

NUTRITIONAL STATUS OF AIRCRAFT
WORKERS IN SOUTHERN CALIFORNIA

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ON ABSENTEEISM, TURNOVER, AND
PERSONNEL RATINGS



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THE effects of vitamin supplementation upon a group of aircraft workers are discussed in this third report (1, 2) from the study of the nutrition of aircraft workers in Southern California. The effects described in this report are on absenteeism, termination rates, and Merit Review Scores, or the ratings made at intervals on work performance of employes.

This report is divided into two parts. Part I explains the position

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We wish to thank the local union (affiliated with the A. F. of L.), to which the workers belonged, for its approval of the Study and for its cooperation.

We are indebted to Miss Dorothy G. Wiehl of the Milbank Memorial Fund for her searching criticism of the data in this report, for many valuable suggestions on the mode of presentation and assistance in the statistical analysis. We are indebted also to Miss Josephine Williams of the California Institute of Technology for her zeal and thoroughness in running down innumerable details in the Company records, and for her participation in the task of rechecking and tabulating all the data. We take this occasion, also, to thank Dr. Roger Stanton of the California Institute of Technology, who assisted us, as a volunteer, in every phase of the Study.

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of the present report in the series comprising a study on nutrition in industry. It compares the workers in this Study with the general industrial population. It explains the nature of the vitamin supplement used, and the nature of the placebo given one control group. It explains the selection and composition of the vitamin and placebo groups, and of a second control group selected to appraise the psychotherapeutic, as distinguished from the putative therapeutic, effect of a vitamin supplement. In order to appraise the possible contribution of changes in diet to the differences in industrial performance observed, a summarized analysis is presented of the two sets of diet histories, one taken at the beginning, the second at the end of the Study.

Part II presents the data on absenteeism, turnover, and Merit Review Scores, and discusses the differences which occurred in these respects between the groups during the year of the Study.

PART I

1. INTRODUCTION

It has been demonstrated repeatedly that the diets of most workers in the United States are inadequate. Some employers, persuaded that they can increase production by improving nutrition, have supplemented workers' diets with vitamin concentrates. But, at the time our Study began, this practice was not accompanied by studies of the nutritional status of workers before and after the feeding of vitamin supplements; nor, apparently, had there been any attempt to estimate from objective data obtained in controlled experiments what had been gained by the use of such supplements.

Accordingly, the Committee on the Nutrition of Industrial Workers recommended in 1941:

That adequately controlled studies be conducted in selected war or defense industries to determine the facts concerning the influence of diet

and nutrition on health, working capacity, incidence of accidents, absenteeism, and the psychological state.

A study among workers of the Lockheed Aircraft Corporation, Burbank, California, was undertaken in direct response to the Committee's recommendation.

The main procedures, which taken together comprised the Study, were as follows:

1. Taking and analysis of the diet history of every subject.
2. Medical history and physical examination by clinical and laboratory methods with special reference to nutritional status.
3. Daily administration of a vitamin supplement to one group of subjects and of a placebo to a control group for a period of one year.
4. The selection, for appraisal of psychotherapeutic effects, of a second control group, which received neither supplement nor placebo.
5. Taking and analysis of diet histories a year after the first.
6. A second medical history and examination by clinical and laboratory methods at the end of the Study.

All the subjects were white males, who volunteered from every major department in the plant. The great majority of them worked on the swing shift (4:00 P.M. to 12:30 A.M.); but some office workers and members of the supervisory staff, from all three shifts, also volunteered. In all, 1,173 men were examined.

The initial examinations of the subjects began in November 1941 and ended in February 1942. The reexamination of the 595 men remaining in the Study began in December 1942 and was completed by mid-March 1943. As referred to hereafter, the Study year covers the period March 1, 1942-February 28, 1943.

Reports have been published on the findings resulting from the first two procedures (1,2). The contents of the present report are described above. A fourth and final report will compare the findings on the second physical examinations with those on the first, and present the findings on the incidence of injuries and illness. The final report will conclude with comment on the Study viewed as a whole.

2. CHARACTERISTICS OF THE SUBJECTS IN THE STUDY AND THEIR
RELATION TO THE EFFECT REASONABLY TO BE EXPECTED
FROM THE VITAMIN SUPPLEMENT

The subjects in the Study were a highly selected group of young men exceptionally interested in their work. They were highly selected because they had passed a preemployment medical and psychological aptitude examination, and their health and their psychological aptitude were important points in their selection for employment. The factor of selection was real because, at the time these men sought employment, the labor supply exceeded the demand; accordingly, selection standards were high.

Most of the workers were young men. Over 70 per cent were under 30 years of age at the beginning of the Study. Approximately 44 per cent were single, 54 per cent married, and 1 per cent divorced. Of the total number married, 43 per cent had no children, 30 per cent had one child, 17 per cent two children, and 10 per cent more than two children.

The subjects were exceptionally interested in their work. Thirty-one per cent of them, during the year before the Study began, had come from other states to work in the aircraft industry, an industry with an especial appeal to young men.

Two items of evidence taken from data in the sections which follow show the superiority of the Study group. Their rates of absenteeism and of turnover were relatively low compared with the rate for the aircraft industry in southern California during 1942-1943. The rates of absenteeism in the Placebo and Vitamin groups in the Study were 4.4 and 4.0 days absent per 100 working days during the Study year. A representative figure for the whole aircraft industry in southern California, during 1942-1943, is about 7.0 (3). The annual turnover rate (excluding military terminations) for one of the groups was 18 per cent, for the other 24 per cent. The "quit" rate (i.e., nonmilitary terminations plus dismissals) for

the aircraft industry during the same period was 47 per cent (4).

This comparison of the subjects in the Study with the general industrial population in the aircraft industry in the region demonstrates the initial superiority of the Study group in the above two respects; accordingly they were nearer to the highest level possible of attainment. A great effect of the vitamin supplement on absenteeism and turnover and, by inference, on other aspects of industrial performance was, therefore, not to be expected.

The first examination revealed no acute or severe nutritional deficiency diseases. Consequently there was no opportunity for the dramatic results which undoubtedly would have occurred had there been a relatively high incidence of such diseases.

Another consideration to be borne in mind in appraising the effects of the placebo and of the vitamin supplement is that the Placebo and Vitamin groups were composed of men who volunteered for the Study. They may be presumed to be men who are consciously desirous of improving their health, with initiative (they acted on an opportunity to do something about it), and of a cooperative frame of mind. These traits are not present in all workers; and in those who possess them, they make for better industrial morale.

There is in addition a general consideration, to which much weight is given in industrial practice, to be taken into account in anticipating or appraising the effects of any single welfare measure; namely, the multiplicity of factors which affect absenteeism, turnover, and work performance in general. Even among those which are known, some of the most important factors are beyond the control or even influence of either employer or employe. Those responsible for personnel relations in industry do not, therefore, demand a very great improvement from any single ameliorating factor even from those as persuasive and direct as pay increases, introduction of rest periods, and improved eating facilities. What is hoped for is a worth while over-all result from the accumulation of the small effects of many factors in a welfare program. Only a small effect can be ex-

pected from a factor operating as indirectly as the giving of vitamins to a relatively superior group, neither severely malnourished nor undernourished; especially as, for the great majority, the work was not heavy and there were no hazards such as high temperature, very high or very low humidity, or exposure to toxic chemicals.

On the other hand, if a statistically significant benefit of the vitamin supplement, even though small in absolute terms, was observed in this superior group of industrial workers whose work was not particularly strenuous or hazardous, one may reasonably expect similar or larger benefits in the general industrial population, and especially where the work is strenuous or hazardous and the prevailing diet is less adequate than in our Study group.

3. THE NATURE OF VITAMIN SUPPLEMENT AND PLACEBO

The formula for the nutritional supplement, consisting of vitamins and calcium in tablets and capsules, was prescribed by the Committee on the Nutrition of Industrial Workers of the National Research Council. Its composition was as follows:

Vitamin A (from fish liver oil)	50,000 I.U.
Vitamin D (from fish liver oil)	800 I.U.
Vitamin B ₁ (synthetic)	10 mg.
Vitamin B ₂ (synthetic)	10 mg.
Niacinamide (synthetic)	100 mg.
Ascorbic Acid (synthetic)	250 mg.
Calcium (Ca Co ₃)	500 mg.

These amounts of vitamins and calcium, divided into two equal doses, were given five days a week for a period of one year. The recipients of the vitamin-mineral supplement are designated the Vitamin group.

The placebo was given the men exactly as the supplement; it consisted of sodium bicarbonate in tablets, with coloring added to one of them to simulate riboflavin, and of corn oil in capsules to simulate those containing vitamin A and D. The placebo tablets and capsules were identical in appearance with those containing the nutritional

supplement. The secret of the placebo was well kept. Discreet questioning at the end of the Study failed to reveal a single worker who had discovered it. Those who received the placebo are designated the Placebo group.

Both supplement and placebo were given the men at their places of work by a group of dispensers whose duty it was to locate every subject assigned to them for service. The dispensers carried the tablets and capsules in paper cups. It was the duty of each to observe his subjects swallow, with the aid of a cup of water, what had been given them. Then the dispenser recorded on a card that the supplement had been given.³

Volunteers for the Study were men working on the swing shift. They were employed in all the major departments of the plant. As they reported for their first physical examinations, they were assigned alternately either to the Vitamin or to the Placebo group. Feeding of the full vitamin supplement, as described above, began March 1, 1942 and continued throughout the Study year.

4. CLASSIFICATION OF SUBJECTS FOR PURPOSES OF THIS REPORT

Accurate observation of the effect of a vitamin supplement upon absenteeism, turnover, and Merit Review scores demands the comparison of homogeneous populations. In order to obtain the necessary homogeneity in the groups compared, we have confined ourselves in the present report to those employed on direct production.⁴

³ Some men, because they transferred to other plants, departments, and shifts, became inaccessible for daily service by the dispensers. These men were saved to the Study because they called at the office weekly for a five-day supply of vitamins or placebo. We have evidence that the men in the Vitamin group took their supplement in that their blood ascorbic acid values in the second physical examination were so high. By inference, the placebo also was taken regularly.

⁴ Men of supervisory rank are excluded from this report for several reasons. The different ranks of supervisors are not comparable with one another. The criteria in their Merit Review scores differ from those used for production workers. The number was relatively small, and they were not evenly divided between the Placebo and Vitamin groups. Moreover, because they are a more highly selected class than men working on direct production and as a direct consequence of their responsibility, men with supervisory responsibility tend to have markedly fewer absences, to be absent for different reasons, and to have a much lower rate of turnover than the rank and file of direct production workers. A final reason

In addition, changes in work shift during the Study of a considerable number of subjects made it desirable to subdivide them according to whether they remained on the swing shift or were transferred to the day or graveyard shift.

