DIMENSION STANDARDS FOR A HIGH SCHOOL FOODS LABORATORY

by

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DIMENSION STANDARDS FOR A HIGH SCHOOL FOODS LABORATORY

CHAPTER I

PURPOSE OF STUDY

This study presents dimension standards necessary in the planning of a high school foods laboratory. The data contained in this report was collected in connection with a project consisting of the planning and recommendations for food laboratories which was begun in September, 1940, in the department of Home Economics Education at Oregon State College.

This project concerned itself with all the various factors necessary for promoting the best pupil-teacher relationships in food preparation and a carry-over value which sets an ideal to be desired in the girls' homes and which at the same time is practical. The project evolved into various phases of planning for which standards were necessary. A study of available materials and design trends, of present laboratory set-ups, of foods prepared in the laboratory in order to determine equipment and the amount of work and storage space needed, and a study of heights for working surfaces based on the dimensions and judgments of girls were found necessary to the planning of a high school foods laboratory.

That there is a need for such a study is shown by the lack of available material on the subject. Further, good planning is necessary from the standpoint that a foods laboratory may serve as a demonstration for home kitchens; it is also important in that it represents a large initial investment in comparison with that involved in other departments of the high school.

An analysis of the aforementioned project in an attempt to discover some reliable standards for planning working surface heights revealed that the measurements of high school girls which were necessary for setting up such standards were not available. It appears that the only recommendations of dimension standards now available for planning are somewhat inadequate. Since the authors of such recommendations give no basis for their decisions as to standards, it is assumed that these standards are based upon their opinions and observations. The most widely known material dealing with working surface heights for high school food laboratories is Vocational Education Bulletin No. 181, "Space and Equipment for Homemaking Instruction ". (20) That recommendations contained in this bulletin are opinions of several high school home economics teachers was confirmed by a personal letter to the investigator from Edna P. Amidon, Chief of Home Economics Education

Service in the U. S. Office of Education (see Appendix, Exhibit III).

Besides standards for dimensions, this study shows the relation of sizes of girls in Corvallis schools with those of girls in other high schools and with women. It attempts to point out the necessity of dimension standards as an aid to more effective laboratory training.

Since the foods laboratory in a high school is used primarily by adolescent girls, it is necessary to provide dimension standards which will satisfy their needs. Because the foods laboratory is used from two to five days a week for food preparation, good working conditions are necessary from a psychological as well as from a physical point of view. The physical aspect of the laboratory itself should stimulate interest in foods and in planning family meals. The girls can be expected to increase their interest in class work and give more attention to it when desirable working conditions are the result of proper planning.

It is the opinion of the investigator that dimension standards based on girls' measurements also promote good posture and aid in the prevention of fatigue. According to Bennett (3, p. 59), cooking, among other activities, does not tend to correct posture but tends "rather to

increase and complicate the spinal fatigue and defects." In reference to sewing classes, Bennett said that habits of posture formed in these classes are most likely to be carried over into life. (3, p. 273) Thus it may be seen how important optimum conditions are to the physical well-being of the girls.

In presenting dimension standards for a high school foods laboratory, this study concerns itself with sources of data and methods used in determining these standards, a study of the physical measurements and judgments of high school girls, dimension standards based on judgments and measurements of girls, and the significance of the study in relation to its application to future planning and remodelling of high school foods laboratories.

CHAPTER II

SOURCES OF DATA AND METHODS USED

PRELIMINARY STUDY

Since this study concerns itself with dimension standards based on the physical measurements and judgments of high school girls, it was necessary to determine what standards were available, their relative importance and the basis for their selection, and what standards were required to satisfy the needs of girls. Thus the preliminary study concerned itself first with observations of laboratory classes to determine activities carried on in food preparation and to determine postures of high school girls in the classroom; second, with conferences with a member of the physical education department to determine criteria for evaluating posture required in executing the various activities carried on in the laboratory; third, with a study of available data on the maturity of high school girls and the selection of the group to be measured. The plan for the investigation included descriptions of the methods for obtaining the physical measurements and judgments of high school girls necessary in determining dimension standards for a high school foods laboratory.

Observation of Laboratory Work to Determine Activities and Posture of Girls

In a study of the types of activities carried on in the foods laboratory, it was found through observations in food classes conducted in the Corvallis High School that activities concern themselves with two major positions, standing and sitting. Standing included those positions in which girls were erect and those in which girls were crouching. Such activities as reaching up or down, beating, kneading, rolling, dishwashing and sifting flour were included under the erect standing position. Crouching included activities below the eye level such as opening and closing the oven door, lower drawers and lower doors. Sitting included reading, writing and eating. It was found that sitting down to work is not a factor in the short foods laboratory period, so it will not be considered in this study.

From observations of two laboratory classes, one on the preparation of salads and another on cakes, both of which included most of the activities carried on in the laboratory, a study of the characteristic posture for the various activities indicated that girls stand fairly erect; in most cases, heads were bent forward to enable the girls to see their work. There were also girls who

changed position by balancing their weight first on one foot, then on the other. Taller girls maintained a better posture when they put an inch board on the 35-inch working surface, while the shorter girls found the work surface too high. The girls observed the rules of good posture in reaching for high objects. Bending with the back was found to be more common than bending from the thighs.

In studying, the girls maintained a better position when they used the pull-out boards rather than the work surfaces for desks. In sitting listening to a discussion, the girls bent with the back and twined their legs around the stool in an attempt to be comfortable.

Stafford (17, p. 81) says that "the average person assumes a poor sitting position. - - - - - The natural tendency is to round the entire back and protrude the head forward. Moreover, there is a 'buckling at the middle' of the body and a decrease in the pelvic obliquity. In this position the body is allowed to slide down in the seat rather than to be supported by the thighs and buttocks as when sitting up in a seat."

No observations of eating at a table were made at this time, but at other times the investigator has observed posture faults similar to those maintained in studying as described in the preceding observations.

Conferences with Physical Education Instructor To Determine Posture Standards

Before any further study could be made, it was necessary to establish posture standards for girls working at the various activities of the laboratory. Through conferences with Miss Laura McAllester, Assistant Professor of Physical Education for Women at Oregon State College, who is in charge of the posture program, analysis was made of the postures to be used in the various laboratory activities. As an aid to further study, this analysis included the most efficient working posture for the job as well as for the person involved.

Further study was made of available reference material on posture standards. Hallock (8, p. 536) lists the requirements for good posture as set up by the Subcommittee on Orthopedics and Body Mechanics of the White House Conference on Child Health and Protection. In an unpublished thesis written by Elizabeth Stayton (18, p. 4) on heights for high school clothing laboratory tables based on the physical measurements of girls in Analy Union High School, Sebastopol, California, criteria set forth in her study formed a basis for evaluating posture of high school girls whom she measured.

From these references and others not quoted (6, 10, 19, 24), and from conferences with Miss McAllester, posture

standards were developed for use in this study as follows:

I. Standing in an erect position.
   1. Head held up and balanced above the shoulders, hips and ankles.
   2. Chin held "in".
   3. Chest up and forward.
   4. Lower abdomen held "in" and "flat".
   5. Curves of the back maintained within normal limits.

II. Crouching.
   1. Trunk straight.
   2. Motion coming from the hip joint.

III. Sitting.
   1. Trunk straight.
   2. Chin up.
   3. Chest up and forward.
   4. Abdomen in or flat.
   5. Back quite flat (usual curves not exaggerated).
   6. Lower back touching chair.
   7. Body relaxed.

These posture standards were used throughout the study in connection with determining physical measurements necessary for planning dimensions suitable for

girls performing the various activities of the laboratory. They were also used during the investigation as a basis for checking the posture of the girls included in this study.

Study of Available Data on the Maturity of High School Girls and Selection of Group to be Measured

In order to determine what age level of girls to include in this study, it was necessary to study their physical growth in terms of maturity.

A study of available data on high school girls showed that the period of most rapid growth is over before they reach the age of fourteen. Between fourteen and sixteen, girls gain about 2.5 centimeters a year; after 16, the median gain is about .75 centimeters, according to Woolley (25, p. 386). She said that "the tendency toward a more rapid yearly gain for the shorter children shows among girls only in the years fourteen to fifteen."

According to R. Bennett Bean (2, p. 45), the chief growth in stature occurs in the year preceding puberty. "Stature takes on the last period of rapid growth from 12 - 16 years; at this time all linear dimensions of the body increase rapidly." (2, p. 59). Woolley's (25, p. 386) tables indicate that 18 years is very close

to an adult height for girls. Further, the records collected in connection with the Harvard growth study reveal that the average age for maximum growth is 12.56 (16, p. 9).

Van Dyke (21, p. 217) said "that the relation between the spurt in physical growth and the advent of maturity is not definitely determined and further that there is little ground for the belief that tall girls mature earlier than short ones." Further, his investigations on the effect of puberty on growth "show that the sudden rise in height and weight curves of girls comes one or two years before puberty rather than exactly at the time of puberty or after this development."

Leal (9, p. 168) says maturity and height are influenced by chronological age. This author believes girls who mature earlier are taller than those who mature later.

Table 1 indicates the average or mean heights found in various studies on height-age relationships of adolescent girls.

Table 1. Average Heights in Inches of Girls Based on Anthropometric Studies

Age	*Leal(9)	Richey(12)	'Baldwin(1)	"Boynton(4)	McCloy(11)	Diehl(5)	Gordon(7)
11	54.46	57.14	56.00				
12	57.04	59.76	58.00	60.01	61.20		
13	60.98	61.82	60.00	62.03	62.80		
14	61.90	63.14	62.00	63.08	64.00		
15	62.25	63.96	63.00	64.03	64.50		
16	62.76	64.32	64.00	64.54	64.60	63.82	64.60
17	62.17	64.19	64.00	64.58	64.60	63.69	64.70
18	63.32		64.00	64.03	64.60	63.69	64.70
19						63.86	64.50
20						63.85	64.80
21						63.74	

* Citations used are based on 2 stages of maturity-
  1. Girls showing signs of maturity, ages 11 and 12.
  2. Girls having reached maturity, ages 13 on.

' Heights for medium-sized girls.
" Calculated from centimeters.

Table 1 shows that variations in heights of these groups are slight. That there is little variation in heights of college girls with those of younger physiologically mature girls may be seen from this table.

Further study was made of available data which it was possible to secure from two Oregon High Schools, Corvallis and Pendleton. These data, shown in Tables 2 and 3, indicate the range in heights of girls compared with grade and age, respectively.

Table 2. Heights of Girls According to Grade for Corvallis and Pendleton Schools

Height in Inches	7th grade		8th grade		9th grade		10th grade		11th grade		12th grade	
	*C	P	C	P	C	P	C	P	C	P		P
	NUMBER OF CASES											
53	1											
54	4					1						
55		2		1								
56	1	6				1						
57	2	6		2		1				1		
58	6	6		9		1		1				
59	6	8	1	3	1	1	2	1	2	2		1
60	9	5	2	11	5		5	4	6	1		3
61	3	6	10	4	8	3	16	4	6	6		4
62	6	8	7	13	11	18	14	5	13	5		4
63	4	1	7	6	7	7	15	7	16	14		11
64	5	2	12	3	10	7	16	14	22	9		5
65	4		6	3	13	2	12	9	19	7		12
66	1		2	1	4	3	11	14	9	10		7
67					6	3	7	1	7	2		5
68					2	2		4	4	4		2
69			1		1		1		2	2		1
70							1		1			
Total Cases	52	50	48	56	68	50	100	64	107	63	0	55

* C refers to Corvallis girls and P to Pendleton girls.

Table 3. Heights of High School Girls Classified as to Age for Corvallis and Pendleton High Schools

Height in Inches	Ages									
	11	12	13	14	15	16	17	18	19	Total
	NUMBER OF CASES (Corvallis)									
53		1								1
54		1								1
55		1								1
56		3								3
57		5	1							6
58	1	5	2							8
59		4	1		3		1			9
60	1	3	6	1	4	5	3	2		25
61		1	6	9	15	9				40
62		3	5	13	16	14		1		52
63		2	7	5	15	17	5			51
64		1	15	8	16	16	1	1		58
65		1	6	9	19	14	2	1		52
66			3	5	7	10	1			26
67				2	13	5				20
68				2		4				6
69				1	1	1	1			4
70					1					2
Total	2	31	53	55	110	95	14	5	—	365
	NUMBER OF CASES (Pendleton)									
54		4								4
55		2	1							3
56	3	3		1						7
57	2	4	3			1				10
58		6	9	1			1			17
59	2	7	3			2	2			16
60	1	5	8	2	4	1	2	1		24
61	2	5	3	3	3	4	4	3		27
62	2	7	10	15	8	3	4	3	1	53
63		2	6	7	5	10	12	3	1	46
64			8	3	11	10	7	1		40
65		1	1	3	6	10	11	1		33
66			2	3	6	13	9	2		35
67				3	1	3	4			11
68			1	1	4	5	1			12
69					1	1		1		3
Total	12	46	55	42	49	63	57	15	2	341

From Tables 2 and 3 it may be seen that the 11 and 12 year old girls were somewhat shorter than the older girls. That the Pendleton group showed more variation in range among the older girls was not considered of too great significance because of the small number of cases involved. This variation could not be accounted for because of insufficient information about the Pendleton girls.

It was the purpose of this study to provide dimension standards for a high school foods laboratory. These data indicate that inclusion in the study of at least the ninth grade girls, the youngest group included in a regular high school in Oregon, and of the twelfth grade girls, the oldest group, would indicate the span of growth including maximum development for the high school years and might produce an overlapping to the extent that no further cases in the tenth and eleventh grades need be taken.

As was previously stated, the preliminary study concerned itself with the activities carried on in the laboratory, postures necessary in performing these activities and criteria for evaluating such postures, and available data on the maturity of high school girls. With the results of these data, it was possible to plan the investigation.

PLANS FOR THE INVESTIGATION

Following the preliminary study, plans were developed for the investigation necessary in connection with the planning of dimension standards for a high school foods laboratory. These included conferences with school administrators and technical advisers, a selection of measurements necessary to satisfy dimension standards, techniques and equipment for taking these measurements and a plan for obtaining the measurements.

Following the inception of the measurement study it was thought necessary to include a study of the judgments of high school girls as to working surface heights. The method of choosing activities, the basis for selection of subjects, and plans for obtaining the opinions are also included in this section.

Since the success of this study depended upon the cooperation of the Corvallis school administrators, preliminary conferences were held in which the purpose of this study was presented to Mr. J. F. Schenk, Superintendent of Schools, Corvallis, Oregon. With his approval tentative plans were made for a measurement study involving ninth and twelfth grade girls to be

carried on in the junior and senior high schools.

Study of Measurements of Girls

In her study, the investigator was fortunate in having the advice of Miss Maud Wilson, Professor of Home Economics Research at Oregon State College, who has done pioneer work in the field of planning dimension standards for working surface heights for homes. Preliminary plans were made under her direction.

Measurements used in present study

Following the conferences with Miss McAllester on the various activities in the laboratory and their relation to correct posture, it was decided to take certain physical measurements of girls which would most nearly satisfy requirements for dimension standards for these girls. The following measurements were selected.

I. Measurements taken with subject standing:

1. Stature.
2. Height of eye level.
3. Height of shoulder.
4. Height of under forearm.
5. Height of wrist.

6. Breadth of shoulders.
7. Breadth at elbows, arms akimbo.
8. Reaching height.

II. Measurements taken with subject seated:

1. Sitting height.
2. Breadth of thigh.
3. Length of thigh.
4. Height of under knee.
5. Height of thigh.
6. Height of hip.
7. Length from back of hip to extended foot.

From these data, calculations of the following measurements could be made: Eye level, height of shoulder and underforearm for sitting position, and height of thigh and height of hip above the chair seat. Weight, age, residence, and height of chair seat from floor were also recorded at the time measurements were taken.

Techniques used in taking measurements

In addition to the selection of these measurements, techniques for taking them were perfected with the advice of Miss McAllester. Directions used in the

Oregon-Washington Purnell study* of 1937 formed a basis for those used in this study. Equipment used in connection with this study was similar to that used in the Oregon-Washington Purnell study; the same stadiometer and calipers were used as in the original study on women. (A complete set of directions and list of equipment will be found in Appendix Part I).

Before any measurements could be taken on the high school group, it was necessary for the investigator to learn the measurement techniques involved in the study. This was done with the aid of an assistant who also learned these techniques. Following practice in taking the measurements, the investigator and her assistant measured several college girls to check themselves, one against the other, as to their acquired techniques. When a sufficient amount of speed and ability in taking measurements had been developed and the investigator had been examined by Miss McAllester

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* Throughout this study, reference is made to research studies carried on with grants from the Purnell fund. For the purposes of this study, the research carried on cooperatively by Maud Wilson and Ruth Thayer at the Oregon Agricultural Experiment Station and by Evelyn Roberts at the Washington Agricultural Experiment Station will be known as the Oregon Washington Purnell study. Further research on this project was done by Miss Roberts and will be referred to as the Washington Purnell Study II. (See 14, 15, and 22).

as to mastery of technique, the measurement study was begun. The investigator was checked by her assistant on the first 20 cases measured. Following this, the investigator took all the measurements, repeating them to a recorder who checked them to make sure that the second measurement was within one half an inch of the first.

In the junior high school, the measurement study was conducted in the home economics rooms. Girls were taken one at a time from their classes; directions were explained to each. In the senior high, the measurements were taken in a small room near the library. Senior girls came at intervals so one watched the measuring of the girl preceding her. The same methods were used as in the junior high situation.

In addition to the measurement study it was necessary to obtain judgments of high school girls as to working surface heights. A description of the procedure for this study follows.

Study of Judgments of Girls

Cooperators in the judgment study

Following the completion of the measurement study, students were selected from the freshmen and senior

classes to determine their preferences for working surface heights for various activities. These students were chosen on the basis of wrist height, breadth of thigh, and age.

Activities used in judgment study

The following activities were selected as being representative for determining dimension standards for the foods laboratory:

Activity	Position of hands
1. Beating with a dover beater.	Hands held above the surface by a tool.
2. Washing dishes in a deep sink (type generally installed in new laboratories).	Hands near the surface.
3. Washing dishes in a pan (type still used in many laboratories).	Hands near the surface.
4. Rolling with a rolling pin.	Hands at surface with pressure.
5. Stirring in a bowl.	Hands above the surface.
6. Frying at the back of the stove.	Hands near the surface.
7. Stirring in a double boiler at the front of the stove.	Hands above the surface. (The latter two activities represent the most difficult as to their relative position on the top of the stove.
8. Eating at a table.	Hands at and above the surface.

By proceeding from one step table to another, it was possible for each subject to determine the height that seemed best for the activity involved and one that was too high and too low. A detailed explanation of methods for obtaining judgments will be found in Appendix Part II. At the same time, the investigator observed the floor space which girls used in crouching in front of an open oven door. Observations were obtained from each girl until there was a consistent uniformity of results.

Selection of equipment

Since the equipment study included in connection with the major project of planning a high school foods laboratory has not been completed, selection of equipment used for this study was based upon the opinions of Corvallis High School foods instructors. (Description of equipment used will be found in Appendix Part II).

Following the selection of activities and various pieces of equipment necessary in carrying on these activities, it was expedient to set up standards of posture whereby a comparative uniformity of practice could be assurred. Criteria for judging posture for the various activities were set up as follows:

1. Beating with a dover beater. Of the two activities required in beating, grasping the handle required more exertion than actual beating. Thus, having the girl hold the grasping arm in a plane horizontal with the floor was considered to be the least fatiguing position for this activity.
2. Washing dishes. The girl should maintain an erect position. Her hands should touch the bottom of the pan or sink in order that she might have access to all articles contained therein. Her arms should be placed comfortably above the edge of sink or pan, thus avoiding fatigue over a long period of dishwashing.
3. Rolling with a rolling pin. An analysis of this activity revealed that if the cooperator rolled the rolling pin forward, backward and to both sides as far as she could, she would be exerting all the muscle strain necessary for the activity. From the analysis, it was decided that the girl should stand erect and that the height selected should be the one involving the least strain on both her arms and back.

4. Beating or stirring in a bowl with a wooden spoon. This activity required an erect posture which gave the girl maximum freedom to exert pressure on the contents of the bowl.
5. Frying at the back of the stove. This activity required the girl to stand erect and to find the height for frying which would put the least possible strain on the arm--at the lower levels for reaching to hold on to the pan and at the higher levels for reaching up to get the spatula under the pancake in the pan.
6. Stirring in the double boiler at the front of the stove. The standard set for this activity was that the arm used for stirring be on or lower than a horizontal plane with the floor and that the girl should be able to see the bottom of the upper part of the utensil.
7. Eating at a table. For this activity, the girl was seated on an adjusted chair (the one used in the measurement study). She was asked to maintain a correct sitting posture and to choose the table height most comfortable for her.

In order to introduce this part of the investigation to the ninth grade girls, the investigator and her assistant held a special assembly for all those selected to give judgments. At this time, the methods for performing the various activities together with the standards set up for their optimum performance were explained by the investigator while her assistant actually demonstrated the correct method.

Because the senior girls had no free period in which an assembly might be held, it was necessary for the investigator to explain the procedure to small groups of girls.

The judgment study was carried on in the same rooms in the respective schools as before. In the junior high school, it was necessary to perform the activities on the working surface heights provided, making, of course, the necessary modification for height. That the accustomed working height had little effect on the decisions of girls was observed by the investigator. Especially was this true of stove heights; the greatest number of preferred heights chosen by girls was between 31.5 - 33.5 inches (See Appendix Figure VI) while the laboratory stoves were actually 36 inches high. From this and other results,

it may be seen that the physical aspects of the laboratory did not influence choices greatly.

On the other hand, the senior girls gave their preferences in a room which was without suggestion of a foods laboratory set up, the only exception being the utensils with which they worked.

Plans for the study of judgments consisted of the selection of girls from whom to obtain choices as to preferred heights, the selection of activities and equipment necessary for carrying on these activities, and posture standards necessary for use in evaluating judgments.

Analysis of Data

Objectives in analyzing the data were to show the statistical pattern, to show variations and their significance, to make recommendations for dimension standards and to show the percentage of girls for whom these standards are suitable.

CHAPTER III

DESCRIPTION OF COOPERATORS

The present study fell into two main divisions, the study of measurements of girls and the study of the judgments of a group of girls selected from those in the measurement study. In the description of cooperators, it should be kept in mind that all of the cooperators were included in the measurement study while only 60 of these same girls were included in the judgment study.

DESCRIPTION OF SUBJECTS IN MEASUREMENTS STUDY

Selection of subjects

From a preliminary study of data on heights of girls in relation to age and grade based on those obtained from Pendleton and Corvallis schools and on various anthropometric studies of the growth cycle of girls, it was decided that the subjects for this study should include at least the ninth grade or freshmen class and twelfth grade or senior class girls. In making this decision, it was assumed that the dimension standards for the foods laboratory should be confined to the high school level including the ninth to twelfth grades since

the preliminary study indicated that separate standards would probably be necessary for lower grades because of the shorter stature of the girls.

Because of the slight difference in stature found among the ninth, tenth, and eleventh grade girls in the preliminary study of the two schools, it was assumed that taking the ninth and twelfth grade girls for this study might furnish sufficient data to allow for any great differences in growth of girls during the four year high school period and might show an overlapping to the extent that separate standards would not be needed for the various high school grades.

