UNITED STATES DEPARTMENT OF LABOR
W. N. DOAK, Secretary

CHILDREN'S BUREAU
GRACE ABBOTT, Chief

POSTURE AND PHYSICAL FITNESS

By

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AND

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LETTER OF TRANSMITTAL

United States Department of Labor,
Children's Bureau,
Washington, March 6, 1931.

Sir: There is transmitted herewith a report on Posture and Physical Fitness, by Dr. Armin Klein, director of the posture clinic of the Massachusetts General Hospital, and Miss Leah C. Thomas, director, corrective gymnasium, Smith College. This is a report of a study of the effect of group training in posture in an elementary school in Chelsea, Mass.

Acknowledgment is made to Dr. Frank E. Parlin, superintendent of schools in Chelsea, for his cooperation during the study, and to Dr. Robert B. Osgood, professor of orthopedic surgery, Harvard Medical School, for generous assistance both in the survey and in the preparation of the report.

Respectfully submitted.

Grace Abbott, *Chief.*

Hon. W. N. Doak,
Secretary of Labor.

POSTURE AND PHYSICAL FITNESS

THE PROBLEM AND THE GROUP

A study of the posture of 1,708 elementary-school children in Chelsea, Mass., and the effect of group training upon the posture of the individual children was carried out in 1923 and 1924. The study had in the main two purposes: (1) To determine whether group instruction if carried out by the teachers and physical-education directors in grade schools would result in improved posture for a majority of children and whether it was possible to introduce such training into the curriculum, and (2) to study the effect of posture training and improvement in posture upon the nutritional condition, certain body measurements, and general health as shown by absences from school due to illness, and upon general morale as shown by improvement in scholarship and deportment.

Poor body mechanics has been considered the cause of many ailments. When no organic disturbances can be found to account for the ailments complained of, medical men have often felt themselves within the bounds of reason in attributing the symptoms to a functional disturbance of the body mechanics. They were strengthened in their belief also by the frequent cessation of symptoms which followed the application of suitable orthopedic appliances or the correction of the faulty posture by appropriate exercises.[1]

But all these reports were of the results attained by appliances and instruction as remedial measures in cases where body mechanics had been poor so long that compensation was insufficient to balance the drain on the body reserve. The individuals treated usually complained of dysmenorrhea, backache, cyclic vomiting, constipation, toxic arthritis, or general debility without organic causes that could be found for these conditions. It was therefore assumed that the associated poor posture was the cause of the symptoms, and the relief obtained by appropriate appliances or exercises was "ergo propter hoc." The effects of good body mechanics in all these cases were studied from the point of view of remedial or palliative medicine. Though the effects of correcting the poor posture in most cases were striking, no figures were available to show whether or not maintenance of correct body mechanics by any normal individual gave him any advantage over his associates who were like him but who exhibited serious faults of posture.

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[1] Talbot, Fritz B., M. D., and Lloyd T. Brown, M. D.: The Use of Supports in Obscure Abdominal Conditions (American Journal of Diseases of Children, vol. 21, No. 4 (April, 1921), pp. 347–356); and Talbot, Fritz B., and Lloyd T. Brown, M. D.: Bodily Mechanics; its relation to cyclic vomiting and other obscure intestinal conditions (American Journal of Diseases of Children, vol. 20, No. 3 (September, 1920), pp. 168–187).

The results of college examinations and of the draft examinations during the World War showed that about 80 per cent of the population in early adult life used their bodies poorly. These people did not necessarily show any signs of physical breakdown that could be attributed to poor posture. Their muscles and ligaments were still adequate to support them in their poor posture without annoying symptoms. The questions that arose therefore were whether the health of such individuals would be improved if they were trained to maintain better posture and whether their efficiency in their daily activities would be increased.

To this end it was decided to note the effects of instruction in proper body mechanics on grade-school children. Young children on the whole are less likely than adults to have had poor posture long enough to show any serious effects from it. They would therefore be the nearest approach to the so-called normal in posture. Their bodies are limber, and they would therefore show the effects of training more quickly. They could be kept under control easily, since, if studied at school, they would be under supervision for about five hours a day. Also at school they would be amenable to instruction and readily available in fairly large groups for study and periodic examination. Again, in grade schools the effect of age and growth as factors could be noted and studied. Finally, this seemed the simplest and easiest method of obtaining a representative group of children for study.

The Williams School, a public grade school in Chelsea, Mass., was selected as the site for the experiment. The school had an attendance of about 3,000 children. The district from which it draws its pupils is largely Russian Jewish.

The plan was to have the master of the school assign rooms from each grade from the first to the ninth, inclusive, and to divide the rooms into two groups, allotting similar numbers of rooms in each grade for posture training and the regular gymnastics prescribed by State regulation. The rooms were to be so selected that the number of children in the grades of the group to receive posture training would be approximately the same as the number in the corresponding grades receiving only the regular gymnastics. It was further planned to take measurements of the children in each group at regular intervals and to keep records of their physical condition and school progress. The group to receive the posture training was to show the results of this type of physical education and the group to receive the regular gymnastic exercises was to indicate the physical changes which would have prevailed generally in the whole group had no posture training been given. The difference in the changes observed in the two groups would indicate the effects attributable to the special posture instruction and exercise.

This plan was carried out during the first year. The master of the Williams School assigned 26 rooms, representing the school grades from the first to the ninth, inclusive, and having about 1,000 children in them. During the second year he assigned for further study 36 rooms, there being 4 rooms in each grade from the first to the ninth, inclusive, which represented in all 1,200 children. The rooms were divided as agreed, one group receiving the special posture instruction and training and the other only the regular gymnastic exercises. Throughout the report the group receiving the special training is referred to as the posture group, and the group receiving only the regular gymnastics, as the control group.

Arrangements were made to give each child a physical examination, including body measurements (for items noted see schedule, Appendix, p. 44) at the beginning and the end of the school year. He was also photographed at those times according to Fradd's method,[2] and the silhouettograph obtained was filed with his schedule. The child's height, standing and sitting, and his weight, all with shoes off and in usual school apparel, were taken every month. His school attendance or absence was noted for every quarter, and the absences were recorded according to whether they were due to infectious diseases—colds, sore throats, etc.—headaches, or other illnesses. Notation was also made whether the child needed cathartics to relieve constipation and how often in a quarter such cathartics were used. All medical attention received outside of school was also recorded. The grade-room teacher marked for each quarter the scholarship, deportment, and concentration in his work, of each child included in the study.

Though 2,200 children were studied thus, not all the schedules could be used. For the purposes of the study only those schedules could be included that showed a physical examination of the child at the beginning and at the end of the school year. Almost one-fourth of the schedules had to be discarded because they did not meet this requirement. Some children died; some moved out of the school district; some were moved out of the rooms in which they started at the beginning of the year because of either promotions or demotions; and finally, some were moved from their original rooms for administrative purposes. Some of the schedules were incomplete because of the absence of the child from school when the examinations were made.

Practically no physical examinations were omitted because of unwillingness of a child or of his parents to allow the examination or any part of it. Some children happened to be in a "control" room during one year of the experiment and in a "posture" room during the other. If they were in the control class the first year and the posture class the second, their schedules for both years were used; but if the year of posture training came first, only that year's schedule was included in the tabulation. A few children were in the posture class and a few in the control class both years of the study. Their schedules for the first year were used with those of the children who were included in the study group a single year. The schedules for the second year have been subjected to special analysis to show the effects of longer training in posture and the postural tendencies of untrained children over a period of two years.

The schedules of 1,708 children were sufficiently complete for inclusion in the study. Of these 961 were in the trained, or posture, group and 747 in the untrained, or control, group. (Table 1.) Seventy-six children were in the posture group for two years, and 68 children were in the control group for two years.

[2] Fradd, Norman W.: A New Method of Recording Posture. Journal of Bone and Joint Surgery, vol. 5, No. 4 (October, 1923), pp. 757, 758. See also Posture Exercises, by Armin Klein, M. D., and Leah C. Thomas, p. 15 (U. S. Children's Bureau Publication No. 165, Washington, 1926).

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TABLE 1.—*Nativity of mother for children in the posture and control groups*

Nativity of mother	Total		Posture group		Control group	
	Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution
Total	1,708		961		747	
Total reported	1,670	100	961	100	709	100
White	1,661	99	955	99	706	100
Native white	89	5	50	5	39	6
Foreign-born white	1,526	91	895	93	631	89
Russian-Jewish	1,089	65	616	64	473	67
Other Jewish	149	9	107	11	42	6
Italian	69	4	37	4	32	5
Armenian	47	3	25	3	22	3
Other foreign born	172	10	110	11	62	9
Nativity not reported	46	3	10	1	36	5
Negro	9	1	6	1	3	(1)
Not reported	38				38	

1 Less than 1 per cent.

The posture and control groups were similar in racial composition. Both groups were composed predominantly of children of foreign-born mothers, and children of Russian and other Jewish maternity constituted 75 and 73 per cent, respectively. Children of Italian and Armenian and other foreign-born mothers represented less than one-fifth of each group, and children of native white mothers approximately one-twentieth of each. Since the two groups are similar in racial composition, the racial traits and dietary customs would have had the same influence in both posture and control groups and could have no effect on the comparability of the figures.

There were 450 boys and 511 girls in the posture classes, and 388 boys and 359 girls in the control group. Thus, a sufficiently large number of each sex were in the control and in the posture groups to demonstrate the results of the experiment.

The youngest children were 5 years of age and the oldest 18, but the largest proportion were between the ages of 9 and 15 years. (Table 2.) This is true for both boys and girls and for both posture and control groups. The comparatively small proportions in the younger age periods are due to the method of room assignment, as the number of rooms assigned in the lower grades was somewhat less than the number assigned in the middle and upper grades. The small proportions in the age periods over 15 years are due partly to the fact that many intelligent children are in high school by the age of 15, and also to the Massachusetts school-attendance laws which permit children of 16 years to leave school entirely for work and those of 14 to leave regular school if they work part time and attend continuation school.

To sum up: Two thousand two hundred children were observed, and the records of 1,708 children were sufficiently complete for analysis. Nine hundred and sixty-one were given instruction in proper body mechanics and are spoken of in the report as the posture group. The remainder (747) were not given such training but continued the regular gymnastic exercises that they and the posture group had been doing previous to the study. They served as a control with which the changes of the posture group might be compared and are therefore called the control group. The two groups, except for the difference in postural training, apparently are quite comparable because of the similarity of distribution of the children within the groups according to nationality, age, sex, and type of body build. The differences in proportional relationships are so slight as to be statistically insignificant in their effect upon the results.

TABLE 2.—*Age at first examination of boys and girls in posture and control groups*

Age at first examination	Posture group					Control group				
	Total	Boys		Girls		Total	Boys		Girls	
		Number	Per cent distribution	Number	Per cent distribution		Number	Per cent distribution	Number	Per cent distribution
Total	961	450	------	511	------	747	388	------	359	------
Total reported	953	449	100	504	100	740	381	100	359	100
5 years	9	5	1	4	1	17	8	2	9	3
6 years	51	25	6	26	5	43	23	6	20	6
7 years	59	29	6	30	6	62	25	7	37	10
8 years	50	24	5	26	5	48	26	7	22	6
9 years	132	59	13	73	14	79	36	9	43	12
10 years	137	58	13	79	16	79	41	11	38	11
11 years	110	67	15	43	9	110	56	15	54	15
12 years	133	70	16	63	13	85	45	12	40	11
13 years	110	52	12	58	12	93	51	13	42	12
14 years	100	36	8	64	13	70	37	10	33	9
15 years	45	19	4	26	5	41	26	7	15	4
16 years	11	4	1	7	1	8	4	1	4	1
17 years	6	1	(1)	5	1	4	3	1	1	(1)
18 years	------	------	------	------	------	------	------	------	1	(1)
Age not reported	8	1	------	7	------	7	7	------	------	------

1 Less than 1 per cent.

PROCEDURE OF STUDY OF EACH CHILD

All the children in both the control and the posture groups appeared at the examining room with their clothes lowered below their buttocks. Each had his card (see Appendix, p. 44) on which were his name, address, nationality, sex, and age, the number of his schoolroom, and the date of the examination. They were seen first by the orthopedic surgeon, who graded them according to their appearance; i. e., on the basis of clinical estimation of their state of nutrition. The nutrition scale included the following classes: A, children superior in health, vigorous looking, excellently nourished (amount of body fat), and of excellent color, with well-developed muscles of good tone and firm skin and subcutaneous tissue; B, those that just fell short of the excellent (A); C, those who were listless, whose muscles were poorly developed and lacked good tone, and whose skin and subcutaneous tissue felt flabby; D, those who showed marked malnutrition and definite need of care.

The children were also graded according to the manner in which they stood before the examiner. (See posture-standards charts, pp. 6–11.)

