blood constituents was investigated among those patients whose records indicated that an elevation of body temperature had occurred during the experiment. Records of the mean body temperature for the individual patients during the control and experimental periods and on the test days at the end of each period are given in Tables 47 and 48 of the Appendix.

Table 17

The Average Concentration According to Age of Certain Blood Constituents of Men With Far Advanced, Active Tuberculosis

Age of Subjects and Period	No. of Subjects	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mcg/100 ml.	Serum Carotene mcg/100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
15 to 24 years							
Control Period	1	14.00	7.70	53	94	0.59	2.70
Period I	1	14.88	7.63	52	102	1.33	2.66
Period II	1	16.00	7.12	47	35	1.16	2.00
Period III	0	--	--	--	--	--	--
25 to 49 years							
Control Period	6	15.38	7.19	55	117	0.51	2.40
Period I	5	15.30	7.13	67	172	1.65	1.80
Period II	4	17.06	6.86	51	80	1.46	1.59
Period III	5	15.98	7.17	71	125	1.56	1.78
50 to 74 years							
Control Period	5	12.67	6.93	48	100	0.43	2.23
Period I	5	13.40	6.82	57	131	1.04	1.73
Period II	4	14.06	6.80	46	61	0.96	2.10
Period III	3	15.25	6.52	62	97	1.47	2.05

Seven patients had mean body temperatures which were elevated above 98.6° Fahrenheit in one or more periods of the study. Body temperatures were measured at three o'clock in the afternoon and 98.6° Fahrenheit was assumed to be "normal" body temperature.

Variations in blood constituents for women and men with active tuberculosis and with fever are given in Tables 18 and 19, respectively. Three female patients; ACO, EA and MI had slight elevations of body temperature on certain test days following the various periods. Atypical values of the various blood constituents did not appear to be associated with these elevations in body temperature. One female patient, MU, had a mean body temperature which was elevated during the control period and period I when she was studied as a patient with far advanced, active tuberculosis. Her body temperature was 100.4° Fahrenheit on both test days following these two periods. Lower serum ascorbic acid, vitamin A and carotene values were observed for this patient in period I than in the control period. This patient died after period I and the lowered blood values and elevated body temperature observed for this patient in period I probably were associated with a progressive stage of the disease.

Three male patients had slightly elevated body temperatures at intervals during the study. One patient, BAK, had low serum vitamin A and carotene values when there was a mean body temperature of 99.4° Fahrenheit. Serum ascorbic acid, blood hemoglobin and alkaline phosphatase, however corresponded satisfactorily with values of other patients. Subjects MA and LE also had low serum vitamin A values on the test days when an elevation in body temperature occurred. Variations in other blood constituents did not appear to be influenced by body temperature.

Table 18

Variation of Blood Constituents of Tuberculous Women With Fever

Subject	Period	Stage of Disease	Body Temperature 7 day ave.	Body Temperature test day	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mcg/100 ml.	Serum Carotene mcg/100 ml.	Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
100	Control	M.A.[1]	98.0	97.6	13.88	6.20	28	71	0.90	2.44
	I		98.3	98.4	13.25	6.33	35	71	0.50	2.44
	II		98.3	99.0	15.25	6.10	42	51	1.69	0.50
	III		98.3	98.8	14.50	6.00	37	67	1.40	0.64
[illegible]	Control	M.A.	98.7	99.0	15.75	7.30	59	103	1.30	0.90
	I		98.7	98.4	15.00	7.53	66	180	1.30	0.85
	II		98.3	98.2	14.50	7.38	64	196	1.20	1.04
	III		98.6	98.6	14.50	7.15	48	174	1.36	1.34
[illegible]	Control	M.A.	98.3	98.4	14.50	6.65	39	94	0.78	0.98
	I		98.6	98.4	14.00	7.10	44	153	1.75	1.50
	II		98.7	98.6	12.50	7.15	48	88	1.08	1.40
	III		99.2	99.2	13.75	6.75	66	157	1.48	1.43
[illegible]	Control	F.A.[2]	99.6	100.4	12.50	6.70	32	374	1.20	2.20
	I		100.5	100.4	12.75	7.15	26	219	0.89	1.66

[1] Moderately advanced

[2] Far advanced

Table 19

Variation of Blood Constituents of Tuberculous Men With Fever

Subject	Period	Stage of Disease	Body Temperature 7 day ave.	Body Temperature test day	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mcg/100 ml.	Serum Carotene mcg/100 ml.	Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
LE	Control	M.A.[1]	98.1	98.0	16.25	7.45	49	131	0.38	1.20
	I		98.4	98.0	16.00	7.15	57	133	1.06	2.00
	II		98.7	98.2	15.25	7.30	44	134	1.38	1.50
	III		98.8	99.2	16.50	7.15	46	113	1.23	1.44
[illegible]	Control	F.A.[2]	98.6	98.4	13.50	6.48	33	55	0.25	1.40
	I		99.0	99.6	14.50	6.62	25	60	0.83	1.50
	II		98.4	98.6	14.50	7.52	38	49	0.73	1.60
	III		99.1	99.2	15.25	7.75	16	43	1.58	1.30
BAK	Control	F.A.	99.4	99.2	13.50	7.50	19	34	0.76	1.20
	I		98.3	98.6	14.00	8.15	28	133	2.20	1.40
	II		98.0	97.8	16.00	7.50	50	51	1.44	1.7[illegible]
	III		98.3	97.6	16.75	7.75	50	102	1.60	2.10

[1] Moderately advanced

[2] Far advanced

Severity of disease: The relation between degree of severity of tuberculosis and the concentration of certain constituents in the blood of tuberculous patients has been reported by a number of investigators. Getz et al. (1944) found that plasma vitamin A was related to the severity of tuberculosis. A positive correlation between stage of disease and ascorbic acid in the blood has been reported by Kaplan and Zonnis (1940). According to Roy et al. (1941), Hurford (1946), and Shaw et al. (1950), there was little or no correlation between the stage of tuberculosis and blood constituents. In the study of Shaw et al. (1950) only hemoglobin showed a relationship with the stage of tuberculosis in that lower concentration of hemoglobin occurred in the patients with far advanced, active tuberculosis.

It is recognized that the classification of tuberculous patients as "moderately advanced" or "far advanced" is dependent upon various factors and does not represent a sharp distinction in degree or stage of disease as perhaps has been implied in the presentation of these data. Nevertheless the classification of patients into two such groups makes it possible to relate, to some extent, the severity of the disease to the concentration of blood constituents.

Comparison of the blood constituents of patients with moderately advanced, active tuberculosis with these of far advanced tuberculosis was made statistically by analysis of variance. Table 20 gives the analysis of variance of blood constituents of tuberculous women. The hemoglobin concentration in the blood was significantly higher ($P \leq 0.05$) for the moderately advanced, active tuberculosis women than for the far advanced,

Table 20

Summary of Analyses of Blood Constituents Data for Women Patients With Active Tuberculosis Between Moderately and Far Advanced Stages

Source of Variation	F Value Obtained	Predicted F .05	Predicted F .01
For Control Period			
Hemoglobin	5.20*	4.41	8.28
Serum protein	1.00		
Vitamin A	0.53		
Carotene	2.56		
Ascorbic acid	0.44		
Phosphatase	0.69		
For Experimental Period			
Hemoglobin	0.21	3.19	5.08
Serum protein	2.30		
Vitamin A	0.10		
Carotene	1.46		
Ascorbic acid	0.88		
Phosphatase	2.06		

active tuberculous women in the control period. There was not a significant difference in any of the blood constituents between the moderately advanced, and far advanced, active tuberculous women in the experimental periods.

The analysis of variance of the blood constituents of men with moderately advanced, and far advanced, active tuberculosis is summarized in Table 21. The hemoglobin concentration in the blood was significantly higher ($P \leq 0.05$) for the men with moderately advanced, active tuberculosis than for the men with far advanced, active tuberculosis in the control period. In the experimental periods, the hemoglobin concentration in the blood was also significantly higher ($P \leq 0.01$) for the men with moderately advanced, active tuberculosis than for the far advanced, active tuberculous men. The fact that several men with far advanced, active tuberculosis were lost from the experiment in the last period and the fact that two of the older subjects with far advanced, active tuberculosis who had a comparatively low hemoglobin values during the experiment may have accounted for the significant difference of hemoglobin in the blood between the two groups of men patients in the experimental periods. The serum alkaline phosphatase was significantly higher ($P \leq 0.01$) for the men with far advanced, active tuberculosis than for the men with moderately advanced, active tuberculosis. Several of the men with moderately advanced, active tuberculosis had higher serum ascorbic acid values then the men with far advanced, active tuberculosis in the control period. The fact that the serum ascorbic acid failed to show a statistically significant difference between the two groups may have

Table 21

Summary of Analysis of Variance of Blood Constituents for Men Patients With Active Tuberculosis Between Moderately and Far Advanced Stages

Source of Variation	F Value Obtained	Predicted F .05	Predicted F .01
For Control Period			
Hemoglobin	5.30*	4.15	7.50
Serum protein	1.10		
Vitamin A	0.66		
Carotene	1.55		
Ascorbic acid	1.[illegible]0		
Phosphatase	11.00**		
For Experimental Periods			
Hemoglobin	6.[illegible]2**	3.11	4.[illegible]
Serum protein	0.00		
Vitamin A	1.25		
Carotene	0.66		
Ascorbic acid	2.77		
Phosphatase	0.09		

been due to the wide variations of the individual serum ascorbic acid (range, 0.08 to 1.94 milligrams per 100 milliliters of serum) for the moderately advanced, active tuberculous men in the control period.