During the course of the Study many subjects were lost through termination of employment, transfer to other shifts and departments, and (a very few) through loss of interest. Since the objective of the Study was to evaluate the effects of a vitamin-mineral supplement, it was considered necessary to allow some period of time before the therapeutic effects would be manifested in performance, and to select some minimum observation period after therapy might become effective.⁵ Therefore, it was decided to base the comparisons of the Vitamin and Placebo groups with respects to absenteeism and the Merit Review scores on those men who continued to receive vitamins or placebos for at least the first nine months of the Study.

There were 528 men who remained in the Study until December 1, 1942 (a period of nine months) or to a later date. These were equally divided between the Vitamin and Placebo groups. These groups differed somewhat in the proportions who continued on the swing shift and who remained in the Study and on production work for the entire twelve months. In the following tabulations, four subgroups of the above Placebo and Vitamin subjects are used, as follows:

(1) Subjects in the Study for twelve months who remained on the swing shift and on direct production throughout this period. This class is designated "Throughout" Class, Swing Shift.

(2) A composite class designated "Whole" Class, Swing Shift, consisting of the following: (a) the "Throughout" Class, Swing Shift; (b) subjects in the Study for more than nine months on the swing shift and on direct production, who terminated their employment before the end of the Study year, i.e., in the last quarter. Their absenteeism records

for excluding men of supervisory rank is to confine this report to men engaged in physical work all their working time. For this last reason the few clerical workers were excluded also.

⁵ This is discussed in greater detail in the next section.

were included to the end of the last full calendar month of their employment, i.e., their records for the month in which they terminated were excluded; (c) subjects employed for twelve months who remained on the swing shift and on direct production throughout this period, but who left the Study in the last quarter because of transfer to other plants or departments where they could not be served by the dispensers, and did not call for a weekly supply of vitamins or placebos. Their records are included for the whole twelve months of the Study year because it was felt that they had been receiving the vitamin supplement or placebo for so long that it was reasonable to expect the effects to persist for so short a remainder of the Study year; (d) men who changed to work other than direct production, e.g., promotion to supervisor or change to clerical work. Their records were included to the end of the last calendar month they were on direct production, although this period may have been less than nine months;^o and (e) subjects who toward the end of the Study year returned to direct production from supervisory or clerical work. These men were in the Study for twelve months and were on the swing shift during their period of production work. Their records were included from the first full calendar month they were on direct production.

(3) Subjects in the Study for twelve months and on direct production throughout this period, who had a change of work shift at any time during the Study year. This class is designated "Throughout" Class, Day and Graveyard Shifts.

(4) A "Whole" Class, Day and Graveyard Shifts similar in composition to class 2 above except that these men had a change in work shift during the Study year.

One other group of direct production workers has been composed and is designated *Terminees*. This group consists of subjects who remained in the Study for less than nine months. Most of these were lost to the Study because they terminated their employment; a smaller number did not call for a weekly supply of vitamins or placebos after they were transferred to other plants, departments,

^o As stated in footnote 4, supervisors of all ranks had less absenteeism than production workers. Inclusion of absenteeism records after promotion to supervisory rank would tend to reduce rates of absenteeism, especially in the second half of the year. Since there were more promotions in the Vitamin group than in the Placebo group, the effect of the factor of promotions on any differences in absence rates has been eliminated.

or shifts where they could not be served by the dispensers. Most of the losses in the Terminees class occurred in the first six months of the Study year. As by far the great majority were working on the swing shift at the time they were lost to the Study, and the number who transferred to other shifts were too few for statistical purposes, the Terminees were not subdivided into swing and day and graveyard shift classes. The records of the Terminees were counted through the last full calendar month they remained in the Study.

Very early in the Study several men in the Placebo group reported improvement in health, which they ascribed to the vitamins they were taking. A questionnaire circulated among both the Vitamin and Placebo groups, after the supplement and placebo had been distributed for about two months, showed that a psychotherapeutic effect was widely felt.

In order to appraise the psychotherapeutic effect *per se* a second control group was added, composed of men who did not participate in the Study in any way, and whose characteristics matched those of the two other groups at the end of the Study. The decision to wait until the end of the Study was made because the Study was under way when the psychotherapeutic effect was first discovered; and we could not anticipate what changes would occur by the end of the Study year in such characteristics of the Vitamin and Placebo groups as age, duration of employment, and type of employment.

Mr. L. Stockford, Analyst of the Lockheed-Vega Aircraft Corporation, selected the men who comprise the nonparticipating second control group. It was selected from men who were employed on the swing shift throughout the period of the Study, and matched with the final composition of the Vitamin and Placebo groups with respect to age, duration of employment, and type of work. Selection was made solely from Company records, without interviewing any of the men. No subject selected was aware of the fact, and the selection was completed before any of the results of the Study were known or even tabulated.

The second control group is designed hereafter as the C group. It is comparable to the "Throughout" Class, Swing Shift, of the Placebo and Vitamin groups.

Table 1. Comparison of Control and Vitamin groups at beginning of Study (March 1942) with respect to age, previous duration of employment, and merit rating.

STUDY GROUP	NUMBER IN GROUP	MEAN AGE IN YEARS	MEAN MONTHS EMPLOYED	MERIT REVIEW ¹ SCORE	
				Number	Mean Total Score
<i>All Subjects Remaining in Study² for Nine Months or More</i>					
Placebo Group	264	28.0	12.6	212	33.9
Vitamin Group	264	29.3	14.1	208	33.9
<i>"Throughout" Class, Swing Shift</i>					
C Group	187	29.5	14.4	165	33.8
Placebo Group	166	28.6	11.0	156	34.0
Vitamin Group	138	29.9	12.8	128	34.2
<i>"Whole" Class, Swing Shift</i>					
Placebo Group	208	27.9	12.3	174	33.7
Vitamin Group	198	29.1	14.8	150	33.8
<i>"Throughout" Class, Changed to Day and Graveyard Shifts</i>					
Placebo Group	34	30.2	12.6	31	34.9
Vitamin Group	51	30.9	12.4	47	33.6
<i>"Whole" Class, Changed to Day and Graveyard Shifts</i>					
Placebo Group	56	28.1	13.7	38	34.7
Vitamin Group	66	29.7	12.1	58	34.0
<i>Termines, All Shifts³</i>					
Placebo Group	158	25.5	11.3		
Vitamin Group	156	25.8	10.6		

¹ The ratings used were made within two months of March 1, 1942, and were of those men for whom a rating at the end of the Study could be obtained.

² Includes men whose occupational status changed from direct production to supervision or clerical work, and vice versa.

³ Includes all men who were lost to the Study for the following reasons: (a) terminated prior to the last quarter of the Study year, and (b) lost to the Study prior to the last quarter of the Study year because of transfer to departments or shifts where they were inaccessible for service by the dispensers, although they remained employed. The great majority in this group were men who terminated their employment.

5. EVIDENCE FOR THE INITIAL SIMILARITY OF THE TWO CONTROL GROUPS AND THE VITAMIN GROUP

Table I compares the three main groups, C, Placebo, and Vitamin, at the time the Study began. This comparison is based upon age, duration of employment, and initial Merit Review scores. With respect to each of these factors, subjects in the Placebo and Vitamin groups who remained in the Study for nine months or more are very similar. The figures show that this conclusion is valid also in the triple comparison of the C group and the "Throughout" Class, Swing Shift subgroups of the Placebo and the Vitamin groups. The small differences in age, duration of employment, and initial Merit Review scores⁷ were not correlated with differences in performance.

The initial comparability of the Placebo and Vitamin groups is further supported by the closely similar initial rates of absenteeism and turnover shown in later sections.

We are justified, therefore, in ascribing to the experimental variants any differences which appeared later.⁸

Table I shows that the Terminee groups were younger and tended to have a shorter period of employment before March 1942 than those who remained in the Study for nine months or more.

6. DIET HISTORIES

Diet histories included as a part of the final examination of subjects were taken and analyzed by the methods used by Wiehl (1) for the diet histories taken at the beginning of the Study. Tables 2, 3, and 4 contain the summarized findings and comparisons with those a year earlier.

⁷ Later sections show that the small initial differences are not statistically significant.

⁸ On the assumption, of course, that the only variants in the three groups were those introduced experimentally, which as far as we know was the case, except for change in shift, termination of employment, promotion from direct production to supervision or demotion, and change from direct production to clerical work. These changes have been taken into account by the classification explained above in Section 2.

FOOD GROUP	RATING ¹	DEC. 1942-MARCH 1943		NOV. 1941-FEB. 1942
		Per Cent of Total in Group		Per Cent of Total Subjects
		Placebo Group	Vitamin Group	
Milk	A	64	60	51
	B	12	18	16
	C	24	22	33
Vegetables	A	15	11	21
	B	22	15	23
	C	63	75	56
Citrus Fruit and Tomatoes; Whole Fruit and Juices	A	34	34	36
	B	22	19	15
	C	44	47	49
Eggs	A	73	60	59
	B	14	16	18
	C	13	24	23
Meat	A	81	77	95
	B	11	19	4
	C	7	4	1

¹ A is satisfactory, B is marginal, and C unsatisfactory. See Footnote 9.

Table 2. Percentage distributions of weekly diets according to the qualitative rating for each of five food groups.

The data in these tables show that the quality⁹ of the diets of

⁹ Diets were classified as: satisfactory (A), marginal (B), and unsatisfactory (C) for each of five food groups, as follows:

Milk: A — 10 or more glasses
 B — 6-9 glasses
 C — 5 or less glasses

Vegetables: A — 6 or more servings of green or yellow vegetables
 B — 4 or more servings of green or yellow vegetables, and at least 7 of all kinds
 C — 3 or less servings of green or yellow vegetables, or less than 7 total with 4 or 5 green or yellow vegetables

Citrus Fruit and Tomato: A — 7 or more
 B — 5 or 6
 C — 4 or less

Eggs: A — 4 or more
 B — 2 or 3
 C — 1 or 0

Lean Meat, Fish, or Poultry: A — 5 or more times
 B — 3 or 4
 C — 2 or less

GENERAL RATING ¹	DEC. 1942-MARCH 1943		Nov. 1941-FEB. 1942
	Per Cent of Total in Group		Per Cent of Total —All Subjects
	Placebo Group	Vitamin Group	
<i>Satisfactory: A</i>	1.6	5.6	2.1
<i>Marginal: B</i>	13.2	7.9	11.2
1 Food Group	4.8	5.1	6.3
2 Food Group	5.8	1.7	3.9
3 Food Group	2.1	1.1	0.8
4 Food Group	0.5	0	0.5
<i>Unsatisfactory: C</i>	85.3	86.4	86.5
1 Food Group	37.6	29.9	32.3
2 Food Group	30.7	35.0	35.8
3 Food Group	13.8	16.4	15.6
4 Food Group	3.2	4.5	2.8
5 Food Group	0	0.6	0

¹ The general rating is the lowest qualitative rating for one or more of the five food groups. See Footnote 9 for the basis of the rating in each food group.