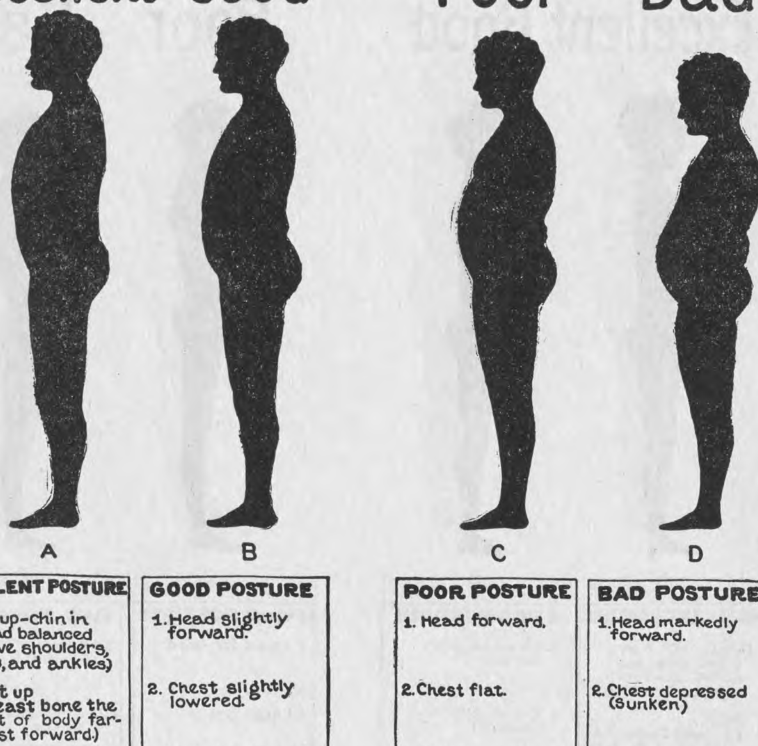
Children were regarded as having A, or excellent, posture if the head was balanced above the shoulders, the chest elevated and the breast bone the part of the body farthest forward, the lower abdomen drawn in and flat, and the back curves not exaggerated. In the lateral view

the body parts would be so aligned that a perpendicular dropped from the ear or just behind it would fall through the shoulder and hip joints, and either through the ankle joints or just in front of them. Children were classed as having B, or good, posture when the head was held inclined only slightly forward and the chest slightly lowered, when the lower abdomen was held in but not flat, so that, though perhaps rounded, it did not protrude, and when the back curves were only slightly exaggerated—enough, however, to show the early signs of a

POSTURE STANDARDS

Stocky-Type Boys

Excellent Good Poor Bad



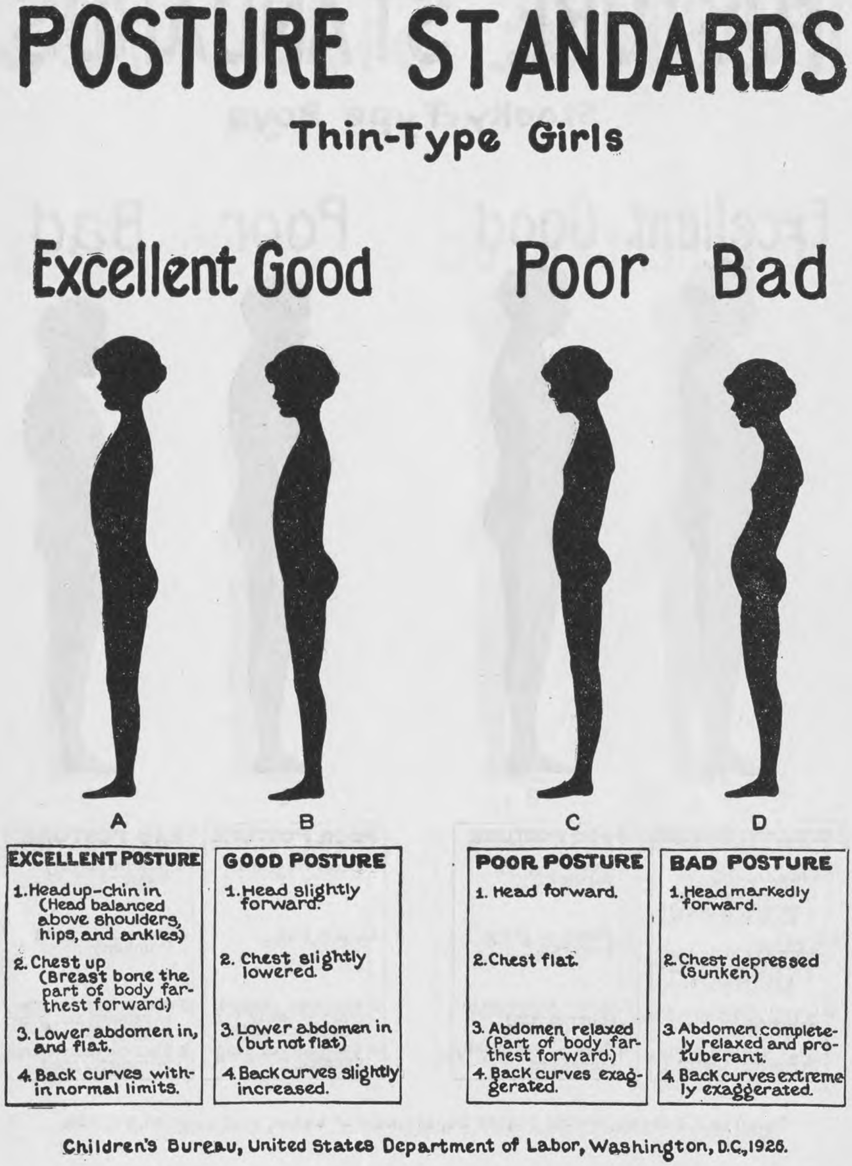
A B C D

EXCELLENT POSTURE	GOOD POSTURE	POOR POSTURE	BAD POSTURE
1. Head up—chin in (Head balanced above shoulders, hips, and ankles)	1. Head slightly forward.	1. Head forward.	1. Head markedly forward.
2. Chest up (Breast bone the part of body farthest forward.)	2. Chest slightly lowered.	2. Chest flat.	2. Chest depressed (Sunken)
3. Lower abdomen in, and flat.	3. Lower abdomen in (but not flat)	3. Abdomen relaxed (Part of body farthest forward.)	3. Abdomen completely relaxed and protuberant.
4. Back curves within normal limits.	4. Back curves slightly increased.	4. Back curves exaggerated.	4. Back curves extremely exaggerated.

Children's Bureau, United States Department of Labor, Washington, D.C., 1925.

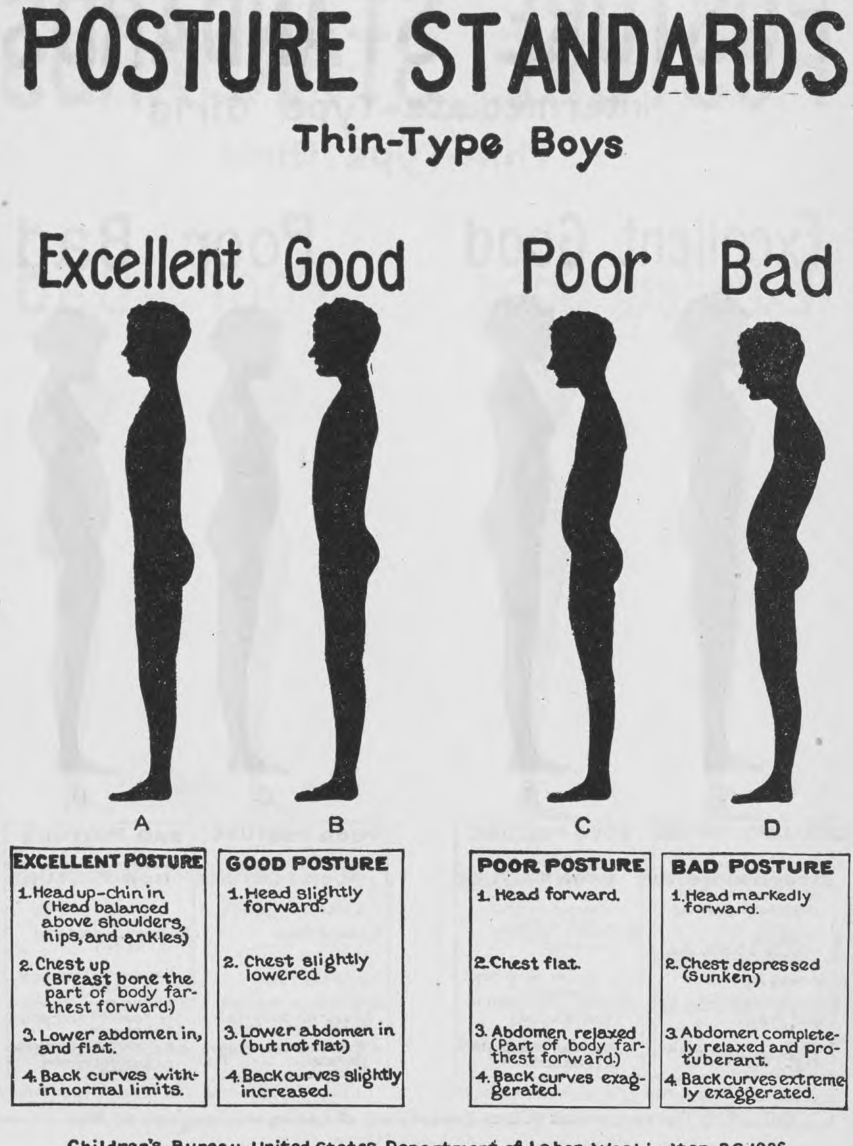
hollow back. The posture was considered C, or poor, if the head was distinctly forward, the chest flat, the abdomen relaxed so that it was the part of the body farthest forward, and back curves distinctly exaggerated. The D, or bad, posture grade was reserved for the child whose head was dropped markedly forward and chest sunken and depressed, whose abdomen was completely relaxed and protuberant, and whose back curves were extremely exaggerated.

The type of body build of the children was of interest because of its relation to posture. Those called thin have a long, slender torso and



a long, thin neck. The extremities and their muscles are also long and slender. They have the long, willowy, flexible bodies, and as they stand poorly they sway backward from the lowest part of their spines while the pelvis is tipped forward.

Children classed as broad have a heavy broad-backed appearance with large skeletons. The neck is short and chunky. The torso is broad and relatively short. Flexibility is lacking in their sturdily built spines. Their extremities are large and broad, their musculature is heavy, and they themselves tend to be obese. Their poor posture

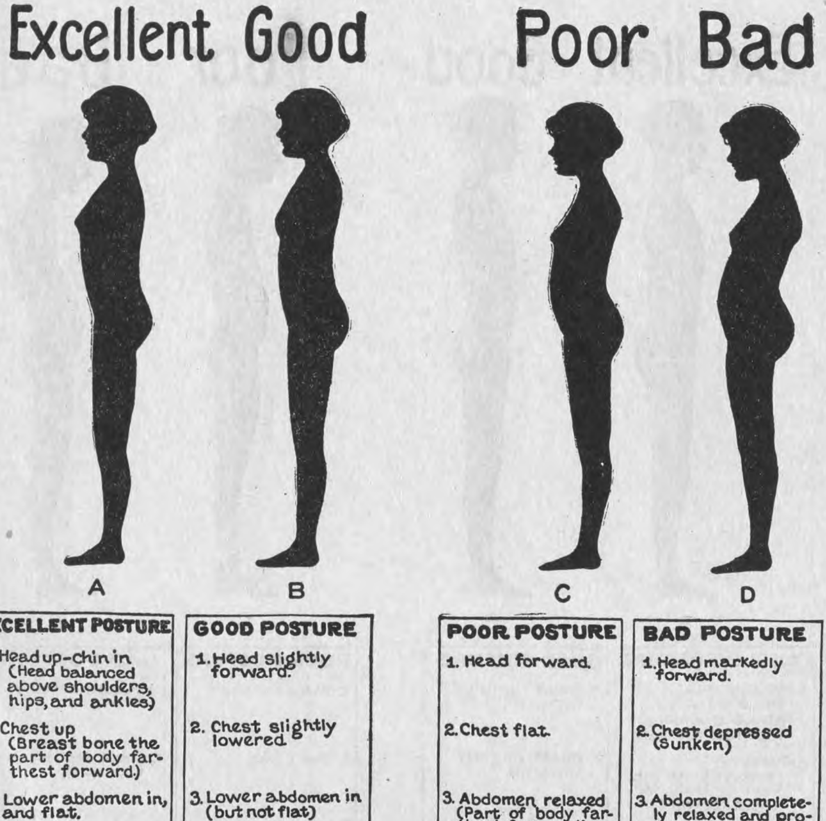


involves leaning backward from the middle of the back at the dorsolumbar junction.

All that did not fall readily into either of these groups were included in the intermediate type. Their torso is intermediate in length and breadth between the other two types. The normal rounded curves of the spine, if they become exaggerated, appear mild and gradual. The sharp curves of the thin type and the large fatty deposits of the broad type are missing. The neck may be almost as long as that of the

POSTURE STANDARDS

Intermediate-Type Girls

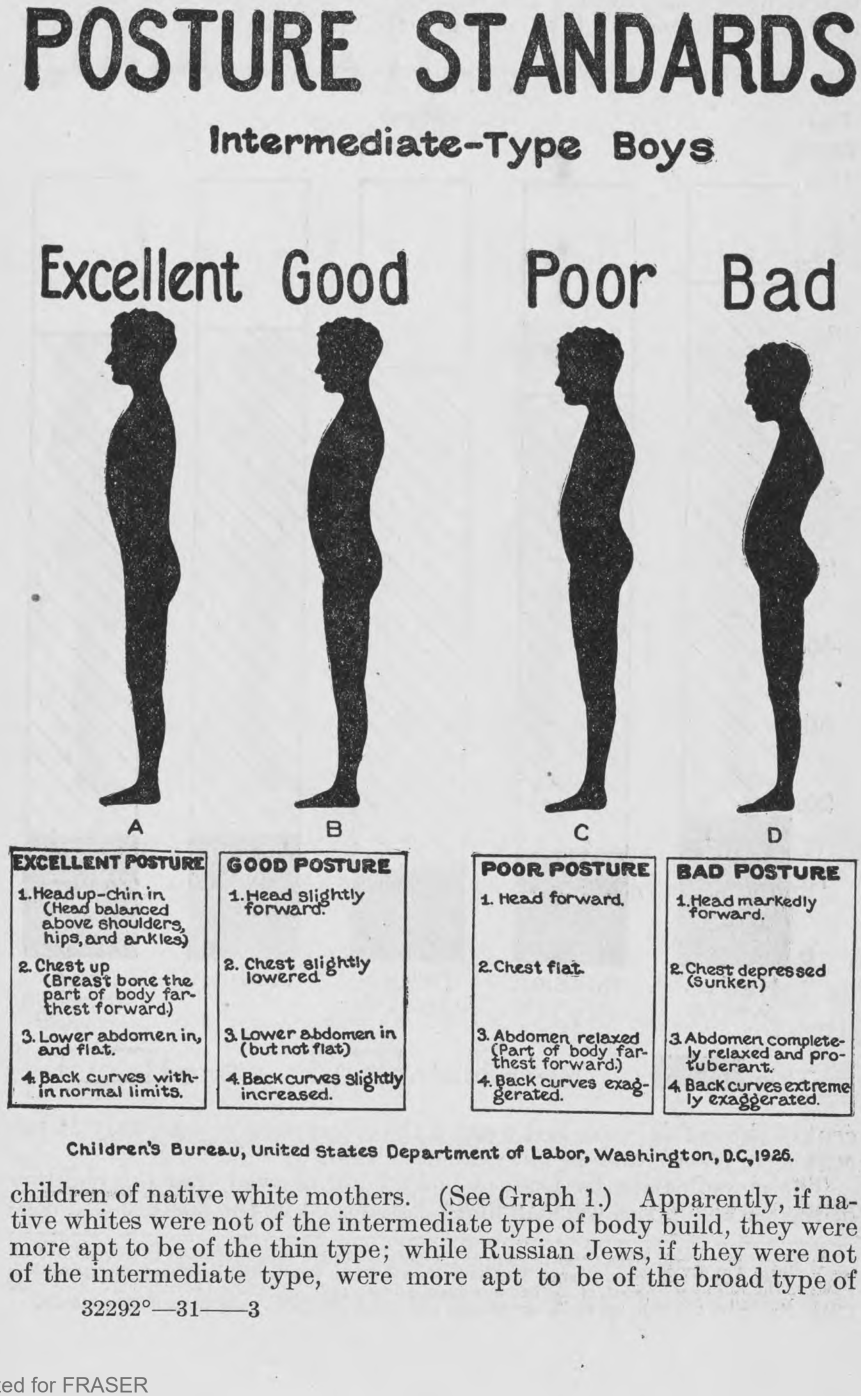


EXCELLENT POSTURE	GOOD POSTURE	POOR POSTURE	BAD POSTURE
1. Head up-chin in (Head balanced above shoulders, hips, and ankles)	1. Head slightly forward.	1. Head forward.	1. Head markedly forward.
2. Chest up (Breast bone the part of body farthest forward.)	2. Chest slightly lowered.	2. Chest flat.	2. Chest depressed (Sunken)
3. Lower abdomen in, and flat.	3. Lower abdomen in (but not flat)	3. Abdomen relaxed (Part of body farthest forward.)	3. Abdomen completely relaxed and protuberant.
4. Back curves within normal limits.	4. Back curves slightly increased.	4. Back curves exaggerated.	4. Back curves extremely exaggerated.