The fact that observations for a control period and period I were obtained for subject HU as a patient with moderately advanced, active tuberculosis and again after the tuberculous involvement had progressed to the point that the patient was classified as a patient with far advanced, active tuberculosis made it possible to compare the concentration of blood constituents for a single patient at two stages in the severity of the disease. Values in the control period for subject HU when the tuberculosis was moderately advanced were 11.25 grams of blood hemoglobin, 7.22 grams of serum protein, 33 micrograms of serum vitamin A, 155 micrograms of serum carotene, 1.22 milligrams of serum ascorbic acid per 100 milliliters and 3.00 nitrophenol units of serum alkaline phosphatase. After period I, her blood hemoglobin and serum ascorbic acid increased to 12.75 grams and 1.68 milligrams per 100 milliliters respectively, and the serum protein was unchanged with a value of 7.23 grams per 100 milliliters of serum. The vitamin A and serum carotene were slightly decreased to 26 micrograms and 138 micrograms per 100 milliliters of serum and the relatively high serum alkaline phosphatase value was decreased to 1.30 nitrophenol units which was in the range for healthy people. She left Ingham County Sanatorium after period I and transferred to Michigan State Sanatorium. After five months, she participated in this study again as a far advanced, active tuberculous subject at the Michigan State Sanatorium. At that time, her condition was quite serious; her body temperature was as high as 104° Fahrenheit because of the infection between the lobectomic spaces. Intakes of all the nutrients in this control period were less than in the control period when the tuberculosis was moderately advanced. Her blood constituents were comparable to values for the control period when the tuberculosis was moderately advanced except for a relatively high serum carotene (374 micrograms per 100 milliliters) and a slightly lower serum protein value (6.70 grams per 100 milliliters). The serum alkaline phosphatase had remained within the range of values for healthy people and was 2.20 nitrophenol units. In period I, her food intakes were increased, particularly for iron, vitamin A, ascorbic acid and niacin which were higher than in the period I when the tuberculosis was moderately advanced. Her blood hemoglobin and serum protein were increased from 12.50 and 6.70 to 12.75 grams and 7.18 grams per 100 milliliters, respectively. However, there was a reduction of serum vitamin A (from 32 to 26 micrograms per 100 milliliters), serum carotene (from 374 to 219 micrograms per 100 milliliters), and serum ascorbic acid (from 1.28 to 0.89 milligrams per 100 milliliters). Serum alkaline phosphatase (1.66 nitrophenol units) was in the range for healthy persons. Serum vitamin A values indicated that there was disturbance of serum vitamin A metabolism in both the moderately advanced and far advanced stages of tuberculosis for this patient. Metabolism of serum ascorbic acid and the ability to convert carotene to vitamin A were disturbed when the tuberculosis of this patient progressed to far advanced stage. The other blood constituents did not show disturbance in this case.

Clinical progress of the subjects

Medical histories of the patients were examined at the end of the experiment and an evaluation was made of the clinical progress of the subjects. Summary of hospital records for each subject are given in Tables 49, 50, 51 and 52 of the Appendix.

The disease was arrested for one subject during the period of study; according to medical records examined one month after the end of the experiment, the disease was arrested for nine additional subjects who were discharged from the sanatoria to their homes during this period.

Eight of the nine patients who received surgical treatment during the course of the study have progressed favorably in their recovery from tuberculosis and three of them were among the group who have been discharged from the sanatoria. The other subject, RW, who received surgical treatment transferred to a sanatorium in Detroit in period III and his progress was not followed.

The clinical progress of patients whose food records indicated particularly poor dietary habits preceding the experiment was examined in relation to changes in blood constituents during the study. Subject DCO had a record previous to the experiment of poor food habits, primarily because of bad teeth. She received dentures during the experiment. There was a marked increase in food intake in period I. This subject had an operation once in period II and twice in period III; her food intake was lowered at these times although her food intake had increased again by the end of period III. Her blood hemoglobin and serum vitamin A values were low in the control period but increased in the experimental period; however there was a reduction of blood hemoglobin again in period III which probably was associated with the effect of the two operations.

Subject DO, who did not eat citrus fruit, had a very low serum ascorbic acid of 0.26 milligrams per 100 milliliters of serum in the control period. After 150 milligrams of ascorbic acid were given to this subject as a daily ascorbic acid supplement, her serum ascorbic acid values were increased above 1.0 milligram per 100 milliliters of serum throughout the study. Her progress in recovery from tuberculosis appeared to be good.

Subject HO was a female patient with far advanced, active tuberculosis who had low blood hemoglobin and serum ascorbic acid values because she did not eat meat and citrus fruit. After the vitamin supplement and protein mixture were added to her diet, there was an increase in blood constituents. This patient showed satisfactory clinical progress during the experiment.

Subject CZ, who disliked citrus fruit, had the lowest serum ascorbic acid of 0.08 milligrams per 100 milliliters of serum in the control period. After the dietary supplement of ascorbic acid was given to this subject, his serum ascorbic acid was markedly increased. His progress in recovery from tuberculosis was favorable in the experimental periods.

Subject HA disliked meat, egg, liver and citrus fruits, but was very fond of milk and had about ten to 12 glasses a day. His daily iron intake was 4.69 milligrams, and the daily ascorbic acid intake was only 33 milligrams in the control period. In addition to the vitamin supplement, he received 12 milligrams of iron during the experimental period. At the end of the experiment, the concentration of blood constituents was similar to that of healthy individuals. This subject was a young man with moderately advanced, active tuberculosis. This was his second sanatorium admission; two years previous to the study he had been admitted as a patient with far advanced, active tuberculosis. His progress in recovery from tuberculosis appeared to be favorable at the end of experiment. During the experiment, the patient developed a willingness to eat eggs but it is doubtful that a liking for meat was developed.

Another subject SC also did not eat meat, egg, liver and citrus fruits. His blood hemoglobin and serum ascorbic acid were low in the control period. There was a satisfactory increase in blood constituents during the experiment and progress in recovery from tuberculosis was also indicated in the experimental periods. This patient also showed a marked improvement of food habits in that he learned to accept meat and eggs readily.

The healing process in tuberculosis is slow and affected by multiple factors. However, the X-ray findings and case records for all of the other subjects except two indicated that the clinical progress in recovery from the disease was favorable. The two exceptions were subjects HU and MA. There were only two subjects whose sputum tests continued positive throughout the experiment.

Subject HU, the 43 year old white house-wife, never felt well after a cold which developed in 1949. She was admitted to Ingham County Sanatorium on February 19, 1951 after a diagnosis of moderately advanced, active tuberculosis. Immediately after admission, a right phrenic nerve was crushed; streptomycin therapy was initiated but discontinued after one month because the patient was allergic to the drug. A right upper and middle lobectomy was done in late 1951. A tonsillectomy was performed on April, 1952; and she had a temperature of 102° Fahrenheit to 104° Fahrenheit following the tonsillectomy. The resected tonsil showed fibro-epitheliod tuberculosis. Productive cough continued and the sputum remained positive on routine microscopic examination. The patient joined this study on October 1952; a low serum vitamin A value and a relatively high serum alkaline phosphatase value were found for the control period but there was a decrease in serum vitamin A, serum carotene and serum alkaline phosphatase in period I. The patient left Ingham County Sanatorium after period I and transferred to Michigan State Sanatorium. The diagnosis at that time was bilateral far advanced pulmonary tuberculosis. There was a definite fistulous tract between the lobectomic spaces; the patient felt severe pain in the lateral chest and had a temperature of 104° Fahrenheit. The patient participated in this study again in August 1953. She showed a low serum vitamin A and high serum carotene in the control period and period I. Her serum ascorbic acid was decreased from the control period in period I although her ascorbic acid intake was high during this interval. She died during surgery after period I.

Subject MM was a 57 year old man poorly nourished and a heavy drinker and smoker; he was admitted to Ingham County Sanatorium in August 31, 1952. The X-ray examination showed active far advanced bilateral cavernous pulmonary tuberculosis with a large cavity in the right lung extending down to the third anterior rib. The sputum was markedly positive on microscopic examination and remained so consistently. He was placed on complete bed rest and given streptomycin therapy. He joined this study in December 1952. He had a slight elevation in body temperature to 99.5° Fahrenheit and 99.2° Fahrenheit during periods I and III respectively. His hemoglobin value was 13.50 grams per 100 milliliters of blood in the control period and 15.25 grams per 100 milliliters of blood at the end of the experiment. His serum protein value was in the range of six to eight grams per 100 milliliters of serum in the first three months but decreased to 5.65 grams per 100 milliliters of serum at the end of the four-month. He also had lower serum vitamin A and carotene value during the periods when his body temperature was above 98.6° Fahrenheit. His serum ascorbic acid was 0.25 milligrams per 100 milliliters of serum in the control period and increased to 0.83, 0.73 and 1.58 milligrams per 100 milliliters in period I, II and III respectively. According to the X-ray film, the cavity on the right lung increased somewhat in size during the study period. The prognosis of his tuberculosis was quite unfavorable. The patient lost 30 pounds before he was admitted to the sanatorium and did not gain any weight during his stay. The changes in blood hemoglobin and serum ascorbic acid are of interest in relation to the reduction of serum total protein and the failure of this patient to show favorable clinical progress. It is unfortunate that the serum albumin-globulin ratio was not determined for this patient during the experiment. His cooperation with the experimental plan in terms of food acceptance was quite good. The experiment was ended on May 26, 1953 for this subject. Later, he transferred to the Northern Michigan Sanatorium in September 15, 1953 and died in October 1953.

SUMMARY AND CONCLUSIONS

The influence of an improved diet on the fasting blood content of hemoglobin, serum total protein, vitamin A, carotene, ascorbic acid and alkaline phosphatase of 53 women and men with moderately advanced, and far advanced, active tuberculosis was studied. Thirty-one of the subjects were bed patients at the Ingham County Sanatorium, Lansing, Michigan and 22 of the subjects were bed patients at Michigan State Sanatorium, Howell, Michigan. Patients from the two sanatoria were grouped together as follows: women with (a) moderately advanced, active tuberculosis and (b) far advanced, active tuberculosis; men with (a) moderately advanced, active tuberculosis and (b) far advanced, active tuberculosis. Ages of 34 male subjects ranged from 18 to 68 years and of 19 female subjects ranged from 15 to 55 years. Irregularities in the experimental plan developed for fourteen patients; some had surgical treatment, others left the sanatoria against medical advice and one patient died before the end of the study.

The average daily dietary intake was calculated and the fasting blood constituents of hemoglobin, total serum protein, vitamin A, carotene, ascorbic acid and alkaline phosphatase were determined for each subject during a seven-day control period. Modifications were made in the regular hospital diets of the subjects so that a generous intake of nutrients was supplied to all subjects during the experimental period which lasted for four months and was divided into three periods of six

weeks each. At the end of each period, a seven-day food record was obtained from each patient and the dietary intake was calculated. Also at the end of each period a blood sample from each patient was analyzed for hemoglobin, serum protein, vitamin A, carotene, ascorbic acid and alkaline phosphatase.

A comparison was made of the food intakes of patients during the control period and during the experimental periods. Statistical analyses indicated that the average caloric intake was increased for women with moderately advanced, active tuberculosis and was maintained for the other three groups in comparison with the control period; the average daily protein intake was increased for both groups of women and maintained for both groups of men; the average daily intake of calcium, phosphorus and iron was maintained in all groups; a vitamin supplement containing vitamin A, ascorbic acid, thiamine, riboflavin and niacin was given daily during the experimental periods. Patients who were in the lowest range of nutrient intakes in the control period had the highest increases during the experimental periods.