Table 3. Percentage distribution of weekly diets according to lowest qualitative rating for any of the five food groups.

subjects in the Placebo and Vitamin groups was very similar in the winter of 1942-1943. In both groups the distributions of diets accord-

Table 4. Percentage distribution of two-day diet histories according to daily intake of calories.

DAILY INTAKE OF CALORIES	DEC. 1942-MARCH 1943		Nov. 1941-FEB. 1942
	Per Cent of Total in Group		Per Cent of Total —All Subjects
	Placebo Group	Vitamin Group	
Less Than 1,800	2.2	3.3	8.8
1,800-2,199	8.4	4.7	17.6
2,200-2,599	14.6	17.4	20.0
2,600-2,999	20.8	27.0	20.0
3,000-3,399	20.8	24.0	17.6
3,400-3,799	9.6	13.0	9.2
3,800-4,199	15.2	4.0	2.8
4,200-4,599	2.2	3.3	2.4
4,600 or More	6.2	3.3	1.6

ing to qualitative ratings are essentially the same as for the total subjects in the winter of 1941-1942. The slightly lower consumption of meat in the second period, compared with that a year earlier, probably was because the meat supply was temporarily restricted during the winter of 1942-1943. The dietary histories indicate that the food habits of both groups remained essentially unchanged during the Study year. It is reasonable to infer that the nonparticipating control group had similar diets.

PART II

The sections which follow present the findings for the Study year with respect to absenteeism, termination rates, and Merit Review scores. All the data were obtained from Company records. The accuracy of the transcription was verified by a second transcription of the original data, followed by correction of discrepancies between the two transcriptions.

1. ABSENTEEISM

Absenteeism during the Study year is presented for two periods, the first and second six months. It is reasonable to expect that any effect of the vitamin-mineral supplement on absenteeism would become manifest only after some period of therapy and that, whatever the time delay in the appearance of any results, the effects would tend to cumulate and should become more measurable in the latter part of the experimental period.

Rates of absenteeism are expressed as days absent per 100 working man days,²⁰ that is, the per cent of total working days lost because of absences.

²⁰ The number of days absent and the number of working days within a given period are computed for each man, and these are summated for all men in a specified group. (Authorized vacations with pay, five days for most men and ten days for a very few, were not included in the number of working days.) From these totals, a per cent or absence rate per 100 days, is readily calculated. The advantage of this rate is that working periods of different durations can be combined, and the absentee records for men in the Study only

Two main comparisons made are: (a) between the Placebo and Vitamin groups to examine the possible therapeutic effect of the Vitamin supplement on absenteeism; and (b) between the C (non-participating control) group and the Placebo and Vitamin groups, to observe the psychotherapeutic effect of the placebo and the vitamin supplement on absenteeism.

The data for each of the above comparisons are treated in two ways: differences in rates of total absences; and differences broken down according to cause.

A. COMPARISON OF ABSENCE RATES OF THE PLACEBO AND VITAMIN GROUPS

Absence Rates from all Causes. Rates of total absences in the first half and second half of the Study year are compared in Table 5 for the Placebo and Vitamin groups. Differences between rates for each Placebo and Vitamin group in each six-month period are given in Table 6, together with the statistical probabilities of the occurrence of these differences.

For the total Study population, designated "Whole" Class, All Shifts, Table 5 shows that in the first six months the absence rates were practically the same in both groups (Vitamin group 105 per cent of the Placebo group). In the second six months, the rate for the Placebo group increased to 120 per cent of its first six months' rate; the rate for the Vitamin group decreased to 93 per cent. In the Placebo group there was the usual fall and winter increase in absenteeism; in the Vitamin group the seasonal influence was counteracted.

The difference between the Placebo and Vitamin groups in the first six months is not statistically significant.

part of a given six months can be added to those for subjects who were employed the full period. All rates are directly comparable since they are expressed in the same unit of 100 days. The numbers of days on which men were supposed to work were not identical for the two six-months periods (131 and 128 days for the first and second six months, respectively) and the average numbers of days absent *per man* (or per capita for a specified period) would not be comparable for the two periods, even though all persons were in the Study for the full period. The absence rate per 100 working days can be converted to an average rate per person for any desired period by multiplying the rate by the ratio of the number of days in the desired period to 100.

In the second six months, the absence rate for the Vitamin group was 19 per cent lower than that for the Placebo group. As shown in Table 6, the rate for the Vitamin group was 0.89 days per 100 working days less than the rate for the Placebo group, a difference that is highly significant in a statistical sense,²¹ since the chances of its occurrence from random sampling are less than one in a million. For the full six months of 128 days, this is equivalent to a difference of 1.14 days per man.

The same initial similarity and subsequent lesser absenteeism in the Vitamin group occurred consistently in all the subgroups of the Placebo and Vitamin groups. In every comparable pair of subgroups the Vitamin subgroup had the higher rate in the first six months and the lower rate in the second six months. None of the differences in the first six months are statistically significant, and all, except one, in the second six months are significant.

The exception is in the "Throughout" Class, Swing Shift. This subgroup had the lowest absenteeism in the second six months. It

²¹ The probability (P) for a difference in absence rates was obtained from the ratio of the difference to the standard error of the difference $\left(\frac{D}{\sigma_d}\right)$. The standard error of the difference was calculated as follows:

$$\sigma_d = 100 \sqrt{pq \left(\frac{1}{N_1} + \frac{1}{N_2} \right)}$$

$$p = \frac{\text{Total days absent in both groups}}{\text{Total number of working days in both groups}}$$

$$q = 1 - p$$

N_1 and N_2 are the numbers of working days in each of the two groups compared

P for any ratio $\left(\frac{D}{\sigma_d}\right)$ is obtained from a table giving the proportion of the area

under a normal curve in terms of the standard deviation.

The meaning of the estimated statistical probability may be briefly explained as follows: it measures the chances that a difference of the observed magnitude or larger would occur if the two groups compared were independent samples drawn at random from a homogeneous population, that is, if the two samples were affected only by the same sources of variation. A convention generally accepted is that a difference is statistically significant when the probability (P) is .05 or less, that is, when the chances are not more than five in one hundred that a difference equal to or greater than the observed difference would arise as the result of random factors. The smaller the probability the greater is the likelihood that the groups compared are *not* samples from the same universe. Interpretation of the cause of a significant difference must rest on other evidence of sources of dissimilarity between the groups compared. In the present Study, so far as could be determined, the Placebo and Vitamin groups differed only with respect to the experimental therapy.

was industrially the most stable subgroup, composed of men who did not terminate their employment and remained on direct production on the same shift for the whole Study year. Terminations and transfers to other shifts operated as selective influences on the initial groups, so that at the end of the year the men who were still employed and on the swing shift (considered the least desirable shift) were those who were best adjusted and most satisfied with their jobs. It was to be expected that the least differences would occur in this subgroup because only a small effect of a vitamin

Table 5. Total absence rates of Placebo and Vitamin Groups.

GROUP	DAYS ABSENT PER 100 MAN DAYS		RATIO TO RATE OF PLACEBO GROUP X 100		RATIO OF RATE OF SECOND TO FIRST SIX MONTHS X 100	NUMBER OF WORKING MAN DAYS		NUMBER OF DAYS ABSENT	
	First Six Months	Second Six Months	First Six Months	Second Six Months		First Six Months	Second Six Months	First Six Months	Second Six Months
<i>"Whole" Class, All Shifts</i>									
Placebo	3.988	4.791	100	100	120	32,551	29,511	1,298	1,414
Vitamin	4.173	3.899	105	81	93	32,063	28,728	1,338	1,120
<i>"Whole" Class, Swing Shift</i>									
Placebo	3.863	4.312	100	100	112	25,911	23,704	1,001	1,022
Vitamin	3.908	3.722	101	86	95	23,671	20,661	925	769
<i>"Whole" Class, Day and Graveyard Shifts</i>									
Placebo	4.473	6.750	100	100	151	6,640	5,807	297	392
Vitamin	4.921	4.351	110	64	88	8,392	8,067	413	351
<i>"Throughout" Class, Swing Shift</i>									
Placebo	3.832	3.973	100	100	104	21,243	20,991	814	834
Vitamin	3.979	3.662	104	92	92	17,567	17,451	699	639
<i>"Throughout" Class, Day and Graveyard Shifts</i>									
Placebo	4.017	6.411	100	100	160	4,332	4,305	174	276
Vitamin	4.754	3.695	118	58	78	6,500	6,469	309	239

supplement or of any other welfare measure could be expected in industrially the most stable subgroup of a population of superior workers (Part I, Section 2). Although the difference in this subgroup is not statistically significant (P is 0.11), there was a definite trend toward less absenteeism for the Vitamin subjects, consistent with but not of equal magnitude to that shown for the other subgroups.

The converse effect, i.e., the influence of instability in an industrial group on its rate of absenteeism may be construed from the higher rates of absenteeism on the day and graveyard shift subgroups. At the beginning of the Study all of these men were working on the swing shift. The fact that they were transferred to the day and graveyard shifts (two-thirds to the day shift) is evidence that they were discontented on the swing shift, because the Company discouraged transfer from one shift to another, and a transfer

Table 6. Differences between total absence rates of total Placebo and Vitamin groups and of subgroups.

CLASS COMPARED (Placebo-Vitamin)	DIFFERENCE (P-V) DAYS PER 100 MAN DAYS	STANDARD ERROR OF DIFFERENCE	P ¹	DIFFERENCE (P-V) DAYS PER 100 MAN DAYS	STANDARD ERROR OF DIFFERENCE	P ¹
	FIRST SIX MONTHS			SECOND SIX MONTHS		
"Whole" Class, All Shifts	-0.185	0.156	>0.20	+0.892	0.169	<0.001
"Whole" Class, Swing Shift	-0.045	0.174	0.80	+0.590	0.187	<0.01
"Whole" Class, Day and Graveyard Shifts	-0.448	0.348	0.20	+2.399	0.387	<0.001
"Throughout" Class, Swing Shift	-0.147	0.197	>0.40	+0.311	0.197	>0.10
"Throughout" Class, Day and Graveyard Shifts	-0.737	0.405	<0.07	+2.716	0.420	<0.001

¹ P gives the probability with which differences equal to or exceeding those observed might arise through chance, see Footnote 11. Values of P above 0.10 are rounded off to the nearest lower 0.10; thus, >0.10 denotes a probability greater than 0.10 but less than 0.20; values between 0.10 and 0.01 are rounded to the next higher 0.01 value, thus, <0.06 denotes a P less than 0.06 but greater than 0.05; values between 0.01 and 0.001 are expressed as <.01; and all values below 0.001 are expressed as <.001.

was gained usually only after some persistence. This discontent, as a working hypothesis, may be considered as an element of "strain." The "strain" was present in the individuals and is not to be construed as a result or reflection of differences in working conditions or environment, as it is unlikely that work on the day shift *per se* is a greater strain than on the swing shift.