Children's Bureau, United States Department of Labor, Washington, D.C., 1926.

thin type; or it may be short, though hardly so thick and chunky as in the broad type. When the children of intermediate-type body build assume a relaxed attitude they bend backward not at the middle of the back as do the broad, stocky ones, nor at the lowest part of the spines as do the thin ones, but midway in the lower back or lumbar spine.

All the children were classified as to body type and nationality. It was found that more of the children of Jewish mothers were of the broad type than were the children of Italian or native white mothers and the highest percentage of thin children was among the



children of native white mothers. (See Graph 1.) Apparently, if native whites were not of the intermediate type of body build, they were more apt to be of the thin type; while Russian Jews, if they were not of the intermediate type, were more apt to be of the broad type of

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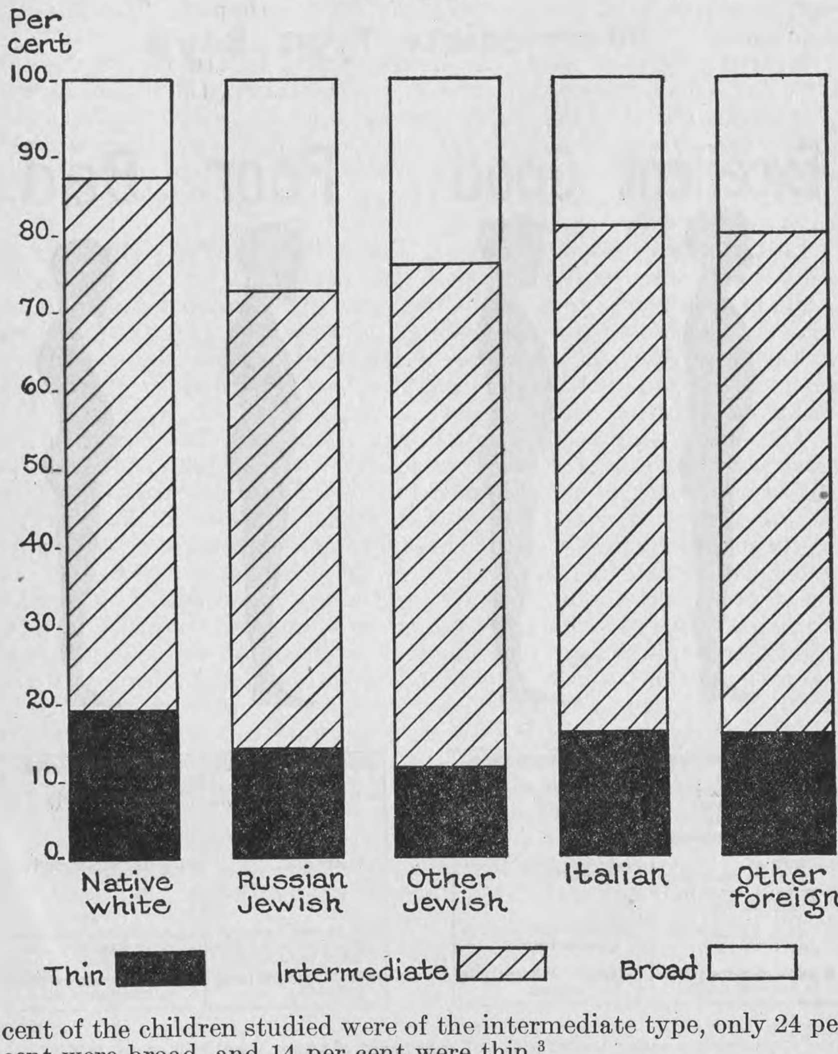
physique. The pure thin type is seemingly most prevalent among the offspring of native whites; the broad type is seen more among the children of foreign-born parents. Thus, since most of the children studied were of Russian-Jewish, or at least foreign extraction, and since, as was noted, all children not regarded as pure types were classified as of the intermediate type, it is at once clear why more than 60 per

GRAPH 1.—TYPE OF BUILD OF CHILDREN OF NATIVE WHITE AND OF FOREIGN-BORN MOTHERS



cent of the children studied were of the intermediate type, only 24 per cent were broad, and 14 per cent were thin.[3]

The classification by type of body build showed that the children of the various types were similarly distributed in the posture and con-

[3] It will be noted that these types conform to the anthropological types described by Osgood in 1921. See Is There Any Evidence to Suggest That Poor Posture Bears Any Causal Relation to Poor Health in Children? by Robert B. Osgood, M.D. (Transactions of American Child Hygiene Associationat New Haven, Conn., November 2-5, 1921, pp. 65-73, also Mother and Child, vol. 3, No. 1 (January, 1922), pp. 5-12).

trol groups. (See Table 6.) The intermediate type predominated in both groups, representing 59 per cent of the children who received posture training and 64 per cent of the control children. Children of the broad type constituted 27 per cent of the posture and 22 per cent of the control group, and 14 per cent of the children in each group were called thin.

After classifying the children into the thin, broad, or intermediate type according to the characteristics of their body build, the orthopedic surgeon noted on the cards any other orthopedic disabilities or deformities.

Next, the surgeon noted the child's type of breathing. If the ribs were the site of most of the activity in respiration, the breathing was recorded as costal; if the diaphragmatic excursion was most noticeable in the upper abdomen the breathing was classified as upper abdominal; and if the breathing action apparently was confined to the lower abdomen it was so noted. Any combinations of these three types were also set down on the cards.

Lastly, the orthopedic surgeon asked the child to "draw in his belly," and observed which part of the child's torso was most mobile while he was trying to do so. Some children retracted the abdomen directly. Others, apparently, found it easier to elevate the chest and in this way drew in the abdomen indirectly. Still others combined direct retraction of the abdominal muscles with indirect retraction by means of elevation of the chest.

The child then passed along to a nurse, who took the height without shoes, the weight while wearing ordinary school clothing, and measured the circumference of the abdomen and also of the chest during inspiration and expiration and between breaths. Another nurse measured with calipers the depth of the chest during inspiration and expiration and between breaths, the breadth of the chest between breaths, and the depth of the abdomen at rest and when retracted. Still another nurse took the vital-capacity readings on the spirometer into which the child blew while sitting comfortably in a chair. The final readings by another assistant were of the costal angle, formed by the lower ribs at their junction with the breast bone or xyphoid cartilage, both between breaths and during full inspiration. This was done with an instrument made of two pieces of steel united at one end by a hinge joint and opening sidewise on an arm on which degrees were marked.

About 30 children passing in single file by the orthopedic surgeon and his four assistants could be examined within an hour.

After these observations were completed, the child was photographed by the method advocated by Norman Fradd,[4] being told merely to stand in front of the camera for his photograph. During the entire examination and at subsequent examinations the child was not told how he should stand. Stencil numbers corresponding to the children's examination-card numbers were fixed on the screen during the photography so as to identify the pictures. A male assistant for the boys and a female assistant for the girls did the photographing, while a second assistant kept the children in single file passing regularly to a position in front of the camera. In this way it was possible after a

[4] Fradd, Norman W.: A New Method of Recording Posture. Journal of Bone and Joint Surgery, vol. 5, No. 4 (October, 1923), pp. 757-758.

very little experience to photograph between 50 and 60 children in an hour.

These photographs were later developed and graded according to the type of body mechanics manifested. They were then attached to the examination cards after first having been shown to the children. To each child in the posture group, as he was shown his own photograph, were demonstrated the errors in his body mechanics and the methods by which he could correct them, as he was urged to do.

Every month thereafter the children's weight, and sitting and standing height were taken. The same assistants took these readings throughout the year. The other readings and observations described were likewise always taken by the same assistants throughout all examinations both at the beginning and at the end of the school terms.

At the end of every quarter of the school term the grade teacher noted on his card the number of sessions each child was absent from school for colds, sore throats, headaches, or other personal illnesses. She also noted his scholarship, his deportment, and the degree of concentration in his work. She graded each child in these last characteristics according to the scale of A, B, C, and D.

After the child was examined by the orthopedic surgeon and his corps of assistants, he was ready, if he was in the posture group, for his posture training. The children in the control group, of course, were allowed to continue with the usual school work without posture training.

All instruction was guided by the orthopedic surgeon and his first assistant. The latter was the supervisor in active charge of the posture instruction to the children. She was a physical instructor with much experience in posture work. She first taught the grade teachers the fundamentals of good posture, so that they knew how to use their own bodies correctly and to teach these fundamentals to others. She herself started the children in their training by giving each child his first lessons in the fundamentals of good posture. She then visited each posture room once a week to conduct each class herself and to note any occasion for stressing certain aspects of the instruction with the teachers or with the children. She also met the assistant supervisors and the orthopedic surgeon periodically for conference on the problems that arose in regard to the routine of instruction.

The assistant supervisors were girls from the graduating class of a neighboring physical-education school, who had had their academic instruction in body mechanics for two years while at school. They came once a week for a morning's work with the children. They were observed, while instructing the children, by a supervisor from their own physical-education school. Each girl had the children in about six posture rooms assigned to her for intensive instruction in body mechanics. She spent about 20 minutes in each room trying to supplement the posture instruction given daily by the grade teachers. During this time she conducted the classes assigned to her through the prescribed exercises, and especially assisted the grade teacher in starting the children on any new exercises to which they might have advanced. She reported to the supervisor and the orthopedic surgeon in charge all children that needed special attention and the details of these requirements, and also reported the grade teachers under her assignment who needed special support in imparting good posture to the children.

The grade teachers in the posture rooms, as has been said, were first taught the fundamentals of good posture and methods of teaching them. They also observed the methods used by the supervisor and the assistant supervisors on their visits to the classroom. They attended a course of lectures by eminent orthopedic surgeons and in this way were continually stimulated in their instruction of good body mechanics. They taught the children the exercises formally for 10 minutes each day, but as they had their pupils under constant supervision for the whole school day, they were able to watch the children's posture for about 5 hours. Thus they had the best opportunity to correct the child who had faulty habits of body carriage and to stimulate him to form better habits of posture while exercising formally and while doing the rest of the school-day's work.

The exercises taught by the entire corps may be found in Posture Exercises, a handbook for schools and for teachers of physical education, United States Children's Bureau Publication No. 165.

THE POSTURE OF THE SELECTED GROUP BEFORE TRAINING

The first examination of the 1,708 children considered in this analysis disclosed that only 1 per cent had A posture, less than 10 per cent had B posture, 61 per cent ranked C, and 31 per cent ranked D. (Table 3.) Thus at the beginning of the survey 92 per cent had poor posture.

TABLE 3.—*Posture grade at first examination and type of build of all children included in the study*

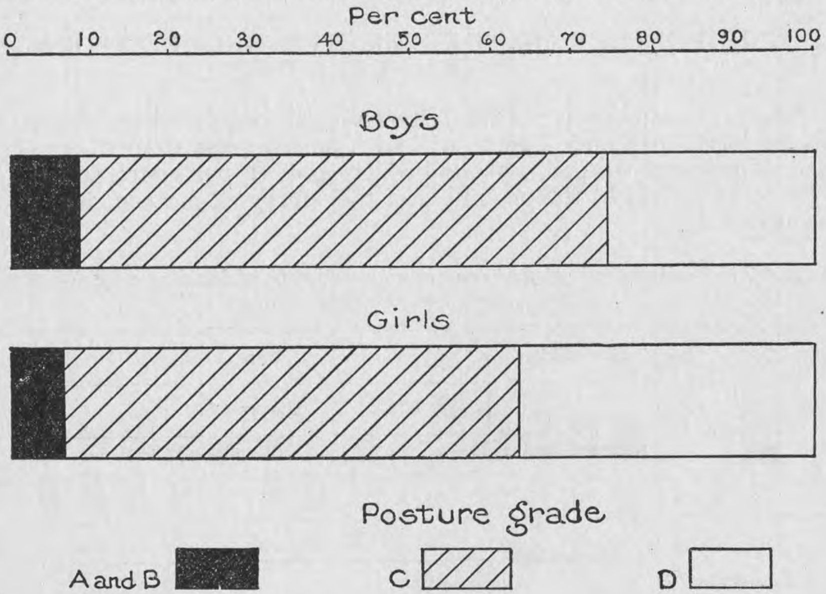
Posture grade at first examination	Total children		Type of build					
			Thin		Intermediate		Broad	
	Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution
Total	1,708	100	246	100	1,044	100	418	100
A	9	1	2	1	5	(1)	2	(1)
B	124	7	14	6	72	7	38	9
C	1,039	61	122	50	629	60	288	69
D	536	31	108	44	338	32	90	22

1 Less than 1 per cent.

As the group studied was selected at random in a public school, this is probably what might be expected for any group of children, though the figures might vary somewhat, depending on whether the group was predominantly boys or girls. Boys apparently use their bodies mechanically better than girls. (See Graph 2.) Although there was little difference in the proportion of boys and girls having good posture (9 and 7 per cent, respectively), a much larger proportion of the boys (65 per cent) than of the girls (56 per cent) had poor posture (grade C), and a smaller percentage of the boys (26 per cent) than of the girls (37 per cent) had bad posture (grade D).