Statistical analysis indicated that modifications in the diet were effective in increasing the concentrations of hemoglobin in the blood of men and women patients with far advanced, active tuberculosis. The average values for women with far advanced, active tuberculosis were 11.88, 12.35, 14.75 and 13.88 grams per 100 milliliters of blood; for men with far advanced, active tuberculosis, the blood hemoglobin values were 14.13, 14.28, 15.61 and 15.65 grams per 100 milliliters of blood in the control period and periods I, II and III respectively. Mean blood hemoglobin values of patients with moderately advanced, active tuberculosis were comparable to those of healthy adults in the control period and there was no significant change during the experimental periods. There was no change in mean serum protein values in the experimental periods as compared with the control period.

The mean serum vitamin A for women with moderately advanced, active tuberculosis was significantly higher in the experimental periods than in the control period. However, no difference between the control and the experimental periods was found for the other three groups; mean serum vitamin A values for these patients were comparable to those of healthy adults in the control period.

The daily dietary supplement of 150 milligrams of ascorbic acid during the experimental periods resulted in a statistically significant increase of serum ascorbic acid values in comparison with the control period.

There was not a significant difference between the serum alkaline phosphatase values in the control period and the experimental periods for any group except for the women with moderately advanced, active tuberculosis; this group had a higher mean serum alkaline phosphatase in the control period than in the experimental periods.

Medical histories of the patients indicated that the clinical progress in recovery from the disease was favorable during the experimental periods with the exception of one subject who died during the experiment and one subject who died five months after the last experimental period.

The results of this investigation indicated that the nutritional status was an important factor in association with maintenance of the blood constituents in tuberculous patients at values comparable to those of healthy individuals.

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APPENDIX

Table 22

Comparison of the Average Daily Food Intake of Patients from Ingham County Sanatorium and Michigan State Sanatorium; Control Period

Nutrient	Daily Intake--Men Patients				Daily Intake--Women Patients			
	Ingham County Sanatorium		Michigan State Sanatorium		Ingham County Sanatorium		Michigan State Sanatorium	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Calories (cal)	1974±130.6*	1237-2967	1933±291	1035-2604	1742±87	1131-2082	1702±778	1140-2466
Protein (gm)	85±4.30	55-116	87±6.40	43-151	72±3.87	45-93	67±6.78	32-91
Fat (gm)	94±10.00	52-203	87±9.75	36-121	73±4.69	44-89	80±14.39	42-136
Carbohydrate (gm)	197±11.45	122-283	199±9.00	126-262	179±7.61	149-243	169±29.9	123-315
Calcium (gm)	1.60±0.14	0.85-3.17	1.37±0.10	0.62-2.33	1.20±0.10	0.52-1.73	1.13±0.14	0.59-1.75
Phosphorus (gm)	1.54±0.10	0.95-2.53	1.53±0.10	0.77-2.38	1.30±0.10	0.75-1.80	1.22±0.42	0.70-1.69
Iron (mg)	9.86±0.50	4.49-13.44	11.35±0.65	6.11-16.30	9.00±0.50	7.60-14.07	8.47±0.89	6.19-13.3
Vitamin A (I.U.)	7361±711	2821-13494	7691±15.33	2571-28369	12373±1114	6673-21584	10972±2923	1715-21276
Vitamin C (mg)	74±7.74	33-169	78±8.25	39-186	85±6.70	59-140	127±21.09	29-288
Thiamin (mg)	1.20±0.22	0.58-1.76	1.67±0.43	0.67-8.55	1.65±0.37	0.77-5.36	3.19±1.42	0.66-8.74
Riboflavin (mg)	2.85±0.32	1.48-6.73	2.95±0.48	0.86-9.32	2.51±0.28	1.22-4.94	4.08±1.40	1.09-10.11
Niacin (mg)	10.62±0.65	6.89-15.71	15.39±3.66	7.39-89.77	11.50±1.53	1.16-23.42	26.82±12.20	7.35-71.95

* Standard error of the mean

Table 23

Daily Food Intake of Fifteen Women With Moderately Advanced, Active Tuberculosis; Individual Data, Control Period

Period and Subject	Calories	Protein	Fat	Carbo-hydrate	Calcium	Phos-phorus	Iron	Vitamin A	Ascorbic Acid	Thiamine	Riboflavin	Niacin
		gm.	gm.	gm.	gm.	gm.	gm.	I.U.	mg.	mg.	mg.	mg.
HU	1864	81	89	183	1.46	1.52	8.33	10,998	83	0.93	1.46	9.8
MO	2005	84	87	215	1.65	1.67	8.14	13,678	92	1.03	3.02	9.8
ACO	1946	79	76	185	1.34	1.47	8.53	14,126	88	1.75	2.57	11.7
DE	2075	93	81	243	1.73	1.80	8.70	21,584	113	1.16	3.14	20.2
PA	1131	58	49	149	0.97	1.10	7.70	9,944	59	0.87	2.37	9.6
L.	1719	66	87	164	1.12	1.22	9.66	10,940	63	0.99	2.15	10.0
DCO	1324	56	48	158	0.85	1.00	7.95	10,580	64	0.77	1.74	9.4
KN	2082	74	73	155	1.09	1.23	8.80	9,909	79	0.99	2.12	18.8
ER	1498	45	44	163	0.52	0.75	7.60	9,760	140	2.88	3.27	23.4
MS	1711	72	74	177	1.15	0.76	8.97	15,546	95	1.93	1.22	11.7
AS	1673	77	78	165	1.44	1.70	14.07	14,742	79	5.36	4.94	10.4
DO	1690	73	84	167	1.18	1.23	7.72	17,326	49	0.99	2.03	8.8
DU	1962	76	86	220	1.14	1.35	8.12	8,785	69	1.04	2.08	11.5
EA[1]	2466	82	136	228	1.75	1.60	9.50	21,276	288	8.74	10.11	72.0
MI	1307	72	64	123	0.96	1.06	6.81	16,940	153	8.65	9.12	68.0

[1] Received three vitamin tablets

Table 24

Daily Food Intake of Fifteen Women with Moderately Advanced, Active Tuberculosis; Individual Data, Period I

Period and Subject	Calories	Protein	Fat	Carbo-hydrate	Calcium	Phos-phorus	Iron	Vitamin A	Ascorbic Acid	Thiamine	Riboflavin	Niacin
		gm.	gm.	gm.	gm.	gm.	mg.	I.U.	mg.	mg.	mg.	mg.
HU	1861	87	93	163	1.61	1.61	9.27	16,053	218	3.70	6.20	29.6
MO	2063	99	98	193	1.95	1.96	11.30	17,911	212	3.98	5.17	31.3
ACO	2610	120	60	265	2.34	2.38	12.80	18,594	223	4.24	6.70	33.4
DE	1620	77	76	155	1.28	1.42	9.39	17,135	224	3.70	5.17	31.1
PA	2742	87	107	164	1.48	1.59	9.83	20,948	193	3.80	5.80	32.2
LA	2196	104	103	196	2.44	2.16	9.59	14,485	239	3.73	6.23	30.2
DCO	1711	86	65	154	1.36	1.56	10.04	24,351	207	3.70	6.43	35.4
KN	1695	80	78	153	1.28	1.41	8.47	19,115	238	3.55	5.25	30.9
MR	1536	89	85	169	1.34	1.57	10.39	19,329	240	3.65	5.40	32.4
HS	1740	93	85	153	1.16	1.51	10.50	18,885	228	3.70	5.33	34.5
AS	1604	88	87	147	1.47	1.59	10.10	23,912	270	4.78	5.43	32.3
DO	1561	60	73	170	1.05	1.09	6.60	9,490	180	3.43	4.21	28.2
DU	1881	75	88	196	1.62	1.39	7.61	10,226	197	3.51	4.77	30.3
EA	2831	111	155	256	2.22	1.63	10.22	6,022	332	4.91	5.26	29.1
MI	1644	78	77	150	1.49	1.50	10.34	11,344	220	3.72	4.95	28.8

Table 25

Daily Food Intake of Fifteen Women with Moderately Advanced, Active Tuberculosis; Individual Data, Period II

Period and Subject	Calories	Protein gm.	Fat gm.	Carbo-hydrate gm.	Calcium gm.	Phos-phorus gm.	Iron mg.	Vitamin A I.U.	Ascorbic Acid mg.	Thiamine mg.	Riboflavin mg.	Niacin mg.
HU	-	-	-	-	-	-	-	-	-	-	-	-
NO	2014	91	105	173	1.76	1.74	8.78	10,863	212	3.79	5.40	29.1
ACO	2143	108	103	185	2.06	2.10	9.29	15,459	246	3.96	6.21	32.4
DE	2404	117	107	222	2.29	2.17	13.22	12,776	221	4.06	6.24	31.0
PA	1589	79	71	160	1.29	1.44	8.74	18,899	214	3.60	5.33	30.5
LA	1739	81	85	161	1.24	1.42	9.98	13,147	189	3.83	4.97	31.3
DCO[1]	1350	57	55	155	1.70	1.46	13.67	20,392	765	11.06	9.25	67.7
KN	1778	85	77	188	1.14	1.41	15.57	14,182	233	3.71	4.88	32.8
ER	1547	85	83	149	1.33	1.54	13.35	17,638	259	3.67	5.36	31.5
HS	1469	77	58	154	1.28	1.49	13.89	16,316	218	3.63	5.34	31.6
AS[2]	1615	74	77	173	1.18	1.32	20.80	36,520	424	8.20	9.49	68.6
DO	1483	67	66	153	1.01	1.19	8.19	14,022	172	3.32	4.63	11.1
DU	1848	71	80	204	1.25	1.38	8.99	14,139	211	3.66	4.96	31.3
EA	3220	124	172	292	2.03	1.97	11.25	6,544	270	4.14	6.08	33.1
MI	1910	92	104	145	1.79	1.81	10.00	10,862	197	3.88	5.50	27.9

[1] Received 600 mg. of ascorbic acid supplement.

[2] Received 400 mg. of ascorbic acid supplement.