For the investigator's purpose, it seemed best to take girls from one high school and set up standards for them with recommendations for differences shown by students from other schools. With the exception of three girls, one Chinese and one Italian in the freshman class and one Mexican in the senior class, all girls participating in this study represented the Nordic races. The exceptions were used in calculating measurements used in this study, because, although they were below average in stature, they were not the shortest girls measured.

Relationship of age, class and residence

Measurements were taken of 87 freshman girls and 100 senior girls. Except for one case in the junior high school and three cases in the senior high school which were omitted because of absences at the time this study was being carried on, all girls in both classes were measured. Table 4 indicates the relationship of age, class and residence of each of the 187 girls included in the measurement study.

Table 4. 187 Cooperators Classed with Respect to Age, Residence, and Class

Number of Students Participating in This Study

Ages	Freshmen				Seniors				All Cases			
	Rural Number	Urban Number	All No.	Per cent	Rural Number	Urban Number	All No.	Per cent	Rural Number	Urban Number	All No.	Per cent
13	2	1	3	3.5					2	1	3	1.6
14	10	22	32	36.8					10	22	32	17.1
15	12	27	39	44.8					12	27	39	20.9
16	5	4	9	10.3	1	3	4	4	6	7	13	7.0
17	1	3	4	4.6	16	33	49	49	17	36	53	28.4
18					14	22	36	36	14	22	36	19.3
19					0	7	7	7	0	7	7	3.7
20						1	1	1		1	1	.5
21						2	2	2		2	2	1.0
22						1	1	1		1	1	.5
	30	57	87	100.0	31	69	100	100.0	61	126	187	100.0

It will be observed from Table 4 that of the freshman group, 30 were girls from rural homes and 57 were from urban homes. Of the 100 seniors, 31 were from rural homes and 69 from urban homes. Thus, 61 of the entire group represented rural homes and 126 represented urban homes. Table 4 also shows that freshmen included in this study range in age from 13 to 17 years and the seniors range in age from 16 to 22 years. The distinction between the rural and the urban girls was made to determine whether any marked differences in stature existed between the girls of the two home backgrounds. That there was little difference in the range of heights for the two groups is indicated by Tables I and VII (See Appendix).

Experience of subjects

Of the 187 girls included in this study, all had taken or were taking at least one term of foods. Many of the seniors had had more than one term. Foods as taught in Corvallis High School always includes laboratory work in food preparation. It also requires that some "work" must be carried on outside the school in the form of a home project. Thus school work may have some carry-over value to the home situation. This fact reemphasizes the importance of setting correct standards for planning

a laboratory and of producing optimum working conditions in order to further the students' interest in class procedure.

Relationship between height and weight

In order to study the relationship of height and weight of the 187 ninth and twelfth grade girls Table 5 was devised.

Table 5. Cooperators Classified with Respect to Standing Height and Approximate Weight

Height in Inches	Weight in pounds														
	70-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200-	Total	Per cent
58*				1											1	.5
59			1												1	.5
60	1	1	1	1	1		1								6	3.2
61	1	2	3	2		2	1								11	5.9
62			3	5	5	1	2	2			1				19	10.2
63			3	8	7	9	4	1		1					33	17.6
64		1	1	4	4	6	3			1		1			21	11.3
65				1	9	8	3	2		1					24	13.8
66				3	4	8	4	4	3						26	13.9
67					4	9	8	3	2	1				1	28	15.0
68						5	2	2	3	1					10	5.4
69							1	1				1			6	3.2
70																
71																
72						1									1	.5
Total	2	4	12	25	34	49	29	15	8	5	1	2	0	1	187	100.0

*58.0 and less than 59.0. Subsequent groups similarly defined.

Table 5 indicates that range in weight varied greatly; 73.26% of the entire group varied from 100 - 139 pounds in weight and 87.70% varied from 90 to 149 pounds. It appears that the taller girls are also the heavier in this study.

Determining the adequacy of the sampling

In order to compare the stature of girls in this study with those for adult women measured in the Oregon-Washington Purnell study and with those for 100 California high school students in the Stayton study, Figure 1 was devised.

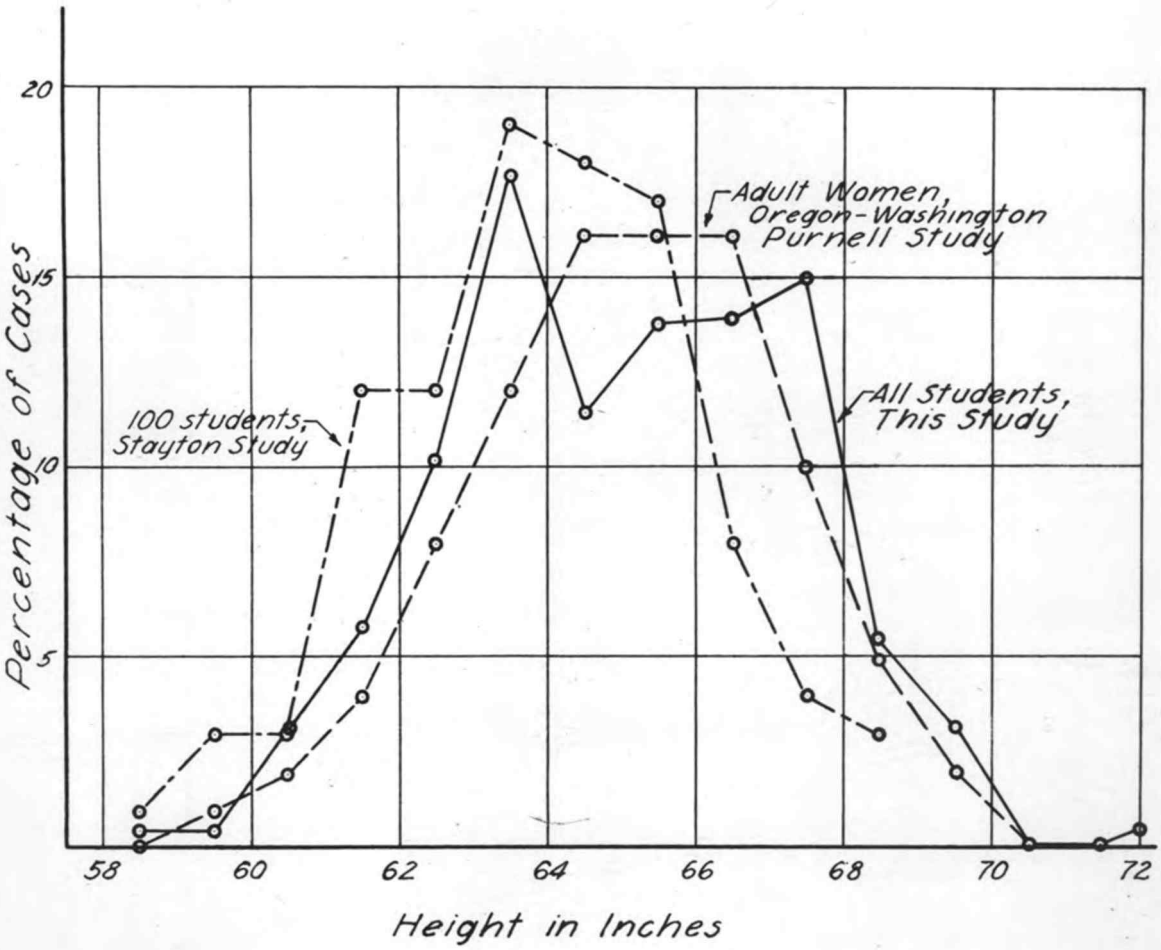

Figure 1. Comparison of Heights of Adult Women in the Oregon-Washington Purnell Study and 100 California High School Students in the Stayton Study With Those of High School Students in the Present Study.

From Figure 1 it may be seen that the girls are taller and also shorter than are the women in the Oregon-Washington Purnell study. This may be due to the fact that, because the number of cases is greater than those contained in this study, the Oregon-Washington Purnell study more nearly approximates a normal curve.

Further, Figure 1 compares this study with that made by Elizabeth Stayton in 1938 on recommendations for heights for clothing laboratory tables. It is found that girls in this study are taller than those in the Stayton study. Miss Stayton accounts for this difference by the presence in her group of six Japanese and a number of Italians and Portuguese; also her sampling is not as extensive as is that of this study. (18, p. 10).

Table 6 shows a comparison of averages of samplings of 25 cases each from this study with averages of samlings of 50 cases each from the Oregon-Washington Purnell study.

Table 6. Comparison of Four Different Measurements Made by Group Sampling in Inches

PRESENT STUDY

Groups	Stature	Shoulder	Forearm	Wrist
Fr. 1	64.78	53.82	40.23	32.91
Fr. 2	64.55	53.46	39.92	32.58
Fr. 3	64.58	53.62	40.19	32.51
Sr. 1	64.74	53.85	40.35	32.86
Sr. 2	65.14	54.07	40.38	32.71
Sr. 3	65.24	54.23	40.55	33.26

OREGON-WASHINGTON PURNELL STUDY*

Groups	Stature	Shoulder	Elbow	Wrist
O-1	64.8	53.4	41.6	33.1
O-2	64.9	53.2	41.5	33.1
O-3	65.2	53.8	41.9	33.6
O-4	66.2	54.6	42.6	33.7
O-5	64.8	53.2	41.4	32.9
W-1	65.2	53.9	41.6	33.0
W-2	65.0	53.9	41.8	32.9
W-3	65.3	54.0	42.0	32.9
W-4	65.5	54.5	42.6	33.1
W-5	65.0	53.9	41.8	32.6

*taken from 22, p. 19
Forearm measurement from this study corresponds to elbow, O-W Purnell.

Table 6 indicates that differences in averages of samplings from the two studies are so slight that they make any marked deviations from the normal curve on the part of this study seem insignificant. Because of the similarity in results of averages from samplings from the two studies, it may be assumed that were this study increased in scope, its results would more nearly approximate those of the Oregon-Washington Purnell study.

That the differences between the statures of girls in this study and those of women in the Oregon-Washington Purnell study are not great enough to be significant is further substantiated by the application of the X^2 formula (test of goodness of fit) to data in Figure 1 (see Appendix Part IV). X^2 for this study was 18.04; this figure is less than 19.675 which was obtained from a reading in the X^2 table as representing a difference of five per cent. The results of the use of this formula show that the variation between the two studies is less than five per cent; thus, it may be said that there is goodness of fit between the two studies.

DESCRIPTION OF SUBJECTS FOR JUDGMENT STUDY

From the 187 girls for whom measurements were obtained, 60 were selected to give their judgments as to working surface heights for various activities. Of these 60 girls, one-half were freshmen and the other half were seniors. As has been previously stated of the group as a whole, all had had or were taking one term of foods; actually, all but about 10 of the freshmen had completed a term of foods, and many girls had taken more than one term. The amount of home experience these subjects had was not determined.

Girls were selected for this study on the basis of wrist height and breadth of thigh measurements. Wrist height was considered to be a better basis for selection than stature or other related physical measurements because the Oregon-Washington Purnell study (22, p. 31) indicated that this height was more closely correlated with the heights for working surfaces preferred by women.

Girls with wrist heights varying from 30-35.9 inches inclusive were selected (See Appendix Tables II and VIII). Of this group, only two had wrist heights between 30-30.9 inches and two between 35-35.9; thus it will be observed

that the wrist height of 56 girls was within a range of four inches (31 to 35, inclusive).

The breadth of thigh measurement was used as a determining factor because it indicated to a certain extent the size of the girl. Girls with thigh measurements from 11 - 14 inches were chosen since they represented the greatest number of cases for the entire group. (See Appendix Tables IV and X).

In making the final selection of the girls, preference was given to girls most nearly approaching the average age of their class. This eliminated the retarded pupil and gave a more representatively intelligent group. Freshmen chosen for this study ranged in age from 14-15 years and seniors from 17-18 years of age. (See Appendix Tables VI and XII).

The sixty girls chosen for the judgment study were selected on the basis of age most representative of their class, breadth of thighs in the sitting position, and wrist height. As a result of this selection, it was expected that dimension standards finally set up would satisfy the needs of the average high school girl.

CHAPTER IV

DIMENSION STANDARDS BASED ON PHYSICAL MEASUREMENTS OF HIGH SCHOOL GIRLS

The basis for selection of the groups measured and a description of subjects have been treated in the preceding chapters. This chapter attemps to show the use of physical measurements in determining certain dimension standards of value to the planning of a high school foods laboratory. Dimensions included are for chairs, eating tables, passageways and other space units and heights for shelves and drawers.

As was stated previously, a study was made of the dimensions for which measurements were necessary. This study was followed by a selection of a list of measurements which would most nearly satisfy the requirements for these dimensions. Certain measurements from this list could be applied directly to dimension standards while others were used only for calculation. For the purpose of this study, measurements used for calculation are treated in Appendix Part V, while measurements applying directly to dimension standards are discussed in this chapter. Directions for taking each of the measurements included in this study are given in Appendix Part I. It

will be useful for the reader to review these before studying the results of the measurements.

From Table 7, averages and the range in values for the various physical measurements may be studied. This table is shown here for reference preceding a detailed explanation of the measurements. Figures 2 to 6, inclusive, are also introduced at this time. Because of the nature of reproducing them, it was not possible to introduce them in logical order throughout the text.

Table 7. Average Body Measurements of Girls Included in this Study

Measurement	Average of Measures			Range of Values
	Freshmen	Seniors	All	
Stature	64.80	65.09	64.95	58-72
Eye level	60.03	60.50	60.28	53-67
Shoulder height	53.81	54.15	53.99	47-60
Under forearm height	40.22	40.48	40.36	34-45
Wrist height	34.53	33.09	33.76	28-36
Arm length	21.12	21.04	21.08	17-23
Breadth of shoulders	14.10	14.28	14.20	12-16
Breadth of elbows	28.97	29.38	29.19	24-34
Sitting Height	33.56	33.73	33.60	30-36
Eye level	28.69	29.11	28.91	25-32
Shoulder height	22.46	22.80	22.64	19-25
Under forearm height	8.92	9.15	9.04	6-11
Thigh height	5.38	5.66	5.33	3-8
Hip height	8.56	8.64	8.60	6-10
Breadth Thigh	12.65	13.11	12.89	10-17
Length Thigh	21.71	22.18	21.96	19-25
Under knee height	17.05	17.11	17.08	14-19
Height of chair	16.33	16.38	16.35	14-19
Length from hip to extended foot	34.38	35.49	34.97	29-39
Reaching height	75.71	75.53	75.61	69-82
Age	14.76	17.8	16.38	13-22
Weight	119.16	126.40	123.02	70-180

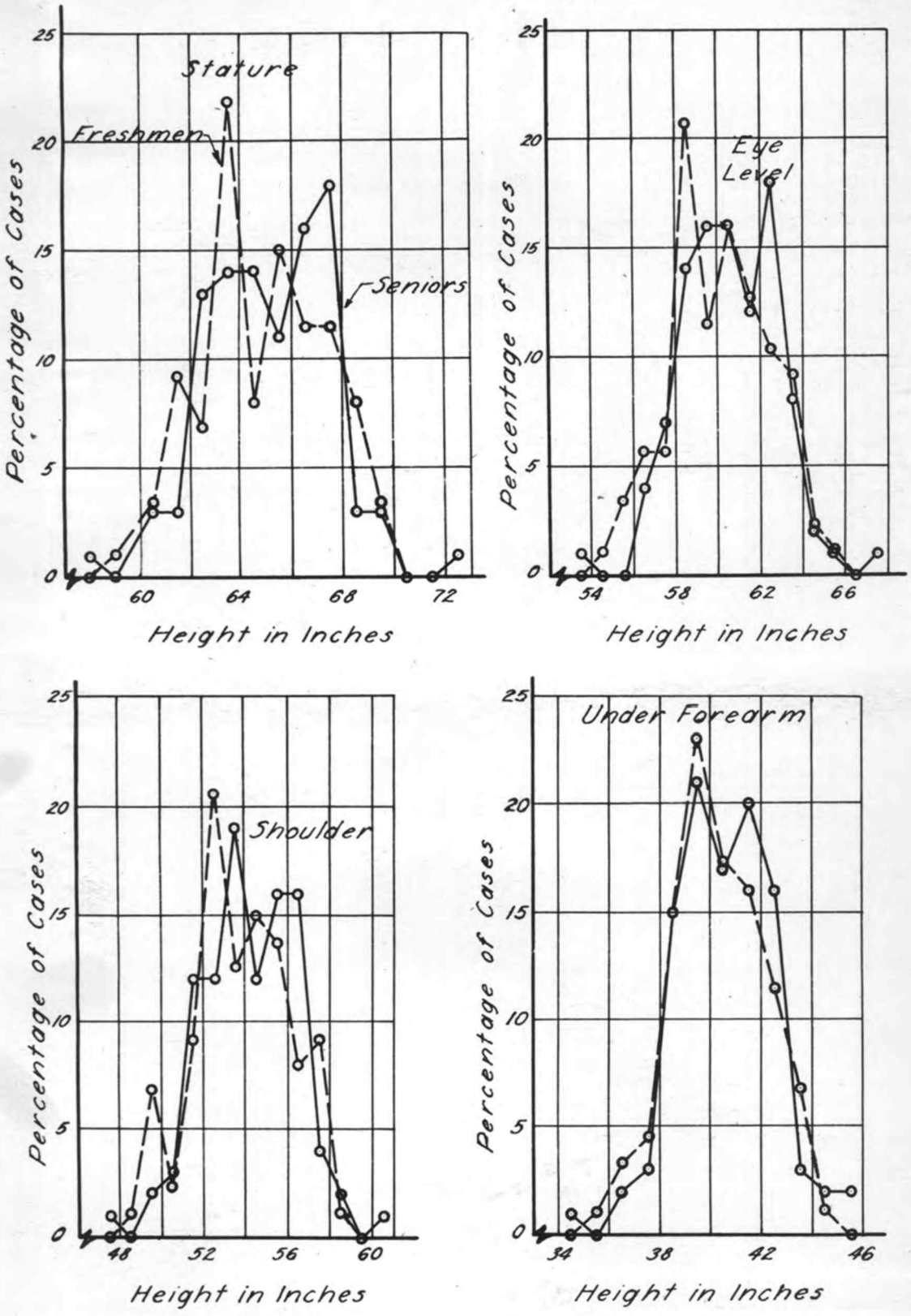

Figure 2. Comparison of Freshmen and Seniors in This Study With Respect to Various Body Measurements Taken With Subject Standing.

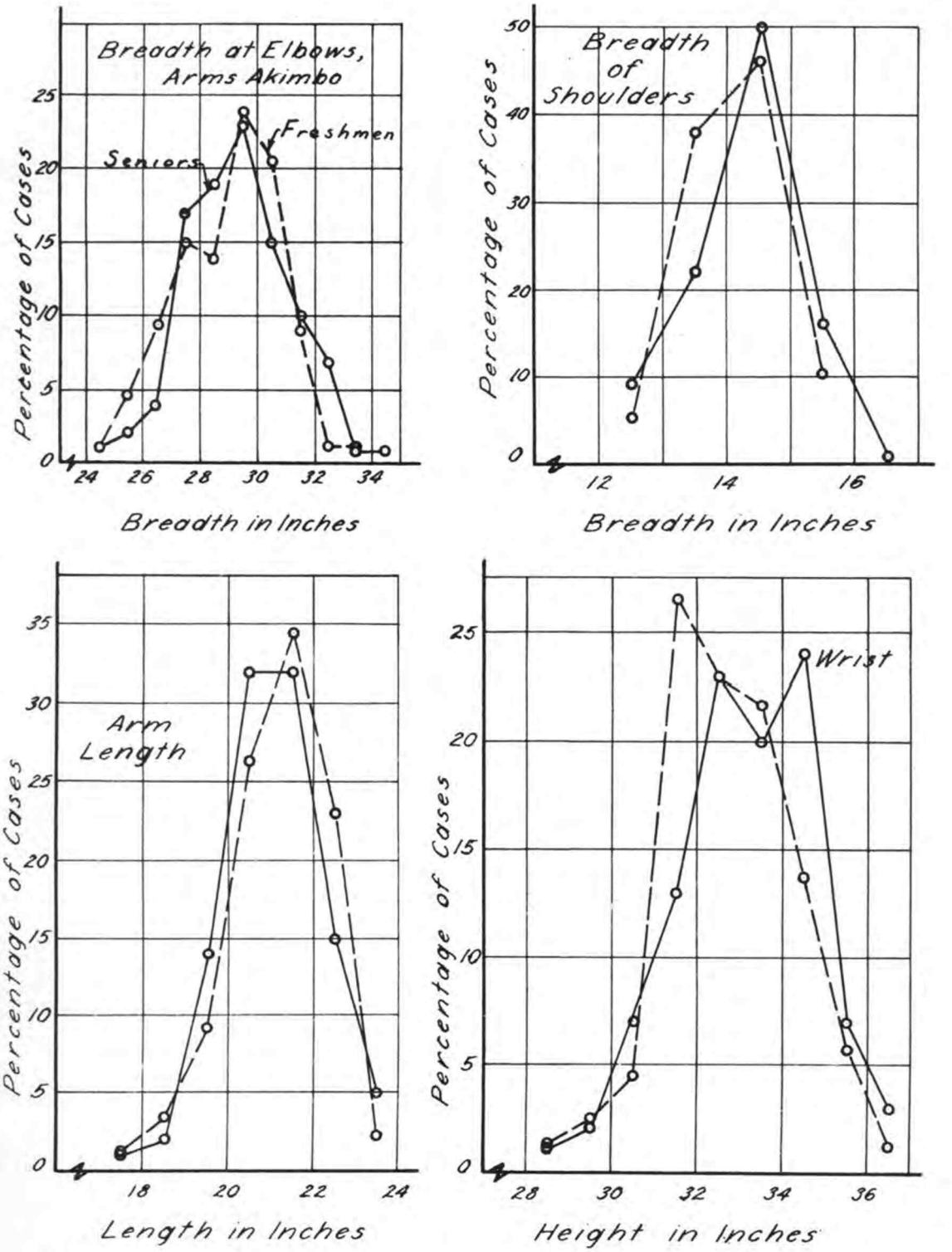

Figure 2 (Continued). Comparison of Freshmen and Seniors in This Study With Respect to Various Body Measurements Taken With Subject Standing.