Body mechanics of the children studied showed a definite though slight relationship to age. (See Graph 3.) The youngest children (those under 7 years of age) had better posture than those in the immediately succeeding ages. But at the age of 7 and less than 9 years, the percentage who had good posture (i. e., those who ranked either A or B) dropped from 5 to less than 1. In other words, the child when he enters school has a better posture apparently than he has after he has been in school for a while. In his so-called preschool age, he is as a rule out of doors for a large part of the day and leads an active life. He then abruptly changes from a method of living conducive to robust, vigorous health, with presumably good muscle control to a less active, more sedentary occupation—going to school. This with the unaccustomed confinement, especially in seats and at desks (rarely properly adjusted), together with the strain of the usually sudden transition

GRAPH 2.—POSTURE GRADE OF BOYS AND GIRLS AT FIRST EXAMINATION



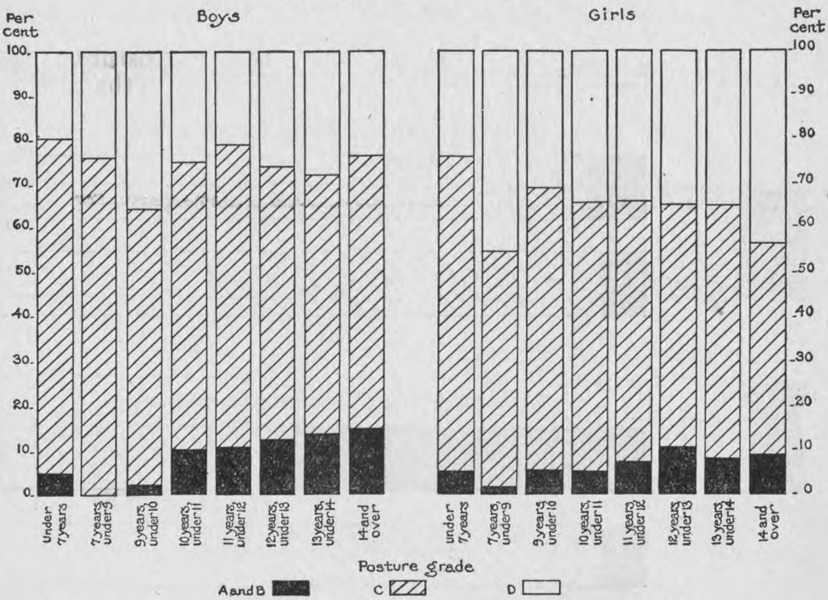
from play to work, undoubtedly contributes to weakened muscular control and therefore to poor posture. Apparently the effort on the part of the child to accommodate himself to his new mode of existence tires him, and is evidenced in the posture of fatigue—the C and D postures. As the child accustoms himself to his environment the strain gradually slackens. The posture of fatigue is less evident, for after the initial drop in good posture at 7 to 9 years of age there is a slight but steady increase in the percentage with good posture (A and B) in each succeeding year of age.

Practically all (99 per cent) of the children had poor posture in the age period 7 and under 9 years, but from this age onward the prevalence of poor posture gradually decreased until in the age group 14 years and over, 88 per cent of the children were found to have poor posture. When this figure is compared with the results of Lee and

Brown[5] in their examination of Harvard freshmen in 1916 and 1919, a definite correspondence is evident. Their subjects were about 18 or 19 years of age, and about 80 per cent had poor posture. Though good posture is somewhat more prevalent as children grow older, as is shown by the increase in the percentage of children having good posture in the higher age periods, poor posture predominates markedly. Poor body mechanics, although most common among young children, is not outgrown to any marked degree.

Body mechanics also showed a definite relationship to type of body build. The greatest percentage of good posture (A and B) was found among the broad-type children, the next largest percentage was found among children of intermediate build, and the smallest

GRAPH 3.—POSTURE GRADE AT FIRST EXAMINATION OF BOYS AND GIRLS OF SPECIFIED AGE PERIODS



among thin children. This is about what one would expect, for the anatomical construction of the bodies of broad children precludes, as a rule, the assumption of the exaggerated, almost grotesque, attitudes frequently found among thinner children. The latter showed the largest proportion (93 per cent) of poor posture (C and D). As further evidence that the intermediate type is a truly compromise type it showed almost as large a percentage of individuals having poor posture (93 per cent) as the thin type but did not have so large a proportion in the D grade (32 per cent) as did the thin type (44 per cent). Most of the intermediate and broad children with poor body mechanics were in the C group (60 and 69 per cent, respectively).

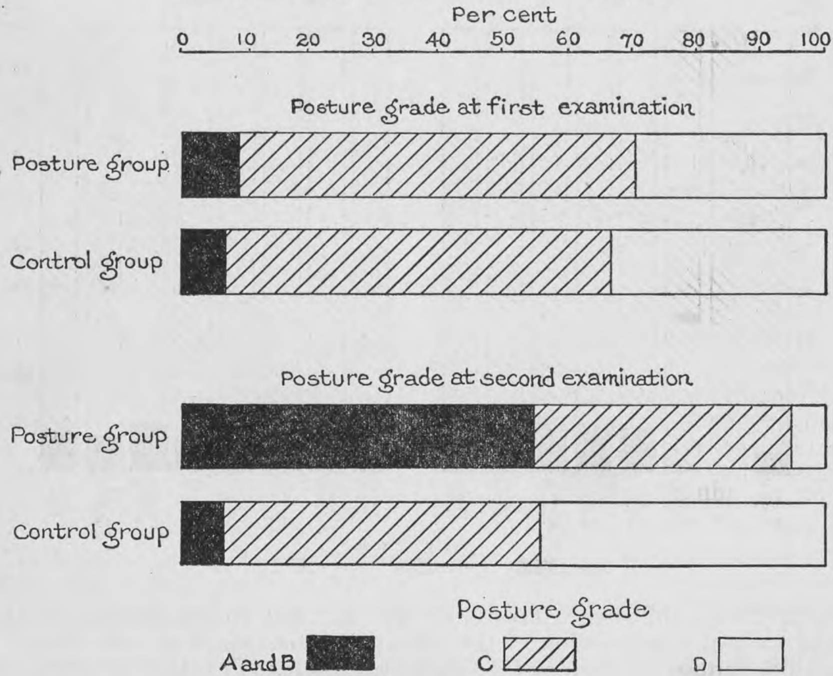
[5] Brown, Lloyd T., M. D., F. A. C. S.: A Combined Medical and Postural Examination of 746 Young Adults (American Journal of Orthopedic Surgery, vol. 15, No. 11 (November, 1917), pp. 774–787); and Lee, Roger I., William H. Geer, and Lloyd T. Brown: Bodily Mechanics in Harvard Freshmen (American Physical Education Review, vol. 25, No. 8 (November, 1920), pp. 337–342).

THE IMPROVEMENT SHOWN IN POSTURE AFTER TRAINING

The incidence of excellent, good, poor, and bad posture in the posture and control classes was practically identical at the beginning of the school year when the children were first examined, and had it not been for the posture training it is assumed that the postural habits of the children in the different classes would have been correspondingly similar at the end of the year. Instead of this similarity at the end of the year, however, it was found that the distribution of posture grades among the trained children was significantly different from that among the control children. (See Graph 4.)

Good posture was found more frequently among the children in the posture classes than among those in the control classes, which had

GRAPH 4.—POSTURE GRADE AT FIRST AND SECOND EXAMINATIONS OF CHILDREN IN THE POSTURE AND CONTROL GROUPS



only the calisthenic exercises usually given to the school children. In the control class at the end of the school year 10 per cent had improved their posture, 22 per cent had worse posture than at the beginning of the year, and 67 per cent received the same grade that they had formerly. (Table 4.) In the posture class, on the other hand, 62 per cent of the children had improved in posture by the end of the year, 1 per cent had regressed, and 37 per cent had not changed.

At the end of the school year none of the 47 children originally graded B in the control class had progressed to A grade; 23 received the same grade at the end as at the beginning, and 24 received a lower grade, either C or D. Of those who ranked C originally, only 4 per cent progressed to a B posture. The majority, about two-thirds, did not change at all, and one-third regressed. Of those who ranked D originally, about one-quarter improved, but most of them progressed only one grade to C; only 4 per cent improved to B posture, and none to A.

TABLE 4.—*Posture grade at first examination and change in posture for children in the posture and control groups*

Posture grade at first examination	Total	Change in posture																	
		Improvement						No change						Regression					
		Total		Grade at second examination				Total		Grade at second examination				Total		Grade at second examination			
		Number	Per cent	A	B	C	D	Number	Per cent	A	B	C	D	Number	Per cent	A	B	C	D
Posture group	961	598	62	150	331	117	---	351	37	4	35	266	46	12	1	---	2	3	7
A	6	-----	-----	---	---	---	---	4	-----	4	---	---	---	2	-----	---	2	---	---
B	77	39	51	39	---	---	---	35	45	---	35	---	---	3	4	---	---	3	---
C	591	318	54	89	229	---	---	266	45	---	---	266	---	7	1	---	---	---	7
D	287	241	84	22	102	117	---	46	16	---	---	---	46	-----	-----	---	---	---	---
Control group	747	78	10	---	26	52	---	504	67	1	23	292	188	165	22	---	1	19	145
A	3	-----	-----	---	---	---	---	1	-----	1	---	---	---	2	-----	---	1	1	---
B	47	-----	-----	---	---	---	---	23	-----	---	23	---	---	24	-----	---	---	18	6
C	448	17	4	---	17	---	---	292	65	---	---	292	---	139	31	---	---	---	139
D	249	61	24	---	9	52	---	138	76	---	---	---	188	-----	-----	---	---	---	---

After one year's training a definite improvement was evident in the posture class. One-half of those who had B posture (51 per cent) improved, obviously to A; 54 per cent of those who started with C improved, as did 84 per cent of those with D; about 45 per cent of the original B and C posture children did not change their grades, and about 4 per cent regressed. The percentage of regression was greater in the B group, but none of these children fell below C grade. Of those who improved, 72 per cent who were originally rated C progressed to B, and 28 per cent progressed to A. Of the original D grade that improved, 9 per cent progressed three grades to an A rating; nearly one-half of the remaining D children who improved progressed to B, and the others got C.

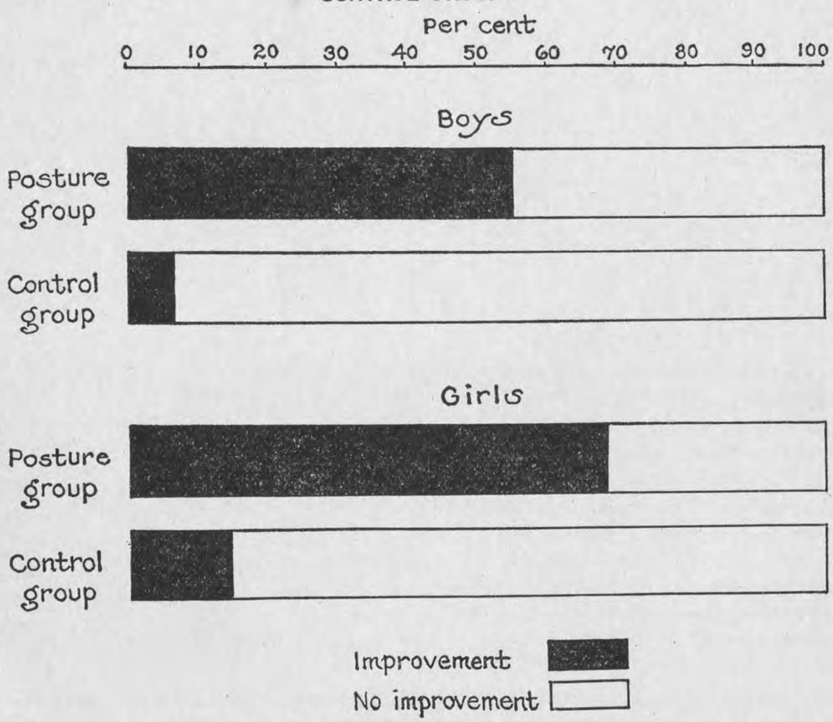
Thus the effect of posture training is shown by the much greater frequency of improvement in posture by the end of the school year in the trained class than in the control class. More than six-tenths of the trained children and only one-tenth of the untrained children improved their posture. Even when there was no improvement, the posture of almost all the trained group remained the same, while that of many in the untrained group grew worse.

Not only did more of the children trained in posture improve, but their degree of improvement was greater than that of the untrained children. Sixty-three per cent of the trained children who could improve (that is, children receiving B, C, or D grade at the first examination) had progressed at least one grade, whereas the corresponding percentage for the control children was only 10. When the possible improvement was two grades, 24 per cent of the trained children and only 1 per cent of the untrained children improved to that extent. Among those who could have improved three grades, 8 per cent of the posture group but none of the control group did so.

In the control group it was chiefly the children who had D posture at the first examination who improved (24 per cent). Only a few of those who had C posture (4 per cent) and none who had B posture improved during the school year. In the posture class half the children who received grade B and half the children who received grade C improved, as well as 84 per cent of those whose original posture grade was D.

The results of the posture training did not vary greatly with age but were significantly different among boys and girls. (See Graph 5.)

GRAPH 5.—CHANGE IN POSTURE OF BOYS AND GIRLS IN THE POSTURE AND CONTROL GROUPS



Under training, 55 per cent of the boys improved their posture as compared with 68 per cent of the girls. (Table 5.) This difference is noticeable among the untrained children also, for 6 per cent of the boys and 15 per cent of the girls in the control group improved in posture during the year they were under observation.

Among the boys under 8 years of age who had posture training improvement took place less frequently than among the older boys, for only 41 per cent of these young boys improved under training as compared with 63 per cent in the age period between 10 and 12. The apparent failure of young boys to improve under training suggested by these figures may be due to the smallness of the numbers in the lower age group. On the other hand, it may be associated with lack of coordination and cooperation and the other physical factors of maladjustment operating in the early years of school life. Among girls the percentage showing improvement was practically the same (slightly more than two-thirds) in each group.