Table 26

Daily Food Intake of Fifteen Women with Moderately Advanced, Active Tuberculosis; Individual Data, Period III

Period and Subject	Calories	Protein gm.	Fat gm.	Carbo-hydrate gm.	Calcium gm.	Phos-phorus gm.	Iron mg.	Vitamin A I.U.	Ascorbic Acid mg.	Thiamine mg.	Riboflavin mg.	Niacin mg.
HU	-	-	-	-	-	-	-	-	-	-	-	-
NO	1809	84	89	168	1.52	1.55	7.74	12,436	242	3.84	5.05	31.5
ACO	1891	89	88	164	1.36	1.53	10.70	11,612	221	3.91	4.93	33.2
DE	2141	97	87	234	1.78	1.85	11.12	10,136	242	4.05	5.48	31.6
PA	1417	67	61	145	1.25	1.23	6.23	7,868	218	3.44	4.46	28.2
LA	1619	79	82	148	1.12	1.31	7.83	8,233	189	3.48	4.44	27.6
DCO[1]	2009	79	113	171	1.07	1.30	15.51	19,930	604	8.72	9.52	70.8
KN	-	-	-	-	-	-	-	-	-	-	-	-
EH	1542	62	76	132	1.07	1.26	8.90	10,083	215	3.51	4.49	30.5
HS	1453	68	60	161	1.21	1.30	8.40	10,863	220	3.80	4.50	29.9
AS[2]	1903	90	102	183	1.46	1.61	16.54	21,004	425	8.86	9.98	71.7
DO	1633	81	82	143	1.37	1.47	8.32	7,915	170	3.48	4.52	29.4
DU	2051	79	95	227	1.34	1.44	6.89	9,586	185	3.46	4.56	28.6
EA	2762	106	141	272	1.80	1.67	9.24	16,043	285	3.89	5.28	29.3
MI	1748	87	89	146	1.63	1.65	8.91	10,771	193	2.68	5.25	20.7

1 Received 600 mg. of ascorbic acid supplement.
2 Received 400 mg. of ascorbic acid supplement.

Table 27

Daily Food Intake of Four Women with Far Advanced, Active Tuberculosis; Individual Data

Periods and Subject	Calories	Protein gm.	Fat gm.	Carbo-hydrate gm.	Calcium gm.	Phos-phorus gm.	Iron mg.	Vitamin A I.U.	Ascorbic Acid mg.	Thiamine mg.	Riboflavin mg.	Niacin mg.
Control period												
RO	1823	77	84	187	1.12	1.33	9.74	6,673	67	1.24	2.06	1.2
HO	1067	39	42	133	0.59	0.70	6.19	1,715	29	0.66	1.09	6.0
ME	2556	91	103	315	1.50	1.69	13.30	10,332	116	1.41	2.63	12.0
HU	1140	32	43	139	0.80	0.93	7.65	3,735	254	0.84	1.39	7.4
Period I												
RO[1]	1850	98	79	198	1.21	1.43	16.41	20,543	414	13.68	11.91	43.1
HO	856	33	33	105	0.41	0.57	5.72	13,986	173	3.06	3.54	25.9
ME	2281	122	105	222	1.56	1.88	13.70	12,001	228	4.16	5.35	36.0
HU	1588	66	64	182	1.07	1.17	11.50	19,865	364	3.56	4.72	32.2
Period II												
RO[1]	2005	94	87	209	1.26	1.53	16.21	19,542	402	12.30	12.01	43.3
HO	1261	77	48	130	0.53	0.77	6.86	12,354	171	3.17	3.85	27.6
ME	2190	117	99	208	1.43	1.60	11.40	12,899	231	3.60	5.05	30.2
HU[2]	-	-	-	-	-	-	-	-	-	-	-	-
Period III												
RO	1584	73	67	171	0.90	1.15	15.72	12,962	253	10.47	6.17	41.1
HO	2613	176	105	248	2.23	1.95	6.27	6,923	193	3.59	5.90	25.6
ME	1735	86	80	164	1.23	1.50	11.19	16,655	232	3.78	4.96	31.5
HU[2]	-	-	-	-	-	-	-	-	-	-	-	-

[1] Subject received three vitamin tablets per day

[2] Subject died

Table 28

Physical Description of Women Patients with Moderately Advanced, Active Tuberculosis

Subject	Age	Height	Weight Initial lbs	Weight Final lbs	Standard Weight For The Height lbs	Percent Deviation From Standard Weight Initial %	Percent Deviation From Standard Weight Final %	Gain or Loss lbs
MU[2]	42	5' 1/2"	113	118	129	-12	-9	+5
MO	22	5' 6"	130	152	133	-2	+14	+22
ACO	30	5' 4"	117	135	132	-11	+2	+18
DE	23	5' 4"	99	125	126	-21	-1	+26
PA	15	5' 2"	94	104	117	-20	-11	+10
LA	55	5' 3"	108	111	143	-24	-22	+3
DCO[1]	30	5' 5"	121	114	136	-11	-14	-7
KA[3]	25	5' 4"	135	140	129	+5	+9	+5
ER	32	5' 2"	129	140	125	+3	+12	+11
HS	51	5' 0"	109	112	133	-20	-15	+3
AS[1]	37	5' 5"	135	132	140	-4	-6	-3
DO	53	5' 0"	106	111	133	-20	-15	+3
DU	15	5' 6"	120	122	130	-8	-6	+2
EA	26	5' 3"	100	107	125	-20	-14	+7
MI	30	5' 6"	126	139	140	-10	-1	+13

1 Received surgical treatment after period I

2 Control period and period I only

3 Omitted period III

Table 29

Physical Description of Women Patients With Far Advanced, Active Tuberculosis

Subject	Age	Height	Weight Initial lbs	Weight Final lbs	Standard Weight For The Height lbs	Percent Deviation From Standard Weight Initial %	Percent Deviation From Standard Weight Final %	Gain or Loss lbs
RO	27	5' 2"	97	107	122	-20	-12	+10
HO	36	5' 7"	118	135	148	-20	-8	+17
ME	23	5' 5"	120	135	129	-7	+5	+15
HU[1]	43	5' 1/2"	113	108	129	-12	-16	-5

[1] Only control period and period I

Table 30

Daily Food Intake of Twenty-two Men with Moderately Advanced, Active Tuberculosis; Individual Data, Control Period

Period and Subject	Calories	Protein	Fat	Carbo-hydrate	Calcium	Phos-phorus	Iron	Vitamin A	Ascorbic Acid	Thiamine	Riboflavin	Niacin
		gm.	gm.	gm.	gm.	gm.	mg.	I.U.	mg.	mg.	mg.	mg.
BE	2670	107	119	278	2.31	2.26	11.02	6,760	116	1.15	3.64	10.1
RA	2981	116	155	283	2.48	0.95	11.37	12,628	109	1.71	3.74	13.2
HA	2967	109	203	181	3.17	2.53	4.49	10,598	33	0.58	4.64	4.4
SH	2134	92	100	268	1.42	1.61	11.54	4,347	41	1.57	2.46	14.3
SC	1340	64	63	133	1.34	1.27	5.89	2,821	35	0.93	2.08	6.7
MA	1750	79	79	178	1.42	1.63	8.79	4,549	89	1.16	2.17	10.5
PR	1237	57	52	122	0.85	0.98	6.80	4,165	44	0.94	1.48	8.9
JE	1879	85	87	185	1.86	1.79	8.02	5,457	51	1.28	2.98	10.0
NE	1740	83	87	153	1.69	1.61	7.10	7,762	54	1.04	2.66	13.3
GO	2670	109	136	252	1.70	1.87	13.44	10,068	78	1.76	2.78	15.7
SI	1533	71	52	200	1.36	1.35	11.17	3,537	96	1.19	2.26	8.6
ST[1]	1465	63	62	167	1.10	1.16	7.72	28,369	186	8.55	9.32	69.8
CZ	2604	115	120	262	1.90	2.01	15.22	5,120	47	1.67	3.32	12.6
WE	2066	61	102	211	1.28	1.38	12.60	5,694	73	1.26	2.23	11.9
CR	2231	103	106	222	1.62	1.79	9.59	5,989	71	1.58	2.81	13.2
WEA	1898	81	91	187	1.17	1.39	9.98	5,483	87	1.15	2.13	10.7
EC	2226	99	109	210	1.47	1.69	12.48	4,293	74	1.63	2.88	13.6
SM	2114	90	90	231	1.52	1.75	12.50	9,750	72	3.03	2.74	12.4
MAR	1861	89	83	194	1.07	1.35	11.30	3,414	55	1.03	2.03	11.8
LE	1822	68	84	186	1.04	1.37	11.50	7,384	59	1.58	2.15	12.9
SHE	1983	87	89	206	1.21	1.49	11.95	8,336	76	1.37	2.23	14.1
MAY	2341	110	114	215	2.03	2.11	16.30	4,016	60	1.54	3.38	12.1

[1] Subject received three vitamin tablets

Table 31

Daily Food Intake of Twenty-two Men with Moderately Advanced, Active Tuberculosis; Individual Data, Period I

Period and Subject	Calories	Protein gm.	Fat gm.	Carbo-hydrate gm.	Calcium gm.	Phos-phorus gm.	Iron mg.	Vitamin A I.U.	Ascorbic Acid mg.	Thiamine mg.	Riboflavin mg.	Niacin mg.
BE	2102	94	102	199	2.40	1.95	8.94	13,193	191	3.82	5.70	29.3
KA[1]	-	-	-	-	-	-	-	-	-	-	-	-
HA	2434	91	164	152	2.67	2.12	16.54	13,429	189	3.65	6.43	23.7
SH	2860	135	128	271	2.68	2.86	16.70	33,340	229	4.23	6.96	34.8
SC	1670	98	76	242	1.68	1.56	19.09	5,411	156	1.79	3.35	12.9
RAA[1]	-	-	-	-	-	-	-	-	-	-	-	-
PR	1599	71	80	152	1.13	1.71	7.58	7,651	197	3.47	4.39	30.8
JE	2080	94	97	200	2.09	1.99	10.14	12,781	210	3.89	5.16	29.1
NE	2391	107	124	205	2.33	2.18	11.90	18,728	234	4.05	6.82	33.1
GO	2509	110	132	253	2.21	1.83	12.10	28,943	194	3.91	5.38	34.1
SI	1790	79	79	207	1.45	1.43	10.09	11,654	224	3.78	4.93	29.8
ST	1403	57	70	136	0.83	1.03	8.40	7,447	241	3.65	3.99	28.7
CZ	2016	74	87	233	1.21	1.55	9.47	9,122	193	3.59	4.63	28.9
WE	1944	77	92	202	1.43	1.43	8.61	10,399	219	3.82	4.84	29.0
CR	2352	99	105	251	1.59	1.70	11.87	9,324	205	3.99	5.09	35.2
WEA	2080	88	97	210	2.95	1.70	11.79	14,015	227	3.90	5.02	14.5
EC	1978	87	90	202	1.49	1.59	10.90	11,227	213	3.74	5.02	31.8
SM	1954	87	77	229	1.61	1.63	11.64	13,099	215	3.87	5.11	30.9
MAR	1132	45	49	127	0.71	0.77	6.00	6,620	171	3.31	3.69	26.0
LE	1962	83	90	208	1.26	1.46	10.60	12,973	203	3.73	4.71	32.2
SHE	2058	88	88	240	1.42	1.60	11.35	13,246	220	3.83	4.89	33.2
HAY	2406	112	119	216	2.13	2.16	11.40	10,861	215	4.13	6.02	33.1

[1] Received surgical treatment

Table 32

Daily Food Intake of Twenty-two Men with Moderately Advanced, Active Tuberculosis; Individual Data, Period II