The "strain" was reflected in the higher rates of absenteeism in the first six months in both the Placebo and Vitamin day and graveyard subgroups than in the corresponding swing shift subgroups, and in the much greater increase in absenteeism in the second six months in the Placebo day and graveyard subgroups than in the corresponding Placebo swing shift groups. On the other hand, in the Vitamin subgroups, the rates decreased in the second six months to not far from those of the Vitamin swing shift subgroups,²² suggesting that the vitamin supplement relieved the "strain," and that the placebo did not.

The findings are in accord with those of Williams, *et al.* (5) that it was in the men in which there was evidence of greater "strain" that the administration of the vitamin supplement was followed by a greater reduction in absenteeism.

Absenteeism Rates According to Reported Cause. Absence rates were classified according to cause as noted in the Company records in order to gain some insight into the reasons for the differences observed in the total absenteeism rates. In the Company records absences are divided into three main categories, as follows:

1. Unauthorized absence:²³

An absence is so classified unless an employe offers an acceptable excuse within the first three hours of the shift on which he works. The

²² The time of year in which transfer to the day and graveyard shift occurred was nearly the same in the Placebo and Vitamin groups. In the "Throughout" Class of the Placebo group, 40 per cent of the transfers occurred in the first six months of the Study year; in the Vitamin group 46 per cent. In the "Whole" classes, 50 per cent of the transfers occurred in the first six months in both the Placebo and Vitamin groups.

²³ This category includes absences on those statutory holidays when employes were expected to work: Labor Day, Thanksgiving, and New Year's Day, and an extra day off before or after Christmas.

great majority of absentees so classed failed even to give notice. Thus, Unauthorized absences reflect directly the attitude of the employe to his job.

2. Absences on account of illness or injury (occupational and non-occupational):

The Company verifies such absences only when they extend beyond three consecutive working days. There is reason to believe that some unverified absences in this category were not due to illness or injury.

3. Authorized absences:

The Company "authorized" absences for such reasons as follows: illness or death in the family, failure of transportation, appearance in court or before a draft board, and an extra vacation of five working days (without pay). Of the total absences in this category, extended vacations accounted for 54 to 76 per cent in the first six months and 43 to 73 per cent in the second six months.

The data on rates of total absences are objective facts; no assumptions of interpretation are introduced. The rates of absenteeism segregated into its causes are less reliable, for not all the alleged reasons for absences were checked. The figures given for Unauthorized absences are minimal figures. If the alleged causes for all absences in the other two categories had been checked, the Illness and Authorized absences probably would have been reduced and the Unauthorized absences increased.

Tables 7 and 8 present the data on absences classified according to cause.

For the total populations of the Placebo and Vitamin groups, it is seen that in the first six months the rates for every cause were slightly, but not significantly, lower in the Placebo group. In the second six months the rates were lower for every cause in the Vitamin group and the differences, except that of illness, were statistically very significant, the probabilities (P) of both differences being less than 0.001. The probability of the difference for illness is 0.08, which is near the conventional borderline between "significant" and "not significant."

A clearer indication of the type of absence which contributes

Table 7. Absence rates of Placebo and Vitamin groups classified according to cause.

GROUP	FIRST SIX MONTHS				SECOND SIX MONTHS			
	All Absences	Unau- thorized	Illness	Author- ized	All Absences	Unau- thorized	Illness	Author- ized
DAYS ABSENT PER 100 MAN DAYS								
<i>"Whole" Class, All Shifts</i> Placebo	3.988	0.482	2.114	1.392	4.791	1.755	2.192	0.844
	4.173	0.493	2.246	1.435	3.899	1.351	1.984	0.564
<i>Whole" Class, Swing Shift</i> Placebo	3.863	0.401	1.941	1.521	4.312	1.569	2.017	0.726
	3.908	0.448	1.994	1.466	3.722	1.244	1.955	0.523
<i>"Whole" Class, Day and Graveyard Shifts</i> Placebo	4.473	0.798	2.786	0.889	6.750	2.514	2.910	1.326
	4.921	0.620	2.955	1.347	4.351	1.624	2.058	0.669
<i>"Throughout" Class, Swing Shift</i> Placebo	3.832	0.391	1.916	1.525	3.973	1.491	1.887	0.595
	3.979	0.461	2.135	1.383	3.662	1.192	1.920	0.550
<i>"Throughout" Class, Day and Graveyard Shifts</i> Placebo	4.017	0.854	2.516	0.646	6.411	2.602	2.532	1.278
	4.754	0.646	2.954	1.154	3.695	1.469	1.855	0.371
NUMBER OF DAYS ABSENT								
<i>"Whole" Class, All Shifts</i> Placebo	1,298	157	688	453	1,414	518	647	249
	1,338	158	720	460	1,120	388	570	162
<i>"Whole" Class, Swing Shift</i> Placebo	1,001	104	503	394	1,022	372	478	172
	925	106	472	347	769	257	404	108
<i>"Whole" Class, Day and Graveyard Shifts</i> Placebo	297	53	185	59	392	146	169	77
	413	52	248	113	351	131	166	54
<i>"Throughout" Class, Swing Shift</i> Placebo	814	83	407	324	834	313	396	125
	699	81	375	243	639	208	335	96
<i>"Throughout" Class, Day and Graveyard Shifts</i> Placebo	174	37	109	28	276	112	109	55
	309	42	192	75	239	95	120	24

most to the total reduction in absenteeism in the second six months is gained if attention is directed to the absolute differences in rates for each cause. The greatest contributor to the total difference was

Table 8. Differences between Placebo and Vitamin groups in rates of absence due to different causes.

CLASS COMPARED (PLACEBO-VITAMIN)	UNAUTHORIZED			ILLNESS			AUTHORIZED		
	Difference		P ¹	Difference		P ¹	Difference		P ¹
	Days Per 100 Man Days	Standard Error		Days Per 100 Man Days	Standard Error		Days Per 100 Man Days	Standard Error	
FIRST SIX MONTHS									
"Whole" Class, All Shifts	-0.011	0.055	>0.80	-0.132	0.115	>0.20	-0.043	0.093	>0.60
"Whole" Class, Swing Shift	-0.047	0.058	>0.40	-0.053	0.125	>0.60	+0.055	0.109	>0.60
"Whole" Class, Day and Graveyard Shifts	+0.178	0.137	>0.10	-0.169	0.275	>0.50	-0.458	0.175	<0.01
"Throughout" Class, Swing Shift	-0.070	0.066	>0.20	-0.219	0.143	>0.10	+0.142	0.122	>0.20
"Throughout" Class, Day and Graveyard Shifts	+0.208	0.167	>0.20	-0.438	0.322	>0.10	-0.508	0.190	<0.01
SECOND SIX MONTHS									
"Whole" Class, All Shifts	+0.404	0.103	<0.001	+0.208	0.119	0.08	+0.280	0.069	<0.001
"Whole" Class, Swing Shift	+0.325	0.113	<0.01	+0.062	0.133	>0.60	+0.203	0.075	<0.01
"Whole" Class, Day and Graveyard Shifts	+0.890	0.241	<0.001	+0.852	0.264	<0.01	+0.657	0.166	<0.001
"Throughout" Class, Swing Shift	+0.299	0.118	<0.02	-0.033	0.140	>0.80	+0.045	0.077	>0.50
"Throughout" Class, Day and Graveyard Shifts	+1.133	0.270	<0.001	+0.677	0.284	<0.02	+0.907	0.168	<0.001

¹ See Footnote to Table 6 and Footnote 11.

Unauthorized absences and the least contributor Illness absences. Of the total difference of 0.89 days per 100 days in the second six months, 0.40 is Unauthorized absence, 0.28 Authorized absence, and .21 is Illness absence. In other words, the absences affected most were those which reflect directly the attitude of the employe to his job.

In general, the difference noted for the total groups in the second six months occurred consistently in all the subgroups. In every subgroup the greatest absolute difference between the Placebo and Vitamin groups was in Unauthorized absences, and all the differences in this category are statistically significant. The differences were least in Illness absences, except for the "Whole" Class, Day and Graveyard subgroup. In fact, in the "Throughout" Class, Swing Shift comparison, the Placebo group had a slightly lower rate than the Vitamin group, even in the second six months, but the difference is negligible.

In accord with trends seen in comparisons of total absenteeism for the Placebo and Vitamin subjects in specific subgroups, in the second six months the smallest differences for every cause occurred in the comparison of the "Throughout" Class, Swing Shift, the most stable industrial subgroup, and the largest differences were in the Day and Graveyard Shift subgroups where the element of "strain" was greater. In the latter there were large differences even in Illness absences in the second six months, and differences for all three types of absence were statistically significant. For the "Throughout" Class, Swing Shift subgroup, only the difference for Unauthorized absences is significant.

In the foregoing discussion little weight was given the findings on Authorized absences. This category is a miscellaneous one, and difficult to interpret. It includes some absences which would have been classified as Unauthorized had it been possible to verify the reasons given for absence. The largest single element, accounting for more than 50 per cent in this category, is an authorized five-day

extension of a vacation, but without pay. When extended vacations are subtracted, the remainder (smaller in the Vitamin subgroups in both six-month periods) is quite small in absolute terms, and the difference in it between the two groups makes an unimportant contribution to the difference in total absence rates in the second six months.

**B. ABSENCE RATES OF THE NONPARTICIPATING CONTROL GROUP (C)
AND OF THE PLACEBO AND THE VITAMIN GROUPS: THE PSYCHO-
THERAPEUTIC EFFECT ON ABSENTEEISM**

In Part I, Section 4, the construction of a nonparticipating control group (C) was described. The purpose was to observe differences between the C and the Placebo groups which might be ascribed to the psychotherapeutic effect of the placebo. It must be recognized that the comparison of the C with the Placebo group tests more than the psychotherapeutic effect of the placebo. At least two additional factors are included. One is the effect *per se* of participation in an experiment; the other is the element of selection, in that the subjects of the Placebo and Vitamin groups volunteered for the Study, whereas the subjects of the C group did not. As the present Study afforded no means of segregating the three factors, for convenience, their combined effect will be referred to hereafter as the psychotherapeutic effect.