TABLE 5.—*Change in posture among boys and girls of specified age periods in the posture and control groups*

Group and age period	Change in posture									
	Boys					Girls				
	Total (number)	Improvement		No improvement		Total (number)	Improvement		No improvement	
		Number	Per cent	Number	Per cent		Number	Per cent	Number	Per cent
Posture group	450	249	55	201	45	511	349	68	162	32
Under 8 years	59	24	41	35	59	60	41	68	19	32
8 years, under 10	83	45	54	38	46	99	67	68	32	32
10 years, under 12	125	79	63	46	37	122	82	67	40	33
12 years, under 14	122	65	53	57	47	121	82	68	39	32
14 years and over	60	36	60	24	40	102	71	70	31	30
Age not reported	1			1		7	6		1	
Control group	388	25	6	363	94	359	53	15	306	85
Under 8 years	56	1	2	55	98	66	6	9	60	91
8 years, under 10	62	8	13	54	87	65	7	11	58	89
10 years, under 12	97	5	5	92	95	92	10	11	82	89
12 years, under 14	96	10	10	86	90	82	14	17	68	83
14 years and over	70	1	1	69	99	54	16	30	38	70
Age not reported	7			7						

Type of build apparently bears no well-marked relationship to change in posture in either the control or the posture group. Under training, 61 per cent of the thin children of the posture group improved in posture as compared with 60 per cent of the children of intermediate build and 67 per cent of the children of the broad type. (Table 6.) In the control group 9 per cent of the thin children improved as compared with 10 per cent of the intermediate and 12 per cent of the broad type. These percentages at first seem to indicate that children of the broad type more frequently improve in posture than children of either the thin or the intermediate type. Careful analysis, however, shows that the differences are too slight to be significant in view of the small number of children of each type of body build.

TABLE 6.—*Type of build and change in posture for children in the posture and control groups*

Type of build	Total children	Change in posture					
		Improvement		No change		Regression	
		Number	Per cent	Number	Per cent	Number	Per cent
Posture group	961	598	62	351	37	12	1
Thin	138	84	61	53	38	1	1
Intermediate	567	343	60	216	38	8	1
Broad	256	171	67	82	32	3	1
Control group	747	78	10	504	67	165	22
Thin	108	10	9	73	68	25	23
Intermediate	477	48	10	322	68	107	22
Broad	162	20	12	109	67	33	20

There were 76 children who had two years' training and 68 who were in control classes for two years. Although the number of children in each group was comparatively small, the distribution of posture grades for the small groups at the beginning of the year was similar to that of the whole group of 1,708 children, and the findings in the posture and control groups at the end of the first year were approximately the same as those among the total posture and total control groups at that time. These small groups of children are probably fairly typical of all children included in the study. The results are suggestive of those which would be obtained under training and of the postural change which would be found without training among school children during an interval of two years. The percentages throughout correspond so closely that it is safe to assume that the experience of the children for whom 2-year records were available affords a fair indication of what might be expected in any average group of children during a 2-year period.

In the group of 76 children to whom two years' posture training was given, 73 improved in posture at some time during the period and 67 maintained their improvement so that their posture was better at the end of the two years' training than at the beginning. Of the 3 who failed to show improvement at any time during the two years, only 1 had worse posture than at first; 2 had no change in posture grade. The 6 other children improved during the period but their better posture did not become habitual, and the final grade was the same as that received before training. These figures indicate that there are few children whose posture can not be improved under proper training. In contrast with this, of the 68 children in the control group for whom there were records over a 2-year period, only 7 had a better grade at the end of the period than at the beginning; 36 had the same grade; and 23 had poorer posture (last posture grade was not reported for 2 children). The percentage of improvement in the second year was about one-half of what it was in the first year (8 and 13 per cent, respectively), and the regression was one-half greater. On the other hand, among the trained children improvement was nearly as great in the second year as in the first, with no increase in the regression, and most striking of all was the fact that more than one-half of those who improved during the first year improved also during the second. Again, those of this group who had good posture (A or B) at the beginning of the second year maintained it and two-thirds of the others improved.

Regression to a poorer posture during the summer vacation when posture training ceased was twice as great among those who had improved as among those whose posture did not change in the first year. All but 4, however, of the 25 whose posture grew worse during this vacation, improved during the second school year. The summer vacation with its cessation of posture training was the occasion for the child to forget to a certain degree what he had learned about good body mechanics. This is undoubtedly what happens with any subject taught during the school year. The habits of good posture evidently were not definitely fixed in a single year.

This regression was not so evident in the control group. Here only 19 per cent had poorer posture in contrast to the 33 per cent of the posture group who were worse after a summer's vacation. The control group had no training in posture to forget. In fact, if school life is one cause of poor posture, as earlier tables would seem to show, then the removal of this cause during the vacation period for a group unaffected by other factors such as posture training, should result in improved posture at the end of the vacation. About one-fourth of the untrained children did show this improvement. Indeed, owing to the active outdoor healthful life of the vacation period, more improved at this time than during the school terms. The posture of only about one-fifth of the children in the posture group, on the other hand, with the harmful effects of school life neutralized as it were by posture training, was improved through the helpful effects of vacation. More forgot what they had learned about posture and proved thereby that children will show a reversion to poorer posture with a cessation of training unless the training is continued long enough for the maintenance of good posture to become a fixed habit.

The experience of the children for whom 2-year records are available suggests that the proportion of children free from structural defects whose posture can not be improved is less than 5 per cent, and that some children require longer training than others. About nine times as many children improved in posture with training as improved without training. Since good posture once acquired (vacation periods excepted) was maintained, on the whole, over the 2-year period of observation, it seems reasonable to expect that with posture instruction continuous throughout grade school, the habits of good body mechanics will become fixed and lasting.

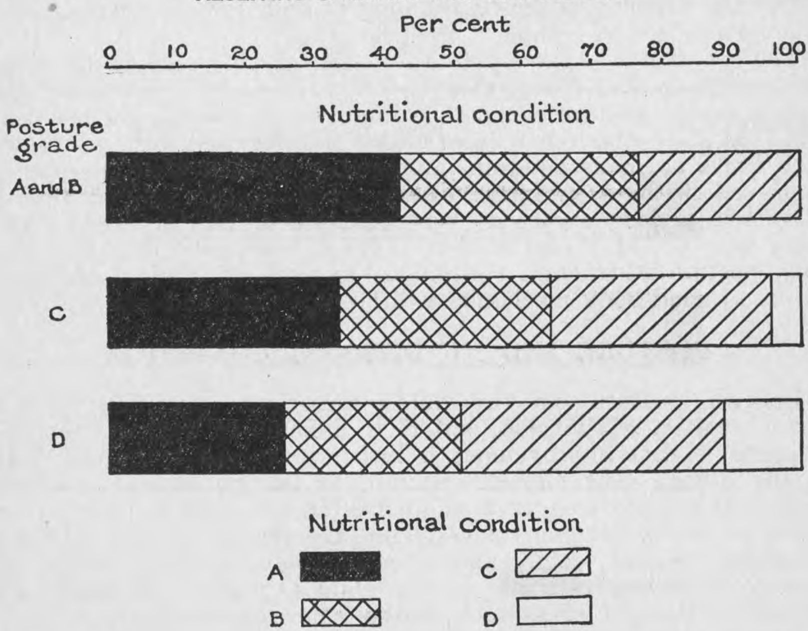
POSTURE AND NUTRITIONAL CONDITION

Between posture and the child's nutritional condition there is undoubtedly a relationship, but it is difficult to evaluate since it is probable that improvement in either may lead to improvement in the other. The clinical estimate of the nutritional condition used in this study covered a number of factors such as general condition of health, amount of body fat, the texture of skin and subcutaneous tissues, color, and muscular development. It is obviously a clinical estimate of the child's general condition and should be thought of as such in the following discussion.

An estimate of the nutritional condition of all the children in the study was made at the beginning of the school year and again at the end of the school year. Not only, therefore, could the relation of the child's nutritional condition to his posture be made before posture training, but also after training; that is, the results of training may be shown by improvement in posture or nutritional condition or both, no change in either, or actual regression in either. The following data will show that though there is apparently a slight preponderance of improvement in nutritional condition with improvement in posture, there is also an improvement in posture with improvement in nutritional condition. It would seem impossible to demonstrate which is the causal factor, but it will be obvious that there is a relationship between the two.

The relation of nutritional condition to posture in the total group (both posture and control groups) at the beginning of the study is shown in Graph 6. More than three-fourths of the children who had good posture (A and B at the first examination) also were in clinically good nutritional condition. (For scale of the clinical estimate of the nutritional condition, see p. 23.) Less than one-fourth with good posture had a C grade of nutritional condition, and none had bad (D) nutritional condition. With poorer posture the percentage of good nutritional condition was lower and that of poor and bad nutritional condition correspondingly higher. Nutritional condition of grade D was present among children receiving C and D posture grades. Graph 7 shows the proportion of A and B, C, and D posture in the children having A and B, C, or D nutritional condition at the first examination. These two graphs would indicate that the children with good posture were generally in better nu-

GRAPH 6.—NUTRITIONAL CONDITION AT FIRST EXAMINATION OF CHILDREN RECEIVING SPECIFIED POSTURE GRADES

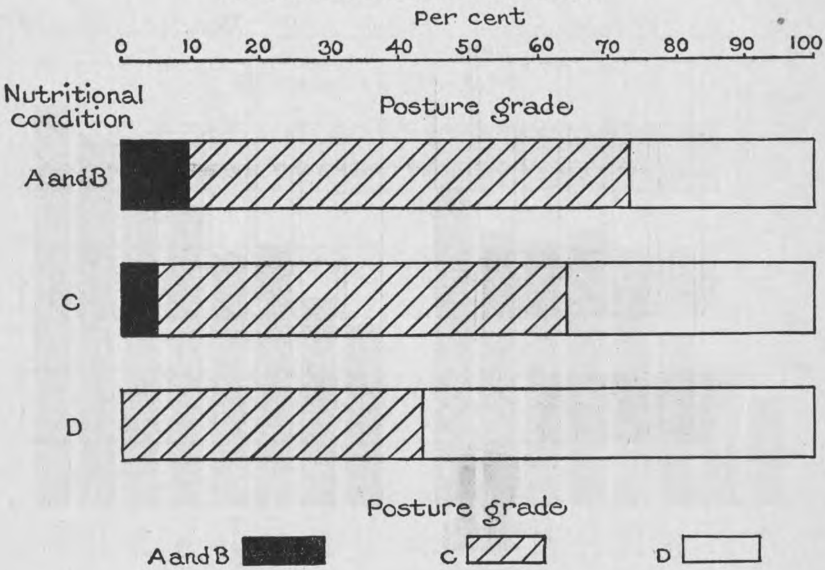


tritional condition than children whose body mechanics were of mediocre character, and that children with more satisfactory nutritional condition tended to have better posture.

Before discussing the nutritional condition of the children in the posture and control groups separately, it should be brought out that there are certain factors other than posture which are also associated with the nutritional condition. Fewer boys than girls (53 per cent as compared with 68 per cent) were in good (A and B) nutritional condition at first examination. In this connection it will be recalled that good posture was more prevalent among boys than girls at that time. The variation of nutritional condition with age was also quite marked. A much smaller proportion of both boys and girls of the lower ages than of the upper ages had good nutrition. (See Graph 8.) Nationality of mother also should probably be taken into consideration, since a larger proportion of the children of both Russian-Jewish and other Jewish mothers were better nourished than those who were of native white or of Italian mothers. The percentages of children with good nutritional condition in these groups were 63, 61, 54, and 54, respectively. Type of build and nutrition were also closely related, the broad type having as a rule good nutrition (95 per cent), and the thin type poor nutrition (only 29 per cent having good nutrition). It should be remembered in this connection that both nutritional condition and body type are graded by clinical estimate and that thinness and obesity are factors entering into both estimates. (See p. 8 for description of of estimate of body type.)

The part which diet and other health habits have played in bringing about the nutritional condition has not been considered in this study.

GRAPH 7.—POSTURE GRADE AT FIRST EXAMINATION OF CHILDREN WITH SPECIFIED NUTRITIONAL CONDITION



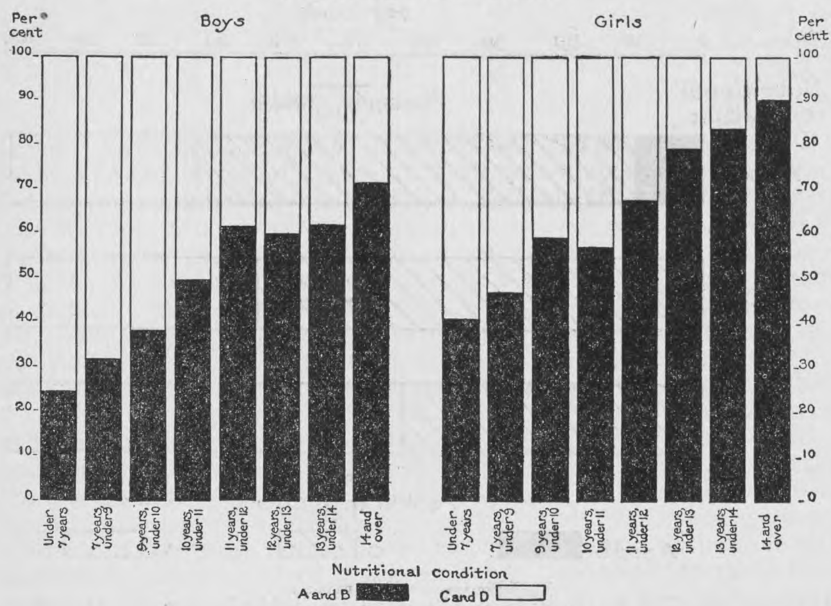
It is not possible to show from the data available how much the above factors are influencing the relationship of posture and nutritional condition.

Comparison of the nutritional condition at first examination of the children in the posture and control groups shows that the posture group, though selected at random, contained a larger proportion of children having A and B nutritional condition (63 per cent) than did the control group (57 per cent) which was similarly selected. This difference, though small, is significant. On this account it has been necessary to study the change among selected children rather than compare the entire posture and control groups.

The effect of posture training on nutritional condition and the effect of nutritional condition on improvement in posture can best be shown by studying those children for whom there was a possibility of improvement in either posture or nutritional condition; that is, those who were graded B, C, or D at first examination. During the training period it would be possible for children in this group to improve one to three grades in either posture or nutritional condition, to show no change in grade, or to regress to a lower grade with the exception of those having D, who were already lowest. Those children who were given A in posture or nutritional condition at the first examination had no opportunity for improvement but did have opportunity for regression. Those children who had A at both first and last examinations had no opportunity to improve and did not regress. These last are therefore kept as a separate group and are not included when improvement is being studied.