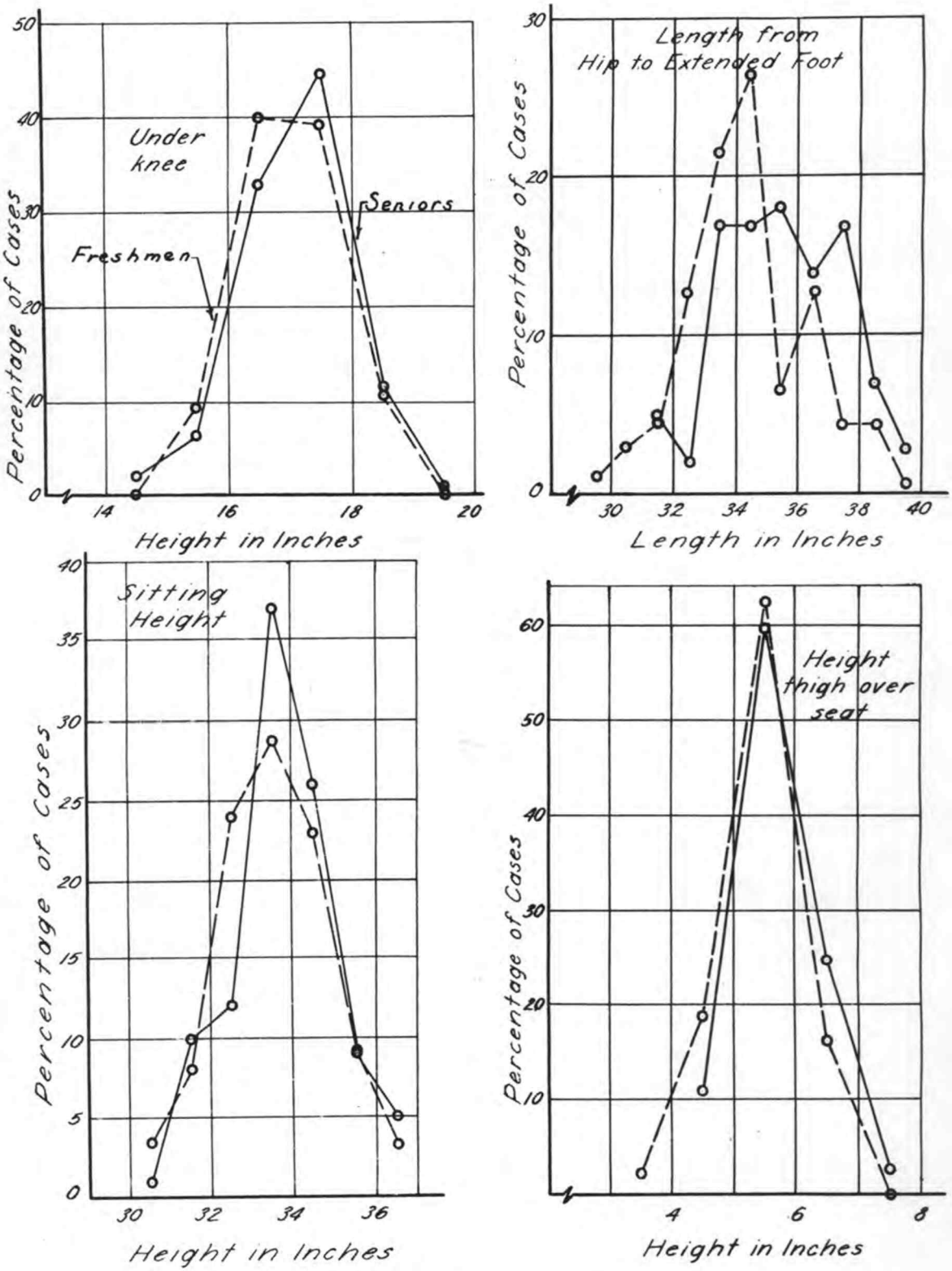

Figure 3. Comparison of Freshmen and Seniors in This Study With Respect to Various Body Measurements Taken With the Subject Sitting.

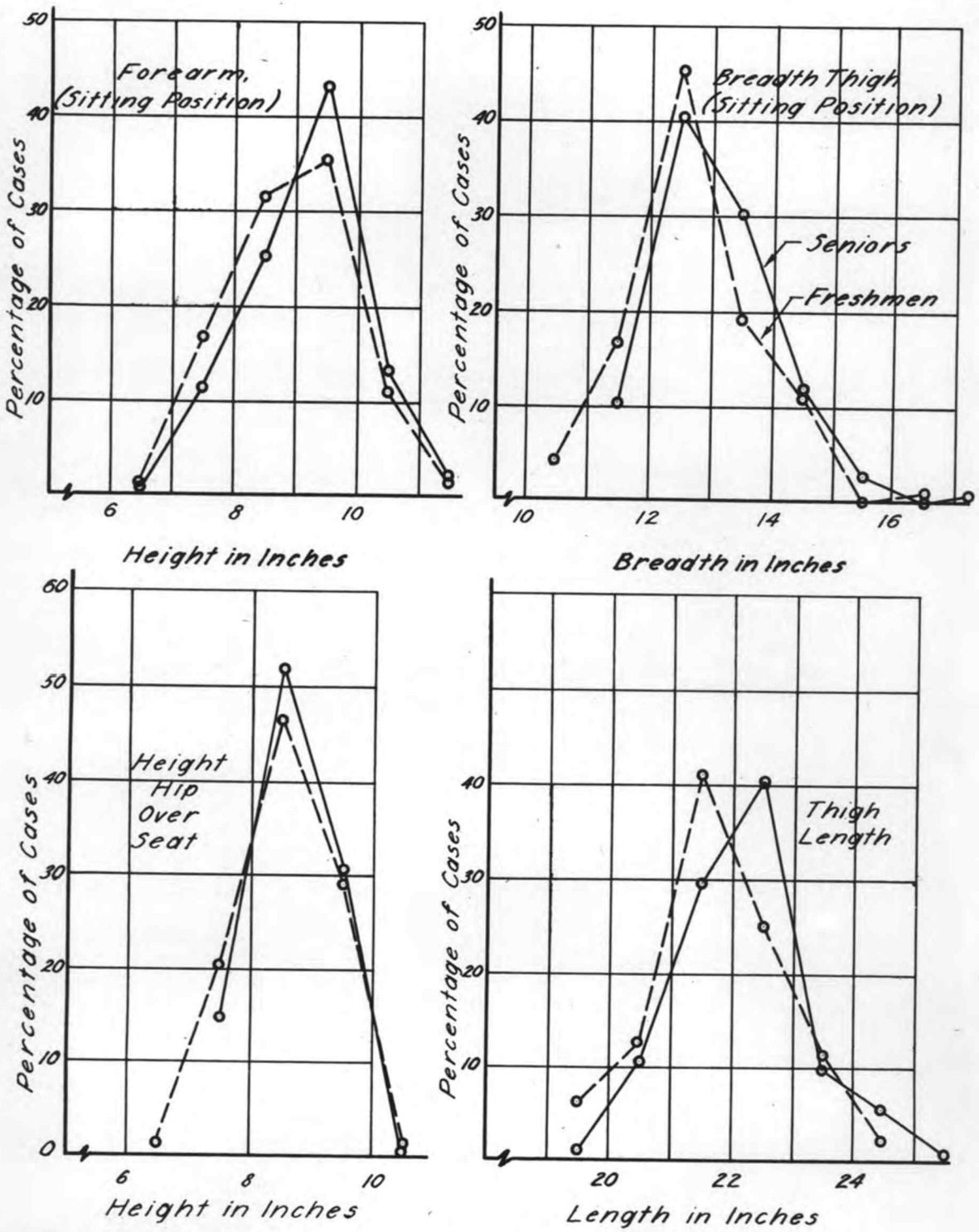

Figure 3 (Continued) Comparison of Freshmen and Seniors in This Study With Respect to Various Body Measurements Taken With the Subject Sitting.

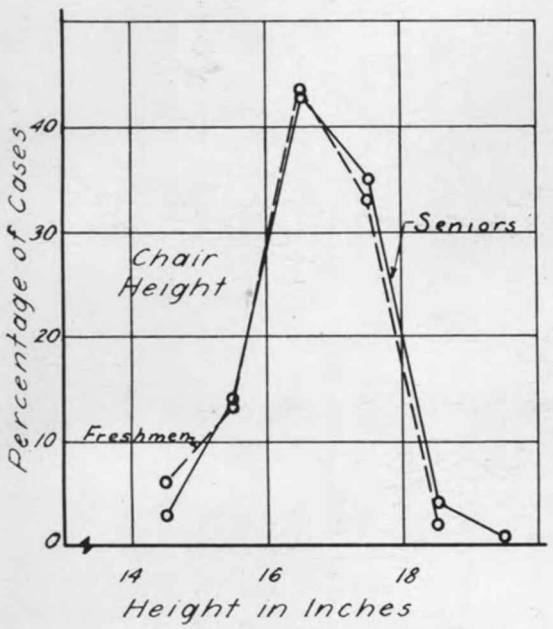

Figure 4. Comparison of Heights of Chairs Selected for Freshmen With Those for Seniors in This Study.

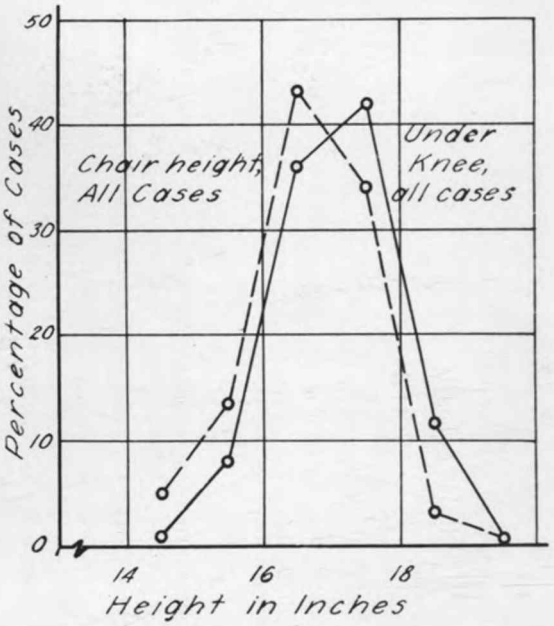

Figure 5. Comparison of Height of Under Knee With Chair Height for all High School Girls in This Study.

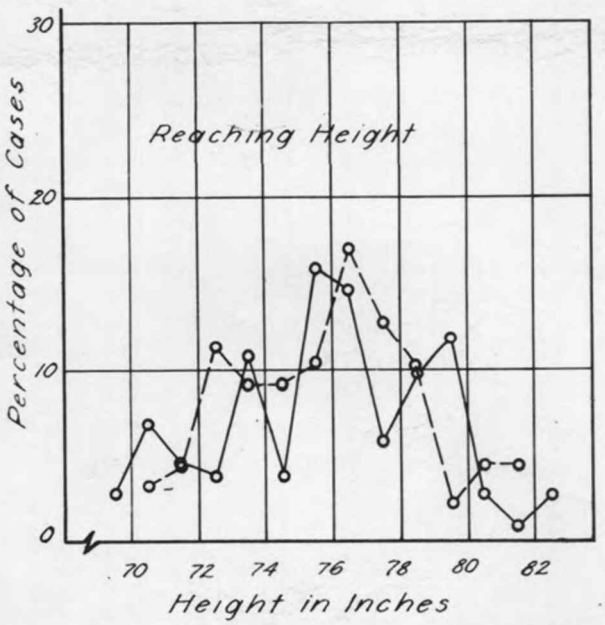

Figure 6. Comparison of Freshmen and Seniors in This Study With Respect to Height of Reaching

HEIGHTS FOR SHELVES AND DRAWERS

Dimensions Included

Since it is necessary in any laboratory set-up to store articles above the working surface, dimensions must be provided for maximum heights for shelves and drawers when no vision is required and when full vision is required. Further, dimensions for maximum height of shelves must include those in which the person may reach up standing in an erect position and those for which an allowance for posture must be made for reaching up over an obstruction.

Measurements on Which Dimensions are Based

The dimensions for heights for shelves and drawers above the working surface are based upon certain physical measurements determined in this study. These include the reaching height where vision of the contents on a high shelf is not required and the eye level (standing position) where full vision is required.

The only measurement taken for determining shelf height in this study was that of reaching up with both hands without obstruction. This assumes that heavy objects such as stacks of plates or objects placed one

behind the other are to be stored on the highest shelf.

For this study, Table 7 indicates that the average height for reaching up with both hands was 75.6 inches. Table 7 also shows that this corresponds rather closely with the height for reaching determined by adding the length of the arm to that of the height of the shoulder; this measurement was 75.07 inches, or a difference of .53 inch less than the actual measurement. Figure 6 shows that the range in reaching heights for the two classes was 69-82 inches.

Table 8 indicates the percentage of cooperators for whom certain shelf heights are adequate.

Table 8. 187 Cooperators Classed with Respect to Height of Reaching with Both Hands

Height in Inches	Number cases	Per cent	Cumulative Per Cent
69*	3	1.6	100.0
70	10	5.4	98.4
71	9	4.8	93.0
72	14	7.5	88.2
73	19	10.2	80.7
74	12	6.4	70.5
75	25	13.4	64.1
76	30	16.0	50.7
77	17	9.1	34.7
78	19	10.2	25.6
79	14	7.5	15.4
80	7	3.7	7.9
81	5	2.6	4.2
82	3	1.6	1.6
	187	100.0	

* 69.0 and less than 70.0. Subsequent groups are similarly defined.

This table indicates that 64.1 per cent of the total group would be able to reach (with both hands) a shelf placed 75 inches or higher above the floor. All of the 187 girls could reach a shelf 69 inches high.

In determining height of reach over an obstruction, it was found that measurements of stature and shoulder height in this study corresponded so closely to those in the Oregon-Washington Purnell study (14, p. 22) that standards set for women in that study might be used for high school girls. Table 7 indicates that the average stature for girls in this study was 64.95 inches while the average for women in the Purnell study was 64.7 inches (14, p. 22). Further, Table 7 indicates the shoulder height for girls to be 53.99 inches while that for women in the Purnell study was 53.7 inches (14, p. 22).

From these figures, we may conclude that shelf heights based on reaching up with one hand over no obstruction and over a 12-inch obstruction in the Oregon-Washington Purnell study would also satisfy the requirements of high school girls. Table 9 indicates the suggested heights set up in the Oregon-Washington Purnell study (13, p. 23).

Table 9. Dimensions Based on Height of Reach

Item	Suggested height* in Inches		
Shelves for light-weight utensils and packaged groceries	Suited to 60 per cent	Suited to 80 per cent	Suited to 90 per cent
No obstruction	79	77	72
12-inch obstruction	76	74	69
Shelves for stacks of plates and glasses			
No obstruction	74	72	67
12-inch obstruction	71	69	64

*Height given is lower limit when cooperators are classed by one-inch differences.

The height of shelf for light-weight objects is based upon the measurement of height of reach to the thumb tip. The height of shelf over a 12-inch obstruction is the measurement of the height of reach to the thumb tip minus three inches. The height of shelf for heavy objects is the height of reach measured to the wrist. The dimension given for this shelf is one inch less than that found in the present study (see Table 8) on the average height of reaching up with both hands. This may be accounted for by the slight difference in height of girls in this study and women in the Oregon-Washington Purnell study.

According to the Oregon-Washington Purnell study (14, p. 24) the difference between reaching over no obstruction and reaching over a 12-inch obstruction was found to be three inches.

Thus Table 9 indicates the height of shelf for reaching up for heavy objects over a 12-inch obstruction is 71 inches or three inches less than that where there was no obstruction.

The maximum height of drawers or shelves requiring full vision is determined by the eye level at standing height. In planning standards based on eye level, it is necessary to consider the posture of the girl. When

she is examining the contents of a shelf in a high cabinet, she may look up to see articles on the front of the shelf without stretching her neck too greatly. When she wants to see the contents on the back of a shelf, she must place her eyes on an even plane with the shelf in order to gain full vision of all the objects. She must necessarily direct her vision downward when examining the contents of a drawer.

Table 7 indicates that the average distance of the eye level from the floor for the 187 cooperators in a standing position was 60.28 inches. As may be seen in Figure 2, the range for the entire group was 53-67.9 inches. Table 10 shows the cooperators in this study classed with respect to the height of the eyes from the floor.

Table 10. 187 Cooperators Classed with Respect to Height of Eye Level from Floor Measured While Standing

Height in Inches	Cooperators: Number	Per cent	Cumulative Per Cent
53	1	.5	100.0
54	1	.5	99.5
55	3	1.6	99.0
56	9	4.8	97.4
57	12	6.4	92.6
58	32	17.1	86.2
59	26	13.9	69.1
60	30	16.0	55.2
61	23	12.4	39.2
62	27	14.4	26.8
63	16	8.6	12.4
64	4	2.2	3.8
65	2	1.1	1.6
66	0	0.0	.5
67	1	.5	.5
	187	100.0	

Table 10 indicates that 55.2 per cent or over half the group had an eye level above 60 inches from the floor. At least 99 per cent had an eye level at and above 55 inches from the floor.

In estimating the maximum height of a shelf visible for the entire width, it was assumed that an inch might be added to the eye level by stretching the neck. In determining heights for high drawers, an inch was deducted to allow for posture (14, p. 26).

Table 11 indicates dimension standards suited to specific percentages of the total group of cooperators.

Table 11. Dimensions Estimated from Measurements for Eye Level from Floor

Item	Dimensions suited to specified percentages of the total group of cooperators		
	At least 65 per cent	At least 80 per cent	At least 99 per cent
Maximum height of shelf visible for entire width	60"	59"	56"
Maximum height of drawer	58"	57"	54"

From Table 11, it may be seen that a shelf allowing full vision might be 60 inches high while a drawer could be only 58 inches high to satisfy the average cooperator for this study.

Application to Design

Dimensions included in this study for heights of shelves and drawers were based on physical measurements taken in this study and on those for average adult women included in the Oregon-Washington Purnell study.

From Tables 9 and 11, Table 12 was devised to show in summary form the dimension standards for shelves and drawers suited to certain percentages of cooperators in this study.

Table 12. Dimensions for Shelves and Drawers

Item	Suggested Heights		
	Suited to 60 per cent	Suited to 80 per cent	Suited to 99 per cent
Shelves for light-weight utensils and groceries			
No obstruction	79	77	72
12 inch obstruction	76	74	69
Shelves for stacks of plates			
No obstruction	74	72	67
12 inch obstruction	71	69	64
Maximum height of shelf visible for entire width	60	59	56
Maximum height for drawer	58	57	54

Table 12 indicates the heights for shelves and drawers suited to 60 per cent, 80 per cent and 99 per cent of the girls included in this study.

DIMENSIONS FOR CHAIRS

It has been the observation of the author in visiting several high schools that seating facilities to be used by girls in home economics laboratories are very uncomfortable. The greatest fault is that chairs are too high for the girls. In one school visited the dimensions of the height for a sewing table were correct, but the chairs were so high it was impossible for the girls to get their legs under the table. In the ninth grade classroom of another school, the investigator found chairs with seats which were 18 inches high.

In some schools, stools are the only provision for seating in the foods laboratories. Either the stool is too high or its seat is too small; in any case, it promotes poor posture on the part of the person who tries to sit on it for any length of time. In one school, stools used in the foods laboratories varied from 18 to 20 inches in height. Thus, the importance of correcting this situation may be seen in the planning of a foods laboratory for high school use. Also, since

it is the aim of home economics to provide practical home situations in its classes, it was felt necessary to plan a chair for use in connection with an eating table for meal service.

Dimensions Included

The dimensions which were included in the scope of this study were height of chair, width of chair seat and height of lower back support. Other dimensions such as length of chair seat from front to back and height of upper back support were taken from the Washington Purnell study II.

Measurements on which Dimensions are Based

Measurements which were found necessary in determining chair dimensions were the underknee height to determine the height for the front of the chair seat, the breadth across the thighs to determine the width of the chair and the height of the hip to determine a place for a back support which would aid in promoting good posture.

In order to determine chair height for each girl, the investigator adjusted the chair by placing boards under the feet of the girl and by determining if there

were pressure under her thighs over the edge of the seat. The measurements for the underknee and the height of the chair seat were recorded for this study.

According to Bennett, (3, p. 124) the chair seat must not be high enough to cause any pressure under the thighs at or near its front edge. Further, he states that "the edge of the seat should not come within an inch of the under angle of the knee joint" (3, p. 158). From Figure 5 it will be observed that there is a slight variation in the present study from the Bennett standard. This may be explained by the fact that in some cases, the girls' thighs were so plump that it was difficult for them to get the measuring stick up under the knee (see Appendix Part I, directions for taking under knee measurement). In other cases, the investigator observed that when girls had long thin thighs, comfortable chair heights were reached before the heights for the under knee were raised one inch above the chair heights from each case.

Tables 13 and 14 show the relationship between the 187 cooperators classed according to heights of chair and under knee, respectively.

Table 13. 187 Cooperators Classed According to Height of Chair

Height in Inches	Number of Cases	Per cent	Cumulative Per cent
*14	9	4.9	100.0
15	26	13.9	95.1
16	81	43.3	81.2
17	64	34.2	37.9
18	6	3.2	3.7
19	1	.5	.5
	187	100.0	

* 14.0 inches and less than 15.0. Subsequent groups are similarly defined.

Table 14 187 Cooperators Classed According to Under Knee Height

Height in Inches	Number of Cases	Per cent	Cumulative Per cent
*14	2	1.0	100.0
15	15	8.0	99.0
16	68	36.3	91.0
17	79	42.2	54.7
18	22	12.0	12.5
19	1	.5	.5
	187	100.0	

* 14.0 inches and less than 15.0 inches. Subsequent groups are similarly defined.

Further, Figure 4 shows the comparison between the chair heights for the juniors and seniors in this study. Figure 5 shows the relationship between chair height and under knee height for the 187 girls.

From these tables and from Figures 4 and 5 it will be observed that the average height of a chair suitable for high school girls is 16 inches. This 16 inch chair would be satisfactory for at least 54 per cent of all cases, though Table 13 indicates that 81 per cent could sit on a 16 inch chair. If two chair heights might be chosen, the other would have a seat height of 15 inches, thereby satisfying the needs of at least 95 per cent of the group. If three chairs might be chosen, the 17 inch chair would also be desirable for the taller girls.

If it were possible to provide more than one height of chair seat in the laboratory, Table 14 indicates that out of every ten chairs, one 14 inch, three 15 inch, five 16 inch and one 17 inch chair should be provided. This assumes that the optimum height for a chair should be one inch less than the under-knee height.

In order to determine the width of a chair seat which would satisfy the needs of the greatest number

of girls in foods classes, the breadth across the thighs was measured with the subject in a sitting position. Table 15 shows the cooperators in this study classed as to the breadth of thighs in the sitting position.

Table 15. 187 Cooperators Classed According to Breadth of Thighs in Sitting Position

Breadth in Inches	Cooperators Number of Cases	Per cent of Cases	Cumulative Per cent
10	4	2.2	100.0
11	26	13.9	97.8
12	81	43.3	83.9
13	48	25.6	40.6
14	23	12.4	15.0
15	3	1.6	2.6
16	1	.5	1.0
17	1	.5	.5
	187	100.0	

Table 15 indicates that the average breadth of thighs measured in the sitting position is 12.89 or 13 inches. Further, Table 15 indicates that a chair seat 13 inches wide would satisfy 59.4 per cent of the cases while a chair seat 14 inches wide would satisfy 85 per cent. For this particular dimension, the wider is to be desired to satisfy the greatest number of cases.

Because no measurement for the length of the chair seat was included in this study and physical measurements of girls correspond rather closely to those for women, the measurement for length of chair seat from the Washington Purnell Study II (15, p. 25) will be used here. The average length of thigh from back of hip to inside bend of the knee for the Washington Purnell Study II was 18.8 inches. The depth of seat recommended in that study was one not greater than 16 inches, or three inches less than the length of thigh.

According to Bennett (3, p. 168-9), "a moderate backward slope of the seat tends gently to hold the sitter back in firm contact with the lumbar back support and to prevent the ischials from sliding forward on the seat, both of which go far toward assuring good

posture." He states further that the slope should be very slight and should become level under the back support. This information is included here as a recommendation to be used in connection with the chair planned to suit the measurements of high school girls.