The C group was selected at the end of the Study to match the subjects of the Placebo and Vitamin groups in the "Throughout" Class, Swing Shift. The only comparisons warranted, therefore, are between the C group and these two subgroups of the population which participated actively in the Study. Table 9 contains the data for these comparisons.

In the first six months the absence rate for all causes was slightly higher in the C group than in the Placebo and Vitamin groups, but statistically the differences are not significant. In the second six months the absence rate in the C group was 1.4 and 1.7 days per 100

days higher than in the Placebo and Vitamin groups, respectively, and both of these differences are very significant statistically.

The interpretation of absenteeism in the C group as compared with the Placebo and Vitamin groups becomes much clearer when differences in absence rates by specific causes are considered. These differences are, therefore, summarized from Table 9. In the first six months the rates of Unauthorized and Illness absences were higher in the C group than in either of the other two groups. The differences in Unauthorized absences are statistically significant; the C-Placebo difference in Illness absences is significant; and the C-Vitamin difference is nearly so (P .08). But the Authorized absence rate was significantly lower in the C group than in the Placebo and Vitamin groups, and very largely offset the higher absenteeism

Table 9. Absence rates of the nonparticipating Control group (C) compared with rates of the Placebo (P) subjects, and of the Vitamin (V) subjects in the "Throughout" Class, Swing Shift.

PERIOD AND CAUSE OF ABSENCE	NUMBER OF DAYS ABSENT FOR C GROUP ¹	DAYS ABSENT PER 100 MAN DAYS			DIFFERENCE IN RATES					
					C—Placebo			C—Vitamin		
		C	P	V	Days Per 100 Man Days	St. Error	P ²	Days Per 100 Man Days	St. Error	P ²
<i>First Six Months</i>										
Total Absences	974	4.103	3.832	3.979	+0.271	0.185	>0.10	+0.124	0.196	>0.50
Unauthorized	152	0.640	0.391	0.461	+0.249	0.068	<0.001	+0.179	0.075	<0.01
Illness	568	2.393	1.916	2.135	+0.477	0.138	<0.001	+0.258	0.149	<0.09
Authorized	254	1.070	1.525	1.383	-0.455	0.106	<0.001	-0.313	0.109	<0.01
<i>Second Six Months</i>										
Total Absences	1,258	5.338	3.973	3.662	+1.365	0.201	<0.001	+1.676	0.210	<0.001
Unauthorized	355	1.506	1.491	1.192	+0.015	0.115	>0.85	+0.314	0.116	<0.01
Illness	704	2.987	1.887	1.920	+1.100	0.147	<0.001	+1.067	0.157	<0.001
Authorized	199	0.844	0.595	0.550	+0.249	0.081	<0.01	+0.294	0.084	<0.001

¹ For C group the total number of working man days in the first six months is 23,736, and in the second six months it is 23,568. See Table 7 for numbers for the P and V groups.

² Probability of the observed difference occurring by chance. See Footnote to Table 6.

from Unauthorized and Illness absences. In the second six months the rate of Unauthorized absences became nearly the same in the C and Placebo group; the C-Vitamin difference, on the other hand, was nearly double that in the first six months, and the difference is statistically significant. The excess absence rate from illness in the C group became much greater in the second six months. Authorized absences also became significantly higher in the C group than in either of the other groups.

As previously discussed, little weight can be given to differences in Authorized absences. Approved extended vacation absences affected the rates for the different groups to an unequal degree in the first and second six-month periods. If vacation absences are subtracted from total Authorized absence rates, the remainders are: in the first six months, 0.375, 0.701, and 0.336 in the C, Placebo, and Vitamin groups, respectively; in the second six months, 0.483, 0.180, and 0.149 days per 100 days. The miscellaneous nature of the causes of these Authorized absences makes it impossible to interpret differences in rates.

A simple interpretation, and one in accord with general experience, is to ascribe the differences in Unauthorized and Illness absences in the first six months between the C and the two other groups entirely to the psychotherapeutic effect. A psychotherapeutic effect would be expected to manifest itself quite early.²⁴ In the second six months there was practically no difference in rates of Unauthorized absences between the C-Placebo groups; the psychotherapeutic effect on this category of absences had, therefore, worn off. The large difference in Unauthorized absences between the C and Vitamin groups and between the Placebo and Vitamin groups in the second six months may, therefore, be ascribed to a therapeutic effect of the vitamin supplement. This interpretation is strengthened by the fact that the difference between the Placebo and Vita-

²⁴ See discussion on page 137 of the elements which enter into the psychotherapeutic effect.

min groups in Unauthorized absences in the first six months is not statistically significant; the psychotherapeutic effect, presumably, was equal in these two groups.

It would be expected, if the state of well-being of the recipients of the vitamin supplement gradually improved, as compared with the men in the two other groups, that the rate of Unauthorized absences, at first the same in the Vitamin and Placebo groups, would gradually become relatively less in the Vitamin group, while those of the C and Placebo groups would remain more nearly alike. The data are in accord with this hypothesis. It is common clinical experience that one of the earliest manifestations of an inadequate vitamin intake (especially of thiamine) is an impairment of the feeling of well-being. This affects mental attitude in many ways (5,6,7) and in industrial workers would affect attitude toward the job, which reflects itself in the rate of Unauthorized absences more than any other category of absences.

The greater rate of Illness absences in the C than in the other two groups in both the first and second six months is to be ascribed entirely to the psychotherapeutic effect, as there was no difference in this respect between the Placebo and Vitamin groups ("Throughout" Class, Swing Shift) in either the first or second six months. The therapeutic effect of the vitamin supplement on Illness absences manifested itself only in those workers in which there was evidence of "strain" (transferees to the day and graveyard shifts, Tables 7 and 8).

Paradoxical as it may seem at first, this was the result to be expected (in the event of any positive result). The men in the Placebo and Vitamin groups believed they were getting large doses of vitamins, which they expected would benefit their health. In the final medical histories, many in the Placebo group reported improved health and gave the credit to the vitamins they believed they were taking. There were, of course, similar reports from the Vitamin group. The expectation of better health evidently encouraged

the feeling that this had occurred and this, in turn, tended to reduce absenteeism due to illness in the recipients of the placebo and vitamin supplement.

It would be unwarranted and premature to ascribe the whole of the psychotherapeutic effect to self-delusion. Participation in an experiment concerned with health undoubtedly increases the interest of a subject in his health. It is reasonable that, as a result, he will pay greater attention to and take more care of his health than if his interest in it were not refreshed every day he was at work by his being given what he believed was helping him (placebo or vitamins). It is a commonplace of medical practice that greater interest in health and the better care which follows it are real therapeutic factors.

C. ABSENTEEISM AMONG TERMINEES

Table 10 gives the absenteeism rates of the Terminees. The survey year is divided into the first quarter and the Remainder, and no separation is made of subjects on different shifts because there were

Table 10. Absence rates of Terminees in Placebo and Vitamin Groups, classified according to cause of absence.

GROUP	DAYS ABSENT PER 100 WORKING DAYS				NUMBER OF WORKING DAYS	NUMBER OF DAYS ABSENT			
	All Absences	Unau- thorized	Illness	Author- ized		All Absences	Unau- thorized	Illness	Author- ized
FIRST QUARTER									
Placebo	4.090	0.423	2.641	1.025	8,974	367	38	237	92
Vitamin	3.921	0.366	2.728	0.827	8,467	332	31	231	70
SECOND AND THIRD QUARTERS									
Placebo	8.922	0.981	4.229	3.712	5,604	500	55	237	208
Vitamin	8.904	1.337	4.330	3.238	5,312	473	71	230	172

too few working man days to warrant division into two six-month periods or into swing, and day and graveyard shifts.

In the first quarter the rates of both the Placebo and Vitamin groups were nearly the same, and were very similar also to those of the other Study groups in the first six months. In the Remainder period, the rates were again nearly the same in both groups of Terminees, but were much higher than the rates for those who remained in the Study nine months or more.

The higher absence rates in the Terminees, as compared with the other groups, occurred in Illness and Authorized absences. The rates of the Terminees in the latter category are so high because the second and third quarters in the Remainder period include the months when most of the extended five-day vacations were taken, whereas in the two six-month periods the vacation months were divided, and also because many men with a short employment period received a vacation before terminating employment.

The high absence rates of the Terminees in the Remainder period is in accord with the general experience that workers who terminate their employment tend, prior to their termination, to have a higher than average rate of absenteeism.

The fact that the rates for Terminees in the Placebo and Vitamin groups were nearly the same in the Remainder period is in accord with the view that at least six months was required for the manifestation of differences in absenteeism between the Placebo and Vitamin groups.

2. INDUSTRIAL TURNOVER

The rate of industrial turnover is determined, of course, by many causes, and the causes vary, depending upon time, place, and type of industry. Before any possible effect of a vitamin supplement upon the rate of industrial turnover can be measured, we must subtract the men who terminated their employment in order to join the armed forces; for obviously only those who terminated for other

MONTH	TERMINATED FOR MILITARY REASONS		TERMINATED FOR NONMILITARY REASONS		LEFT SURVEY BUT REMAINED WITH COMPANY		TOTAL LOST TO SURVEY FOR ALL REASONS	
	P	V	P	V	P	V	P	V
March, 1942	2	8	14	8	1	2	17	18
April, 1942	13	11	11	10	3	2	27	23
May, 1942	11	13	10	9	7	7	28	29
June, 1942	4	3	7	7	5	13	16	23
July, 1942	3	13	5	2	5	7	13	22
August, 1942	10	11	7	6	3	6	20	23
September, 1942	15	10	11	3	4	4	30	17
October, 1942	18	11	7	2	4	4	29	17
November, 1942	6	5	5	4	0	1	11	10
December, 1942	10	9	4	1	2	5	16	15
January, 1943	7	6	1	2	1	3	9	11
February, 1943	7	8	0	2	1	1	8	11
TOTAL	106	108	82	56	36	55	224	219
Total as Per Cent of Number in Survey, March 1, 1942¹	24.6	26.4	19.0	13.7	8.4	13.5	52.0	53.5

¹ Number in survey March 1, 1942: Placebo group (P), 431; Vitamin group (V), 409.

Table 11. The number of production workers lost to the survey from March 1, 1942 to February 28, 1943 in the Placebo and Vitamin groups, classified according to three main reasons.

reasons are to be considered for purposes of this Study as industrial turnover.¹⁸

Table 11 gives the numbers, month by month, of production workers who left the Study for whatever reason. Men on all shifts are combined in the analysis of turnover.

It will be noted that more men in the Vitamin group left the Study but remained with the Company than in the Placebo group. A larger number in the Vitamin group were transferred to other shifts during the Study year and among those transferred approxi-

¹⁸ The tables on industrial turnover are based only on men who were production workers throughout their period of employment during the Study year.