Table 7 shows the relation of change in posture to change in nutritional condition. Improvement in nutritional condition during the school year was not striking in either the posture or the control

GRAPH 8.—NUTRITION GRADE AT FIRST EXAMINATION OF BOYS AND GIRLS OF SPECIFIED AGE PERIODS



group. Of those having the opportunity to improve in nutritional condition, 20 per cent did improve in the posture group, whereas only 15 per cent improved in the control group. This difference is small, but it is statistically significant. Improvement in condition was found more frequently among the children who received posture training than among the control group which had regulation gymnasium work. If improvement in nutritional condition is studied in the group of posture-trained children only, comparing those who showed improvement in posture under training and those who showed no change in posture, it will be seen that there was a slightly larger proportion of improvement in nutritional condition in those who actually improved in posture with training (24 per cent) than in those who showed no change in posture (15 per cent). This difference, though not large, is likewise significant. These figures show that posture training, particularly when the children cooperate sufficiently to improve their posture, is associated with improvement in nutrition.

TABLE 7.—*Change in nutritional condition and change in posture for children in the posture and control groups*

Change in posture	Total children	Change in nutritional condition				
		Improvement (received B, C, or D at first examination)	No change (received B, C, or D at first examination)	Regression (received A, B, or C at first examination)	No change (received A at both first and second examination)	Not reported
Posture group	961	132	499	20	310	----------
Improvement	598	94	290	5	209	----------
No change	351	38	201	14	98	----------
Regression	12	----------	8	1	3	----------
Control group	747	83	412	45	206	1
Improvement	78	9	32	2	35	----------
No change	504	60	283	30	130	1
Regression	165	14	97	13	41	----------

The effect of nutritional condition on the results of posture training may be shown by comparing the frequency of improvement in posture under training among children receiving the specified nutrition grades. Of those children in the posture group who were given A in nutritional condition at the first examination, 66 per cent improved in posture under training, as compared with 61 per cent of those with grade B nutrition, and 60 per cent of those with grades C and D nutrition at first examination. These successive differences are not significant, but the trend suggests that had larger numbers of children been included in the experiment statistically significant results might have been obtained.

If, however, improvement in nutritional condition is considered in relation to improvement in posture among children in the posture group, it is found that 71 per cent of those who improved in nutritional condition improved also in posture, whereas only 58 per cent of those who showed no change in nutritional condition improved in posture, a difference of 13 per cent. Of those children who were A in nutritional condition at first examination and at last examination, 67 per cent showed an improvement in posture. Improvement in posture was found, therefore, to be associated with improvement in nutritional condition, or with an A grade of nutritional condition which was maintained through the training period.

If the relation of improvement in posture during the year to nutritional condition at first examination is considered in the control group of children who had no posture training, it is found that 16 per cent of those with nutritional condition A, 10 per cent of those with B, and 7 per cent of those with C or D showed improvement in posture. The difference between the percentages for the best and poorest groups is small but significant. Even without postural training, posture improves more frequently among those who have the best nutritional condition.

THE RELATION OF POSTURE TO SCHOOL WORK

Do children trained to acquire improved body mechanics show any evidence of improved efficiency in their daily activity—their school work?

To investigate this problem, a record was kept for each pupil of his absences due to his personal illness for each quarter of the school year. The first quarter ran from the opening of school to November 20, the second from November 21 to January 20, the third from January 21 to April 20, and the last quarter ran from April 21 to the end of the school year. The teachers also graded each child in scholarship and deportment for each quarter. No child knew that any such records were being kept for the survey. He could, therefore, in no way consciously affect the records. The teachers themselves did not know why these records were kept.

Variation in the frequency of absence due to illness for school children is generally shown by morbidity or absence rates per 1,000 children, which are reduced to the basis of a school year of 180 days, the rate for any period such as a quarter representing the rate that would have resulted if absence had continued throughout the year at the rate which occurred during the quarter. By this method the rates for the different quarters, which vary in length, are reduced to a common basis and made comparable. The fact that part of the absences occurred in 1923–24 and part in 1924–25 has been taken into account in the calculations.

In the fall quarter the rate for absence due to illness for the children in the posture group was 3,418 per 1,000 children per school year of 180 days, as compared with 2,660 in the control class, or 28 per cent higher than that of the control. In the spring quarter the rate for the posture group was 2,104 as compared with 2,702 in the control, or 22 per cent lower than that of the control. The rate of absence due to sickness in the posture class was thus 1,314 points, or 38 per cent, lower in the spring quarter than it had been in the fall, whereas in the control class the rate for the spring quarter showed an increase of 42 points, or 2 per cent, over the rate of the fall.

The experience in the control class shows the same general tendencies as other studies of morbidity and absence from school. A rate for the 3-month period, September to November, 1922, in Hagerstown, Md., is 3,950 per 1,000 children per school year of 180 days as compared with 7,238 and 4,723 for the spring periods, April and May of 1922 and 1923, respectively. The study of sickness among school children in 13 localities of Missouri in the school year 1919–20 gives rates of 4,893 for September, October, and November combined, as compared with 8,734 for the months April and May.[6]

In the first quarter of the school year the rate of absence from school on account of illness of the posture-trained children was higher than that of the children in the control group. By spring, however, the rate for the posture group had decreased so that it was considerably below what it had been in the fall and also much below that of the control group. In the control group, in contrast

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[6] Morbidity among School Children in Hagerstown, Md., by Selwyn D. Collins, pp. 2391–2423 (Public Health Reports, vol. 39, No. 38); Sickness among School Children, by Selwyn D. Collins, pp. 1549-1559 (U. S. Public Health Reports, vol. 36, No. 27). The rates shown in these reports are for school days of calendar months. These rates have been combined on a general quarterly basis per 1,000 children per school year of 180 days.

with the posture, the rate was a few points higher than it had been in the fall. Although the increase was insufficient to be statistically significant, it is of interest in that the direction was in accord with the findings of other studies. The tendency of the rate in the spring quarter for the children who received posture training is directly opposite to that shown by other studies of absence from school due to illness in that the spring rate for the posture group is lower than that of the fall. Both the Hagerstown and the Missouri study showed considerably higher rates for absence due to sickness in the spring than in the fall. There seems to be no question that the posture training was associated with the low morbidity rates of the spring quarter among children who had been trained during the year.

The rates of the control group and those of the Hagerstown and Missouri studies would seem to bear out the theory that children are in better health in the fall following the summer vacation and the long play periods out of doors. During the school year, however, the children are kept indoors concentrating on their studies and sitting in poor positions. The natural result is increase in absence due to illness. That posture training and improvement in body mechanics are beneficial and improve the health of the child seems to be demonstrated by these figures.

There were also the following indications of the relationship between posture and scholarship among children for whom scholarship was reported during the first and last quarters: 28 per cent of the children trained in posture improved in scholarship during the school year as compared with 20 per cent of the control children. In the posture group comparison shows that there was no significant difference in the proportion of children who improved in scholarship between the group that improved in posture (29 per cent) and the group that showed no change (27 per cent); but in the control group 24 per cent of the children who improved in posture also improved in scholarship, as compared with 18 per cent of the children whose posture did not change.

Improved deportment also seemed to be associated with posture training. Among children not receiving A in deportment during both first and last quarters the percentage showing improved deportment was higher among the children trained in posture (40 per cent) than among the control children (20 per cent). Also regression in deportment was less frequent among the posture-trained children (6 per cent) than among the children in the control group (11 per cent). In the first quarter 38 per cent of the children in the posture group for whom deportment grade was reported at first and last quarters were graded A as compared with 32 per cent of the similar group of the control children. In the fourth quarter 54 per cent of the same group of posture children attained grade A as compared with 34 per cent of the control children.

The improvement in scholarship and deportment has been shown to occur more frequently among children who received posture training. Since there is no basis for the assumption that the children in the posture group were brighter and therefore more likely to have improved in scholarship nor that there was any other reason for more improvement or better deportment in the posture group than in the control, there seems to be little question that these improvements were associated with posture training. With posture training there apparently follow improved health, as evidenced by lower rates of absence from school on account of personal illness, and improved deportment and improved scholarship, both of which possibly reflect increased ability to concentrate on work in hand.

PHYSICAL INDEXES OF THE RESULTS OF POSTURE TRAINING [7]

VITAL CAPACITY

Vital capacity has been used, especially by cardiologists, as a fair index of the physical fitness of an individual. Some authorities [8] have considered it dependable enough to state that anyone with as much as 10 per cent less vital capacity than is normal for his class is probably suffering from some health-depressing condition. If he is as much as 15 per cent below normal it is practically certain that he is abnormal in this respect. The question therefore immediately presented itself as to whether a change in body mechanics affects the vital capacity.

Other investigators have established the physiological fact that in animals there is a constant ratio between the weight of the lungs and the skin surface. They have also noted that in human beings, according to sex, there is a definite ratio of vital capacity to the body surface area, and that there is less vital capacity in the lying than in the sitting position. But no difference in chest conformation seemed to account for this variation.[9] It was worth while then to determine whether improvement in body mechanics, as it brought about a more elevated chest and an increase in the anteroposterior diameter of the chest, would thereby cause a greater expansion of the lungs within; i. e., increase the vital capacity.

The changes in vital capacity between the first and the last examination were practically the same irrespective of whether the children had been given posture training and also irrespective of whether they improved in posture. The average increase in vital capacity for posture children was 0.182 ± 0.006 liters as compared with 0.188 ± 0.007 for the control children, and the average increase for the posture-trained children who improved was 0.192 ± 0.008 as compared with 0.160 ± 0.010 for the posture-trained children who showed no change in posture. The study does not show that either posture training or improvement in posture is associated with change in vital capacity.

TYPE OF RESPIRATION

In ordinary quiet respiration, without obvious effort, inspiration is accomplished by the contraction of the diaphragm alone or by the diaphragm together with some of the rib muscles. At the end of

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[7] The statistical analysis in this section was made by Dr. Elizabeth C. Tandy, director of the statistical division of the Children's Bureau. The statistical method used is that of arithmetic average and its probable error, which is placed after the average and separated from it by a plus and minus (±). An average is considered statistically significant if it is greater than three times its probable error. The difference between two averages is obtained by subtraction. The probable error of the difference is obtained by squaring the probable errors of the two averages, adding the two squared probable errors, and extracting the square root of the sum. The result is the probable error of the difference of the two averages. This difference is considered significant if it is greater than three times its probable error. For example, the increase in vital capacity for both posture and control groups (0.182 ± 0.006 and 0.188 ± 0.007, respectively) was significant, each average being more than three times its probable error; but the difference between the two averages (0.006 ± 0.009) was insignificant, since the difference does not exceed three times its probable error.

[8] Dreyer, Georges: The Assessment of Physical Fitness. Quarterly Publication of the American Statistical Association, vol. 17, No. 135 (September, 1921), pp. 929–932.

[9] Christie, Chester D., and Argyl J. Beams: The Estimate of Normal Vital Capacity. Archives of Internal Medicine, vol. 30, No. 1 (July 15, 1922), pp. 34–39.

inspiration, expiration is entirely passive and is due to purely physical forces, such as the elasticity of the expanded lungs and the elasticity of the distended abdominal wall. Therefore, the nomenclature used in the study for types of respiration, was based on inspiration—whether the movement of the abdomen due to the contraction of the diaphragm was the chief or only feature and therefore the inspiration was "abdominal," or whether the elevation of the ribs was the most noticeable factor and therefore the inspiration was "costal," or whether the movement was evenly balanced between the chest and the abdomen and the inspiration was "costal and abdominal."

The respiration of almost all the children (98 per cent) at the first examination was costal and upper abdominal in character. No significant variations are shown in the percentages of the various kinds of respiration among children of the different types of body build. The incidence of the different types of breathing was essentially the same among children having good posture and children having poor posture.

Change in type of breathing did not strikingly accompany improved posture, but change to the upper abdominal type of breathing was more frequent among children who improved in posture than among those who did not improve. This change was also more often found among trained children whose posture improved than among the control children who improved in posture (17 as compared with 5 per cent). (Table 8.)

TABLE 8.—*Change in type of breathing and change in posture for children in the posture and control groups*

Change in type of breathing	Total children		Change in posture					
			Improvement		No change		Regression	
	Number	Per cent distribution [1]	Number	Per cent distribution [1]	Number	Per cent distribution [1]	Number	Per cent distribution [1]
Total	1,708		676		855		177	
Posture group	961	100	598	100	351	100	12	
Improvement	118	12	104	17	13	4	1	
No change	770	80	452	76	307	88	11	
Regression	70	7	40	7	30	9		
Not reported	3		2		1			
Control group	747	100	78	100	504	100	165	100
Improvement	17	2	4	5	10	2	3	2
No change	691	94	72	94	466	94	153	94
Regression	29	4	1	1	22	4	6	4
Not reported	10		1		6		3	

[1] Not shown where number of children is less than 50.

When a child has attained good body mechanics and it has become habitual, the chest is elevated almost to its highest point and is practically immobile in respiration. The diaphragm is the mobile part, and this is manifested with each contraction of the diaphragm by the movement of the upper abdomen. The lower abdomen, since it is held retracted in good posture, is naturally also immobile.

Quiet breathing is then mainly diaphragmatic or upper abdominal in type in contrast to the more difficult or labored breathing which necessitates a greater effort of the rib muscles with each inspiration.

Many of the children did not change to this upper abdominal type of breathing as an improvement in posture took place. Perhaps the period of observation was too short for them to have acquired in any great measure this more facile method of respiration that is characteristic of good body mechanics. Experience with children given individual and more intensive training in posture clinics would indicate that they acquire a type of respiration upper abdominal in character only when they have acquired excellent body mechanics and have learned to maintain it. In the present study the children who improved in posture showed a greater tendency to acquire this almost effortless type of abdominal breathing than did those who did not improve their posture, and, as has been noted previously, the upper abdominal type of respiration was much more frequent among the children who had postural training than among the control group.

POSTURE AND COSTAL MOBILITY

Quiet breathing ideally is diaphragmatic in character, and then the inspiratory movement is manifested chiefly by movement of the upper abdomen, due to the contraction of the diaphragm. As soon as the breathing movements become at all forced, the action of the other inspiratory muscles, the elevators of the ribs, come into play. In most children, as has been seen, the tendency in natural respiration is to show a certain balance between the diaphragm and the ribs. Only in those children that have acquired excellent posture and the habitual maintenance of it, is the diaphragmatic type found practically alone. In all others there will be a certain degree of excursion (expansion) of the ribs with each respiratory cycle to compensate perhaps for the inadequate excursion of the diaphragm. Is this excursion of the ribs then different with changes in body mechanics?