In order to determine where the back support should be placed for the eating chair, the height of hip was measured since it corresponded to the fourth lumbar vertebra the base of the "small" of the back and of the two measurements was the simpler to obtain. Table 7 indicates that the average for this measurement was 8.60 inches. Figure 3 shows that the hip height for this study had a range of from 6-10 inches, inclusive.

The Washington Purnell study II states (15, p. 25) that the lower supporting bar should not be higher than 11 inches for women. Because of the close proximity between the measurements for sitting height in the two studies, (see Appendix Part V) it may be assumed that this figure might be used in determining the upper limits of the back support. Thus the lower edge of the back support might be 8.5 inches from the seat and the upper edge 11 inches from the seat.

Because the chair for which dimensions were obtained was to be used primarily for an eating posture in which

a higher back support is seldom used, no further study was made on back supports. However, the chair would probably be used for other purposes in which an upper back support was necessary. For this reason, the standards set for the upper back support in the Washington Purnell study II (15, p. 24) are presented here.

The Washington study placed the lower level of this support at 13 inches and the upper at 16 to enable the upper back support to fit just above the lower edge of the shoulder blade. (15, p. 24).

Application to Design

From the measurements related to chair dimensions, certain dimensions have been derived which satisfy the average girl. Further, recommendations have been made for variations from the average. Table 16 presents chair dimensions for the average girl with recommended variations for the height of the chair seat.

Table 16. Average Dimension for a Chair With Recommended Variations

Dimensions	Average In Inches	Variations In Inches
Height of chair	16	one 14) three 15) five 16) one 17) out of 10
Width of chair seat	14	
Length of chair seat	16	
Height for lower back support	8.5-11	
Height for upper back support	13-16	

Where it is possible to have only one chair in the laboratory, it is recommended that the chair be designed for the average girl and that special provision such as a foot rest be made available to the shorter girl. Taller girls are not handicapped by a chair designed for the average in this study.

DIMENSIONS RELATED TO TABLE USED FOR EATING

Dimensions Included

Because a detailed study has been made by Bennett (3) on the table used for reading and writing, only the dimensions for a table to be used for eating are included in this study. Certain table dimensions can be based directly upon physical measurements of girls rather than upon their judgments. The dimensions included in this section are the width for the table, the minimum distance from the edge of the table to a knee obstruction, the length of table space necessary for one person and for each additional person and the distance between the legs of the table.

Measurements upon Which Dimensions are Based

The measurement most useful in determining the width of the table is the length from the back of the

hip to the extended foot. The minimum distance at which an obstruction can be placed from the edge of the table is determined from the length of thigh. The measurement used for obtaining the length of table space is the breadth at elbows, arms akimbo. The minimum distance between table legs is determined from the width of the chair seat and from breadth of thighs.

Since the dining table is planned with reference to seating people facing each other, and since the measurement from the back to the extended foot allows for the amount of foot space required for each person, the width for the table may well be determined by doubling this measurement, making allowances for body width from the edge of the table.

Table 7 indicates that, for this study, the average length from the back of the hip to the extended foot was 34.97 or 35 inches. Allowing 12 inches for body thickness plus allowance for comfort, the distance required under the table for one person is 23 inches.

Thus a dining table planned for seating people facing each other would be 48 inches wide in order to seat the average girl for this study.

Figure 3 indicates a great variation in the distance the feet were extended in front of the chair. Through observation, the investigator found that the taller, thinner

girl could extend her feet farther than the tall, large girl. Likewise, the short thin girl can extend her feet farther than the short, large girl.

The distance at which the chair is placed under the table also determines the width of the table. If the edge of the chair were placed at the edge of the table, the table need not be as wide to satisfy the average girl. However, it is the observation of the investigator that most people tend to move the chair under the edge of the table as they sit down to eat. Exceptions to this are girls whose body thickness does not permit their getting close to the table and girls for whom the chairs are so high that they prefer to push the chair away from the edge of the table, thus sitting on the edge of the seat.

For the average girl in this study, the investigator found that allowing 12 inches for body thickness and comfort beyond the edge of the table was sufficient. This figure is based upon observations of 60 girls who participated in the judgment study.

In determining the length of table space the measurement most useful to this study is that of the breadth at elbows, arms akimbo, since that is the maximum width necessary for carrying on activities related to eating. Table 7 indicates that the average breadth at elbows was 29.19

or 30 inches. This measurement represents the average length of table space needed by one person.

When additional people are seated at the table, it is of importance to know if the same amount of space is necessary for them. In her bulletin, "The Willamette Valley Farm Kitchen," (23, p. 41) Maud Wilson assumes that it is not necessary but states that "arm movement requires a seating allowance of 24 inches per person." This measurement is greater than the breadth at shoulders measurement for the present study (see Table 7) and is less than the breadth at elbows measurement by six inches.

In determining the minimum distance between table legs, the minimum width of the chair seat for this study (see Table 16) can be used. In addition to the width of chair seat, the maximum breadth of the thighs must also be considered (see Table 15). The minimum width for the chair seat for this study is 14 inches according to Table 16. Table 15 indicates that the maximum breadth of thighs is 17 inches. Thus, in allowing 18 inches between table legs or two inches on both sides of the 14 inch chair for comfort, provision has been made for the breadth of thighs of all girls included in this study.

The minimum distance from the edge of the table to a knee obstruction may be based upon the length of

thigh for this study. Table 7 indicates that the average length of thigh was 22 inches. Allowing 12 inches for body thickness, the minimum distance at which an obstruction can be placed from the edge of the table is 12 inches when allowance is made for the comfort of the individual.

From a study of the measurement from the back of hip to the extended foot, it may be assumed that the desirable width for an eating table is 48 inches. The basis for this measurement was further confirmed during the judgment study on table heights since each girl was asked at this time to place the table as close as she liked it. In all cases, girls pulled the edge of the table over their knees and past the front edge of the chair seat.

The length of table space required for one person is 30 inches. This allows for unused space at the ends of the table. For each additional person, the recommended length of space is 24 inches. This measurement assumes that at no one time are all the people seated at the table using the maximum space necessary for the average girl whose arms are akimbo.

The minimum distance between table legs was set at 18 inches to allow for maximum comfort for the average person and to satisfy the greatest breadth at thighs for any girl included in this study.

The minimum distance from the edge of the table to a knee obstruction is influenced by body thickness and practice of the girl in seating herself at the table. For this study, the minimum distance was placed at 12 inches.

SPACE FOR PASSAGES

Dimensions Included

Provision for adequate passages is one of the most important points to consider in the planning of a laboratory because of the amount of activity necessary in food preparation. Dimensions included in this study are concerned with the amount of space required by one person in the standing and in the crouching positions as well as the widths of passages necessary for carrying on various activities.

Measurements on Which Dimensions are Based

The measurements upon which dimensions for passages are based in this present study include breadth at shoulders and breadth at elbows for the side to side measurements and the length of the thigh for the front to back measurement when the subject is in the crouching position.

The measurement for the breadth of shoulders is useful in determining the side to side space required when the

person is moving from one part of the room to another in an erect position.

Table 7 indicates that the average breadth of shoulder measurement for this study was 14.20 inches. Figure 2 shows that the range for the entire group was from 12-16.9 inches. Table 17 was devised to show the classification of cooperators in this study with respect to the measurement for breadth of shoulders.

Table 17. Cooperators Classed with Respect to Breadth at Shoulders

Breadth in Inches	No. of Cases	Per cent of Cases	Cumulative Per cent
12	14	7.5	7.5
13	55	29.4	36.9
14	92	49.2	86.1
15	25	13.4	99.5
16	1	.5	100.0
	187	100.0	

From Table 17 it will be observed that only one case was not included in the range 12-15.9 inches, so it may be assumed that a 16-inch passageway plus an allowance for comfort would be maximum for one girl moving about in an erect position. At the time the breadth at shoulders measurement was taken, the investigator observed that, in all cases, it was larger than that for the breadth of hips in the standing position. From this, it may be assumed that 16 inches would serve as a minimum passage between cabinets less than elbow or hip height.

Through observation the investigator found a need for dimensions where for efficiency in laboratory procedure the crouching position was required for looking into low shelves, drawers and ovens.

In an analysis of the crouching position (see Appendix Part I), it was found that the measurement which most nearly satisfied the requirement for space from front to back was that for the length of thigh.

Table 7 indicates that the average length of thigh for this study was 21.96 inches. Further, Figure 2 shows that the range for the entire group was from 19 to 25.9 inches. Table 18 was devised to show the cooperators in this study classed with respect to the length of thigh.

Table 18. Cooperators in this Study Classed With Respect to Length of Thigh

Length in Inches	Cooperators: Number of Cases	Per cent of Cases	Cumulative Per Cent
19	7	3.7	3.7
20	22	11.7	15.4
21	66	35.4	50.8
22	63	33.7	84.5
23	20	10.7	95.2
24	8	4.3	99.5
25	1	.5	100.0
	187	100.0	

Table 18 shows that only one case is not included in a range of 19-24.9 inches.

Since planning for space for the crouching position should include the maximum amount necessary, it appears that a front to back space of 25 inches would be satisfactory for the greatest number of cases in this study.

Application to Design

Dimensions for passages include those measurements in which the girl is either in an erect or a crouching position. Passages in a laboratory situation should provide for more than one person at a time, as a rule. For the purpose of this study, dimensions for spaces required by one person will be discussed and finally applied to spaces required by two or more persons.

Since the measurement of floor space necessary for crouching represents the maximum needed for all positions, it was thought this should be considered in dimensioning space between two work centers. Taking the average, the front to back minimum measurement was found to be 21.96 or 22 inches as based on the length of thigh. This is not the only measurement which must be considered, however. The amount of space required for opening drawers and doors of various sizes must also be taken into account. Dimensions

for these are not obtainable since they are to be included in a later study of the planning of the high school foods laboratory.

Besides space required for the person and for opening the drawers or doors, some allowance between the two is necessary for comfort and for ease in carrying on the activities. At the time of the judgment study, the author also observed the amount of front to back space required for opening a low oven door while the girl was in a crouching position. The subject was directed to crouch and open the door wide to remove a cooking utensil. The amount of space between the opened door and the subject varied from 2-5 inches for 25 cases. In each case, the investigator noted that the length of thigh measure was sufficient for planning front to back space for the individual. This observation was based on the assumption that in order to see into and remove objects from an oven, the subject would crouch in front of the oven.

One subject suggested that if the oven were very hot, she would crouch at the side rather than directly in front of the door. The author based her decision to have the subjects crouch in front of the door partly on observation of girls actually performing the task in the laboratory and partly in order to obtain the maximum front to back measure necessary for the activity.

Because the thigh measurement is more or less constant, it is desirable that a maximum recommendation be made which would be based upon the largest measurement obtained. According to Table 18, all but one case was included in the range 19 - 24.9 inches, so in setting 25 inches as a maximum measurement for one person only, 99.5 per cent of the cases would be served by such a dimension.

In cases such as opening the door of a hot oven, the maximum allowance for comfort would be necessary in order to avoid burns caused by the hot door or the rush of heat.

In opening drawers, the space required would be that of the drawer plus the minimum allowance for comfort plus the thigh length of the person from front to back. In opening doors, the space would at no time exceed that of the width of the door plus a minimum allowance for comfort plus the length of thigh.

Where there is minimum space from front to back such as that between a work cabinet and a wall, it is necessary to provide for the maximum length of thigh plus allowance for comfort rather than for the average. Where a passageway is provided between two work counters, the average space required for two persons crouching at one time plus allowance for comfort is sufficient for the

minimum requirement. Adding space for passage of one person standing erect represents a close approximation to maximum. However, in a foods laboratory where a great deal of activity is being carried on, additional passage for a third person would be a desirable standard.

The minimum width for passage where one person is crouching and another is passing is 40 inches. This dimension was obtained by combining the average length of thigh with the minimum space required by one person for passing objects below elbow height.

A space forty-two inches wide would be adequate where two people were crouching back to back. A passage five feet wide is advisable where it is necessary for one person to pass between the two in a crouching position. This passage five feet wide would allow for various activities and provide minimum passage for four people at once with no allowance for comfort. It would be adequate for two people to pass each other while two others worked at opposite cabinets providing the body thickness was not great.

OTHER SPACE UNITS

Space for Working Side by Side

In analyzing the amount of space necessary for two people working side by side, it may be assumed that the minimum space required would be that equal to the measurement for breadth of shoulders. Since this measurement does not allow for any great activity, this study recommends that the minimum amount of space provided for working involving a side to side measure be the average breadth at elbows, arms akimbo. In any case, provision should be made for at least two people to work side by side at a work counter.

Table 7 indicates that the average breadth at the elbows, arms akimbo, for this study was 29.19 inches. Figure 2 shows that the range for the entire group was 24 - 34.9 inches. In order to classify the 187 cooperators with regard to breadth across the elbows, arms akimbo, Table 19 was devised.

Table 19. Cooperators Classed with Respect to Breadth at Elbows, Arms Akimbo

Breadth in Inches	Number of Cases	Per Cent of Cases	Cumulative Per Cent
24	2	1.1	100.0
25	6	3.2	98.9
26	12	6.4	95.7
27	30	16.0	89.3
28	31	16.6	73.3
29	44	23.5	56.7
30	33	17.7	33.2
31	18	9.6	15.5
32	8	4.3	5.9
33	2	1.1	1.6
34	1	.5	.5
	187	100.0	

As is shown in Table 19, only about one-third of the group had a breadth across the elbows exceeding the average measurement.

The breadth at elbows is not a stable measurement nor is there often occasion for interference with the side to side position. Hence the average measurement seems sufficient for recommendation.

Thus, the maximum provision for two people working side by side is 60 inches. In any case, the minimum amount of space for two people working side by side is 34 inches (derived from average measurement of breadth of shoulders plus allowance for comfort).

WIDTH BETWEEN UPPER AND LOWER CABINET

While the depth of cabinets has not been determined for this study, it is assumed that they may approximate the usual depth for stock cabinets. In determining the width between the upper and lower cabinet which will enable the worker to see the entire work surface for the lower cabinet, the eye level of the worker standing directly in front of the cabinet must be considered. According to Table 7, the average eye level for this study was 60.28 inches. Allowing for the posture of the worker, Figure 7 indicates the width between the upper and lower cabinet when the lower cabinet is 32.5 inches from the floor and the upper cabinet has a depth of 12 inches.

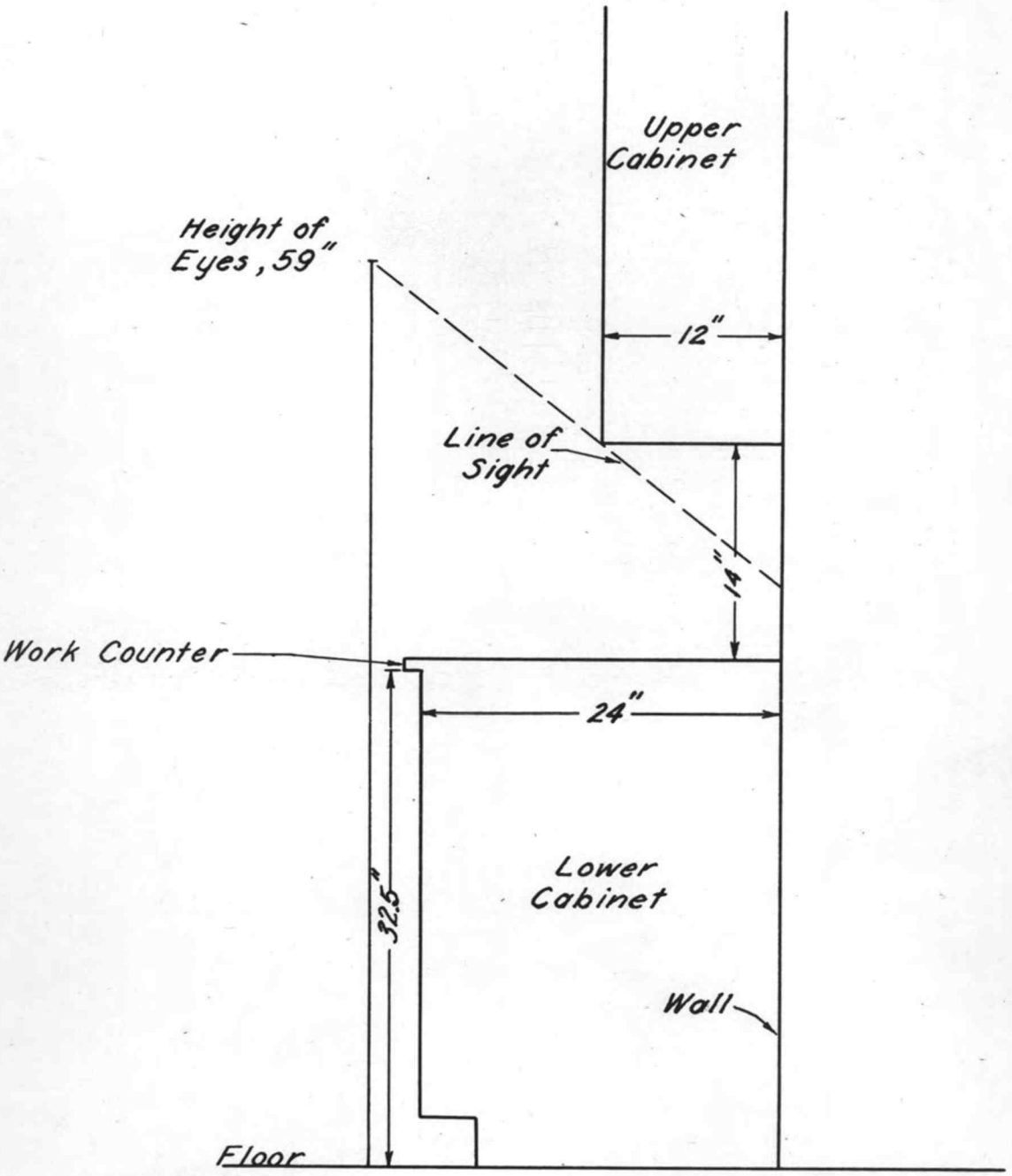

Figure 7. Minimum Distance Between Work Counter and Upper Cabinet When Difference in Widths is 12 Inches.

From Figure 7, it will be seen that the minimum width between upper and lower cabinet when full vision for the objects at the back of the lower cabinet is required is 14 inches. Where the work surface is 37.5 inches high, the width required between the upper and lower cabinets is 11 inches. These standards were calculated by means of a formula found in the Oregon-Washington Purnell study (22, p. 54). (See Appendix Part III).

Included in this chapter are dimensions for chairs, heights for shelves and drawers, dimensions related to eating tables, spaces for passageways, and dimensions for other space units. Since the dimensions set up in this chapter are included in a summary table in Chapter VI, they are not presented in summary form here.

CHAPTER V

DIMENSION STANDARDS BASED ON JUDGMENTS OF GIRLS

Dimension standards described in this chapter are based on the judgments of 60 high school girls who were selected as being most representative of their group in physical measurements (see p. 40). Each girl gave her own preference as to heights of surfaces for beating, washing dishes in a sink, washing dishes in a pan, stirring in a bowl, rolling with a rolling pin, frying on the back burner of the stove, stirring in a double boiler on the front of the stove and eating at a table. (Detailed directions for these will be found in Appendix Part II). The basis for choice and the reason for including several rather than just one or two of these activities is explained on pages 21 to 27.

The first five of these are described under working surface heights, the following two under stove height and the last one under height for a table used for eating. For the purpose of this study, Appendix Figures I to VII were devised from the original data to show the selected heights and heights too high and too low as chosen by each of the 60 girls taking part in the judgment

study.

For purposes of clarity and ease in comparison, Tables 20, 21, and 22 are introduced at this time. Because of the data continued in Figure 8, it is also introduced now.

Table 20. Average Heights Preferred by 60 Cooperators

Activity	Average Preferred Heights in Inches			Measurement in Inches Tolerated by Greatest Number
	Total	Freshmen	Seniors	
Beating	30.6	30.4	30.8	30.5
Washing dishes in sink	28.9	29.1	28.6	29.0
Washing dishes in pan	31.9	32.0	31.8	32.0
Stirring in bowl	32.4	32.8	32.1	32.5
Rolling	33.3	33.6	33.1	33.5
Frying	33.0	33.5	32.6	32.5
Stirring in double boiler	31.9	31.9	31.9	

Table 21. Percentage of Cooperators Choosing Heights for Specified Activities

Height in Inches	Beating		Washing Dishes Sink		Washing Dishes Pan		Rolling		Stirring		Frying		Stirring Double Boiler	
	No Cases	Per Cent	No Cases	Per Cent	No Cases	Per Cent	No Cases	Per Cent	No Cases	Per Cent	No Cases	Per Cent	No Cases	Per Cent
26			4	6.7										
27			6	10.0										
28	8	13.4	22	36.6	1	1.7							1	1.70
29	11	18.3	12	20.0	2	3.4			1	1.7	1	1.7	1	1.70
30	16	26.6	12	20.0	8	13.3	3	5.0	8	13.4	3	5.0	9	15.00
31	14	23.3	3	5.0	16	26.6	5	8.4	12	20.0	7	11.6	21	35.00
32	6	10.0	1	1.7	20	33.3	16	26.6	18	30.0	20	33.3	16	26.60
33	4	6.7			9	15.0	15	25.0	11	18.3	10	16.6	5	8.35
34	1	1.7			3	5.0	11	18.3	3	5.0	11	18.4	5	8.35
35					1	1.7	6	10.0	7	11.6	5	8.4	2	3.30
36							3	5.0			3	5.0		
37							1	1.7						
Totals	60	100.0	60	100.0	60	100.0	60	100.0	60	100.0	60	100.0	60	100.00

Table 22. Comparison of Heights Preferred for Beating, Rolling, and Washing Dishes in This Study with Oregon-Washington Purnell Study (22, p. 25)

Height in Inches	Beating		Dishwashing		Rolling	
	This Study	Purnell	This Study	Purnell	This Study	Purnell
	NUMBER OF CASES					
26		1				
27		5				
28	8	11	1	2		
29	11	18	2	18		1
30	16	86	8	43	3	7
31	14	133	16	102	5	38
32	6	104	20	170	16	80
33	4	70	9	148	15	167
34	1	33	3	59	11	140
35		9	1	13	6	76
36		3		6	3	34
37		1			1	9
38		1		1		7
39						1
40						1
41						1
	60	475	60	562	60	562
	PER CENT OF CASES					
26		0.2				
27		1.1				
28	13.4	2.3	1.7	0.4		
29	18.3	3.8	3.4	3.2		0.2
30	26.6	18.1	13.3	7.6	5.0	1.2
31	23.3	28.0	26.6	18.2	8.4	6.8
32	10.0	21.9	33.3	30.2	26.6	14.2
33	6.7	14.7	15.0	26.3	25.0	29.7
34	1.7	7.0	5.0	10.5	18.3	24.9
35		1.9	1.7	2.3	10.0	13.5
36		0.6		1.1	5.0	6.1
37		0.2			1.7	1.6
38		0.2		0.2		1.2
39						0.2
40						0.2
41						0.2
	100.0	100.0	100.0	100.0	100.0	100.0