MONTH	TERMINATIONS PER 100 PERSONS PER MONTH			CUMULATIVE TERMINATION RATES			DIFFERENCES BETWEEN RATES FOR THE P AND V GROUP (P-V)	
	Nation- al Rate ¹	P Group	V Group	Nation- al Rate	P Group	V Group	Monthly Rates	Cumulative Rates
March, 1942	3.70	3.25	1.96	3.70	3.25	1.96	1.29	1.29
April, 1942	3.79	2.66	2.56	7.49	5.91	4.52	0.10	1.39
May, 1942	4.06	2.58	2.45	11.55	8.49	6.97	0.13	1.52
June, 1942	3.60	1.95	2.06	15.15	10.44	9.03	-0.11	1.41
July, 1942	3.76	1.46	0.63	18.91	11.90	9.66	0.83	2.24
August, 1942	4.29	2.12	2.04	23.20	14.02	11.70	0.08	2.32
September, 1942	4.72	3.55	1.11	27.92	17.57	12.81	2.44	4.76
October, 1942	4.41	2.50	0.79	32.33	20.07	13.60	1.71	6.47
November, 1942	3.86	1.99	1.69	36.19	22.06	15.29	0.30	6.77
December, 1942	3.40	1.67	0.44	39.59	23.73	15.73	1.23	8.00
January, 1943	3.86	0.45	0.94	43.45	24.18	16.67	-0.49	7.51
February, 1943	3.71	0	1.00	47.16	24.18	17.67	-1.00	6.51

¹ "Quit" rate in whole aircraft industry (nonmilitary terminations plus dismissals) (4).

Table 12. Monthly percentages of persons in the Study at the beginning of a specified month who left the Company in that month for nonmilitary reasons.

mately an equal proportion of the Vitamin and of the Placebo subjects remained in the Study.

Table 12 gives the monthly rates of nonmilitary terminations²⁸ and the "Quit" rate (i.e., nonmilitary terminations plus dismissals) in the whole aircraft industry. The method of computation in Table 12 needs to be explained. The baseline for nonmilitary terminations (i.e., the number of subjects potentially liable to nonmilitary termination), changed each month. This baseline was computed as the total number remaining in the group at the beginning of the month after those leaving the Study and those terminating employment for any reason in the previous months are deducted from the total. The percentage of nonmilitary terminations is computed for each month, and monthly rates may be cumulated to obtain the termination rate for any part or all of the twelve-month period.

²⁸ There was only one dismissal among subjects in the Vitamin group and four dismissals in the Placebo group.

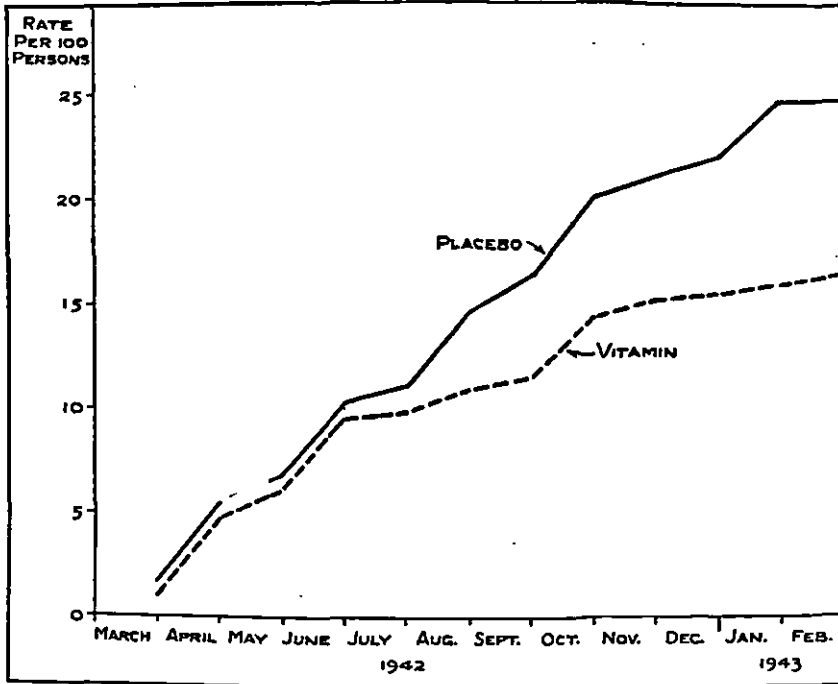


Fig. 1. Nonmilitary terminations in the Placebo and Vitamin groups. Monthly percentages for terminations among employes in Study at beginning of each month cumulated.

Tables 11 and 12 show that the rate of nonmilitary terminations over the period of the whole year was less in the Vitamin group than in the Placebo group, whether computed on the basis of the number in each group on March 1, 1942, or on a cumulative monthly basis. On the latter basis, the annual termination rate for the Placebo group was 24 per cent and for the Vitamin group, 18 per cent.

The difference between the two groups was too small during the first four months (Table 12 and Figure 1) to be significant. It consisted mainly in the difference in the first month, March 1942, which was too short a period for the vitamin supplement to have exerted any manifest influence.

After the first four months the rate in the Placebo group continued essentially unchanged until December (Figure 1). In the

Vitamin group, on the other hand, the rate declined sharply after June to approximately one-half its former value and persisted at this lower rate.

For two related reasons the termination rates in the last quarter are not significant in either group. The total number of nonmilitary terminations was quite small (five in each group), and by the last quarter both groups had become stable with respect to turnover; i.e., by that time nearly all the men who were likely to leave the Company for nonmilitary reasons had done so. It is well known that employees who have been with a company for a long time are less likely to leave than new employees.

By the end of the twelve-month period the cumulative rate of nonmilitary terminations in the Vitamin group was 73.1 per cent of that in the Placebo group. In terms of over-all annual percentages,

Table 13. Differences in military and nonmilitary terminations in the Placebo and Vitamin groups in the first four months and last eight months of the Study year.

TYPE OF TERMINATION, PERIOD OF TERMINATION, AND STUDY GROUP	NUMBER OF EM- PLOYEES ¹	NUMBER OF TER- MINATIONS	TERMI- NATIONS PER 100 EMPLOYEES	DIFFERENCE (P-V)		
				Per 100 Employees	Stand. Error	Proba- bility
<i>Military Terminations</i>						
First Four Months:						
Placebo	409	30	7.33	-1.60	1.93	> 0.40
Vitamin	392	35	8.93			
Last Eight Months:						
Placebo	308	76	24.68	-0.67	3.55	> 0.80
Vitamin	288	73	25.35			
<i>Nonmilitary Terminations²</i>						
First Four Months:						
Placebo	416	42	10.10	+1.38	2.06	> 0.50
Vitamin	390	34	8.72			
Last Eight Months:						
Placebo	297	40	13.47	+5.10	2.66	0.055
Vitamin	263	22	8.37			

¹ The number of employees is the average of the numbers at the beginning of each month in any period after excluding those terminated in previous months for other reasons.

² Termination rates in this table differ slightly from those obtained by cumulating monthly rates shown in Table 12, but the differences are almost identical.

i.e., the total number of nonmilitary terminations during the year divided by the number of those present on March 1, 1942, the rate for the Vitamin group was 71.9 per cent of the rate for the Placebo group.

Table 13 contains the data on the statistical significance of the differences in military and nonmilitary termination rates. The Study year was divided into the first four months and the remaining eight months because, as Figure 1 shows, a sharp difference between the two groups occurred in the middle of the second quarter.

Differences in the rates of military terminations between the Placebo and Vitamin groups are not statistically significant, neither in the first four months nor in the last eight months of the year. Similarly, the difference in rates of nonmilitary terminations in the first four months is not statistically significant. This is additional evidence of the similarity of the Placebo and Vitamin groups at the beginning of the Study.

In the last eight months the rate of nonmilitary terminations in the Vitamin group is 8.4 per cent compared with 13.5 per cent in the Placebo group. The difference (5.1 per cent) has a statistical probability of 0.055, which is a borderline value, indicating that chances are about one in eighteen for the occurrence of such a difference as a result of pure chance.³⁷

The most frequent reasons given for nonmilitary terminations were: the offer of a job elsewhere with more money; dissatisfaction with living conditions causing the men to move to another city; an obligation, usually for family reasons, to return to the home city; and dissatisfaction with the job. The "freezing" order came toward the very end of this Study; therefore it did not operate to reduce nonmilitary terminations. An independent study at the Lockheed Aircraft Corporation showed that reasons given for termination are

³⁷ If the nonmilitary termination rates for the five months July-November are compared, the difference is 5.35 per cent and P for this difference is 0.025.

often only rationalizations, the real reasons being dissatisfaction with the job or failure of adjustment.

A reasonable explanation for the lower rate of nonmilitary termination in the Vitamin group is a better attitude of the men toward the job; i.e., their morale became better. Hence such reasons for leaving the job as alleged above came to be felt as less pressing. This explanation of the findings on termination rates is in accord with that of the findings on absenteeism and, as shown below, with those on the Merit Rating Reviews.

Since the data on turnover concern only the Placebo and Vitamin groups, the psychotherapeutic effect was present in both and is canceled out in comparisons made between them. The only difference, as far as we are aware, in the factors operating on the two groups is the possible therapeutic effect of the vitamin supplement. On the evidence, the greater improvement in morale in the Vitamin group may, therefore, be ascribed to this therapeutic effect.

3. MERIT REVIEW SCORES

(AN INDEX OF INDUSTRIAL MORALE)

The Company's contract with the Union calls for a Merit Review rating on every employe at six-month intervals. Each review, which is made by the employe's immediate superior, attaches a numerical score to each of six characteristics: quality of production, quantity of production, adaptability, knowledge of the job, dependability, and attitude. The lowest score possible for each characteristic is 0, and the highest 8. There are no fractional scores. The lowest individual score given any employe in this survey was 2, in one case. The score on the Merit Rating Review in conjunction with comments about the man are important factors in determining whether he gets a raise, and how much.

All the reviews used in this Study were made routinely without any reference to the Study. Few supervisors of the many who made the reviews even knew which men were in the Study, and none

knew that some men were receiving placebos. The same supervisors made reports on men in all three groups. The closeness of the scores for all three groups in the review made at the beginning of the Study, and for the two control groups in the review made at the end of the Study, show that there were no differences in leniency and severity of rating the three groups.

The reviews in the two months before and two months after March 1, 1942 are designated "Initial" Reviews. "Final" Reviews were made in a similar period bracketing March 1, 1943. Special reviews were made when men left the Company, and these were used if a routine review had not been made during the final four-month period of the Study. The mean scores obtained by men in the Placebo, Vitamin, and C groups and in the subgroups are given in Table 14.