The question put somewhat differently is whether the rib muscles of the child with better posture are in better tone for improved functioning. It would seem that in the child with poor posture, whose chest is drooped because the ribs are drooped, the rib muscles would be more or less relaxed and therefore not in the best tone to effect an even excursion of the ribs. The excursion of the ribs from neutral to full inspiration would be greater than from neutral to expiration, for the position of the ribs at neutral would be almost that of expiration. In other words, the chest at neutral would be almost in a position of expiration while with improved posture the ribs would be more elevated in the neutral position and from it the excursion to full inspiration would be more nearly equal to that of full expiration. The circumference measurements of the chest at the level of the axilla and xyphoid cartilage, and the depth measurements of the chest at the level of the xyphoid were taken at neutral, full inspiration, and expiration for each child, to answer this question.

At the first examination less than 2 per cent of the children showed an even spacing of the circumference readings between neutral and inspiration and neutral and expiration, at either the axilla or the xyphoid, and only 11 per cent showed an even spacing of the depth reading at the xyphoid. The difference between the measurements at neutral and at inspiration was greater than the difference between the measurements at neutral and at expiration. This difference was greater at the axilla of 93 per cent of the children, at the xyphoid of 97 per cent, and in the depth at the xyphoid of 87 per cent. The first examinations showed no relationship between posture grade and difference in respiration readings because the posture was almost uniformly poor. But with improvement in posture a more nearly even excursion of the ribs was shown in many cases. The records of 598 trained children, whose posture improved, showed at the end of the school year that the differences between respiration measurements at inspiration and neutral, and between neutral and expiration were more nearly equal than at the beginning of the year in 51 per cent of the children for circumference at the axilla, in 38 per cent for circumference at the xyphoid cartilage, and in 40 per cent for depth at the xyphoid. From this it would seem logical to conclude that with improvement in posture comes elevation of the ribs, so that at neutral they are no longer dropped almost to the position of expiration, and with respiration, the rib muscles, in better tone at neutral, are more adapted for an even excursion of the ribs and therefore a steady, even aeration of the lungs.

TYPE OF RETRACTION

The position of an individual's abdominal wall, particularly the lower part, is one of the indexes of his posture. If the lower abdominal wall is retracted and flat, it indicates a certain degree of good posture. If, however, it is relaxed and protuberant, it indicates poor posture. In fact, good body mechanics, as taught to the children of the posture group in the present survey, depended on abdominal retraction as one of the fundamentals to be learned. Of course, for a certain period at least, fairly good posture can be maintained without abdominal retraction. In most cases, however, this posture will be one of strain. As a rule, abdominal retraction is essential for the maintenance of good body mechanics, and the ability to retract the lower abdomen easily and directly is an indication of the development in the individual of his sense of muscle position.

Only 4 per cent of the children at the first examination were able to retract their abdomens directly when asked to do so. (Table 9.) About one-fifth (19 per cent) of the children contracted their abdominal muscles slightly, but effected retraction primarily by elevating their chests. Approximately three-fourths (77 per cent of the children) retracted indirectly by pulling up their chests and with them their abdominal walls. Though they were merely asked to draw in their belly walls, most of the children had such a poor sense of position of their abdominal muscles that they apparently found it easiest to use their intercostal muscles to elevate their ribs, and in this way by indirect pull on the abdominal wall upward, to effect its retraction. Their abdominal muscles generally protruded relaxed, serving as a sort of retaining wall. When called upon to retract them, the individual naturally responded by using the accessory respiratory muscles, muscles he was more accustomed to using. This form of retraction could be continued only for a short period—as long as the strain could be endured or the breath could be held.

TABLE 9.—*Type of retraction and posture grade at first examination for all children included in the study*

Type of retraction at first examination	Total children		Posture grade					
			A and B		C		D	
	Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution
Total	1,708		133		1,039		536	
Total reported	1,706	100	133	100	1,037	100	536	100
Abdominal	70	4	19	14	37	4	14	3
Abdominal and costal	328	19	40	30	207	20	81	15
Costal	1,308	77	74	56	793	77	441	82
Not reported	2				2			

Type of body build seemed to have little influence upon type of retraction, for 75 per cent of the thin children, 76 per cent of the intermediate, and 79 per cent of the broad children retracted their abdomens indirectly by pulling up their chests. Among children receiving different posture grades, however, there was variation in the incidence of the different types of retraction. Costal retraction was found most frequently in each type, but direct abdominal retraction was performed by 14 per cent of the children graded A and B as compared with 4 per cent of the children graded C and 3 per cent of those graded D.

Abdominal retraction became more prevalent with posture training, for it was one of the first things taught. By the end of the school year 70 per cent of the trained children retracted their lower abdominal wall immediately when asked to do so, in contrast to the 4 per cent of these same children who did so at the time of the first examination. Improved retraction was most frequent among children who improved their posture under training, for 93 per cent of these children had better retraction at the end of the school year. (Table 10.) Even those who did not improve in posture under training for the most part learned abdominal retraction. (Table 11.) As has been shown, the length of training necessary to improve a child's posture varies, and it may very well take more than one year to effect the improvement. But the fact that 70 per cent had learned abdominal retraction by the end of the school year shows that they had learned at least one of the fundamentals of good posture.[10]

[10] The other fundamental requirements of good posture are back with normal curves, chest held up, and head up with chin in. See Posture Exercises, p. 2 (U. S. Children's Bureau Publication No. 165, Washington, 1926).

TABLE 10.—*Change in type of retraction and change in posture for children in the posture and control groups*

Change in type of retraction	Total children		Change in posture					
			Improvement		No change		Regression	
	Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution[1]
Posture group	961	100	598	100	351	100	12	--------
Improvement	819	85	559	93	255	73	5	--------
No change	132	14	38	6	88	25	6	--------
Regression	10	1	1	([2])	8	2	1	--------
Control group	747	100	78	100	504	100	165	100
Improvement	113	15	15	19	78	16	20	12
No change	525	71	53	69	349	70	123	75
Regression	103	14	9	12	74	15	20	12
Not reported	6	--------	1	--------	3	--------	2	--------

[1] Not shown where number of children is less than 50. [2] Less than 1 per cent.

TABLE 11.—*Type of retraction at second examination and change in posture for children in the posture and control groups*

Type of retraction at second examination	Total children		Change in posture					
			Improvement		No change		Regression	
	Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution[1]
Posture group	961	--------	598	--------	351	--------	12	--------
Total reported	961	100	598	100	351	100	12	--------
Abdominal	676	70	489	82	181	52	6	--------
Abdominal and costal	218	23	97	16	118	34	3	--------
Costal	67	7	12	2	52	15	3	--------
Control group	747	--------	78	--------	504	--------	165	--------
Total reported	743	100	77	100	502	100	164	100
Abdominal	58	8	8	10	41	8	9	5
Abdominal and costal	122	16	9	12	85	17	28	17
Costal	563	76	60	78	376	75	127	77
Not reported	4	--------	1	--------	2	--------	1	--------

[1] Not shown where number of children is less than 50.

The untrained children of the control group showed much less frequent change in manner of retraction after one year's observation. Improvement in retraction with them took place in only 19 per cent of those whose posture improved in contrast to the 93 per cent of the trained children who improved. To be sure, only 10 per cent of the control group improved in posture and in the main only from a bad posture to a type merely not so bad. The small percentage that had abdominal retraction with their better posture indicates that they held the improved posture by contracting the intercostal rather than the abdominal muscles. They had not learned as yet to realize the position, the existence as it were, of their abdominal muscles. They still lacked the control of these abdominal muscles that the posture children had acquired with their training.

Most of the posture children had learned to acquire a sense of the position of their abdominal muscles and had attained conscious control over them. They had progressed definitely toward the ability to keep their lower abdomens retracted continually. If they constantly maintained this position, their abdominal organs were held up to the position in which they belonged. Mankell and Koenig have shown that abdominal viscera which have sagged because of relaxed protuberant bellies can be elevated 1 to 6 inches by simple retraction of the lower abdominal wall.[11] Of this type of retraction most of the children of the posture class (70 per cent) had acquired conscious control. With practice these children would acquire the subconscious habit of continuous retraction and so be on the way to gain the physiological benefits that come from properly supported and properly placed abdominal organs.

CIRCUMFERENCE AND DEPTH OF ABDOMEN

The abdominal wall is one of the sites in the human body for the deposition of excess fat. A certain amount of fat is of course not to be despised; but when it occurs in excessive quantities, it is at least questionable whether this is advantageous. Such deposits are at best a burden to carry, and in the abdominal wall they are a fairly good index of the degree of relaxation of the abdominal muscles. Of course such relaxation may occur unassociated with fatty deposits. In children, however, there are usually varying amounts of fat deposited in the belly wall associated with abdominal-muscle relaxation. This was shown by the effect on the circumference and depth measurements of the abdomen of abdominal retraction, which plays a very large part in improving posture and in posture training.

Before any training was given, the average circumference of the body around the abdomen, at the level of the navel, was slightly greater for the posture group (25.42 ± 0.071 inches) than for the control group (25.01 ± 0.077 inches). At the end of the school year the average circumference for the posture group was 25.07 ± 0.073 inches as compared with 25.13 ± 0.076 inches for the control group. The control children, although there was a period for growth and perhaps also in many cases increase in fat in the belly wall and increase in relaxation of the belly muscles, showed no significant change in circumference measurement ($+0.117 \pm 0.108$ inches) during the school year. The posture children, however, in spite of the same increase in growth, significantly decreased in average circumference (-0.350 ± 0.102 inches). Throughout the year they had practiced

[11] Mankell, Nathalie K., M. D., and Edward C. Koenig, M. D.: Posture and Types of Breathing. New York Medical Journal, vol. 104 (July-December, 1916), p. 938.

retraction of the lower abdomen in the effort to improve their posture. They had exercised the abdominal muscles and had thereby decreased their relaxation. The fatty deposits in the abdominal wall had apparently been reduced as the posture improved, for the average decrease in circumference of the abdomen among the trained children whose posture improved was 0.464 ± 0.128 inches. This decrease must have been associated with training as well as improvement in posture, for there was no change whatsoever in the average circumference of abdomen among the control children whose posture improved and no significant change among posture children who received the same posture grade at the first and last examinations (-0.171 ± 0.173 inches). These trained children whose posture grade did not improve probably increased the tone of their abdominal muscles enough with continuous practice of abdominal retraction so that they had somewhat less relaxation of the abdominal muscles when they stood naturally.

The depth of the abdomen at the level of the navel showed changes in measurement which reflected training and improvement in posture. Although the average depth of the abdomen increased among both posture children ($+0.081 \pm 0.012$ inches) and control children ($+0.140 \pm 0.013$ inches), the average increase was less in the posture-trained class than in the control class (the difference between the two averages being $+0.059 \pm 0.018$ inches) and was also less among those in the posture class whose posture grades improved ($+0.049 \pm 0.015$ inches) than among those in the posture class whose posture grades did not improve ($+0.135 \pm 0.020$ inches). (Difference between the two averages was $+0.087 \pm 0.025$ inches.)

The lack of decrease in depth of abdomen after posture training indicates clearly that the children did not stand with their abdomens retracted while they were being measured; for if they had done so generally there would have been an average decrease in depth. They probably stood in the same manner for circumference measurement of the abdomen, as this was part of the same examination. This latter measurement showed a definite decrease with posture training and especially with improved posture. Since there was no decrease in depth, the lower abdomen could not have been retracted at the time of examination. Since the decrease in circumference of the abdomen could not have been due to retraction of the abdomen, it must have resulted from the reduction of fat in the belly wall which was associated with improved tone of the abdominal muscles following posture training.

BREADTH OF CHEST

The breadth of the chest at the level of the xyphoid cartilage did not change appreciably with changing posture. There was a slight average increase in breadth among both posture children ($+0.239 \pm 0.007$ inches) and control children ($+0.231 \pm 0.008$ inches), but the difference in the increases was insignificant. In the posture group the average increase was practically the same whether the children improved in posture ($+0.238 \pm 0.009$ inches) or showed no change under training ($+0.239 \pm 0.012$ inches).

THE COSTAL ANGLE

The costal angle is that angle formed by the margins of the lower ribs in front at their junction with the xyphoid cartilage. This angle was measured, as has been described, at each examination at neutral and also at full inspiration.

The costal angle, it had seemed from experience gained from working with individuals and in posture clinics, was a good index of the degree of relaxation and drop of the chest. The angle apparently was smaller as the ribs dropped lower and nearer together. The size of the costal angle also seemed to be associated with the type of body build. The thin type apparently had the smallest angle and the broad type the largest. Study of the measurements obtained in the examination of the children in the present study partly confirmed these impressions.

The costal angle at neutral was found to vary with type of body build, the average angle being much larger for the broad type (71.791° ±0.444°) than for either the intermediate (67.718° ± 0.297°) or the thin type (66.087° ± 0.653°), which were essentially the same. The average costal angle at neutral of children with good posture (72.586° ±0.744°) was found to be significantly greater than that of children with poor posture (68.137° ± 0.245°). In this connection it must be remembered that the children of the broad type more frequently had good posture prior to training than children of either the thin or the intermediate type. One type, however, did not improve under training more frequently than another. Posture training had no obvious influence upon the average size of the costal angle at neutral. The average change in the angle among trained children who improved in posture (+1.462° ± 0.527°) was insignificant, and that for trained children who retained the same posture grade throughout the year (+0.861° ± 0.660°) was similarly insignificant.

The average costal angle at inspiration at the first examination was similarly found to be greater for children with good (A and B) posture (90.677° ± 0.740°) than for children with poor (C and D) posture (86.889° ± 0.222°). The average angle at first examination for children of the posture group (87.381° ± 0.282°) was similar to that of children of the control group (86.935° ± 0.324°) and to that of children of the posture group who improved during the year (86.884° ± 0.363°). At the end of the year the average angle at inspiration was found to have increased for each of the groups just mentioned. The average angle at the second examination for the control children was 91.230° ± 0.259°, that of the posture group was 95.386° ± 0.235°, that of the posture children who improved was 95.713° ± 0.298°, and that of the posture children who showed no change in posture was 94.730° ± 0.388°. The average increase in the angle for the posture group (8.005° ± 0.367°) was considerably greater than the average increase for the control group (4.295° ± 0.415°). The average increase for the posture children who improved in posture (8.829° ± 0.470°) was greater than that of children in the control group who improved (3.346° ± 1.234°) but not significantly different from the average increase of posture children who made no change in posture (6.669° ± 0.599°). The average increase in this last-mentioned group was greater than that of either the total control group or those in the control group who improved.