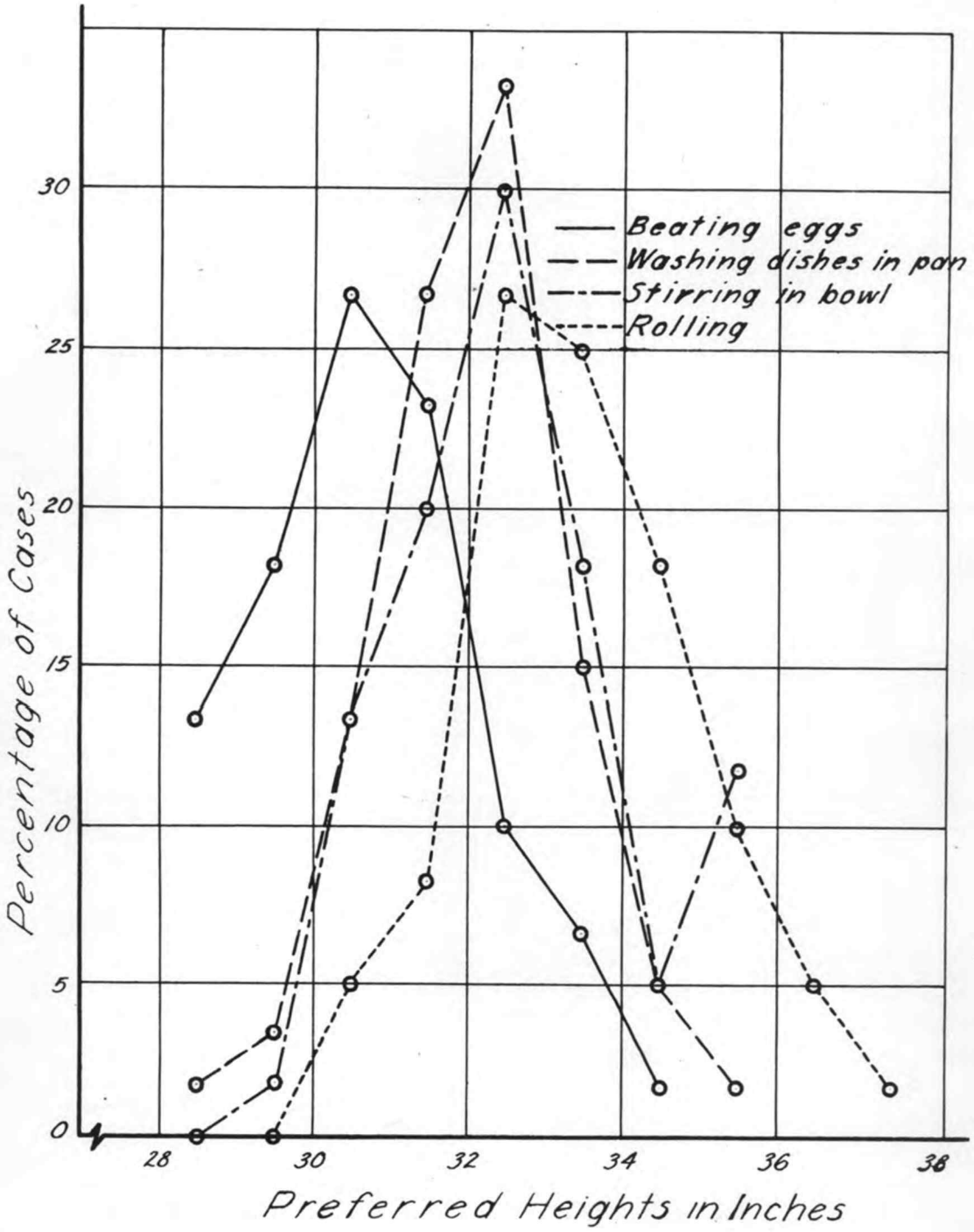

Figure 8. Comparison of Frequency Distributions for Preferred Activity Heights Such as Beating, Washing Dishes, Stirring, and Rolling.

HEIGHTS FOR WORKING SURFACES

Beating Eggs

Preferred heights and variations

According to Table 20, the average preferred height for this activity was 30.6 inches. Figure 8 indicates that the greatest number of preferred heights were contained between 30-30.9 inches. Further, Table 21 indicates that at least two-thirds of the total group chose heights for beating between 29-31.9 inches.

Upper and lower limits for beating eggs

In studying Figure I, (See Appendix) it is found that the point of greatest tolerance* for the 60 cases falls at 30.5 inches. Also, over 20 per cent of all cases chose a beating height at this level. Sixty per cent of all cases chose heights for beating between 29.5 and 31.5 inches. Of the cases which specified 30.5 inches to be too high, four found it too high by one-half inch, two by one inch and the remaining two by one and one-half inches. Of the cases

* Tolerance. This term is used in the present study in connection with working surface heights to indicate a certain range of heights from low to high which a girl could tolerate or use without discomfort. (A point of greatest tolerance indicates that more of the 60 girls are satisfied with that height for a working surface than they are with any other height.)

finding 30.5 inches too low, four found this height too low by one-half an inch, two by only one inch and the other two cases too low by one and one-half and two inches respectively. For the entire group a height of 30.5 inches for beating could be tolerated by 73.3 per cent. This height represents the average for the group. In order to satisfy all cases in this study, working surface heights used for beating eggs must fall between 29.5 and 32.4 inches.

Comparison of preferred heights with those of Oregon-Washington Purnell study

Figure 9 was devised to show the variation in the results of this study on preferred heights of high school girls with those of 562 women in the Oregon-Washington Purnell Study.

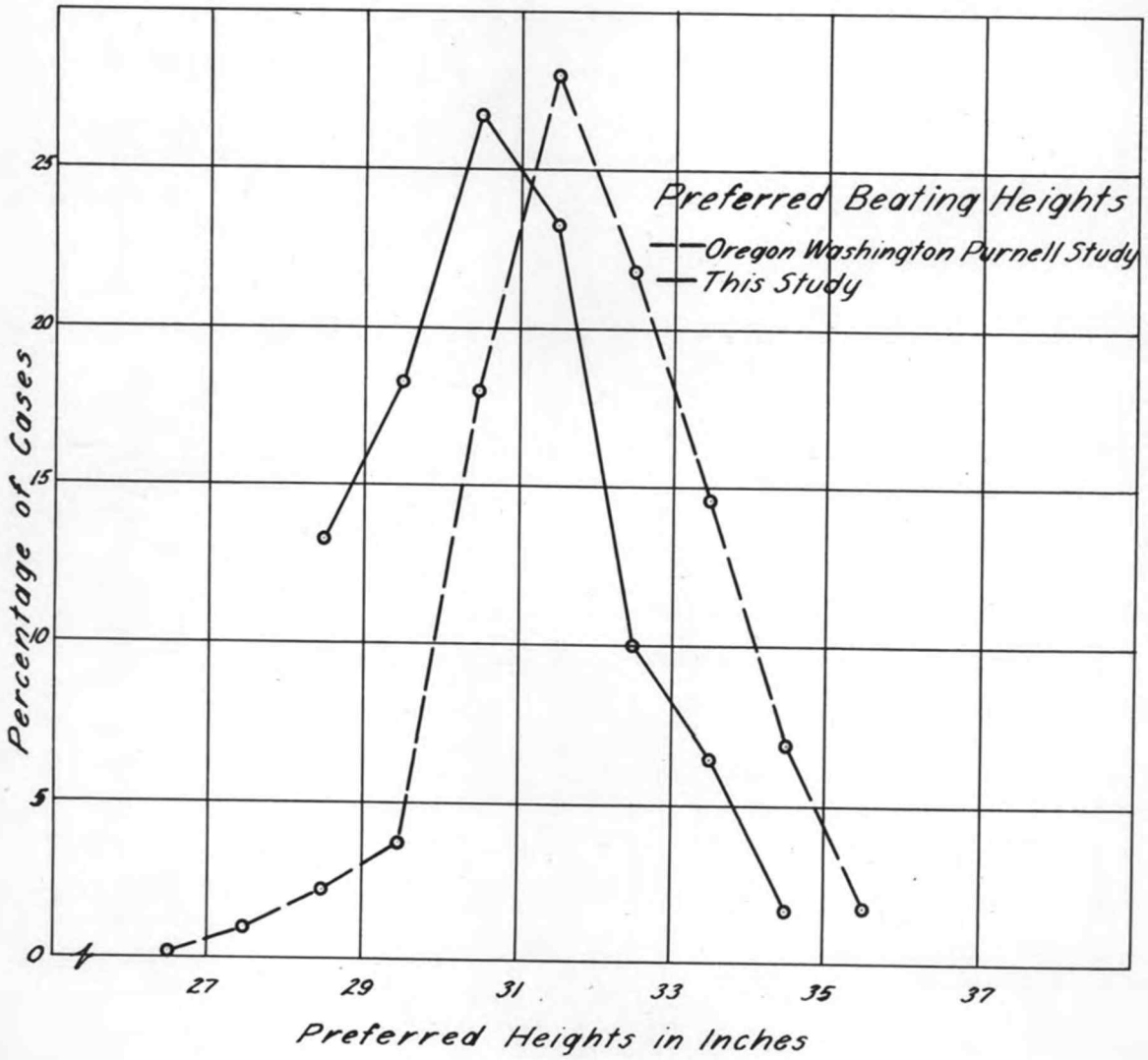

Figure 9: Comparison of Preferred Beating Heights of Adult Women in the Oregon-Washington Purnell Study With Those of High School Girls in This Study.

From Figure 9, it may be seen that there was a consistent variation in the preferred heights for beating in the two studies. Table 22 indicates that the mode for this study was an inch lower than that of the Oregon-Washington Purnell study. In comparing the results for this study with those for the Oregon-Washington Purnell study, it is necessary to bear in mind that this study contains fewer cases than the latter study, that standards for posture were set up in this study and were not in the other study, and that the egg beater (See Appendix Part II) used in this study was an inch higher than that used in the Oregon-Washington Purnell study (22, p. 80).

Application to design

Because the differences between the results of this study and those of the Oregon-Washington Purnell study may be accounted for and because the average preferred height corresponds so closely with the height chosen by the investigator as being most satisfactory for the greatest number of cases following an analysis of the upper and lower limits of tolerance expressed by the subjects in this study, it may be assumed that a height most suitable for the average high school girl who is beating with a dover beater is 30.5 inches.

Washing Dishes in a Sink

Preferred heights and variations

As is indicated in Table 20, the average preferred height for washing dishes in a sink was 28.9 inches. Figure 10 was devised to show the range of choices for the floor of the dishwashing sink.

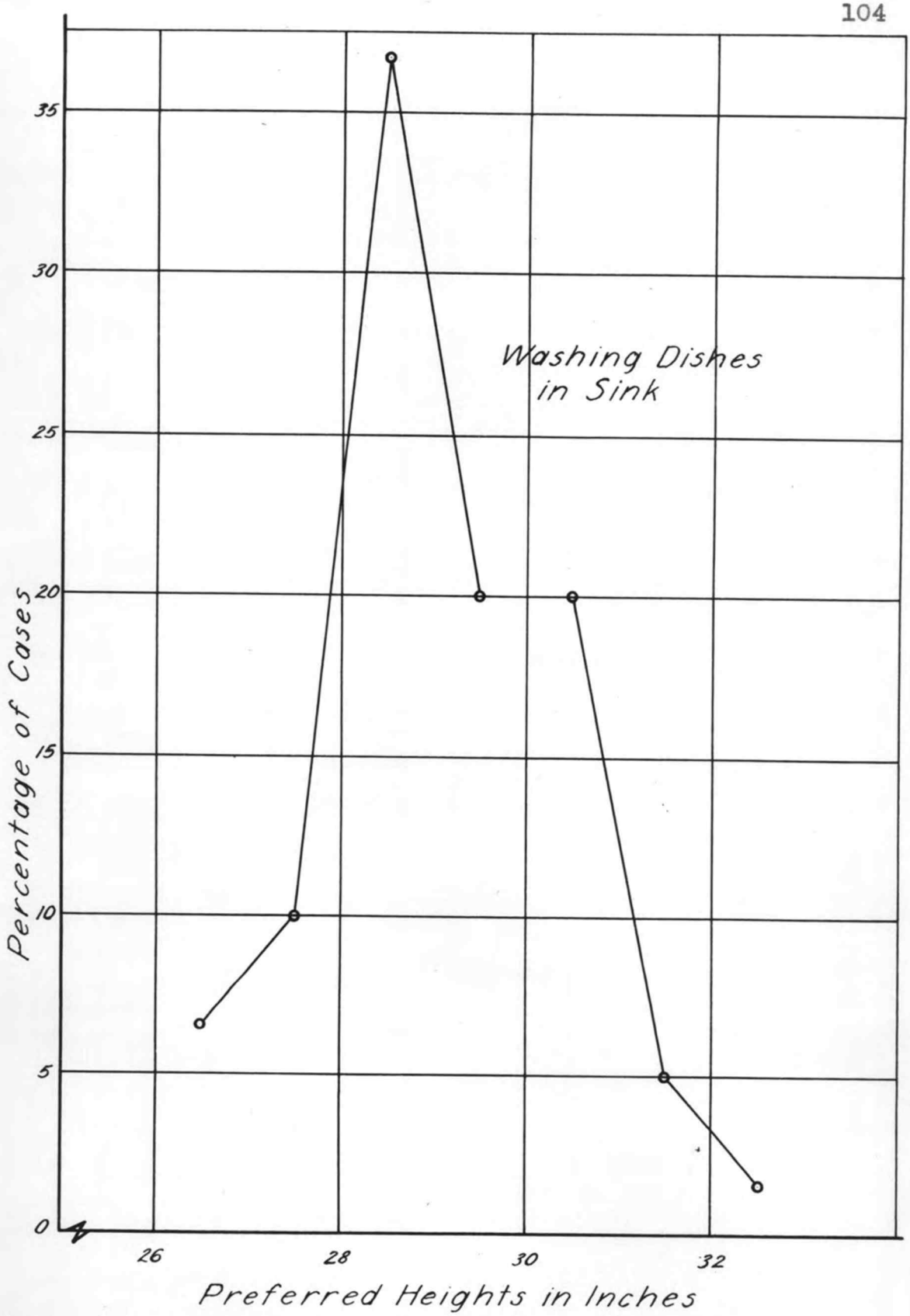

Figure 10. Preferred Heights of Cooperators in This Study For Washing Dishes in a Sink.

From Figure 10, it will be seen that the range of choices for the dishwashing or 8½" sink was from 26-32.9 inches. According to Table 21, 76 per cent of the entire group preferred the floor of the dishwashing sink to be not lower than 28 nor higher than 30 inches.

Upper and lower limits for washing dishes

According to Figure II (See Appendix), sixty-five per cent of the girls chose heights between 28-31 inches for the floor in a deep sink. The greatest balance between tolerance for heights too low and too high lies at 29 inches. Figure II further indicates that this height would satisfy 76.6 per cent of all cases. Of all the cases finding 29 inches too high, three found it too high by only one-half an inch; two of the cases specified 30 inches as the highest they could tolerate and the same number 30.5 inches. Of those finding 29 inches too low for the bottom of the sink, five found it too low by one-half inch while the remainder of the cases found it too low by one to one and one-half inches. Since the average choice for washing dishes in a sink was 28.90, it may be assumed that 29 inches is the height satisfying the greatest number of cases.

Application to design

That the bottom of the dishwashing sink be placed at a height of 29 inches from the floor is indicated by the results of a study of preferred heights and of tolerance ranges. Since the average choice of the sixty girls was 28.9 inches and the height tolerated by the greatest number of cases was 29 inches, the latter height appears to be the better choice for a height for the bottom of the sink. Since the sink used in this study was 8½" deep, and since the height tolerated by the greatest number of girls for the floor of the sink was 29 inches, the rim of the sink must be placed at 37½" to meet the requirements for optimum height for dishwashing.

Washing Dishes in a Pan

Preferred heights and variations

As is indicated by Figure 8, the range of choices for washing dishes in a pan on the work surface is from 28-35.9 inches. Table 20 shows that the average preferred height for this activity was 31.9 or close to 32 inches. Further, Table 21 indicates that at least 87 per cent of all the cases chose heights between 30-33.9 inches.

Upper and lower limits for washing dishes in a pan

There was some variation in the choices of heights for washing dishes in a pan. Figure III (See Appendix) indicates that 80 per cent of the group preferred heights between 30.5 - 33.4 inches. The greatest tolerance level appeared to be a height 32 inches from the floor; 83.3 per cent found this height satisfactory. Of the group finding this height too high, seven found it only one-half inch too high. Of the two cases finding 32 inches too low, both show it to be only one half inch too low. Thus it appears that a range of 31.5 - 32.5 would include the tolerance level for all cases in this study.

Comparison of preferred heights for this study with those of the Oregon-Washington Purnell study

Figure 11 indicates the variation in the preferred heights for girls in this study with those of women in the Oregon-Washington Purnell study.

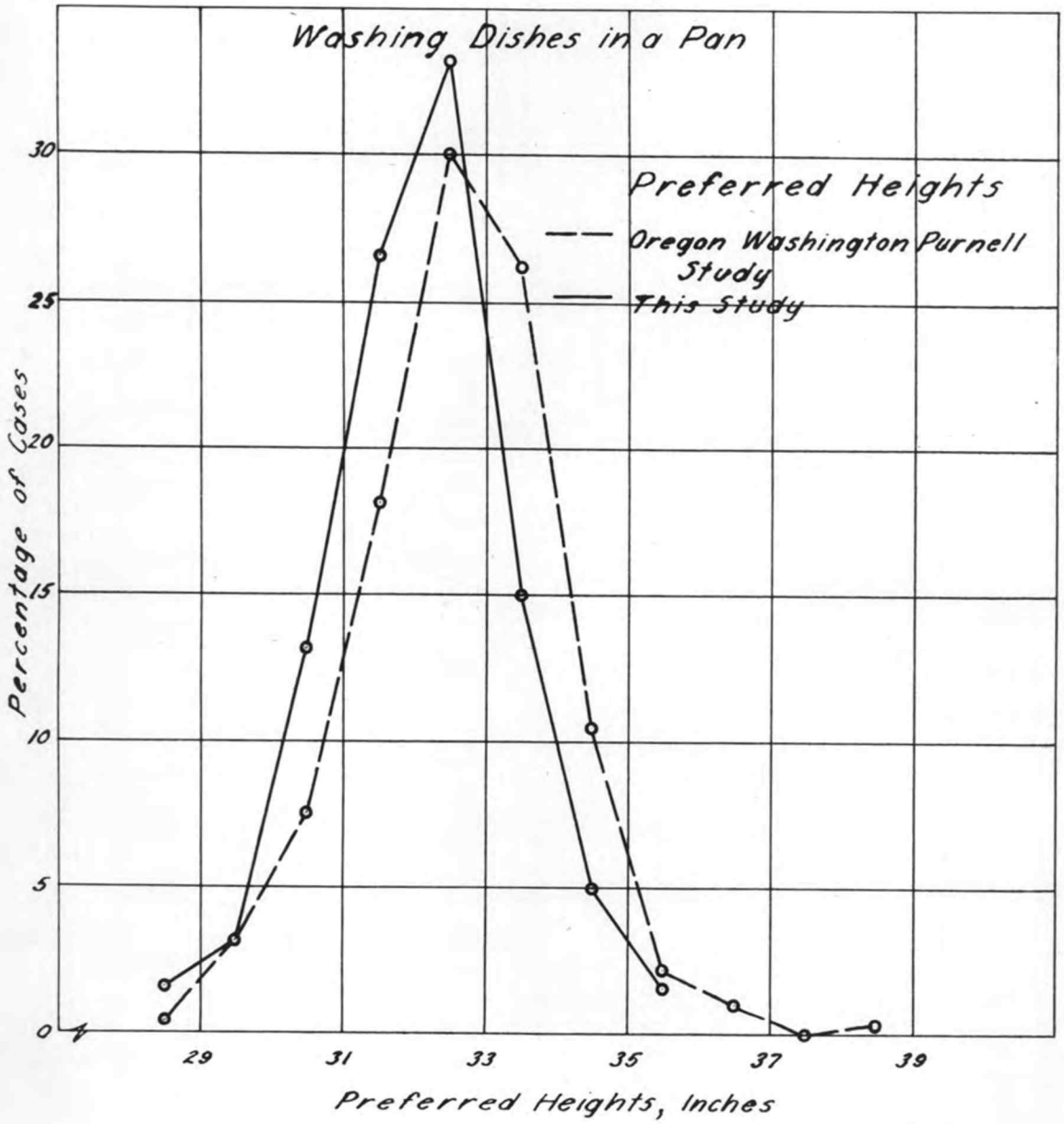

Figure 11. Comparison of Preferred Dishwashing Heights of Adult Women in the Oregon-Washington Purnell Study With Those of High School Girls in This Study.

From Figure 11, it will be seen that the preferred heights from the two studies were similar. Referring to Table 22, it may be seen that the tendency was for girls to select lower heights than those preferred by adult women. Whether this would be true if more cases had been included in this study is not known. In comparing the results of the two studies, the reader must bear in mind that girls who chose heights for the various activities in this study composed a selected group while women performing these activities in the Oregon-Washington Purnell study included the entire group for that study.

Application to design

From this study, it may be seen that the average preferred height corresponds rather closely with the height tolerated by the greatest number of girls. Because of this, it may be assumed that the height of a working surface for washing dishes in a pan which will satisfy the greatest number of cases in this study is 32 inches from the floor.

Stirring in a Bowl

Preferred heights and variations

Table 20 indicates that the average working surface

height for stirring in a bowl preferred by the 60 girls was 32.4 inches. Referring to Figure 8, it may be seen that there is a decided relationship between preferred heights for stirring and for washing dishes in a pan. Figure 8 further indicates that there is a slight variation from the normal curve at its upper extreme. This variation may be accounted for by a study of individual cases made by the investigator which revealed that girls choosing this height were above average in stature and that in all cases, the choice was consistent with the results of choices for heights for other activities. Table 21 shows that two-thirds of all girls preferred heights between 31-33.9 inches.

Upper and lower limits for stirring in a bowl

According to Figure IV (See Appendix) a range of from 32 - 33.5 inches will satisfy the tolerance level for all cases and represents the preferred heights of 46.6 per cent of all cases selecting heights for stirring in a bowl. Over half of the cases preferred heights from 31.5 - 33.5 inches. Of the seven cases for whom a working surface of 32.5 inches is too low, four found it too low by one-half an inch while three found it too low by one and one-half inches. For those who found this surface too

high, two cases reported 32.5 inches too high by one-half an inch and five, too high by one inch. Further, 76.6 per cent of all cases could tolerate a working surface height of 32.5 inches for stirring in a bowl.

Application to design

Since the average for heights chosen by girls is similar to the greatest tolerance level, it may be assumed that a working surface height 32.5 inches high would be most satisfactory for the greatest number of cases included in this study.

Rolling

Preferred heights and variations

From Figure 8, it may be seen that preferred heights for rolling were higher than those for any other activity. Further, Table 21 indicates that almost 80 per cent of the entire group preferred rolling heights from 32 - 35.9 inches high. Table 20 shows that the average preferred height chosen by the 60 girls who cooperated in this study was 33.3 inches.

Upper and lower limits for rolling

Figure V (See Appendix) indicates that 58.3 per cent

of all the girls chose heights between 32.5 and 34 inches. Over 80 per cent of the group could tolerate a working height of 33.5 inches. In order to satisfy all cases, working heights from 32 - 35 inches are required. Those cases which could not tolerate a working surface height of 33.5 inches were scattered throughout this range.