Period and Subject	Calories	Protein gm.	Fat gm.	Carbo-hydrate gm.	Calcium gm.	Phos-phorus gm.	Iron mg.	Vitamin A I.U.	Ascorbic Acid mg.	Thiamine mg.	Riboflavin mg.	Niacin mg.
BE	2338	97	106	236	2.06	2.02	10.00	14,779	221	3.92	5.85	30.5
RA[1]	1938	82	92	185	2.20	1.89	28.97	10,132	198	3.69	5.59	30.2
HA[1]	2680	95	181	172	5.21	4.89	16.50	14,635	181	3.72	6.46	26.2
SH	1886	93	89	173	1.52	1.74	9.53	13,195	197	3.66	5.17	30.7
SC[1]	1721	80	82	172	1.76	1.66	19.06	9,926	150	2.61	5.37	27.9
HA[1]	1837	86	88	127	1.84	1.74	30.77	29,306	186	5.39	6.12	30.1
PH[2]	-	-	-	-	-	-	-	-	-	-	-	-
JE	1551	72	79	137	1.49	2.15	10.70	10,818	192	2.60	4.91	26.6
NE	2114	101	106	183	1.79	1.88	11.16	15,361	220	3.93	5.45	32.2
GO	1726	86	91	136	1.21	1.43	10.26	11,616	209	4.67	4.07	31.6
SI	2150	91	88	240	1.52	1.71	14.27	13,139	254	3.96	5.06	33.9
ST[3]	-	-	-	-	-	-	-	-	-	-	-	-
CZ	2339	87	101	275	1.39	1.50	8.40	14,684	215	3.45	5.15	29.7
WE	1910	79	89	197	1.46	1.51	8.49	14,182	216	3.66	5.26	11.2
CH	2064	86	87	228	1.46	1.99	13.70	16,628	233	3.82	5.36	31.5
WEA	1910	84	63	207	1.41	1.59	10.93	16,271	235	3.64	5.10	30.1
EC	1814	85	82	187	1.38	1.51	10.60	13,184	238	3.76	5.22	32.8
SM[2]	-	-	-	-	-	-	-	-	-	-	-	-
MAR	1747	75	63	220	1.16	1.30	9.60	9,019	193	3.70	4.56	29.8
LU	1786	75	76	200	1.26	1.76	12.57	15,784	238	3.56	5.00	31.8
SHE	2045	95	83	228	1.67	1.81	12.50	18,127	240	3.89	6.03	33.4
MAY	3169	148	153	287	5.24	3.30	11.75	17,609	237	4.55	6.59	32.1

[1] Received Ferrous sulfate, No. 7, Eli Lilly & Co., Indianapolis

[2] Left sanatorium against medical advice

[3] Received surgical treatment, omitted period II

Table 33

Daily Food Intake of Twenty-two Men with Moderately Advanced, Active Tuberculosis; Individual Data, Period III

Period and Subject	Calories	Protein gm.	Fat gm.	Carbo-hydrate gm.	Calcium gm.	Phos-phorus gm.	Iron mg.	Vitamin A I.U.	Ascorbic Acid mg.	Thiamine mg.	Riboflavin mg.	Niacin mg.
BE	2786	118	127	285	2.64	2.49	11.42	12,827	228	4.32	6.76	30.4
RA[1]	1185	54	56	115	1.03	1.04	27.08	11,447	198	3.19	4.20	27.1
ML[1]	1681	99	175	166	2.77	2.13	17.88	13,000	185	3.88	6.66	25.3
SH	2098	90	81	250	1.48	1.64	14.10	20,420	176	3.66	5.05	31.0
SC[1]	1745	81	81	171	1.53	1.55	19.82	7,457	220	3.71	4.99	28.0
RR[2]	-	-	-	-	-	-	-	-	-	-	-	-
PR	-	-	-	-	-	-	-	-	-	-	-	-
JE	2082	101	101	188	1.89	1.91	10.20	11,146	192	4.06	5.62	31.9
ME	1821	90	92	154	1.55	1.87	9.66	13,871	210	3.89	5.30	32.1
GO	1723	76	80	172	1.12	1.29	9.44	8,211	201	3.76	4.41	30.6
SI	2257	94	96	253	1.66	1.77	12.10	11,779	233	2.81	5.23	33.1
ST	1306	52	60	140	1.03	1.03	6.07	7,393	233	3.27	4.12	27.2
CZ	2564	95	134	250	1.50	1.67	12.37	16,284	195	3.81	5.41	33.8
WE	2086	80	100	216	1.42	1.52	8.93	11,540	165	3.65	4.90	30.4
CR	2002	83	83	229	1.55	1.62	10.10	11,508	239	3.87	5.01	30.7
MM	1760	82	79	194	1.50	1.57	9.66	9,255	208	2.70	4.97	30.1
EC	1692	82	87	173	1.49	1.59	10.44	14,865	218	3.78	5.24	31.8
SM[3]	-	-	-	-	-	-	-	-	-	-	-	-
MR	1681	69	70	171	1.10	1.24	9.10	7,977	215	3.86	4.39	32.2
LN	1641	68	75	173	0.92	1.17	9.60	12,805	206	3.53	4.51	32.1
SHE[3]	-	-	-	-	-	-	-	-	-	-	-	-
MAY	2796	135	140	244	3.34	3.05	16.10	8,654	200	4.43	8.45	30.6

[1] Received Ferrous sulfate, No. 7, Eli Lilly & Co., Indianapolis

[2] Transferred to Detroit sanatorium

[3] Left sanatorium against medical advice

Table 34

Average Daily Intake of Twelve Men with Far Advanced, Active Tuberculosis; Individual Data

Period and Subject	Calories	Protein gm.	Fat gm.	Carbo-hydrate gm.	Calcium gm.	Phos-phorus gm.	Iron mg.	Vitamin A I.U.	Ascorbic Acid mg.	Thiamine mg.	Riboflavin mg.	Niacin mg.
Control period												
BA	1795	87	73	207	1.17	1.34	18.50	5,408	76	1.19	2.11	11.0
RAN	2006	81	85	224	1.30	1.44	11.64	8,216	77	1.32	2.28	13.0
DA	1664	73	73	178	1.31	1.42	8.64	4,247	83	1.12	2.23	9.3
RI	1661	69	76	171	1.81	1.29	12.30	9,670	66	1.28	2.01	11.6
MO	1487	55	59	164	0.86	1.01	8.57	7,000	63	0.89	1.54	9.[illegible]
SMI	2350	106	110	232	2.45	2.23	10.80	13,495	77	1.48	3.84	11.0
MA	1687	75	77	172	1.20	1.32	11.10	7,509	105	1.25	6.74	11.2
BAK	1587	70	64	166	1.13	1.22	7.40	7,796	67	0.94	1.94	8.9
BER	1647	70	76	172	1.02	1.19	9.83	7,002	67	0.86	0.86	8.5
JA	1035	43	36	126	0.62	0.77	6.11	2,571	39	0.67	1.16	7.4
HUG	2647	151	121	253	2.33	2.38	13.80	12,397	101	1.73	3.93	7.1
SA	1425	66	64	145	1.11	1.23	9.80	9,695	87	1.03	1.90	9.5
Period I												
BA	1836	82	88	117	1.27	1.48	9.94	12,544	207	3.58	4.72	32.7
RAN	1720	72	80	178	1.10	1.31	9.07	8,606	211	3.65	4.53	30.6
DA	1794	87	77	183	1.44	1.63	10.50	6,186	256	3.73	5.38	32.0
RI	1754	74	80	182	1.14	1.30	9.14	12,670	209	3.66	4.50	30.0
MO	2084	94	104	193	1.84	1.78	11.16	13,966	223	4.02	5.29	33.0
SMI	2536	114	119	249	2.51	2.33	10.01	15,483	228	4.09	6.53	32.3
MA	2024	87	92	212	1.67	1.72	10.40	15,143	248	3.81	5.54	30.4
BAK	1657	68	74	179	1.23	1.25	10.03	18,219	246	3.71	5.16	30.8
BER[1]	-	-	-	-	-	-	-	-	-	-	-	-
JA	1985	88	103	175	1.78	1.79	8.90	10,064	194	3.54	5.51	27.2
HUG	2714	121	125	272	2.64	2.52	12.97	21,850	234	4.17	6.93	31.2
SA	1651	84	73	157	1.43	1.54	10.60	13,360	206	3.59	4.88	31.5

Period II												
BA[2]	-	-	-	-	-	-	-	-	-	-	-	-
RAN	1707	71	80	194	1.15	1.26	9.76	12,687	222	3.72	4.37	30.88
DA	1722	60	78	163	1.26	1.47	9.40	9,740	223	3.65	4.48	31.37
RI	1798	81	82	183	1.11	1.36	10.01	10,725	212	3.70	4.52	31.46
MO[2]	-	-	-	-	-	-	-	-	-	-	-	-
SMI	2488	119	117	243	2.60	2.39	9.72	15,505	224	4.07	7.49	31.07
MA	2288	102	106	229	1.75	1.91	12.54	12,498	174	3.95	4.46	33.70
BAK	1936	89	86	206	1.51	1.65	11.04	13,683	184	3.81	5.00	30.49
BER[1]	-	-	-	-	-	-	-	-	-	-	-	-
JA	1791	58	82	167	1.33	1.50	9.80	10,129	193	3.39	4.00	29.00
HUG	2679	116	121	276	2.48	2.39	12.80	21,295	246	4.13	6.72	34.59
SA	1976	92	98	180	1.74	1.81	11.07	12,236	206	3.84	5.73	30.12
Period III												
BA[2]	-	-	-	-	-	-	-	-	-	-	-	-
RAN	1400	68	63	124	0.79	1.88	7.12	7,471	195	3.42	4.04	30.17
DA	1940	68	67	105	1.38	1.35	7.12	9.102	231	3.58	3.35	27.00
RI	2043	98	107	212	1.56	1.69	10.61	11,248	224	3.84	5.15	32.06
MO[2]	-	-	-	-	-	-	-	-	-	-	-	-
SMI	2467	125	121	255	2.84	2.65	14.61	11,217	230	4.27	6.98	30.95
MA	2139	93	96	225	1.82	1.62	10.11	13,787	249	6.17	5.74	29.98
BAK	1739	72	71	202	1.22	1.35	8.70	15,345	244	3.62	4.57	32.60
BER	1984	90	80	222	1.43	1.62	16.19	16,593	230	3.63	5.32	32.70
JA[2]	-	-	-	-	-	-	-	-	-	-	-	-
HUG[2]	-	-	-	-	-	-	-	-	-	-	-	-
SA	1069	38	59	101	0.91	0.98	6.66	9,615	221	3.22	4.10	26.14