A certain amount of increase in the costal angle at inspiration is obviously due to growth. The average increases in the angle, however, are considerably greater for trained children than for untrained. The greatest increases are associated with the training process rather than postural improvement.

BIACROMIAL DEPTH

The distance between the two acromion processes of the shoulders has been offered as an anthropometric measurement suitable for use in the study of body-surface area. This measurement varies slightly with respiration, being greater when taken at full inspiration than at the neutral point of respiration. Since with improvement in posture there is a certain amount of elevation of the chest, it was pertinent to determine whether the change in elevation associated with better posture brings a change in the reading of the biacromial-depth measurement.

The distance between the two acromion processes changed in 86 per cent of the children observed during the period of one school year, and in 81 per cent the change was an increase. Increases were for the most part comparatively small. More than two-thirds of the children who increased in this measurement, increased less than an inch. This change was probably associated with growth. It was evidently not related to change in posture, for no significant differences appeared between the average increase in the posture group (0.596 ± 0.013 inches) and the control group (0.573 ± 0.013 inches), nor between the average increase of the trained children whose posture improved (0.616 ± 0.017 inches) and the trained children whose posture remained unchanged (0.562 ± 0.018 inches). The biacromial measurement is apparently not affected to any significant degree by posture training or change in body mechanics.

POSTURE AND PRONATION

The mechanics of the feet are good when a perpendicular dropped through the knee joint, as the child stands, will pass through the ankle and meet at right angles another line passing through the foot from a point between the first and second toes in front, to the middle of the heel in back. If the forefoot is turned outward from the median axis of the body the condition is spoken of as abduction. If the entire foot is rotated outward on a horizontal axis, it is considered everted. A combination of such eversion and abduction is meant by the term pronation. Pronation is therefore a form of poor statics of the feet, an evidence of poor mechanics in that part of the body. There are, of course, different degrees of pronation. All degrees were grouped in the findings of the examination.

Pronation was present in about four-fifths of the children observed, and it was definitely most prevalent among those children who had the worst posture and less prevalent among the children with better posture. Those who had the best posture had the lowest percentage of pronation. The children with a thin type of body build showed pronation more frequently than those of the intermediate or broad type. Nutrition also seemed to be related to pronation for there was less pronation among the well-nourished children.

These conditions must not be considered as the only vital factors influencing the statics of the feet, for shoes, overuse, and strain are also important factors. It is interesting, nevertheless, that both nutrition and body mechanics in general, which were shown to be definitely related to each other, apparently are also related to mechanics of the feet. One would naturally expect poor foot statics to be associated with generally poor body mechanics. Therefore it is not at all surprising to find that 78 per cent of the children examined showed poor mechanics of the feet and 93 per cent of them had generally poor body mechanics.

SCOLIOSIS

Scoliosis, or lateral curvature of the spine, was noted when present. It was considered to be functional or habitual in character if it disappeared in the forward-bend position; i.e., when the child bent forward from the hips with the hands lowered toward the ground; or, if there was no posterior convexity of the ribs in back in this forward-bend position—no hump, the sign of bony rotation in the spinal segments. The scoliosis was considered structural or fixed, on the other hand, if the evidence of bony changes in the spine mentioned above were present. The curves were named right or left according to their convexities—curves convex to the right being called right curves, and vice versa.

Scoliosis was found at the first physical examination in 78 (5 per cent) of the 1,708 children. It was structural or fixed in 4 cases and functional or habitual in 74. Of these functional cases, 45 were left curves, 22 were right, and 7 were mixed or split curves with part of the deviation to the right and part to the left. Thirty-eight of the functional-scoliosis cases were in the posture group and 36 in the control group.

Posture training evidently had considerable effect upon functional scoliosis. Of the 38 children in the posture group who had this type of scoliosis at the first examination, 27 had straight spines at the second examination. Of these 27 children 25 at the same time had improved their posture. In contrast, only 9 of the 36 control cases had rid themselves of their scoliosis, 6 of these 9 having improved in posture.

Habitual scoliosis was found, at the second examination, in 30 children who did not show signs of it at their original examination, but only 1 case of such scoliosis developed in the posture group whereas 29 appeared in the control group.

Posture training, therefore, through improvement in posture in the majority of cases overcame habitual lateral curvature of the spine. It served also as a specific prophylactic measure against the development of such lateral curvature.

SUMMARY

The following conclusions in regard to the effect of good body mechanics on the health and efficiency of grammar-school children are based on experience with 1,708 children in the Williams School at Chelsea, Mass., whose records were adequate for analysis. The posture group included 961 children who were given training in proper body mechanics. The control group included 747 who were not given any posture training. In all other respects the school work of the posture and control children was similar. The two groups were similar at the first examination in respect to age, sex, nationality, and posture grade and various physical indexes.

At the first examination most of the children had poor body mechanics. Judged by the standards of body mechanics used in the study, more than 90 per cent of all observed had poor posture, the boys ranking somewhat better than the girls. Good posture was more prevalent as the children grew older, but poor body mechanics was not outgrown to any marked degree. At least 80 per cent of the children in each age period had poor posture. The children of the broad type of body physique had the largest percentage of good posture, and those of the thin type had the largest percentage of poor posture.

The prevalence of poor body mechanics was strikingly reduced by posture training. During the period of observation six children in the posture class improved in posture to every one of the control children who improved. With adequate training 60 per cent of children above the first grade in school can be expected to improve in posture during a year's training, irrespective of age. The older children grasped the principles more quickly and improved more frequently, but improvement was manifest at all ages. Improvement can be eventually expected in nearly all children, but some require longer training than others. Good posture once acquired was maintained, on the whole, over the 2-year period of observation by the children who received two years of posture training.

Improvement in body mechanics was associated with improvement in health and efficiency. More of the children who started with poor posture, when given training, improved their nutrition when they improved their posture than did those who did not improve their posture. Improvement in posture was found to occur more frequently with training if there was improvement in nutrition as well. Among the children without posture training, improvement in posture occurred more frequently with those in the best nutritional condition. Training was the most essential factor in the acquisition of good body mechanics, and good body mechanics was associated in a small proportion of the children with improved nutrition. Since nutrition has been accepted as an important index of a child's health, posture training would seem to be an important factor favorable to health, as indicated by its association with improved nutrition.

Improvement in body mechanics was also associated with improvement in school work. The rate of absence due to personal illness decreased in children who received posture training until it was considerably lower than that of untrained children. The posture-trained children also showed more improvement in deportment than the untrained children. The percentage of children who improved in scholarship was higher among the trained children than among the untrained.

Posture training had no significant effect on the changes that occurred in the vital-capacity readings. Changes of this character were undoubtedly associated with growth.

A tendency toward the upper abdominal type of breathing was manifest with better body mechanics. A more even excursion of the ribs in respiration and therefore a greater possibility of better aeration of the lungs was also noticeable.

Retraction of the lower abdomen, on request of the examining physician, was effected by direct retraction as a rule only by children with good body mechanics. Posture training and better posture brought an improved sense of muscle position and, therefore, improved ability of direct retraction of the lower abdomen. This ability is of value in that, with practice, the retraction of the lower abdominal wall becomes habitual and steady. The result of this practice is the elevation of the stomach, intestines, and other abdominal organs. Posture training is, therefore, a safeguard against visceroptosis, which is frequently associated with poor health.

Posture training improved the tone of the abdominal muscles and reduced the fat deposited in the abdominal wall. This was indicated by decrease in the circumference measurement of the abdomen without decrease in depth. The effects of posture training, however, are not to be considered as merely reducing in character; for while improved posture is associated with a decrease in abdominal girth, there is also at the same time, in a certain proportion of cases, improvement in the general nutritional condition.

Posture training and improvement in posture had no apparent effect on the breadth of the chest at the level of the xyphoid cartilage, nor on the distance between the acromion processes of the shoulders.

The size of the costal angle varied with type of body build, being smallest for the thin type and largest for the broad type. Change in the angle at neutral and change at inspiration came with growth, but the average increase in the angle at inspiration was greater for trained children than for untrained.

About four-fifths of the children observed had pronated feet. This condition was most frequently associated with poor body mechanics. It was more frequent among children of the thin type and was less frequent among children with good nutrition.

Postural, habitual, or functional lateral curvature of the spine (scoliosis) disappeared generally with improvement in body mechanics. Posture training was an aid in the correction of habitual scoliosis and also served as a specific prophylactic measure against scoliosis.

In conclusion, it seems desirable to recall the purpose of the study. Physicians and physiotherapists who have had experience with posture training have been generally convinced that such training is beneficial to health, nutrition, and morale and that the favorable influence of the training persists as long as the correct posture is maintained. Careful reviews made of small numbers of cases have shown correct posture once attained to be fairly permanent. Hitherto, however, it had seemed impracticable, if not impossible, to provide this expert training for the average school child.

In this study the attempt was made to ascertain: (1) Whether the average school-teacher and the average school director of physical education, having been taught the rudiments of good posture, could impart the general principles to the school children without disorganization or undue increase in curricular work. This study shows that these members of the regular school staff are able to give the children posture training which they have learned from experts without undue rearrangement of the school activities. (2) Whether such training in good posture carried out during the period of one school year would bring greater evidence of improved health, nutrition, and morale among the children who were trained than among a control group receiving no posture training. Analysis of the records shows that favorable results may be attributed to the posture training. Posture training and the maintenance of correct posture contribute to the health and efficiency of normal grade-school children.

APPENDIX.—PHYSICAL-EXAMINATION SCHEDULE USED IN POSTURE STUDY

Field No. ------ Office No. ------

1. Name ------------------------------ 2. Address ---------------------- City --------------------
3. (a) W. B. O.: N. F. (spec.) ---------------------- (b) Mother: N. F. (spec.) ----------------------
4. Sex: M. F. --------------------- 5. School -------------------- 6. Grade-----------------------------

Physical examination	I	II	III	IV	V
7. Date of examination----------	Y--m--d----	Y--m--d----	Y--m--d----	Y--m--d----	Y--m--d----
8. Date of birth------------------	Y--m--d----	Y--m--d----	Y--m--d----	Y--m--d----	Y--m--d----
9. Age------------------------------	Y--m--d----	Y--m--d----	Y--m--d----	Y--m--d----	Y--m--d----
10. Height--------------------------	----------in.	----------in.	----------in.	----------in.	----------in.
11. Weight--------------------------	---------lbs.	---------lbs.	---------lbs.	---------lbs.	---------lbs.
12. Underweight-------------------	----lbs. ---%	----lbs. ---%	----lbs. ---%	----lbs. ---%	----lbs. ----%

	VI	VII	VIII	IX	X
7. Date of examination----------	Y--m--d----	Y--m--d----	Y--m--d----	Y--m--d----	Y--m--d----
8. Date of birth------------------	Y--m--d----	Y--m--d----	Y--m--d----	Y--m--d----	Y--m--d----
9. Age------------------------------	Y--m--d----	Y--m--d----	Y--m--d----	Y--m--d----	Y--m--d----
10. Height--------------------------	----------in.	----------in.	----------in.	----------in.	----------in.
11. Weight--------------------------	---------lbs.	---------lbs.	---------lbs.	---------lbs.	---------lbs.
12. Underweight-------------------	----lbs. ---%	----lbs. ---%	----lbs. ---%	----lbs. ---%	----lbs. ----%

13. School attendance:

14. Absent for—	Past	I	II	III	IV
(a) Infectious diseases (specify)--	Yes, No-----	Yes, No-----	Yes, No-----	Yes, No-----	Yes, No-----
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(b) Colds---------------------------	Yes, No-----	Yes, No-----	Yes, No-----	Yes, No-----	Yes, No-----
(c) Sore throats--------------------	Yes, No-----	Yes, No-----	Yes, No-----	Yes, No-----	Yes, No-----
(d) Headaches----------------------	Yes, No-----	Yes, No-----	Yes, No-----	Yes, No-----	Yes, No-----
(e) Other illnesses (specify)------	Yes, No-----	Yes, No-----	Yes, No-----	Yes, No-----	Yes, No-----
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(f) Constipation-------------------	Yes, No-----	Yes, No-----	Yes, No-----	Yes, No-----	Yes, No-----
(Spec. how often cathartic taken.)	------------	------------	------------	------------	------------
15. Medical work by outside agencies.	Yes, No-----	Yes, No-----	Yes, No-----	Yes, No-----	Yes, No-----
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16. Scholarship--------------------	------------	------------	------------	------------	------------
------------------------------------	------------	------------	------------	------------	------------
17. Deportment---------------------	------------	------------	------------	------------	------------
(a) Restlessness-------------------	------------	------------	------------	------------	------------
(b) Concentration------------------	------------	------------	------------	------------	------------
(c) Obedience (orderliness)-------	------------	------------	------------	------------	------------

APPENDIX.—PHYSICAL-EXAMINATION SCHEDULE USED IN POSTURE STUDY—Continued

18. Grade A. B. C. D.

19. Teacher________ 20. Assistant________ 21. Group________

22. Diagnosis: ________

Physical examination	I	II
23. Date		
24. Appearance	A. B. C. D.	A. B. C. D.
25. Type	Thin, Nor., Broad	Thin, Nor., Broad
26. Standing position		
27. Gen. (phys. exam.), specify		
28. Pronation	Yes, No	Yes, No
29. Abduction		
30. Breathing	Cos. Up. Abd., Low. Abd.	Cos. Up. Abd., Low. Abd.
31. Retraction	Costal, Abdominal	Costal, Abdominal
Circumference—		
32. Abdomen at navel	in.	in.
33. Axilla: (*a*) Neutral	in.	in.
(*b*) Inspiration	in.	in.
(*c*) Expiration	in.	in.
34. Xyphoid: (*a*) Neutral	in.	in.
(*b*) Inspiration	in.	in.
(*c*) Expiration	in.	in.
Depth—		
35. Interacromial	in.	in.
36. Xyphoid: (*a*) Neutral	in.	in.
(*b*) Inspiration	in.	in.
(*c*) Expiration	in.	in.
37. Abdomen: (*a*) Normal	in.	in.
(*b*) Retracted	in.	in.
38. Breadth of chest at xyphoid	in.	in.
39. Vital capacity	liters	liters
40. Costal angle		
41. Examined by		
42. Photographed by		

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