Higher scores were given all three groups in the "Final" Reviews. This may be explained, in part at least, by the assumption that the longer a man works at a given job the more useful he becomes. The consistency of higher scores in the "Final" Reviews reflects also a possible tendency to make scores justify the raises all companies had to give their men in order to keep them during the period of rapid expansion. This must be borne in mind in appraising the data on Merit ratings.

It is clear from Table 14 that the scores for dependability and attitude, in both the "Initial" and "Final" Reviews, tended to be higher than those for the other four characteristics. The attitude scores are consistently slightly higher than those for dependability.

Nearly always, when the score for any one characteristic was low, those for all the others were low, and vice versa for the high scores. A conservative interpretation of the scores given for the various characteristics is that the individual scores are, largely, appraisals of an employe's general reliability and work performance which are reflections of his morale. It is difficult otherwise to account for the

Table 14. Merit Review scores at the beginning and end of the Study year for subjects in the Placebo, Vitamin, and nonparticipating control group.

CLASS AND STUDY GROUP	NUMBER OF SUBJECTS ¹	MEAN SCORE FOR SPECIFIED CHARACTERISTIC						MEAN SCORE FOR ALL RATINGS
		Quality	Quantity	Adaptability	Knowledge	Dependability	Attitude	
"INITIAL" MERIT REVIEWS								
<i>"Whole" Class, All Shifts</i> Placebo	212	5.623	5.448	5.623	5.420	5.797	5.991	5.650
	208	5.574	5.442	5.654	5.452	5.760	5.976	5.643
<i>"Whole" Class, Swing Shift</i> Placebo	174	5.569	5.431	5.598	5.397	5.787	5.948	5.622
	150	5.547	5.427	5.633	5.447	5.753	5.973	5.630
<i>"Whole" Class, Day and Graveyard Shifts</i> Placebo	38	5.868	5.527	5.737	5.527	5.843	6.185	5.781
	58	5.655	5.466	5.707	5.466	5.776	5.983	5.676
<i>"Throughout" Class, Swing Shift</i> C	165	5.612	5.430	5.588	5.455	5.758	5.982	5.638
	156	5.628	5.474	5.635	5.442	5.853	6.000	5.672
<i>"Throughout" Class, Day and Graveyard</i> Placebo	128	5.594	5.500	5.703	5.508	5.789	6.063	5.693
	31	5.903	5.548	5.806	5.613	5.903	6.161	5.822
<i>"Throughout" Class, Day and Graveyard</i> Vitamin	47	5.596	5.383	5.596	5.383	5.723	5.894	5.596
	"FINAL" MERIT REVIEWS							
<i>"Whole" Class, All Shifts</i> Placebo	212	6.203	6.071	6.193	6.057	6.288	6.495	6.218
	208	6.447	6.183	6.293	6.332	6.442	6.567	6.377
<i>"Whole" Class, Swing Shift</i> Placebo	174	6.259	6.144	6.264	6.121	6.356	6.557	6.284
	150	6.487	6.260	6.387	6.427	6.567	6.647	6.463
<i>"Whole" Class, Day and Graveyard Shifts</i> Placebo	38	5.948	5.711	5.843	5.711	5.974	6.236	5.904
	58	6.344	5.983	6.051	6.120	6.189	6.362	6.175
<i>"Throughout" Class, Swing Shift</i> C	165	6.370	6.194	6.273	6.224	6.345	6.466	6.312
	156	6.282	6.205	6.269	6.173	6.385	6.577	6.315
<i>"Throughout" Class, Day and Graveyard</i> Placebo	128	6.570	6.336	6.438	6.453	6.656	6.711	6.527
	31	6.032	5.839	5.871	5.742	6.000	6.290	5.962
<i>"Throughout" Class, Day and Graveyard</i> Vitamin	47	6.362	5.979	6.043	6.085	6.213	6.340	6.170

¹ Only those men were included for whom ratings as production workers were available at the beginning and at the end of the Study. For example, men who were promoted to supervision or who changed to clerical work were excluded. Since every man was given a Merit rating on the termination of his employment, ratings were available of those who terminated in the last quarter, and they were included.

higher scores in the "Final" Reviews for all characteristics made by the Vitamin group than by the two control groups. The Vitamin group excelled most in "knowledge" and "quality" and also in "adaptability," "quantity," "dependability," and "attitude." The reviewer, having no objective measures or records of a cumulative character on which to base his scores, had to rely mostly upon the impression an employe made upon him. This fact reenforces the interpretation that the scores for each characteristic are not so much specific appraisals of an employe's merit, in these six different respects, as they are of his attitude toward his job which, of course, affects every aspect of his work performance. Accordingly, differences in the group means of the average scores for six characteristics give as much information regarding differences in performance for the three groups, and between the "Initial" and "Final" Reviews, as the differences in the mean scores for the individual characteristics. They may be taken to represent mainly differences in morale. We shall, therefore, confine ourselves in the following discussion mainly to the differences in the group means of the average ratings on six characteristics.

Table 14 shows that the scores in the "Initial" Reviews were very nearly the same in the total populations and in the swing shift subgroups of the Placebo and Vitamin groups. The scores of the non-participating control group and the corresponding Placebo and Vitamin subgroups also were approximately the same. The day and graveyard shift subgroups of the Placebo group had higher "Initial" scores than the corresponding Vitamin subgroups. None of the differences in comparable groups in the "Initial" Reviews are statistically significant²⁸ (Table 15), except that for the "Through-out" Class, Day and Graveyard Shifts.

²⁸ The probability that the observed divergence in means of Merit Review scores for any two Study groups is the result of random variation was estimated by analysis of variance (8). The magnitude of the variation in a distribution of the over-all mean scores for individual employes in any specific group is increased by the fact that the mean scores for each of the six characteristics varied. This variation in mean scores for the different characteristics is

(Continued on page 40)

The picture is quite different in the "Final" Review scores. Every Vitamin subgroup received a higher score for every individual characteristic than the corresponding C group or Placebo subgroup and, of course, a higher mean score. As shown in Table 15, the mean score for the total Vitamin group and for each subgroup differed significantly from the mean score of its corresponding Placebo group. In the comparisons of the mean "Final" score for the non-participating control group (C) with the Study groups, the difference between the C group and the Placebo group is not statistically significant but the C group has a significantly lower score than the Vitamin group.

The consistency of the differences in the "Final" Reviews and their absence in the "Initial" Reviews deserve some emphasis. In their "Initial" Reviews the two swing shift subgroups of the Placebo group received higher scores for individual characteristics in five instances, the corresponding Vitamin subgroups in seven. Among the day and graveyard shift subjects the Placebo subgroups received in their "Initial" Review the higher score in all twelve instances for individual characteristics. In the "Final" Reviews, each Vitamin subgroup received the higher score for every individual characteristic.

The absence of any such reversal in the second six months in the common to subjects in all the Study groups and is independent of any variation associated with membership in a particular Study group; therefore, variation due to this factor should be eliminated in obtaining a valid estimate of the variation among individuals with respect to Merit ratings. By analysis of variance, the total variation in Merit ratings is separated into (1) the variation of individual scores from the mean scores for the respective characteristics and the mean variance from this source is designated in Appendix Table 1 as mean square for "within characteristics"; (2) the variation among mean scores for the different characteristics, for which the variance is shown in Appendix Table 1 as mean square among means of characteristics; (3) the variation between the over-all mean scores for subjects in any two groups compared, for which the variance is shown in the Table as mean square between group means; and (4) a remainder or interaction variance for factors not controlled. For purposes of this Study, we are interested in determining whether any two groups compared are homogeneous or heterogeneous samples with respect to the Merit scores obtained. From the measure of variation among individual scores (mean square "within characteristics"), the probability that any observed difference in group means would occur from random sampling is determined by the ratio of the mean square between group means to the mean square "within characteristics" and this ratio is termed the F value. The probability corresponding to any ratio is taken from statistical tables of F values for appropriate degrees of freedom.

comparison of the C group with the corresponding Placebo subgroup stands in sharp contrast. In the "Initial" Review the latter received the higher score for five of the six individual characteristics; and in the "Final" Review each received the higher score for three. The Vitamin subgroup corresponding to these two received the highest score for all six individual characteristics.

Both the "Initial" and "Final" scores of the C group and of the corresponding Placebo subgroup are nearly identical, from which it must be concluded that the psychotherapeutic elements in the Placebo group (and absent in the C group) did not make for a higher Merit Review score. By a similar argument the higher scores in the Vitamin group are to be ascribed to a therapeutic effect of the vitamin supplement.

The data in the section on absenteeism indicated the presence of

Table 15. Differences between mean Merit Review scores for Vitamin and Placebo groups and subgroups and between the nonparticipating control group and each of the corresponding Study groups.

GROUPS COMPARED	"INITIAL" REVIEW		"FINAL" REVIEW	
	Difference in Means	p ¹	Difference in Means	p ¹
"Whole" Class, All Shifts Placebo—Vitamin	+0.007	*	-0.159	<.001
"Whole" Class, Swing Shift Placebo—Vitamin	-0.008	*	-0.179	<.001
"Whole" Class, Day or Graveyard Shift Placebo—Vitamin	+0.105	>.05	-0.271	<.001
"Throughout" Class, Swing Shift Placebo—Vitamin	-0.021	*	-0.212	<.001
Control—Placebo	-0.034	*	-0.003	*
Control—Vitamin	-0.055	>.05	-0.215	<.001
"Throughout" Class, Day or Graveyard Shift Placebo—Vitamin	+0.226	.01-.05	-0.208	.01-.05

¹ P is the probability of obtaining group means as divergent or more so by chance.
 * Means do not differ significantly; greater mean square is that "within characteristics." See Appendix Table I and Footnote 18.

an element of "strain" in the men who transferred to the day and graveyard shifts; this "strain" was not present, or was less, in those who remained on the swing shift throughout the Study year. The absenteeism data indicated also that this "strain" appeared to have been largely relieved by the vitamin supplement. Similar evidence both of the existence of the "strain" and of its relief by the vitamin supplement is seen in Table 16 which compares the changes in the Merit Review scores between the

Table 16. Increase in "Final" over "Initial" mean Merit Review scores on all characteristics for Placebo and Vitamin subgroups and for the nonparticipating control group.

Class and Shift	Increase in Mean Score		
	C	Placebo	Vitamin
"Whole" Class Swing Shift Day and Grave- yard Shifts		0.662	0.833
		0.123	0.489
"Throughout" Class Swing Shift Day and Grave- yard Shifts	0.674	0.643	0.834
		0.140	0.574

"Initial" and "Final" ratings for the different groups. The increase in the "Final" over the "Initial" Review scores was much smaller in the Placebo subgroups on the day and graveyard shifts than in those who remained on the swing shift. The Vitamin subgroups on the day and graveyard shifts also had smaller increases in their "Final" Reviews than the Vitamin swing shift subgroups; but the Vitamin subgroups were much more alike in their increases than the Placebo subgroups.