[1] Received surgical treatment

[2] Left sanatorium against medical advice

Table 35

Physical Description of Men Patients With Moderately Advanced, Actice Tuberculosis

Subject	Age	Height	Weight Initial lbs	Weight Final lbs	Standard Weight For Height lbs	Percent Deviation From Standard Weight Initial %	Percent Deviation From Standard Weight Final %	Gain or Loss lbs
BE	26	5' 8"	138	142	150	-8	-9	+4
MA[1]	27	5' 11"	149	150	160	-9	-8	+1
HA	20	5' 7"	110	124	142	-23	-13	+14
SH	28	6' 2"	145	137	181	-20	-24	-8
SC	23	5' 11"	145	158	158	-8	0	+13
RAM[1,2]	28	5' 9"	137	136	154	-11	-12	-1
PR[3]	47	5' 9"	132	132	166	-20	-20	0
JE	35	5' 7"	142	161	152	-7	+6	+19
NE	34	5' 4"	132	140	137	-4	+2	+8
GO	27	5' 11"	182	187	163	+12	+15	+5
SI	23	5' 7"	160	160	142	+13	+13	0
ST[4]	55	5' 3"	113	111	143	-21	-23	-2
CZ	52	5' 8"	149	155	162	-8	-4	+6
WE	48	5' 6"	145	147	152	-5	-3	+2
CR	39	5' 8"	185	186	157	+17	+18	+1
WEA	40	5' 6"	137	139	152	-10	-9	+2
EC	58	5' 4"	170	175	146	+16	+20	+5
SM[3]	22	5' 8"	125	117	146	-14	-20	-8
MAR	65	5' 10 1/2"	134	139	176	-24	-21	+5
LE	65	5' 3"	123	137	143	-14	-4	+14
SHE[2]	45	5' 10 3/4"	151	154	176	-14	-12	+3
MAY	18	5' 7 1/2"	148	148	138	+7	+7	0

1 Received surgical treatment, omitted period I

2 Omitted period III

3 Control period and period I only

4 Received surgical treatment, omitted period II

Table 36

Physical Description of Men Patients With Far Advanced, Active Tuberculosis

Subject	Age	Height	Weight Initial lbs	Weight Final lbs	Standard Weight For Height lbs	Percent Deviation From Standard Weight Initial %	Percent Deviation From Standard Weight Final %	Gain or Loss lbs
BA[1]	47	5' 5"	115	131	148	-22	-11	+16
RAN	40	5' 7"	148	153	154	-4	-1	+5
DA	66	5' 10"	93	107	173	-46	-38	+14
RI	66	5' 10"	165	168	173	-5	-3	+3
MC[1]	63	5' 9"	142	143	168	-15	-15	+1
SMI	30	5' 10 1/2"	145	157	165	-12	-5	+12
MA	57	5' 11"	137	137	179	-23	-23	0
BAR	48	5' 7"	115	119	156	-26	-23	+4
BER[2]	41	6' 0"	147	142	181	-19	-22	-5
JA[3]	68	5' 6"	92	106	154	-40	-30	+14
HUG[3]	20	6' 3"	164	183	178	-8	+3	+19
SA	30	5' 10"	131	135	163	-20	-17	+4

1 Control period and period I only

2 Received surgical treatment; omitted period I and II

3 Omitted period III

Table 37

The Fasting Blood Constituents of Fifteen Women with Moderately Advanced, Active Tuberculosis; Individual Data, Control Period

Period and Subject	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mg./100 ml.	Serum Carotene mg./100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units[1]
Control period						
HU	11.25	7.22	33	155	1.22	3.00
MO	11.63	7.00	31	80	0.75	3.14
ACO	13.88	6.20	26	71	0.90	2.44
DE	12.75	7.22	25	86	1.20	1.70
PA	14.00	7.05	21	101	1.20	1.50
LA	12.75	7.15	17	66	0.77	3.40
DCO	11.63	6.72	11	42	0.54	1.80
KM	12.75	6.72	28	88	1.73	2.00
ER	13.75	6.55	31	89	0.86	1.80
MS	13.75	6.72	58	208	1.27	3.16
AS	14.00	6.55	40	149	0.73	1.54
DO	16.00	6.75	40	92	0.28	2.20
DU	15.85	7.22	34	76	0.48	2.50
EA	15.75	7.30	59	103	1.38	0.90
MI	14.50	6.05	39	94	0.78	0.90

[1] Nitrophenol Unit -- one unit is the amount of phosphatase activity per liter of serum which required to liberate one millimole of nitrophenol per hour from sodium para-nitrophenyl phosphate under the specific conditions of the test.

Table 36

The Fasting Blood Constituents of Fifteen Women with Moderately Advanced, Active Tuberculosis; Individual Data, Period I

Period and Subject	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mg./100 ml.	Serum Carotene mg./100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
MU	12.75	7.23	26	138	1.38	1.30
MO	13.00	6.47	39	93	1.30	1.15
MCO	13.25	6.33	35	71	0.50	2.44
DE	11.25	7.03	57	127	1.10	1.25
PA	13.00	6.33	53	107	1.60	1.30
LA	14.25	6.92	28	71	0.60	0.45
DCO	12.00	6.70	22	71	0.54	1.09
KN	12.50	6.50	27	103	0.66	1.28
MR	14.00	6.17	73	158	0.77	0.83
HS	13.75	6.47	106	171	1.30	1.90
MS	13.25	6.55	51	154	1.12	1.50
DO	17.00	6.75	43	80	1.29	3.00
DU	15.25	7.10	34	7[illegible]	1.14	2.35
MA	16.00	7.53	66	168	1.35	0.65
MI	14.00	7.10	44	153	1.75	1.50

Table 39

The Fasting Blood Constituents of Fifteen Women with Moderately Advanced, Active Tuberculosis; Individual Data, Period II

Period and Subject	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mg./100 ml.	Serum Carotene mg./100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
HU[1]	-	-	-	-	-	-
MO	14.50	5.95	40	86	1.39	1.40
ACO	15.25	6.15	42	81	1.69	0.50
DM	13.50	7.00	38	114	1.75	0.90
PA	13.50	5.72	33	71	1.43	0.70
LM	14.00	7.15	38	86	1.23	1.10
DCO	14.50	6.[illegible]5	32	61	1.60	0.50
KH	13.00	6.70	37	138	1.68	1.00
MR	14.50	6.10	35	139	1.06	1.00
HS	14.50	6.50	49	170	1.75	1.[illegible]0
AS	12.00	6.15	33	88	1.24	2.00
DO	14.50	6.25	54	68	1.23	2.10
DU	14.00	7.30	38	[illegible]0	1.50	2.25
MA	14.50	7.38	64	196	1.20	1.04
MI	12.50	7.15	48	88	1.08	1.40

[1] Transferred to the Michigan State Sanatorium

Table 40

The Fasting Blood Constituents of Fifteen Women with Moderately Advanced, Active Tuberculosis; Individual Data, Period III

Period and Subject	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mg./100 ml.	Serum Carotene mg./100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
HU[1]	-	-	-	-	-	-
NO	14.00	6.18	51	83	1.60	1.30
ACO	14.50	5.95	37	67	1.40	0.64
DE	13.50	6.85	33	102	1.53	1.20
PA	13.50	6.00	31	59	1.42	1.08
LA	15.25	6.65	44	96	0.66	2.01
DCO	12.00	6.65	36	98	2.08	0.90
KN[2]	-	-	-	-	-	-
ER	14.50	6.55	40	140	1.19	0.92
HS	15.25	7.15	72	155	2.13	1.45
AS	14.25	6.70	36	121	1.55	0.92
DO	16.00	6.85	37	74	1.53	2.24
DU	15.25	7.38	58	44	1.54	2.85
ER	14.50	7.15	48	174	1.36	1.34
MI	13.75	6.75	66	157	1.48	1.43

1 Transferred to Michigan State Sanatorium

2 Discharged to her home

Table 41

The Fasting Blood Constituents of Four Women with Far Advanced, Active Tuberculosis, Individual Data

Period and Subject	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mg./100 ml.	Serum Carotene mg./100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
Control period						
RO	11.25	6.33	41	146	0.60	1.90
HO	11.25	6.85	36	60	0.28	1.60
ME	12.50	6.70	43	73	0.95	1.43
HU	12.50	6.70	32	374	1.28	2.20
Period I						
RO	13.00	7.90	52	127	1.34	1.76
HO	12.50	6.44	29	53	1.48	2.25
ME	13.00	7.18	41	69	1.50	1.80
HU	12.75	7.18	26	219	0.89	1.66
Period II						
RO	14.50	6.63	55	83	1.50	1.96
HO	14.50	6.93	41	27	1.85	2.30
ME	15.25	7.03	38	24	1.44	1.60
HU[1]	-	-	-	-	-	-
Period III						
RO	13.75	6.50	85	125	1.78	1.56
HO	14.00	8.05	41	84	1.80	1.83
ME	13.90	6.63	64	63	1.80	1.30
HU[1]	-	-	-	-	-	-

[1] Subject died

Table 42

Fasting Blood Constituents of Twenty-two Men with Moderately Advanced, Active Tuberculosis; Individual Data, Control Period

Period and Subject	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mg./100 ml.	Serum Carotene mg./100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
BE	14.00	7.00	26	103	1.33	0.90
RA	14.50	5.17	34	76	1.20	1.20
HA	16.50	6.60	35	54	0.50	1.40
SH	12.50	6.25	47	35	1.30	1.10
SC	12.50	7.30	39	106	0.45	1.50
RAA	15.05	7.00	47	124	1.00	0.80
PR	13.75	5.50	36	129	0.18	1.60
JE	17.50	7.15	77	73	1.94	0.90
NE	15.30	7.95	38	74	0.28	1.80
GO	16.13	6.48	31	56	0.35	1.50
SI	17.50	6.60	34	52	0.30	2.00
ST	14.78	7.40	72	107	1.50	2.30
CZ	14.50	7.40	31	99	0.08	3.24
WE	16.50	6.75	49	114	0.28	1.80
CR	16.38	6.25	63	76	0.43	2.40
WEA	17.88	7.55	48	132	1.33	1.50
EC	15.05	6.70	32	107	0.43	0.80
SM	16.50	6.70	50	56	0.20	1.25
MAR	18.75	8.10	56	89	0.48	1.45
LE	16.25	7.45	49	131	0.38	1.25
SHE	15.25	7.25	40	150	0.55	1.00
HAY	17.00	6.80	29	31	0.50	1.60

Table 43

Fasting Blood Constituents of Twenty-two Men with Moderately Advanced, Active Tuberculosis; Individual Data, Period I