Comparison of preferred heights for this study with those of the Oregon-Washington Purnell study

Figure 12 was devised to show the relationship of heights preferred by girls in this study with those preferred by women in the Oregon-Washington Purnell Study.

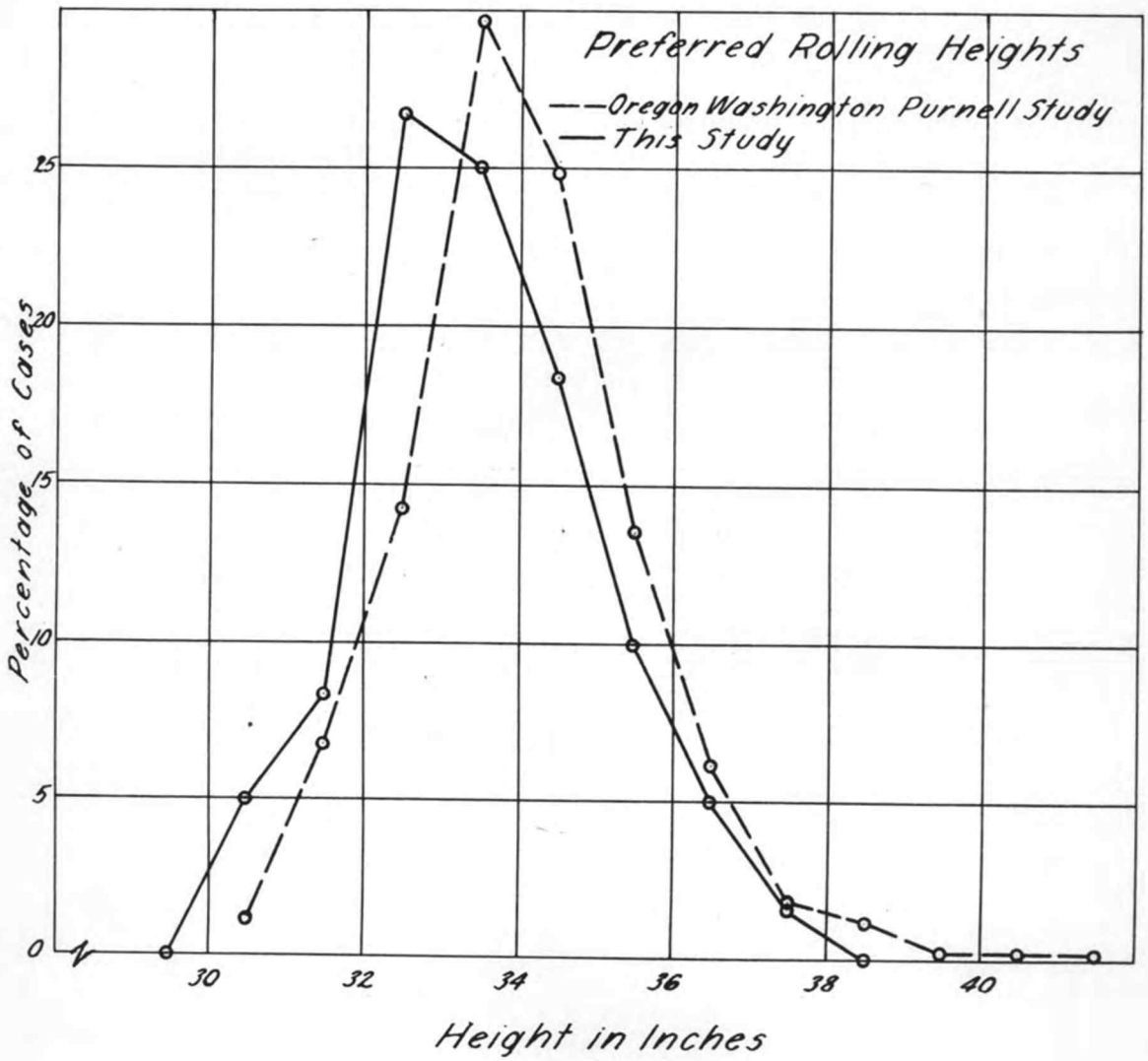

Figure 12. Comparison of Preferred Rolling Heights of Adult Women in the Oregon-Washington Purnell Study With Those of High School Girls in This Study.

From Figure 12, it may be seen that there is a marked similarity between heights chosen by high school girls and those selected by adult women in the Oregon-Washington Purnell study. If anything, heights girls selected are somewhat lower than those chosen by women. Further, Table 22 indicates that about 80 per cent of the girls in this study and 82 per cent of the adult women chose heights for rolling between 32 - 35.9 inches.

Application to design

Because of the marked similarity between chosen heights in this study and the Oregon-Washington Purnell study and because of the similarity between the average preferred height and the height tolerated by the greatest number of cases, it may be assumed that a working height of 33.5 inches would prove most satisfactory for the entire group.

In determining heights for working surfaces, it is well to keep in mind that while in most home situations it is possible to have two heights for working surfaces, the usual school situation provides only one height. From an analysis of the activities which were included in this study for working surface heights, it is desirable to plan for two working surface heights in order to satisfy the

variations in optimum heights which occur among the activities included in this study. From Table 20, it may be seen that the height of 32.5 inches satisfies the requirements for stirring in a bowl. By placing a one-inch board on this surface, the optimum height for rolling may be reached. By using this height for washing dishes in a pan, the average preferred height is raised only one-half inch.

The two activities not satisfied by this height are beating and washing dishes in a sink. Where it is possible, a pull-out board with a height two inches below the work surface is recommended. However, since beating is one of the less frequently used activities, it may be assumed that use of the 32½-inch work surface is possible without producing an excess amount of fatigue on the part of the worker.

The height preferred for the bottom of the dish-washing sink assumes that the upper edge of the sink be 37.5 inches high. If it is possible to provide two heights for working surfaces in the laboratory, this sink may be used. Where there is only one height for working surface, the investigator recommends that provision be made for washing dishes in a pan. In making this recommendation, it is assumed that a sink

of the catch-basin type be provided. Where it is necessary to use a sink, one of the shallower sinks is recommended; if possible, this should be set at the optimum height determined for the rim of the sink.

From this study, it is found that the working height satisfying the greatest number of activities is 32.5 inches. This assumes that a one-inch board be placed on the surface to provide an optimum rolling height. Also, it advises that a pull-out board be provided for beating eggs; and that if the dishwashing sink is to be used, that at least two working surface heights be provided.

HEIGHT FOR STOVES

Preferred heights and variations for frying and stirring in a double boiler

From Table 20, it may be seen that the average of the preferred heights for frying was 33 inches and the average for stirring in the double boiler was 31.9 inches; the difference for the averages of these two activities is a little over one inch. Figure 13 indicates the differences in ranges of the preferred heights for the two activities. From Figure 13, it will be observed that heights preferred by girls for frying are higher than those preferred for stirring in the double boiler.

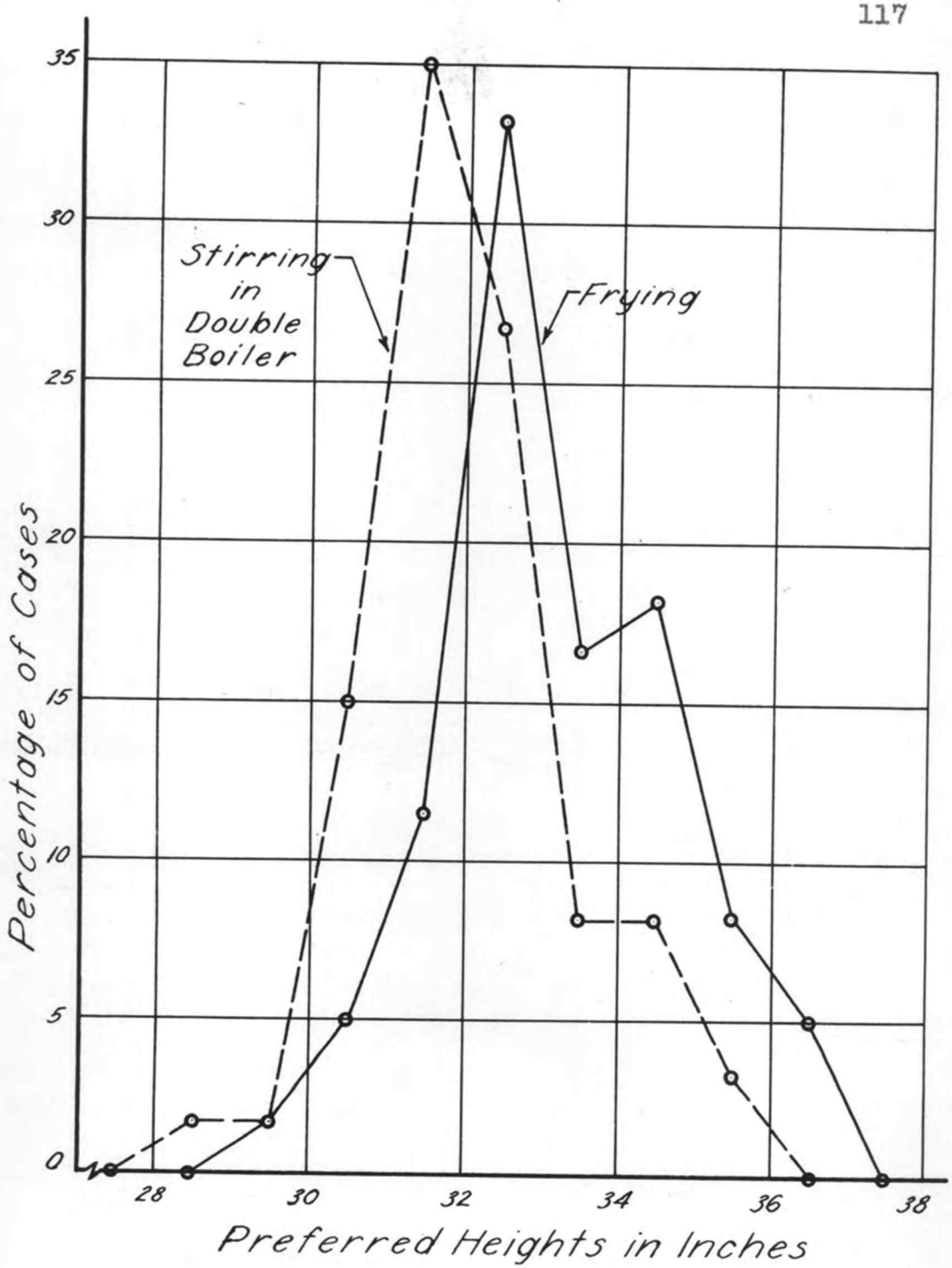

Figure 13. Comparison of Preferred Heights for Frying With Those for Stirring in a Double Boiler.

Table 21 shows that 68.3 per cent of all the girls preferred heights for frying between 32-34.9 inches; further, 76.6 per cent of the group chose heights between 30-32.9 inches for stirring in a double boiler.

Upper and lower limits for stove height

Since it seemed logical that only one surface be planned for a stove, the tolerance ranges for the two activities, frying and stirring in the double boiler, were thrown together as indicated in Figure VI (See Appendix). For the two activities, Figure VI shows that 60.83 per cent of the group chose heights ranging from 31.5 - 33.5. An additional 24 per cent was included when the range was 31.5 - 34 inches. Twenty-five per cent of the group chose 32.5 inches as the preferred height for frying or stirring in the double boiler. The girls not tolerating this height might be satisfied by stove heights from 31.5 - 33.5 inches; of these girls, five out of six could be satisfied with a 32-inch stove, and an additional one could tolerate a stove 31.5 inches high. Of those for whom a 32.5-inch stove was too low, three might tolerate a 33-inch stove and an additional three would desire at least a 33.5-inch stove.

Comparison of preferred stove heights for this study with those of Washington Purnell study II

Since both this study and that described as Washington Purnell study II (15, p. 13) included determining heights for stove based upon the use of low and high utensils, it is interesting to compare the results of the two studies. The studies differ somewhat in method and in utensils used. This study bases its determination of stove height upon working with a low utensil on the back burner of the stove and working with a high utensil on the front part of the stove; no distinction was made as to position of the utensil on the stove in the Washington Purnell study II. Further, the high utensil used in this study was a double boiler while that used in the Washington Purnell study II was a small pressure cooker; both studies used frying pans.

Figure 14 was devised to show the relationship of heights preferred by girls in this study and those preferred by women in the Purnell study II.

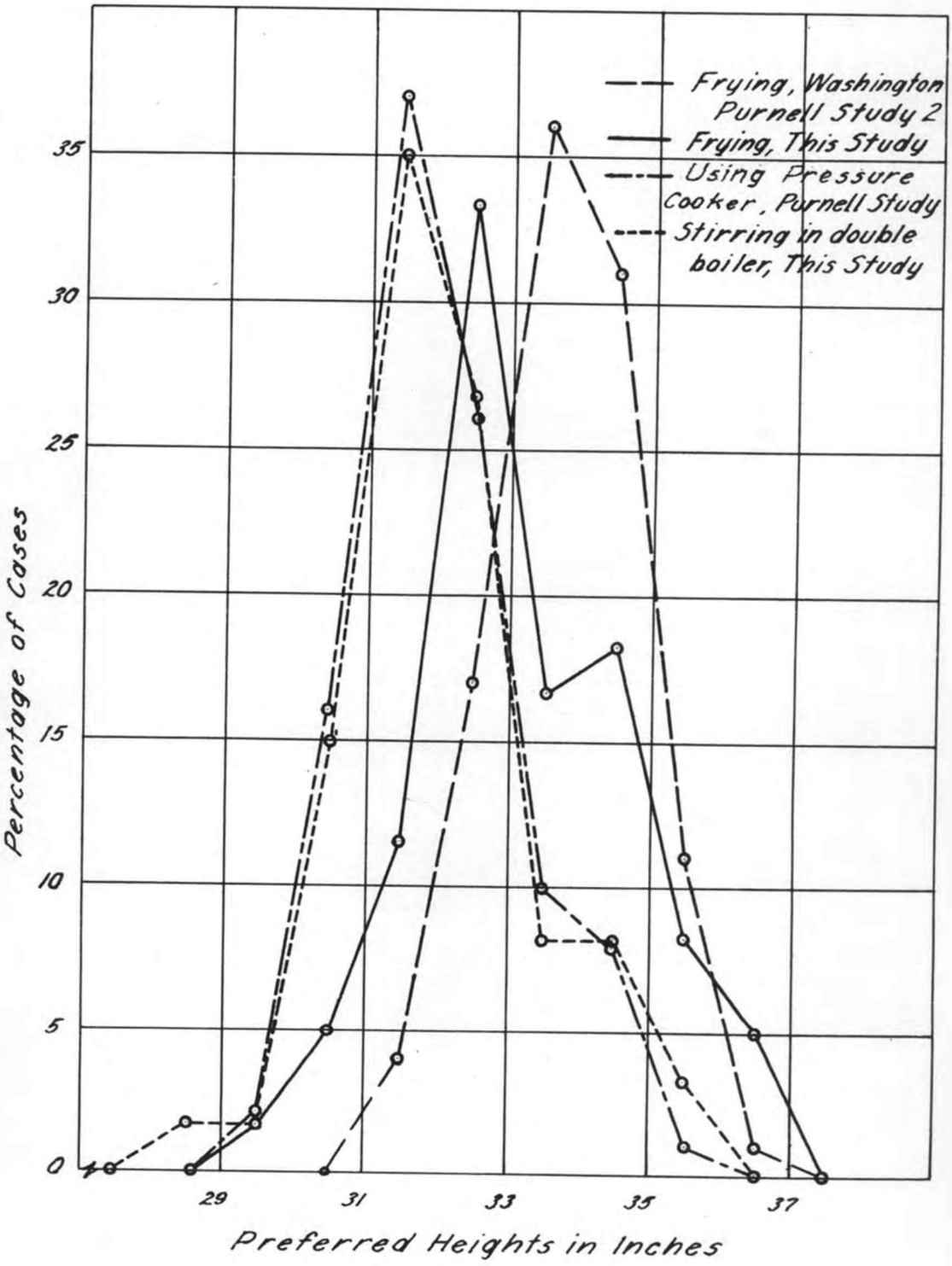

Figure 14. Comparison of Heights for Activities Performed on a Stove Preferred By Adult Women in the Washington Purnell Study II With Those of High School Girls in This Study.

Figure 14 indicates that the results of these two studies are markedly similar in the case of the high utensil. The differences between the results for frying may be ascribed to the fact that in this study a spatula was used to turn a pancake while in the Washington Purnell study II a wooden spoon was used for stirring in the frying pan.

Table 23 further indicates the relationship between the two activities for each study.

Table 23. Comparison of Heights for Activities Performer on the Stove Preferred by Girls in this Study with Those Preferred by Women in the Washington-Purnell Study II

Height in Inches	Frying This Study	Frying Washington Purnell II	Stirring DB This Study	Pressure Cooker Washington-Purnell Study II
28			1.70	
29	1.7		1.70	2
30	5.0		15.00	16
31	11.6	4	35.00	37
32	33.3	17	26.60	26
33	16.6	36	8.35	10
34	18.4	31	8.35	8
35	8.4	11	3.30	1
36	5.0	1		

From Table 23 it may be seen that approximately the same percentage of cooperators in both studies chose a 31-inch surface for working with high utensils, while choices as to heights for using low utensils were higher in the Washington Purnell study II than they were in this study.

Application to design

Since the average preferred heights for the two activities differ by about one inch and since the height at which there is greatest tolerance for the combined activities lies half way between the averages for the two activities, it may be assumed that the optimum stove height for this study is one of 32.5 inches.

HEIGHT OF THE TABLE FOR EATING

Preferred heights and variations

By calculation from Tables XIII and XIV (See Appendix), it was found that the average table height preferred by the 60 girls was 24.93 inches. Figure 15 shows the comparison of preferred heights for the freshmen and seniors with those for the group as a whole.

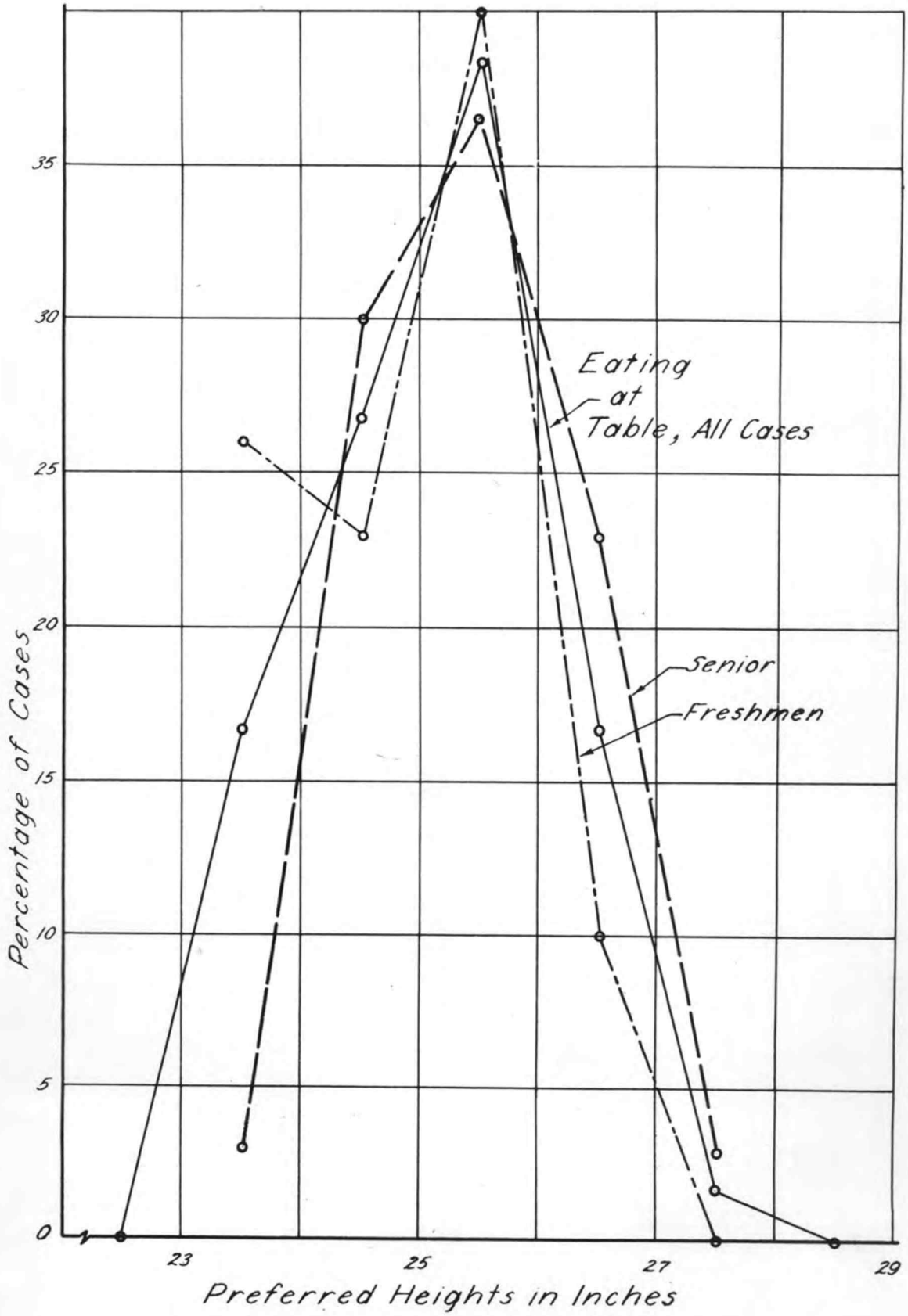

Figure 15. Comparison of Table Heights Preferred by Freshmen and Seniors in This Study With Those Preferred by the Entire Group.

From this figure, it may be seen that the freshmen girls chose slightly lower tables than did the seniors. The range of preferred heights was from 23 - 28.9 inches.

Upper and lower limits for preferred heights

Figure VII (See Appendix), indicates that the girls included in this study had a greater tolerance for a table 25 inches high than they did for any other height table. Figure VII also indicates that because of the fact that the chair was adjusted for each girl, table heights are usually low for some of the shorter, thinner girls; hence in choosing the height for a table, it is necessary to keep in mind the fact that tables must serve many sizes of girls. If any deviation is made above or below the average, the tendency would be to choose the height above in order to include more of the larger girls.

Of the four girls who specified that a 25-inch table was too low, three girls would be satisfied with an additional half-inch added to the table height; only one found it too low by one and one-half inches. This girl was one of the taller girls of those studied; thus it is possible that the difference between her adjusted chair height and the table height chosen was no greater than that for other girls. Of those who specified the

table was too high, nine girls stated that they would like it one-half inch lower, and eight girls would find a 24-inch table more satisfactory.

Further analysis of Table VII revealed that a 25.5-inch table was too low for only one of the 60 girls choosing table heights; however, 25 girls specified that this height was too high. Over 80 per cent of the entire group studied had a tolerance for a 25-inch table while only 73 per cent were satisfied with a table of 25.5 inches. Out of 60 girls, 11 chose heights above 25.5 inches; in a study of cases preferring these heights, the investigator found that most choices occurred among the taller girls.