The scores in the Merit Reviews for the six individual characteristics all refer to different aspects of industrial morale. The reasons for this view have been given above. The higher Merit Review scores of the Vitamin group indicate, therefore, that the morale in this group became better, or improved more, than in the two control groups. Three independent lines of evidence, the data on absenteeism, industrial turnover, and Merit Review scores point, therefore, to the same conclusion; namely, that the effect of the vitamin supplement was to improve the morale or attitude toward the job of

the recipients, and that this effect was separate from the psychotherapeutic effect of the placebo.

AN ESTIMATE OF THE CUMULATIVE EFFECTS ON PRODUCTION OF THE
LESS ABSENTEEISM AND TURNOVER AND IMPROVED WORK
PERFORMANCE IN THE VITAMIN GROUP

The absenteeism rate of the Placebo group ("Whole" Class, All Shifts) in the second six months was 4.791 days per 100 working days, and in the corresponding Vitamin group, 3.899. The difference is 0.892 days per 100 working man days, or for a year of 254 working days the difference is 2.27 days per person.

The reduction in absenteeism in the Vitamin group expressed as a percentage of the rate of the Placebo group is $\frac{0.892 \times 100}{4.791} = 18.6$ per cent.

It is more difficult to estimate the gain from reduction in turnover than that from reduction in absenteeism. Expressed as a percentage of the rate in the Placebo group, the reduction in turnover in the Vitamin group was 26.9 per cent. The difference in cumulative rates of nonmilitary terminations for the year was 6.51 fewer terminations per 100 men in the Vitamin group. It has been estimated in the southern California aircraft industry that the loss to a company in the termination of an employe is about \$200. This reduction in turnover meant a gain of \$1,302 per year per 100 men employed, or \$13.02 per year per man employed. This saving is equal approximately to 1.63 days' wages per man per year.

The following discussion aims to estimate the gain to production from the reduction in absenteeism, the reduction in turnover, and from better general work performance in the Vitamin group as compared with the Placebo group.²⁹

The index of general work performance agreed on by both

²⁹ The figures given in the discussion which follows are not intended to be construed in a strict accounting sense. They are offered as admittedly rough indices to illustrate the principle and to indicate the relative orders of magnitude of the gains from reduction in absenteeism, reduction in turnover, and improvement in general work performance. The principle applies regardless of the means employed to obtain these benefits.

SOURCE OF GAIN IN PRODUCTION	PER CENT IMPROVEMENT IN VITAMIN GROUP	MAN DAYS GAINED PER MAN PER YEAR	PER CENT OF TOTAL DAYS DERIVED FROM EACH SOURCE
Reduced Absenteeism	18.6	2.27	21.6
Reduced Turnover	26.9	1.63	15.5
Better General Work Performance (Merit Review Scores)	2.6	6.60	62.9
TOTAL		10.50	100.0

Table 17. Estimated gain in production, expressed as days, per man per year, from the reduction in absenteeism and in turnover, and from improved work performance for employees receiving the vitamin supplement.

management and the Union is the Merit Review score. This index, no doubt, leaves much to be desired, but it was the only one available and it is widely used. The Placebo and the Vitamin groups received practically the same Merit Review scores at the beginning of the Study. At the end of the Study the mean "Final" total score of the Vitamin group was 6.377 and of the Placebo group, 6.218; and the ratio of the former to the latter expressed as a per cent is 102.6.

A 2.6 per cent higher Merit Review score may be taken to represent the greater worth to the production of the Company, and for the sake of this discussion is expressed at 2.6 per cent more work per man. Small as the figure 2.6 per cent is, translated into working days it amounts to a gain of 6.60 working days²⁰ per man per year (.026 x 254), which is nearly three times the gain from the 19 per cent reduction in absenteeism and four times the gain from the 27 per cent reduction in turnover.

The gain in terms of man days of work from the reduction in absenteeism, improved general work performance, and reduced turnover is presented in Table 17. The gain from these three respects, in which the Vitamin group was superior, is represented by

²⁰ This is probably a very conservative estimate.

the estimated figure of 10.5 man days per man year. This corresponds to a gain in manpower of 4.1 per cent $\left(\frac{10.5 \times 100}{254}\right)$. The

total gain from the favorable effects seen in the Vitamin group probably exceeds that in these three specific expressions of work performance which could be measured.

The figures in Table 17 estimate only the gain from the therapeutic effect of the vitamin supplement. There was in addition, as discussed in the section on absenteeism, a psychotherapeutic effect exerted by both the placebo and the vitamin supplement which tended to reduce Illness absences.

SUMMARY

A supplement containing six vitamins and calcium was given to a group of aircraft workers for a year, and a placebo was given to a second group. Men in these groups were volunteers, and evidence is presented that they were superior to the average of industrial workers. A second control group was formed from employes who did not participate actively in the Study.

Initially, these groups were alike in age, duration of employment, and Merit Review scores. The quality of diets, as reported by members of the Placebo and Vitamin groups, was the same and remained essentially unchanged.

In the first six months of the Study year the Placebo and Vitamin groups had similar absenteeism rates from all causes, and from specific causes classified as Unauthorized, Illness, and Authorized absences.

In the second six months the total absenteeism rate of the Placebo group was 4.79 days per 100 working days, and of the Vitamin group, 3.90 days. This difference of 0.89 days is statistically significant and represents a reduction in absenteeism of 18.6 per cent.

There was a reduction in absenteeism in the Vitamin group in each of the above three categories; the reduction was greatest in Unauthorized absences and least in Illness absences.

The subjects were classified according to changes in work shift and period under observation (twelve months and nine months but less than twelve). In every comparison of matched subgroups the Vitamin subgroup had a significantly lower absenteeism rate. As in the case of the total Placebo and Vitamin groups, the greatest differences were in Unauthorized absences.

Comparison of absenteeism in the Placebo and Vitamin groups with that of a matched nonparticipating control group showed that the giving of both the placebo and vitamin supplement exerted a psychotherapeutic effect. This effect was persistent in reducing Illness absences throughout the Study year. It reduced Unauthorized absences at first, but this effect did not persist through the second six months.

The rate of nonmilitary terminations was nearly equal in the Placebo and Vitamin groups in the first four months. For the remaining eight months this rate was 38 per cent lower in the Vitamin group. This difference is of borderline significance statistically.

Merit Review scores for the total Placebo and Vitamin groups, which were initially similar, showed a significant superiority of the Vitamin group at the end of the year. The same superiority appeared in the matched subgroups.

The Merit ratings of the Placebo and the nonparticipating control groups showed no significant differences in their "Initial" or "Final" Reviews, indicating that the psychotherapeutic effect did not make for higher Merit Review scores.

A conservative estimate of the over-all gain to production from the therapeutic effect of the vitamin supplement on absenteeism, turnover, and general work performance is 10.5 working days per man per year, corresponding to a gain in manpower of 4.1 per cent. Of these, 6.6 days are the result of improved work performance, 2.3 days are from a reduction in absenteeism, and 1.6 days are from reduced turnover. These figures exclude gains due to psychotherapeutic effects.

The three independent lines of evidence furnished by the data on absenteeism, turnover, and Merit Review scores point toward improvement in industrial morale as the major factor responsible for the statistically significant effect of the vitamin supplement.

The consistency of the trend toward superior performance in the Vitamin group as the Study year progressed is the most persuasive feature of the evidence for crediting benefit to the therapeutic effect of the vitamin supplement. This consistency runs through all the causes given for absence, the data on turnover, and all six individual items in the Merit Review scores; it is seen in the comparison of the total populations of the Placebo and Vitamin groups and in the comparisons of their four subgroups.

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Table 1. Results of analysis of variance for comparisons of Merit Scores for Placebo and Vitamin groups and subgroups and for Placebo and Vitamin groups with a nonparticipating control group.

GROUPS COMPARED AND SOURCES OF VARIATION	"INITIAL" MERIT SCORES				"FINAL" MERIT SCORES			
	Degrees of Freedom	Mean Square	F ¹	P ²	Degrees of Freedom	Mean Square	F ¹	P ²
<i>"Whole" Class, All Shifts</i>								
Within Characteristics	2,508	1.207			2,508	1.178		
Between P and V Means	1	0.036	*	*	1	17.527	14.9	<.001
Among Means of Charac.	5	18.399			5	8.946		
Interaction	5	0.115			5	0.810		
<i>"Whole" Class, Swing Shift</i>								
Within Characteristics	1,932	1.244			1,932	1.235		
Between P and V Means	1	0.033	*	*	1	15.433	12.5	<.001
Among Means of Charac.	5	14.171			5	6.676		
Interaction	5	0.091			5	0.560		
<i>"Whole" Class, Day-Graveyard</i>								
Within Characteristics	564	1.094			564	0.917		
Between P and V Means	1	1.531	1.4	>.05	1	10.175	11.1	<.001
Among Means of Charac.	5	4.427			5	2.582		
Interaction	5	0.147			5	0.291		
<i>"Throughout" Class, Swing</i>								
Within Characteristics	1,692	1.199			1,692	1.254		
Between P and V Means	1	0.181	*	*	1	18.990	15.1	<.001
Among Means of Charac.	5	12.932			5	5.615		
Interaction	5	0.228			5	0.402		
<i>"Throughout" Class, Day-Graveyard</i>								
Within Characteristics	456	1.208			456	1.059		
Between P and V Means	1	5.767	4.8	.01-.05	1	4.859	4.59	.01-.05
Among Means of Charac.	5	3.317			5	2.115		
Interaction	5	0.054			5	0.235		
<i>C and P Groups</i>								
<i>"Throughout" Class, Swing</i>								
Within Characteristics	1,914	1.154			1,914	1.147		
Between C and P Means	1	0.577	*	*	1	0.004	*	*
Among Means of Charac.	5	14.247			5	4.711		
Interaction	5	0.107			5	0.386		
<i>C and V Groups</i>								
<i>"Throughout" Class, Swing</i>								
Within Characteristics	1,746	1.190			1,746	1.115		
Between C and V Means	1	1.325	1.1	>.05	1	20.033	18.0	<.001
Among Means of Charac.	5	12.679			5	4.059		
Interaction	5	0.150			5	0.264		

¹ F is ratio of mean square for group means to the mean square "within characteristics" (see Footnote 18).

² P is the probability of obtaining group means as divergent or more so by chance.

* Greater mean square is that "within characteristics"; means do not differ significantly.