Period and Subject	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mg./100 ml.	Serum Carotene mg./100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
BE	16.00	7.30	51	127	1.23	1.30
RA[1]	-	-	-	-	-	-
HA	16.75	7.15	45	79	1.10	1.70
SH	14.88	7.15	56	88	1.68	1.60
SC	13.00	7.37	47	124	1.50	1.66
RMA[1]	-	-	-	-	-	-
PA	13.50	6.48	57	133	2.28	1.40
JE	17.00	6.78	46	78	1.60	2.10
NE	15.25	6.43	47	96	1.55	2.10
GO	16.00	6.78	72	75	1.40	2.00
SI	18.50	6.25	41	50	1.30	1.80
ST	14.00	7.00	97	99	1.25	1.50
CZ	15.25	6.85	35	114	1.60	3.20
WE	16.50	6.18	62	121	1.40	1.35
CR	16.50	6.18	45	70	1.26	1.85
WEA	18.50	7.25	47	108	2.00	1.60
EC	15.25	6.48	53	99	1.63	0.70
SM	16.50	6.18	55	53	1.48	2.40
HAR	18.00	6.85	29	59	0.95	1.30
LE	16.00	7.15	57	133	1.06	2.00
SHE	16.00	7.00	34	130	1.55	0.35
HAY	17.00	7.30	30	40	1.28	1.66

1 Received surgical treatment

Table 44

Fasting Blood Constituents of Twenty-two Men with Moderately Advanced, Active Tuberculosis; Individual Data, Period II

Period and Subject	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mg./100 ml.	Serum Carotene mg./100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
BE	16.50	7.27	36	107	1.55	1.10
RA	16.00	6.30	33	77	1.43	1.30
MA	18.25	7.30	48	76	1.24	1.40
SH	16.50	6.77	30	61	1.40	1.20
SC	15.63	7.00	33	123	1.35	1.50
MAA	16.50	7.30	32	104	1.53	2.10
FA[1]	-	-	-	-	-	-
JE	15.25	6.47	48	58	1.35	1.90
NE	17.50	7.65	55	91	1.18	1.52
GO	18.25	6.77	55	61	1.52	1.70
SI	17.00	6.10	46	62	1.36	1.70
ST[2]	-	-	-	-	-	-
CZ	14.00	7.53	51	168	1.53	3.80
WE	16.00	6.63	57	138	1.45	2.25
CH	15.25	6.48	73	106	1.38	[illegible]
WEA	16.00	7.23	55	143	2.20	[illegible]
EC	14.00	6.78	48	107	1.68	1.10
SA[1]	-	-	-	-	-	-
MAR	17.00	6.78	54	74	1.83	1.75
LE	15.25	7.30	44	134	1.38	1.50
SHE	16.50	7.47	45	137	1.59	1.20
MAY	16.50	7.38	33	41	0.36	1.80

1 Left sanatorium against medical advice

2 Received surgical treatment

Table 45

Fasting Blood Constituents of Twenty-two Men with Moderately Advanced, Active Tuberculosis; Individual Data, Period III

Period and Subject	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mg./100 ml.	Serum Carotene mg./100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
BE	16.50	6.85	[illegible]	100	1.34	1.40
AA	16.00	6.10	43	82	1.55	1.20
HA	18.00	6.85	51	85	1.49	1.70
SH	15.25	7.00	41	66	1.73	1.80
SC	16.75	7.00	40	110	1.50	1.60
RA[1]	-	-	-	-	-	-
PH[2]	-	-	-	-	-	-
JE	18.00	7.15	64	50	1.18	1.65
ME	17.00	7.50	65	93	1.54	1.55
GO	17.00	6.95	66	67	[illegible]	1.30
SI	16.50	6.25	51	64	1.41	2.30
ST	15.25	7.08	93	129	1.49	[illegible]
CZ	1[illegible].25	7.45	45	165	0.99	3.64
ML	16.50	6.25	59	132	1.50	2.90
CH	16.75	6.75	61	118	1.35	4.20
WA	1[illegible].50	7.52	59	166	1.91	2.34
LO	14.50	6.32	54	94	1.65	1.58
SA[2]	-	-	-	-	-	-
MAR	19.00	7.52	68	172	2.06	3.90
LE	16.50	7.15	4[illegible]	113	1.23	1.44
SHE	-	-	-	-	-	-
HAY	17.00	7.30	31	26	1.44	1.90

[1] Transferred to Detroit Sanatorium

[2] Left sanatorium against medical advice

Table 46

The Blood Constituents of Twelve Men with Far Advanced, Active Tuberculosis; Individual Data

Period and Subject	Hemoglobin gm./100 ml.	Serum Protein gm./100 ml.	Serum Vitamin A mg./100 ml.	Serum Carotene mg./100 ml.	Serum Ascorbic Acid mg./100 ml.	Serum Alkaline Phosphatase Nitrophenol Units
Control period						
BA	16.50	7.40	67	192	0.28	3.80
MAN	14.00	6.70	40	181	0.60	3.90
DA	10.25	6.88	72	135	0.35	3.10
MI	14.50	7.15	40	81	0.38	2.10
MO	13.10	6.63	55	158	0.58	1.94
SMI	18.50	7.15	78	81	0.48	2.00
MA	13.50	6.48	33	55	0.25	1.40
BAK	13.50	7.50	19	34	0.76	1.20
BER	15.25	7.70	55	130	0.61	2.05
JA	12.00	7.52	39	70	0.60	2.80
HUG	14.00	7.70	53	94	0.59	2.70
SA	14.50	6.70	69	83	0.33	1.44
First experimental period						
BA	16.25	7.60	121	226	1.55	3.22
MAN	14.00	6.93	58	249	1.51	1.76
DA	12.00	6.85	63	134	0.60	1.50
MI	14.00	6.78	56	126	1.17	1.65
MO	14.00	5.88	65	183	1.35	1.35
SMI	16.50	6.55	71	154	1.38	1.36
MA	14.50	6.82	25	60	0.83	1.50
BAK	14.00	8.15	28	133	2.28	1.40
BER[2]	-	-	-	-	-	-
JA	12.50	7.93	58	154	1.24	2.90
HUG	14.88	7.63	52	102	1.33	2.66
SA	14.50	6.43	59	98	1.53	1.66

Second experimental period

BA[1]	-	-	-	-	-	-
MAN	18.00	7.23	56	188	2.10	1.28
DA	13.25	6.43	67	61	0.70	2.50
MI	16.00	7.00	47	60	1.03	1.90
MO[1]	-	-	-	-	-	-
SMI	18.00	6.43	48	56	1.03	1.86
MA	14.50	6.60	38	49	0.73	1.60
BAK	16.00	7.50	50	51	1.44	1.74
BER[2]	-	-	-	-	-	-
JA	12.50	7.15	30	75	1.38	2.40
HUG	16.00	7.12	47	36	1.16	2.00
SA	16.25	6.28	51	26	1.25	1.48

Third experimental period

BA[1]	-	-	-	-	-	-
MAN	16.50	7.30	66	221	1.23	1.96
DA	14.25	6.80	85	144	0.97	2.50
MI	16.25	7.10	85	105	1.65	1.64
MO[1]	-	-	-	-	-	-
SMI	18.25	7.20	93	118	1.10	1.90
MA	15.25	5.65	16	43	1.58	1.30
BAK	16.75	7.75	50	102	1.80	2.10
BER	13.30	7.40	75	120	1.89	1.70
JA[1]	-	-	-	-	-	-
HUG[1]	-	-	-	-	-	-
SA	15.10	6.18	70	69	1.76	1.24

[1] Left against medical advice

[2] Received surgical treatment

Table 47

Variation in Temperatures[1] of Nineteen Women
With Active Tuberculosis

	Control Period		First Period		Second Period		Third Period	
	7 Days Ave.	Test Day	7 Days Ave.	Test Day	7 Days Ave.	Test Day	7 Days Ave.	Test Day
Moderately advanced, active tuberculosis								
HU	98.4±.26[2]	98.2	98.4±.40	98.0	-	-	-	-
NO	98.4±.23	98.2	98.6±.23	98.6	98.3±.30	98.2	98.4±.14	98.4
ACO	98.0±.17	97.8	98.3±.21	98.4	98.3±.33	99.0	98.3±.30	98.8
DE	98.2±.14	98.0	98.4±.23	98.6	98.3±.30	98.4	98.6±.26	98.6
PA	98.3±.33	98.0	98.5±.27	98.6	98.4±.37	98.6	98.7±.17	98.6
LA	98.0±.23	98.0	98.1±.36	98.6	98.0±.49	97.8	97.9±.26	97.6
DCO	97.7±.17	98.0	98.3±.24	98.0	98.2±.37	97.2	98.3±.24	98.0
KN	98.1±.19	98.2	98.4±.40	97.0	98.4±.26	98.0	- -	-
EK	98.4±.20	98.0	98.4±.20	98.0	98.3±.27	98.0	98.5±.26	98.6
HS	98.2±.20	98.4	98.0±.20	97.6	98.3±.30	98.6	98.3±.41	98.0
AS	98.0±.54	98.6	98.3±.24	98.4	98.4±.60	98.0	97.9±.24	98.0
DO	98.6±.26	98.4	98.4±.31	98.6	98.1±.36	97.0	97.9±.30	98.0
DU	98.5±.13	98.6	98.7±.27	98.6	98.6±.17	98.8	98.2±.43	98.0
EA	98.7±.20	99.0	98.7±.21	98.4	98.3±.30	98.2	98.6±.26	98.6
MI	98.3±.24	98.4	98.6±.14	98.4	98.7±.24	98.6	99.2±.26	99.2
Far advanced, active tuberculosis								
RO	97.4±.40	97.8	98.7±.36	98.6	98.7±.25	98.6	98.4±.31	98.0
HO	98.2±.31	98.0	97.9±.36	98.2	97.9±.61	98.6	98.1±.56	98.0
ME	98.7±.24	98.6	98.4±.26	98.6	98.1±.73	98.6	98.5±.13	98.2
HU	99.6±.40	100.4	100.5±.66	100.4	-	-	-	-

[1] Degrees Fahrenheit

[2] Mean deviation

Table 48

Variation in Temperatures[1] of Thirty-Four Men Patients With Active Tuberculosis