Comparison of average selected height with related physical measurements

It was the observation of the investigator that, in choosing table heights, most girls preferred those which were approximately level with the under forearm. Since the construction for a table must, of necessity, extend somewhat below the table top, it is of interest to this study to ascertain the difference between the top of the thigh and the height of the underforearm when the girl is sitting on the average chair selected from the results of physical measurements of girls in this study.

From a study made on the comparison of related physical measurements to the height for a table for eating (See Appendix Table XXXI), the differences between the forearm and thigh heights could be studied for the 60 girls participating in the judgment study. From this, Table 24 was devised.

Table 24. 60 Cooperators Classed According to the Distance from the Top of the Thighs to the Underforearm.

Cooperators

Height in Inches	Number of Cases	Per cent	Cumulative Per cent
0.0 - 0.4	1	1.7	100.0
0.5 - 0.9	0	0.0	--
1.0 - 1.4	0	0.0	--
1.5 - 1.9	0	0.0	--
2.0 - 2.4	6	10.0	98.3
2.5 - 2.9	10	16.6	88.3
3.0 - 3.4	16	26.6	71.7
3.5 - 3.9	8	13.4	45.1
4.0 - 4.4	7	11.6	31.7
4.5 - 4.9	5	8.4	20.1
5.0 - 5.4	5	8.4	11.7
5.5 - 5.9	2	3.3	3.3
	60	100.0	

Table 24 indicates that the range of differences between the forearm and thigh heights was 0.0 - 5.9 inches; only one case was included in the interval 0.0-0.4 inches. Of the entire group, 97.3 per cent had a difference between the two measurements of at least two inches. Over 70 per cent had differences above 3 inches. Thus, if tables were made lower to satisfy the height preferred by the average girl in this study, some change in the usual width of the apron or construction under the table must necessarily be made to allow for the height of the thighs above the chair seat.

Application to design

Figure 16 illustrates the chair designed for the average girl in this study and the table height suited to the greatest number of girls whose judgments were included in this study.

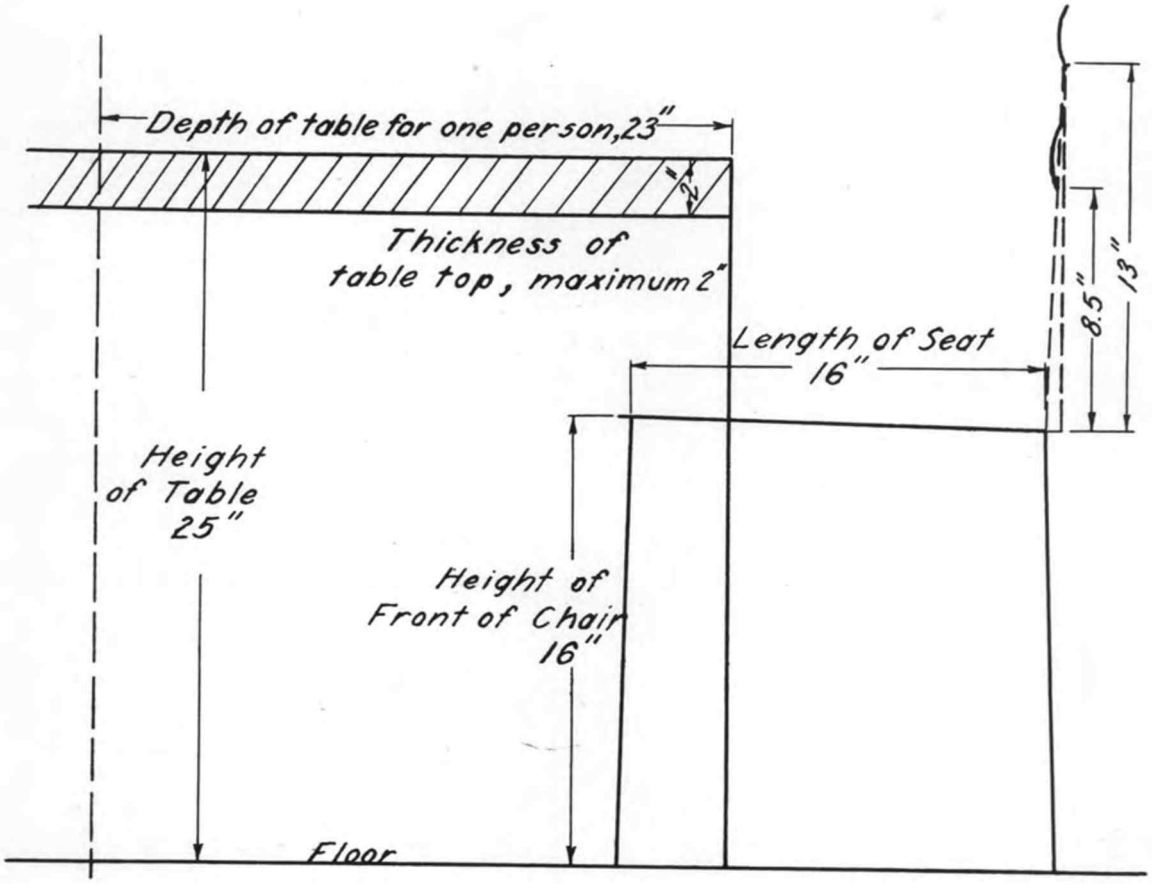

Figure 16. Dimensions of Eating Table and Chair Based on Preferences and Various Body Measurements of High School Girls in This Study.

The average chair height determined in this study was 16 inches at the highest point on the front of the seat. The table height most suitable for the greatest number of cases in this study was 25 inches. From a study of the distance between the thighs and underforearm, it was found that in order to satisfy the greatest number of cases possible, the width of the apron on the table could be not more than two inches.

Dimension standards based on the opinions of girls as to heights of surfaces for such activities as beating, washing dishes in a sink, washing dishes in a pan, stirring in a bowl, rolling, stirring in a double boiler, frying and eating at a table are included in this chapter. A summary of these recommendations will be found in Chapter VI.

CHAPTER VI

PRACTICAL APPLICATION OF DIMENSION STANDARDS

In connection with a major project for planning a high school foods laboratory now being carried on in the department of Home Economics Education at Oregon State College, this study presents dimension standards based upon the physical measurements and judgments of high school girls. That there was a need for such a study is shown by the lack of available data on the subject and the importance of the laboratory as an investment and as a demonstration to the community. Further, the need of the pupil for adequate working conditions is important since optimum working conditions tend to promote a greater carry-over value between school and home because of increased interest in pupil activities carried on in the laboratory.

Before the actual study began, it was necessary to determine what standards were available and what standards were necessary to satisfy the needs of high school girls. The preliminary study evolved into observations of activities and postures used by the girls in food preparation, of conferences with a member of the physical education department to determine criteria for evaluating posture required of activities used in the laboratory,

and a study of available data and selection of the group to be measured. Plans for the investigation included descriptions of the data obtained in this study and of the methods for obtaining these data necessary for determining dimension standards for a high school foods laboratory to be used by adolescent girls.

Cooperators in the measurement study included 187 girls from the ninth and twelfth grades of Corvallis schools. These girls ranged in height from 58-72 inches and represented ages from 13-22 years. All had or were studying at least one term of foods and many had taken more than one term. Physical measurements which were obtained in this study included those in standing and sitting positions. Of these, certain measurements were used as a basis for determining dimension standards. Others were used in calculations and in interpreting results of the judgment study.

Among the girls included in the measurement study, 60 were selected on the basis of age most representative of their classes, breadth of thighs in the sitting position and wrist height. These were to give their judgments as to optimum working surface heights for activities such as beating eggs, washing dishes in a sink, washing dishes in a pan, rolling with a rolling pin, stirring in a bowl, frying and stirring in a double boiler, and as to optimum

height for a table designed for eating purposes. These activities were chosen according to the relationship of the hands to the working surface.

From the results of physical measurements and judgments, certain dimension standards were set up which satisfy the requirements of adolescent girls working in a high school foods laboratory. These standards may be used in planning only insofar as they are applicable to girls. They do not attempt to satisfy all dimension standards necessary in a laboratory; others must necessarily be the result of further study on design factors, necessary storage facilities, and laboratory practices in food preparation.

Dimensions based upon an analysis of opinions and physical measurements of cooperators in this study include the following: heights for working surfaces, stoves, eating tables and chairs, and for shelves and drawers, other dimensions pertaining to chairs and tables, spaces for passageways and other space units.

For the convenience of the reader, the dimensions suited to the requirements of the average high school girl are presented in table form at this time. Recommendations for their use in planning are presented immediately following the set of standards derived from the measurements and judgments of the girls.

Dimensions suited to the requirements of the average girl

Dimensions of tables and cabinets used for laboratory work

Heights:	
Working surface	32½"
Rim of double sink, or single sink 24" or more in length	37½"
Rim of sink less than 24" long (assume the use as catch basin only)	32½"
Pull-out board for beating	30½"
Minimum length of table or counter for girls working side-by-side	60"
Other cabinet dimensions	
Maximum height of shelf for articles in frequent use	
No obstruction	
Shelves for books, light-weight utensils	79"
Shelves for dishes, utensils	74"
12-inch obstruction	
Shelves for books, light weight utensils	76"
Shelves for dishes, utensils	71"
Maximum height of shelf visible throughout entire width	60"
Maximum height of top of drawer	58"
Desirable distance between upper and lower cabinets when work surface of the lower cabinet is visible for the entire width	
When work surface is 32½" high	14"
When work surface is 37½" high	11"
Height of stove	32½"
Width of passages and floor areas	
Minimum body clearance for passages between equipment less than elbow height	16"
Minimum body clearance for passage between cabinets above elbow height	18"

Minimum front-to-back measure, subject in crouching position	22"
Minimum width of passage where one person may be crouching while another is passing	40"
Minimum width for passage where two people may be crouching back-to-back while a third walks between them	60"

Dimensions of table used for eating

Table height	25"
Width of table allowing for seating on both sides	48"
Maximum thickness of table top	2"
Length of table space:	
One person	30"
Additional persons, each	24"
Minimum distance between table legs	18"
Minimum distance from edge of table to knee obstruction	12"

Dimensions of chair

Height of front of chair	16"
Minimum width of chair seat	14"
Length of chair seat	16"
Distance of back supports from chair seat:	
Bottom of lower support	$8\frac{1}{2}$"
Top of lower support	11"
Bottom of upper support	13"
Top of upper support	16"

The dimensions suited to the requirements for the average girl have been presented in summary form in the preceding pages. Before they can be accepted, it is necessary to discuss them in their relationship to the foods laboratory situation.

In considering heights for working surfaces and stoves, the reader must take into account that it is impossible in the usual laboratory to provide working surfaces suitable for each of the activities included in this study. Therefore, it is necessary to make some compromise as to heights for the working surfaces. Since it is the practice in most laboratories to provide only one work surface, the investigator has chosen a height of 32.5 inches as being best suited to the various activities.

A height of 32.5 inches is the one preferred for stirring in a bowl and for the activities performed on the stove.

By placing a one-inch board on the work surface, the optimum height for rolling is obtained.

This height is least suitable for the rim of the sink which requires a height 37.5 inches from the floor and for beating which has an average height two inches lower than the 32.5-inch work surface. The investigator recommends a pull-out board two inches below the 32.5

work surface to provide optimum facilities for beating. Since beating is one of the less frequently used activities of the laboratory, it may be assumed that the work surface 32.5 inches high would not be used often enough to cause any serious fatigue on the part of the high school girl.

In planning for the use of the dishwashing sink 8.5 inches deep, it appears from this study that another working surface higher than the optimum for food preparation should be provided to satisfy the requirements of the average high school girl. The optimum height for the floor of this sink is 29 inches. Thus, the rim of the sink must be on a level with a work surface 37.5 inches from the floor.

In case it is inadvisable to provide two working heights to accommodate the optimum heights for food preparation and for washing dishes in the sink, the investigator recommends that plans be made for washing dishes in a pan on the work surface. If this is done, it is necessary to provide a sink of the catch-basin type (less than 24 inches long) as a convenience to the worker.

Another possibility is the use of a shallow sink placed with the rim at the 32.5 inch working height. Since this would require sacrificing comfort on the part of the worker, it is not recommended by the investigator in this

study.

The height preferred for the stove is 32.5 inches. This height is not in agreement with that of the stove now being purchased generally for laboratory use. However, since the height preferred for the stove in this study is in agreement with that preferred by women in the Washington Purnell study II, it is assumed that the height of the stove preferred by girls is more nearly correct than is the height of the stove on the market. It is recommended that working surface heights in a new laboratory be 32.5 inches high and that, if possible, separate surfaces be provided for optimum sink height. Further, it is recommended that an effort be made to secure a stove of the optimum height rather than one of the higher models.

The investigator recommends that in a remodelled laboratory the optimum heights for working surfaces as set forth in this study be used wherever it is possible to do so. Where two heights may be provided in order to accommodate the optimum sink height and the height for the activities used in food preparation, it is advisable to consider both dimensions. Where this is not possible, it may be assumed that providing the optimum height for other activities and planning for washing dishes in a pan is the best compromise.

In applying these dimensions to cabinets, it is well for the reader to remember that the final study on storage requirements for the foods laboratory has not been made and that without this material, adequate recommendations for dimensions involving storage area can not be made.

In choosing a table and chair suitable for eating purposes in the laboratory, it is important to consider that dimensions presented here are based on actual opinions and measurements of girls. In order for the average girl to be seated comfortably at the table recommended, she must be sitting on a chair not more than 16 inches high.

While it is possible to obtain chairs 15 and 16 inches high, tables designed for eating purposes are usually higher and have a wider apron than that recommended in this study. Thus, the problem is not simply a matter of cutting off the legs of the table to adjust it to the optimum height, but the amount of construction under the table edge must also be considered. For this study, the maximum distance for the width of the apron is two inches. In order to satisfy the greatest number of girls, the investigator recommends that an apron two inches wide be used.

Where two girls are seated facing each other at an eating table, the investigator recommends that the width

of the table be 48 inches in order to allow maximum freedom of movement under the table. From the length of thigh, it was determined that an obstruction under the table could not be placed less than 10 inches from the edge of the table.

The length of table space required for one person is 30 inches. A space of 24 inches should be provided for each additional person. The space between table legs should be at least 18 inches to allow for the maximum breadth of thigh for girls in this study.

Heights for shelves and drawers included in this study are based upon measurements of girls and upon heights determined for women in the Oregon-Washington Purnell study.

Dimensions for spaces for passages were based upon measurements of girls which most nearly satisfied the uses for the passages. The measurements used to determine these spaces were length of thigh in the crouching position, breadth of shoulders and breadth of elbows, arms held akimbo. The combinations in which these measurements were used were based upon observations of the investigator as to space needs in a foods laboratory period.

Space required for two girls working side by side was based on two times the average breadth at elbows, arms akimbo. In the case of a foods laboratory where it is necessary for several people to be working in one center,

this dimension is the minimum for two girls.

In the planning of a new foods laboratory, it is essential that a great deal of attention be given to the matter of space requirements in order to promote optimum working conditions for the girls. The investigator for this study recommends that the planner consider the needs of the students, taking into account the number of students using a particular space at one time and the type of activities being carried on simultaneously. This same recommendation applies to the remodelling of a foods laboratory.

In using the dimension standards set forth in this study, it is necessary for the reader to consider that these recommendations are for the average high school girl according to measurements obtained in this study. Therefore, in any given situation, it is necessary for the user to determine the variations in measurements of girls which may exist in the particular situation and to adapt these standards to the variations.

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APPENDIX

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EXHIBIT I. FORM USED FOR COLLECTING MEASUREMENTS OF GIRLS

Number Name Time Date

Age Date of Birth Weight Heel Height Grade

Type of Build Glasses: Yes No Residence: Rural Urban

Comments:

Measurements	1	2	Average	Measurements	Calculation
Standing height				Length of arm	
Height of eye level				Sitting: eye level	
Height of shoulder				shoulder	
Height of under forearm				forearm	
Height of wrist					
Sitting height					
Breadth shoulders					
Breadth at elbows, arms akimbo					
Breadth thigh, sitting position					
Length of thigh					
Height of under knee					
Height of thigh				Height of thigh from chair seat	
Height of hip				Height of hip from chair seat	
Length from back of hip to extended foot				Height of chair seat	
Reaching up, two hands					

EXHIBIT II. FORM USED FOR COLLECTING JUDGMENTS OF GIRLS

Number Name

Opinion	Height			Height			Average
	Upper	Lower	Selected	Upper	Lower	Selected	
Beating eggs							
Washing dishes in sink							
Washing dishes in pan							
Stirring in bowl							
Rolling							
Frying (back burner)							
Stirring in double boiler (front stove)							
Eating at table							

Observation	1	2	Average	Comments:
Back of person and oven door				

EXHIBIT III

FEDERAL SECURITY AGENCY

U. S. OFFICE OF EDUCATION

WASHINGTON

June 24, 1941

Miss Doris Anderson
Route 2
Monmouth, Oregon

Dear Miss Anderson:

The statement "The basis for the standards contained in this bulletin are the opinions of several instructors in high school clothing", which was made concerning working surface heights for clothing laboratories as set up in the Vocational Education Bulletin No. 181, Space and Equipment for Homemaking Instruction, is equally applicable to working surface heights for food laboratories.

Sincerely yours,

(signed)
Edna P. Amidon
Chief, Home Economics
Education Service

Table I. Frequency Distributions of Physical Measurements: Stature, Eye Level, Shoulder and Underforearm Heights for 87 Ninth Grade Girls*

1. Stature

Range in Inches	Number of Cases	Percentage of Cases
59	1	1.1
60	3	3.5
61	8	9.2
62	6	6.9
63	19	21.8
64	7	8.0
65	13	15.0
66	10	11.5
67	10	11.5
68	7	8.0
69	3	3.5
Total	87	100.0

2. Eye Level

Range in Inches	Number of Cases	Percentage of Cases
54	1	1.1
55	3	3.5
56	5	5.7
57	5	5.7
58	18	20.8
59	10	11.5
60	14	16.1
61	11	12.6
62	9	10.4
63	8	9.2
64	2	2.3
65	1	1.1
Total	87	100.0

3. Shoulder

Range in Inches	Number of Cases	Percentage of Cases
48	1	1.1
49	6	6.9
50	2	2.3
51	8	9.2
52	18	20.8
53	11	12.6
54	13	15.0
55	12	13.8
56	7	8.0
57	8	9.2
58	1	1.1
Total	87	100.0

4. Under Forearm

Range in Inches	Number of Cases	Percentage of Cases
35	1	1.1
36	3	3.5
37	4	4.6
38	13	15.0
39	20	23.1
40	15	17.2
41	14	16.0
42	10	11.5
43	6	6.9
44	1	1.1
Total	87	100.0

*Raw data for Tables I to XII will be found in the office of Home Economics Education, Home Economics Building, Oregon State College

Table II. Frequency Distributions of Physical Measurements: Wrist Height, Breadth at Shoulders and Breadth at Elbows, and Arm Length for 87 Ninth Grade Girls

5. Wrist

Range in Inches	Number of Cases	Percentage of Cases
28	1	1.1
29	2	2.3
30	4	4.6
31	23	26.4
32	20	23.1
33	19	21.8
34	12	13.8
35	5	5.8
36	1	1.1
Total	87	100.0

6. Shoulders, Breadth of

Range in Inches	Number of Cases	Percentage of Cases
12	5	5.7
13	33	38.0
14	40	46.0
15	9	10.3
Total	87	100.0

7. Elbows, Breadth at

Range in Inches	Number of Cases	Percentage of Cases
24	1	1.1
25	4	4.6
26	8	9.2
27	13	15.1
28	12	13.8
29	21	24.0
30	18	20.8
31	8	9.2
32	1	1.1
33	1	1.1
Total	87	100.0

8. Arm Length

Range in Inches	Number of Cases	Percentage of Cases
17	1	1.1
18	3	3.5
19	8	9.2
20	23	26.4
21	30	34.4
22	20	23.1
23	2	2.3
Total	87	100.0

Table III. Frequency Distribution of Physical Measurements: Sitting Height, Eye Level, Shoulder and Under Forearm Heights Taken with the Subject Seated for 87 Ninth Grade Girls.

9. Sitting Height

Range in Inches	Number of Cases	Percentage of Cases
30	3	3.4
31	7	8.0
32	21	24.1
33	25	28.8
34	20	23.1
35	8	9.2
36	3	3.4
Total	87	100.0

10. Eye Level (Sitting)

Range in Inches	Number of Cases	Percentage of Cases
25	1	1.1
26	5	5.8
27	19	21.8
28	30	34.5
29	21	24.1
30	7	8.1
31	3	3.5
32	1	1.1
Total	87	100.0

11. Shoulder (Sitting)

Range in Inches	Number of Cases	Percentage of Cases
19	2	2.3
20	5	5.8
21	21	24.1
22	36	41.4
23	11	12.6
24	10	11.5
25	2	2.3
Total	87	100.0

12. Under Forearm (Sitting)

Range in Inches	Number of Cases	Percentage of Cases
6	1	1.1
7	15	17.3
8	28	32.2
9	31	35.6
10	10	11.5
11	2	2.3
Total	87	100.0

Table IV. Frequency Distribution of Physical Measurements: Heights of Thigh and Hip above Chair Seat, Breadth and Length of Thigh, and Height of Under Knee for 87 Ninth Grade Girls

13. Thigh Over Seat

Range in Inches	Number of Cases	Percentage of Cases
3	2	2.3
4	16	18.4
5	55	63.2
6	14	16.1
Total	87	100.0

14. Hip (Over Chair Seat)

Range in Inches	Number of Cases	Percentage of Cases
6	1	1.1
7	18	20.8
8	41	47.2
9	26	29.8
10	1	1.1
Total	87	100.0

15. Breadth Thigh

Range in Inches	Number of Cases	Percentage of Cases
10	4	4.6
11	15	17.2
12	40	46.1
13	17	19.5
14	10	11.5
15	0	0.0
16	1	1.1
Total	87	100.0

16. Length Thigh

Range in Inches	Number of Cases	Percentage of Cases
19	6	6.9
20	11	12.6
21	36	41.4
22	22	25.3
23	10	11.5
24	2	2.3
Total	87	100.0

Table IV. Frequency Distribution of Physical Measurements: Heights of Thigh and Hip above Chair Seat, Breadth and Length of Thigh, and Height of Under Knee for 87 Ninth Grade Girls. (continued)

17. Under Knee

Range in Inches	Number of Cases	Percentage of Cases
15	8	9.2
16	35	40.2
17	34	39.1
18	10	11.5
Total	87	100.0

Table V. Frequency Distributions of Physical Measurements Length from Hip to Extended Foot and Reaching Height from 87 Ninth Grade Girls

18. Length from Hip to Extended Foot			19. Reaching Height		
Range in Inches	Number of Cases	Percentage of Cases	Range in Inches	Number of Cases	Percentage of Cases
29	1	1.1	70	3	3.5
30	3	3.5	71	4	4.6
31	4	4.6	72	10	11.5
32	11	12.6	73	8	9.2
33	19	21.8	74	8	9.2
34	23	26.6	75	9	10.4
35	6	6.9	76	15	17.2
36	11	12.6	77	11	12.5
37	4	4.6	78	9	10.4
38	4	4.6	79	2	2.3
39	1	1.1	80	4	4.6
			81	4	4.6
Total	87	100.0	Total	87	100.0

Table VI. Frequency Distributions for Age, Weight and Height of Chair for 87 Ninth Grade Girls

20. Age

Range in Ages	Number of Cases	Percentage of Cases
13	3	3.4
14	32	36.9
15	39	44.8
16	9	10.3
17	4	4.6
Total	87	100.0

21. Chair

Range in Inches	Number of Cases	Percentage of Cases
14	6	6.9
15	12	13.8
16	38	43.7
17	29	33.3
18	2	2.3
Total	87	100.0

22. Weight

Range in Pounds	Number of Cases	Percentage of Cases
70	2	2.3
80	3	3.5
90	9	10.4
100	10	11.5
110	20	23.0
120	23	26.4
130	7	8.0
140	7	8.0
150	3	3.5
160	2	2.3
170	0	0.0
180	1	1.1
Total	87	100.0

Table VII. Frequency Distributions of Physical Measurements: Stature, Eye Level, Shoulder and Under Forearm Heights for 100 Twelfth Grade Girls

1. Stature

Range in Inches	Number of Cases	Percentage of Cases
58	1	1
59	0	0
60	3	3
61	3	3
62	13	13
63	14	14
64	14	14
65	11	11
66	16	16
67	18	18
68	3	3
69	3	3
70	0	0
71	0	0
72	1	1
Total	100	100

2. Eye Level

Range in Inches	Number of Cases	Percentage of Cases
53	1	1
54	0	0
55	0	0
56	4	4
57	7	7
58	14	14
59	16	16
60	16	16
61	12	12
62	18	18
63	8	8
64	2	2
65	1	1
66	0	0
67	1	1
Total	100	100

3. Shoulder

Range in Inches	Number of Cases	Percentage of Cases
47	1	1
48	0	0
49	2	2
50	3	3
51	12	12
52	12	12
53	19	19
54	12	12
55	16	16
56	16	16
57	4	4
58	2	2
59	0	0
60	1	1
Total	100	100

4. Under Forearm

Range in Inches	Number of Cases	Percentage of Cases
34	1	1
35	0	0
36	2	2
37	3	3
38	15	15
39	21	21
40	17	17
41	20	20
42	16	16
43	3	3
44	1	1
45	1	1
Total	100	100

Table VIII. Frequency Distributions of Physical Measurements: Wrist Height, Breadth at Shoulders and Breadth at Elbows and Arm Length for 100 Twelfth Grade Girls.