	Control Period		First Period		Second Period		Third Period	
	7 Days Ave.	Test Day	7 Days Ave.	Test Day	7 Days Ave.	Test Day	7 Days Ave.	Test Day
Moderately advanced								
BE	98.8±.09[2]	98.6	98.2±.23	98.0	98.2±.23	98.0	98.4±.17	98.2
RA	97.9±.13	98.0	-	-	97.8±.11	97.9	97.9±.71	97.4
HA	98.2±.23	98.0	97.8±.34	97.8	97.5±.30	97.0	98.2±.26	98.4
SH	98.5±.19	98.6	97.6±.31	98.0	97.9±.30	98.0	98.3±.29	98.4
SC	97.9±.61	97.8	97.9±.19	97.8	97.7±.49	98.6	97.9±.19	98.2
RAA	98.0±.14	98.0	-	-	98.0±.14	98.6	-	-
PR	98.6±.37	98.2	98.4±.26	98.2	-	-	-	-
JE	98.3±.15	98.2	98.2±.36	98.0	98.7±.39	98.6	98.0±.14	98.0
NE	98.0±.26	97.8	97.5±.37	97.4	97.9±.50	98.2	98.4±.23	98.0
GO	97.6±.37	97.6	97.5±.33	97.2	97.6±.37	97.6	97.6±.26	97.2
SI	98.6±.26	98.6	98.3±.24	98.0	98.2±.29	98.0	98.6±.46	98.0
ST	98.0±.14	97.6	98.5±.21	97.8	-	-	98.5±.21	98.6
CZ	98.0±.20	97.6	98.2±.20	98.2	98.4±.34	98.4	98.4±.23	98.2
WE	98.3±.21	98.0	98.4±.23	98.4	98.4±.33	98.2	98.6±.20	98.0
CR	98.3±.19	98.2	98.5±.30	98.4	98.7±.44	98.6	98.5±.21	98.6
WEA	98.3±.19	98.2	98.4±.25	98.4	98.9±.24	98.8	98.5±.16	98.4
EC	98.2±.11	98.2	98.2±.29	98.6	98.2±.26	98.0	98.7±.39	98.0
SM	98.5±.19	98.6	98.5±.30	98.4	-	-	-	-
MAR	98.1±.30	98.4	98.7±.76	98.0	98.3±.16	98.2	98.5±.41	98.2
LE	98.1±.17	98.0	98.4±.26	98.0	98.7±.27	98.2	98.8±.31	99.2
SHE	98.4±.14	98.2	98.1±.19	98.0	98.3±.31	98.2	-	-
HAY	98.4±.20	98.0	98.5±.29	98.4	98.7±.13	99.5	98.6±.14	98.6
Far advanced								
BA	98.1±.24	98.0	97.7±.24	98.0	-	-	-	-
RAN	98.9±.10	98.8	98.5±.10	98.6	98.7±.26	98.0	98.8±.27	98.6
DA	98.7±.27	98.8	98.6±.26	98.6	98.1±.17	98.0	98.3±.27	98.2
RI	98.3±.33	98.6	98.0±.20	98.6	98.0±.29	97.8	98.4±.26	98.6
MO	98.4±.23	97.8	97.9±.43	98.0	-	-	-	-
SM	97.6±.23	97.6	97.5±.44	97.2	97.8±.26	97.6	97.8±.34	98.0
MA	98.6±.11	98.4	99.0±.19	99.6	98.4±.19	98.6	99.1±.14	99.2
BAR	99.4±.36	99.2	98.3±.37	98.6	98.0±.20	97.8	98.3±.30	97.8
BER	98.4±.26	98.6	-	-	-	-	98.5±.13	98.4
JA	98.1±.44	98.4	98.1±.44	97.0	98.0±.49	97.6	-	-
HUG	98.0±.34	98.2	98.4±.20	98.2	98.2±.34	97.2	-	-
SA	98.6±.09	98.6	98.1±.19	98.6	98.1±.41	98.0	98.6±.31	98.4

[1] Degrees Fahrenheit

[2] Mean deviation

Table 49

Brief Summary of Number of Sanatoria Admissions, Degree of Tuberculosis and the Progress of Each Patient; Women with Moderately, Active Tuberculosis

Subject	Age	Date of Initial Diagnosis of Tuberculosis	Number of Sanatoria Admissions	Date of Last Admission	Initial Date of Control Period	Diagnosis	Comments
[illegible]	42	Late '49	2	2-19-51	10-30-52	Mod. adv.	Slightly clearing; Sputum remained positive
MO	22	May '52	1	9-13-52	10-30-52	Mod. adv.	Improvement
[illegible]OO	30	May '52	1	9-13-52	10-30-52	Mod. adv.	Marked clearing of infiltration
D[illegible]	23	6-24-52	1	6-30-52	10-30-52	Mod. adv.	Steady and continuous clearing
F[illegible]	15	10-24-52	1	10-27-52	10-30-52	Mod. adv.	Progress favorable
L[illegible]	55	'45	1	[illegible]-13-52	10-30-52	Mod. adv.	Asthma; progress satisfactory
DCO	30	2-5-52	1	2-8-52	10-30-52	Mod. adv.	3 operations during experiment; recovery favorable
K[illegible]	25	11-51	1	11-10-51	10-30-52	Mod. adv.	Discharged to her home May 10, 1953
[illegible]	32	9-48	2	7-10-50	10-30-52	Mod. adv.	Discharged to her home June 1953
[illegible]	51	'50	1	6-20-50	10-30-52	Mod. adv.	Discharged, Sept. '53
[illegible]S	37	'49	1	11-20-49	10-30-52	Mod. adv.	Lobectomy; progress favorable Discharged to her home Oct. '53
DO	53	2-6-53	1	2-25-53	5-2-53	Mod. adv.	Progress favorable
D[illegible]	15	1-53	1	1-4-53	5-2-53	Mod. adv.	Progress good; discharged to her home, Dec. '53
[illegible]	26	2-5-53	1	4-13-53	5-2-53	Mod. adv.	Progress good
[illegible]I	30	11-52	1	1-7-53	5-2-53	Mod. adv.	Improvement; discharged to her home 2-54

Table 50

Brief Summary of Number of Sanatoria Admissions, Degree of Tuberculosis and the Progress of Each Patient; Women with Far Advanced, Active Tuberculosis

Subject	Age	Date of Initial Diagnosis of Tuberculosis	Number of Sanatoria Admissions	Date of Last Admission	Initial Date of Control Period	Diagnosis	Comments
MO	27	8-53	1	8-7-53	8-7-53	Far adv.	Continuing clearing
NO	36	Early '53	1	5-16-53	8-7-53	Far adv.	Cavity is not definite Some improvement
ME	23	4-53	1	7-15-53	8-7-53	Far adv.	Slight clearing
MU	43	Late '49	3	6-3-53	8-7-53	Far adv.	Died High temperature Infection Sputum positive

Table 51

Brief Summary of Number of Sanatoria Admissions, Degree of Tuberculosis and the Progress for Each Patient; Men With Moderately Advanced, Active Tuberculosis

Subject	Age	Date of Initial Diagnosis of Tuberculosis	Number of Sanatoria Admissions	Date of Last Admission	Initial Date of Control Period	Diagnosis	Comments
BE	26	1-48-Far adv.	3	9-10-52	12-10-52	Mod. adv.	Clearing of infiltration
[illegible]	27	12-14-51 Minimal	1	10-6-52	12-10-52	Mod. adv.	Discharged 7-9-53
[illegible]	20	7-7-50 Far adv.	2	1-19-52	12-10-52	Mod. adv.	Clearing favorably
SH	28	9-12-51	2	12-3-52	12-10-52	Mod. adv.	Recovering favorably 11-23-53
SC	23	Fall-48 Far adv.	2	12-26-51	12-10-52	Mod. adv.	Clearing infiltration
[illegible]	28	7-47 observed at home	1	5-9-52	12-10-52	Mod. adv.	Transferred to Detroit Sana.
PH	47	6-2-49	2	9-23-52	12-10-52	Mod. adv.	Left against medical advice Clearing
JE	35	9-5-51 Far adv.	1	9-16-51	12-10-52	Mod. adv.	Discharged 11-19-53
ME	34	12-11-49	2	10-14-52	12-10-52	Mod. adv.	Discharged 10-9-53
GO	27	Late 1948	2	10-7-52	12-10-52	Mod. adv.	Discharged 7-1-53
SI	23	2-53	1	2-24-53	5-2-53	Mod. adv.	Progress good
SI	55	1-53	1	3-23-53	5-2-53	Mod. adv.	Received operation; progress satisfactory
CZ	52	12-52	1	3-10-53	5-2-53	Mod. adv.	Shows improvement
[illegible]	48	1-26-53	1	1-29-53	5-2-53	Mod. adv.	He has done very well in handling tuberculosis
CH	39	1-53 1-3 Far adv.	1	1-14-53	5-2-53	Mod. adv.	Improvement
[illegible]	40	9-52	1	2-18-53	5-2-53	Mod. adv.	Response to therapy was satisfactory
[illegible]	58	Inactive '[illegible]	1	1-7-53	5-2-53	Mod. adv.	Continued improvement
[illegible]	22	1-53	1	3-23-53	5-2-53	Mod. adv.	Progress good; discharged against medical advice after period I
[illegible]	65	1-7-53	1	3-10-53	5-2-53	Mod. adv.	Progress fair
LE	65	2-9-53	1	2-19-53	5-2-53	Mod. adv.	Progress fair; continued clearing
[illegible]	45	3-53	1	3-19-53	5-2-53	Mod. adv.	Further improvement Left 9-30-53
[illegible]	18	9-52	1	2-5-53	5-2-53	Mod. adv.	Good

Table 52

Brief Summary of Number of Sanatoria Admissions, Degree of Tuberculosis and the Progress for Each Patient; Men With Far Advanced, Active Tuberculosis

Subject	Age	Date of Initial Diagnosis of Tuberculosis	Number of Sanatoria Admissions	Date of Last Admission	Initial Date of Control Period	Diagnosis	Comments
BA	47	7-14-53	1	7-17-53	8-7-53	Far adv.	Left 9-22-53; good
RMW	40	4-53	1	5-1-53	8-7-53	Far adv.	Some clearing of the infiltration
DA	66	1-53	1	1-7-53	8-7-53	Far adv.	Continued clearing
MI	66	11-52	1	2-16-53	8-7-53	Far adv.	Considerable clearing
MO	63	'44	2	4-24-53	8-7-53	Far adv.	Considerable clearing
SMI	30	Recent	1	11-20-52	8-7-53	Far adv.	Some changing of infiltration
MA	57	9-2-52	1	8-31-52	12-10-52	Far adv.	Unfavorable progress; cavity increased in size; died 10-53
BMK	48	9-5-52	1	10-15-52	12-10-12	Far adv.	Clearing of infiltration
[illegible]	41	'33	numerous	7-15-53	8-7-53	Far adv.	Thoracoplasty--recovery favorable
JA	68	5-53	1	5-24-53	8-7-53	Far adv.	Some decrease in lesion
MBG	20	6-51	2	7-12-53	8-7-53	Far adv.	clearing in right and shadow disappearing in left lung; discharged against medical advice
SA	30	4-53	1	5-11-53	8-7-53	Far adv.	Considerable clearing

Date Due