5. Wrist

Range in Inches	Number of Cases	Percentage of Cases
28	1	1
29	2	2
30	7	7
31	13	13
32	23	23
33	20	20
34	24	24
35	7	7
36	3	3
Total	100	100

6. Breadth Shoulders

Range in Inches	Number of Cases	Percentage of Cases
12	9	9
13	22	22
14	52	52
15	16	16
16	1	1
	100	100

7. Breadth Elbows

Range in Inches	Number of Cases	Percentage of Cases
24	1	1
25	2	2
26	4	4
27	17	17
28	19	19
29	23	23
30	15	15
31	10	10
32	7	7
33	1	1
34	1	1
Total	100	100

8. Arm Length

Range in Inches	Number of Cases	Percentage of Cases
17	1	1
18	2	2
19	14	14
20	32	32
21	32	32
22	14	14
23	5	5
Total	100	100

Table IX. Frequency Distribution of Physical Measurements: Sitting Height, Eye Level, Shoulder and Under Forearm Heights Taken with the Subject Seated for 100 Twelfth Grade Girls

9. Sitting height

Range in Inches	Number of Cases	Percentage of Cases
30	1	1
31	10	10
32	12	12
33	37	37
34	26	26
35	9	9
36	5	5
Total	100	100

10. Eye Level (Sitting)

Range in Inches	Number of Cases	Percentage of Cases
26	4	4
27	11	11
28	29	29
29	36	36
30	13	13
31	6	6
32	1	1
Total	100	100

11. Shoulder Height

Range in Inches	Number of Cases	Percentage of Cases
19	1	1
20	6	6
21	18	18
22	29	29
23	33	33
24	11	11
25	2	2
Total	100	100

12. Forearm Height

Range in Inches	Number of Cases	Percentage of Cases
6	1	1
7	12	12
8	26	26
9	44	44
10	14	14
11	3	3
Total	100	100

Table X. Frequency Distribution of Physical Measurements: Heights of Thigh and Hip above Chair Seat, Breadth and Length of Thigh, and Height of Under Knee for 100 Twelfth Grade Girls.

13. Height of Thigh Over Seat

Range in Inches	Number of Cases	Percentage of Cases
4	11	11
5	60	60
6	25	25
7	3	3
8	1	1
Total	100	100

14. Height of Hip

Range in Inches	Number of Cases	Percentage of Cases
7	15	15
8	52	52
9	32	32
10	1	1
Total	100	100

15. Breadth Thigh

Range in Inches	Number of Cases	Percentage of Cases
11	11	11
12	41	41
13	31	31
14	13	13
15	3	3
16	0	0
17	1	1
Total	100	100

16. Length Thigh

Range in Inches	Number of Cases	Percentage of Cases
19	1	1
20	11	11
21	30	30
22	41	41
23	10	10
24	6	6
25	1	1
Total	100	100

17. Height of Under Knee

Range in Inches	Number of Cases	Percentage of Cases
14	2	2
15	7	7
16	33	33
17	45	45
18	12	12
19	1	1
Total	100	100

Table XI. Frequency Distributions of Physical Measurements: Heights of Thigh and Hip above Chair Seat, Breadth and Length of Thigh, and Height of Under Knee for 100 Twelfth Grade Girls

18. Length from Hip to Extended Foot

Range in Inches	Number of Cases	Percentage of Cases
31	5	5
32	2	2
33	17	17
34	17	17
35	18	18
36	14	14
37	17	17
38	7	7
39	3	3
Total	100	100

19. Reaching Height

Range in Inches	Number of Cases	Percentage of Cases
69	3	3
70	7	7
71	5	5
72	4	4
73	11	11
74	4	4
75	16	16
76	15	15
77	6	6
78	10	10
79	12	12
80	3	3
81	1	1
82	3	3
Total	100	100

Table XII. Frequency Distributions for Age, Weight and Height of Chair for 100 Twelfth Grade Girls.

20. Age

Range in Ages	Number of Cases	Percentage of Cases
16	4	4
17	49	49
18	36	36
19	7	7
20	1	1
21	2	2
22	1	1
Total	100	100

21. Weight

Range in pounds	Number of Cases	Percentage of Cases
90	4	4
100	15	15
110	14	14
120	26	26
130	22	22
140	8	8
150	5	5
160	3	3
170	1	1
180	1	1
230	1	1
Total	100	100

22. Chair Height

Range in Inches	Number of Cases	Percentage of Cases
14	3	3
15	14	14
16	43	43
17	35	35
18	4	4
19	1	1
Total	100	100

Table XIII. Frequency Distributions of Preferred Heights for 30 Ninth Grade Girls *

Beating Eggs

Range in Inches	Number of Cases	Percentage of Cases
28	3	10.0
29	8	26.6
30	7	23.3
31	6	20.0
32	4	13.3
33	2	6.6 (or 6.7?)

Stirring in Bowl

Range in Inches	Number of Cases	Percentage of Cases
30	2	6.6
31	6	20.0
32	7	23.3
33	6	20.0
34	3	10.0
35	6	20.0

Washing Dishes-Sink

Range in Inches	Number of Cases	Percentage of Cases
26	1	3.3
27	2	6.6
28	7	23.4
29	10	33.3
30	7	23.3
31	2	6.6
32	1	3.3

Eating at Table

Range in Inches	Number of Cases	Percentage of Cases
23	8	26.6
24	7	23.4
25	12	40.0
26	3	10.0

Washing Dishes-Pan

Range in Inches	Number of Cases	Percentage of Cases
28	1	3.3
29	1	3.3
30	1	3.3
31	7	23.3
32	11	26.6
33	6	20.0
34	3	10.0

Rolling

Range in Inches	Number of Cases	Percentage of Cases
30	2	6.6
31	1	3.3
32	5	16.6
33	7	23.3
34	8	26.6
35	3	10.0
36	3	10.0
37	1	3.3

*Raw data will be found in the office of Home Economics Education, Home Economics Building, Oregon State College.

Table XIII. Frequency Distributions of Preferred Heights for 30 Ninth Grade Girls* (continued)

Frying			Stirring in double boiler		
Range in Inches	Number of Cases	Percentage of Cases	Range in Inches	Number of Cases	Percentage of Cases
30	1	3.3	28	1	3.3
31	2	6.6	29	0	0.0
32	6	20.0	30	7	23.3
33	7	23.3	31	7	23.3
34	8	26.6	32	6	20.0
35	3	10.0	33	3	10.0
36	3	10.0	34	5	16.6
			35	1	3.3

*Raw data will be found in the office of Home Economics Education, Home Economics Building, Oregon State College.

Table XIV. Frequency Distributions of Preferred Heights for 30 Twelfth Grade Girls *

Beating Eggs

Range in Inches	Number of Cases	Percentage of Cases
28	5	16.6
29	3	10.0
30	9	30.0
31	8	26.6
32	2	6.6
33	2	6.6
34	1	3.3

Stirring in Bowl

Range in Inches	Number of Cases	Percentage of Cases
29	1	3.3
30	6	20.0
31	6	20.0
32	11	36.6
33	5	16.6
34	0	0.0
35	1	3.3

Washing Dishes-Sink

Range in Inches	Number of Cases	Percentage of Cases
26	3	10.0
27	4	13.3
28	15	50.0
29	2	6.6
30	5	16.6
31	1	3.3

Eating at Table

Range in Inches	Number of Cases	Percentage of Cases
23	2	6.6
24	9	30.0
25	11	36.6
26	7	23.3
27	1	3.3

Washing Dishes-Pan

Range in Inches	Number of Cases	Percentage of Cases
29	1	3.3
30	7	23.3
31	9	30.0
32	9	30.0
33	3	10.0
34	0	0.0
35	1	3.3

Rolling

Range in Inches	Number of Cases	Percentage of Cases
30	1	3.3
31	4	13.3
32	11	36.6
33	8	26.6
34	3	10.0
35	3	10.0

*Raw data will be found in the office of Home Economics Education, Home Economics Building, Oregon State College.

Table XIV. Frequency Distributions of Preferred Heights for 30 Twelfth Grade Girls * (continued)

Frying			Stirring in a Double Boiler		
Range in Inches	Number of Cases	Percentage of Cases	Range in Inches	Number of Cases	Percentage of Cases
29	1	3.3	29	1	3.3
30	2	6.6	30	2	6.6
31	5	16.6	31	14	46.6
32	14	46.6	32	10	33.3
33	3	10.0	33	2	6.6
34	3	10.0	34	0	0.0
35	2	6.6	35	1	3.3

*Raw data will be found in the office of Home Economics Education, Home Economics Building, Oregon State College.

Table XV. Cooperators Classed with Respect to Residence and Height

Height in Inches	Freshmen		Seniors		All	
	Rural	Urban	Rural	Urban	Rural	Urban
	NUMBER OF CASES					
58			1		1	
59	1				1	
60		3	1	2	1	5
61	3	5	2	1	5	6
62	2	4	2	11	4	15
63	4	15	3	11	7	26
64	3	4	4	10	7	14
65	5	8	4	7	9	15
66	2	8	5	11	7	19
67	6	4	6	12	12	16
68	2	5	1	2	3	7
69	2	1	2	1	4	2
70						
71						
72				1		1
	30	57	31	69	61	126

Figure I Heights Preferred by 60 Girls for Beating With Upper and Lower Limits of Tolerance.

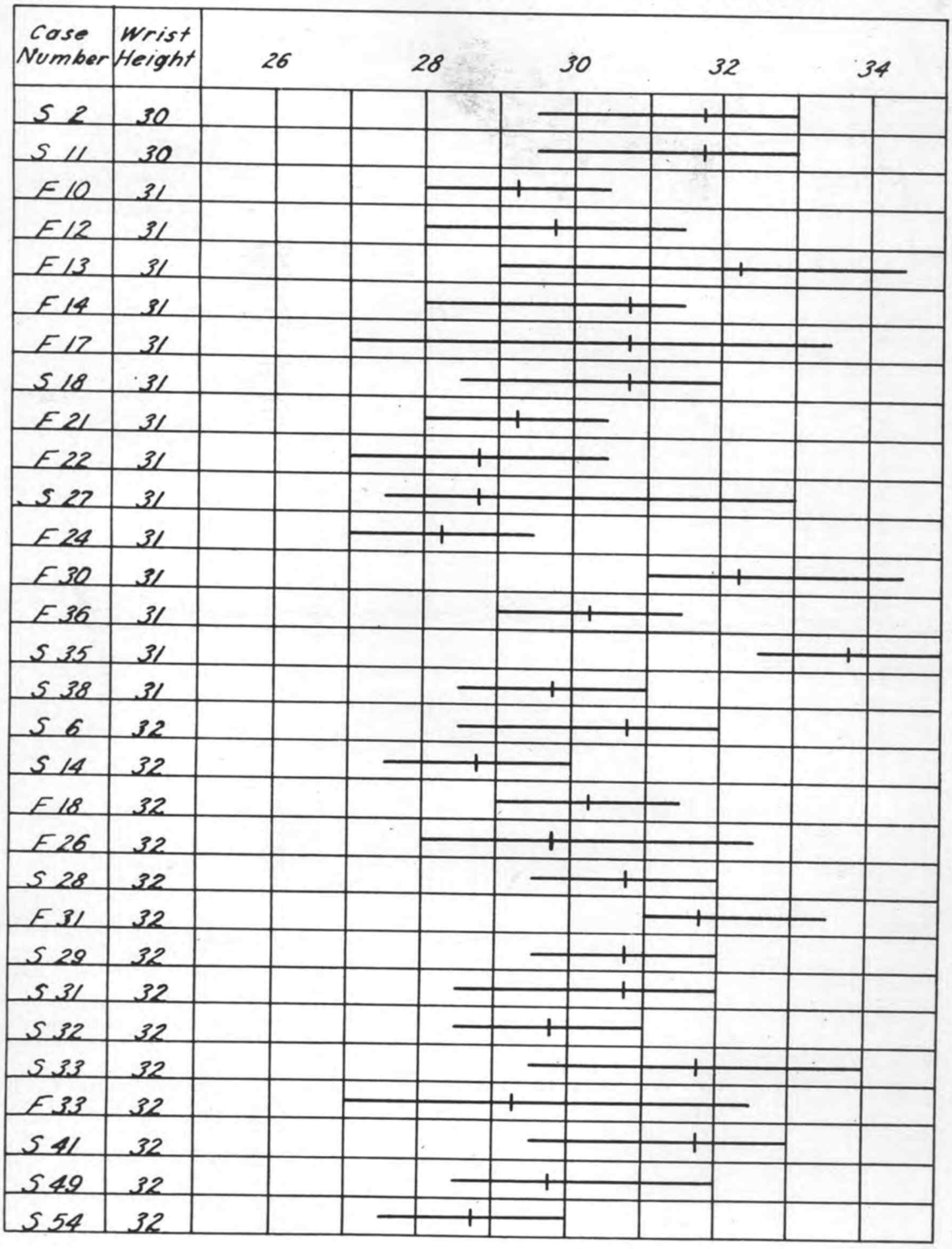
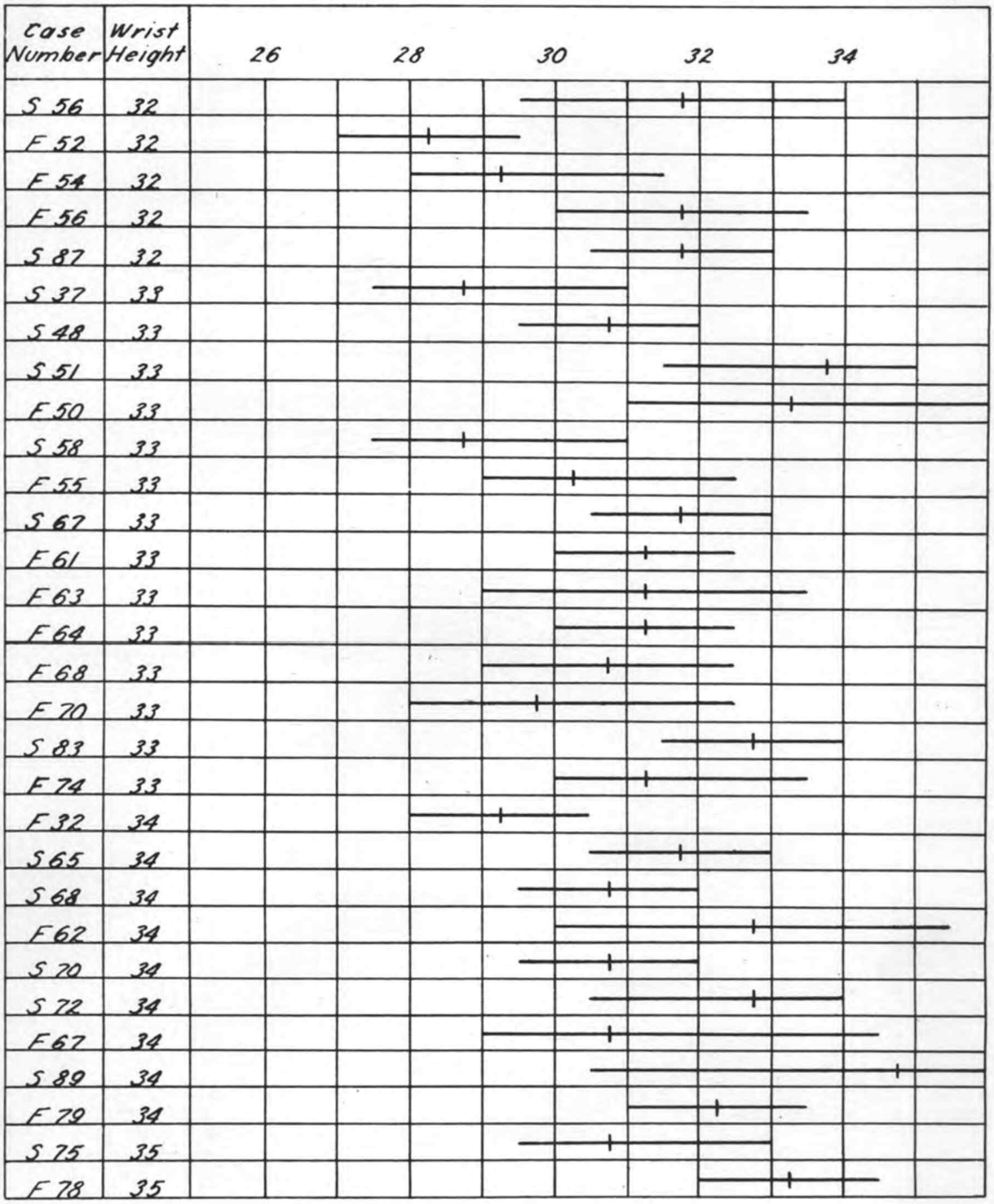


Figure I Continued. Heights Preferred by 60 Girls for Beating With Upper and Lower Limits of Tolerance.



Low	55	50	42	36	29	18	13	8	4	2	1													
High						2	4	8	12	17	26	32	41	47	51	55	57	58						
Choices	2	6	5	6	3	13	4	10	3	3	2	2	0	1										

Figure II. Heights Preferred by 60 Girls for Washing Dishes in a Sink With Upper and Lower Limits of Tolerance.

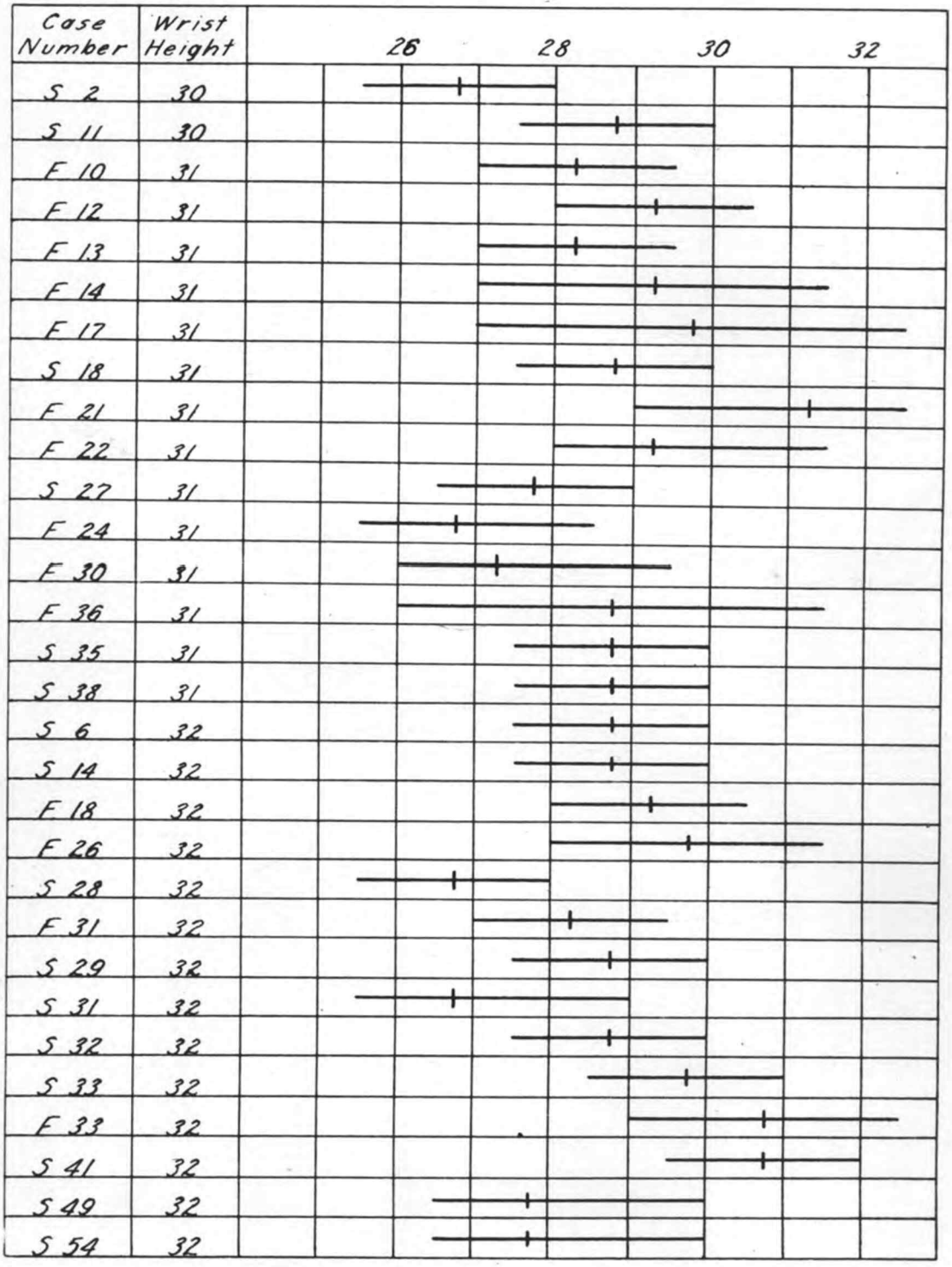
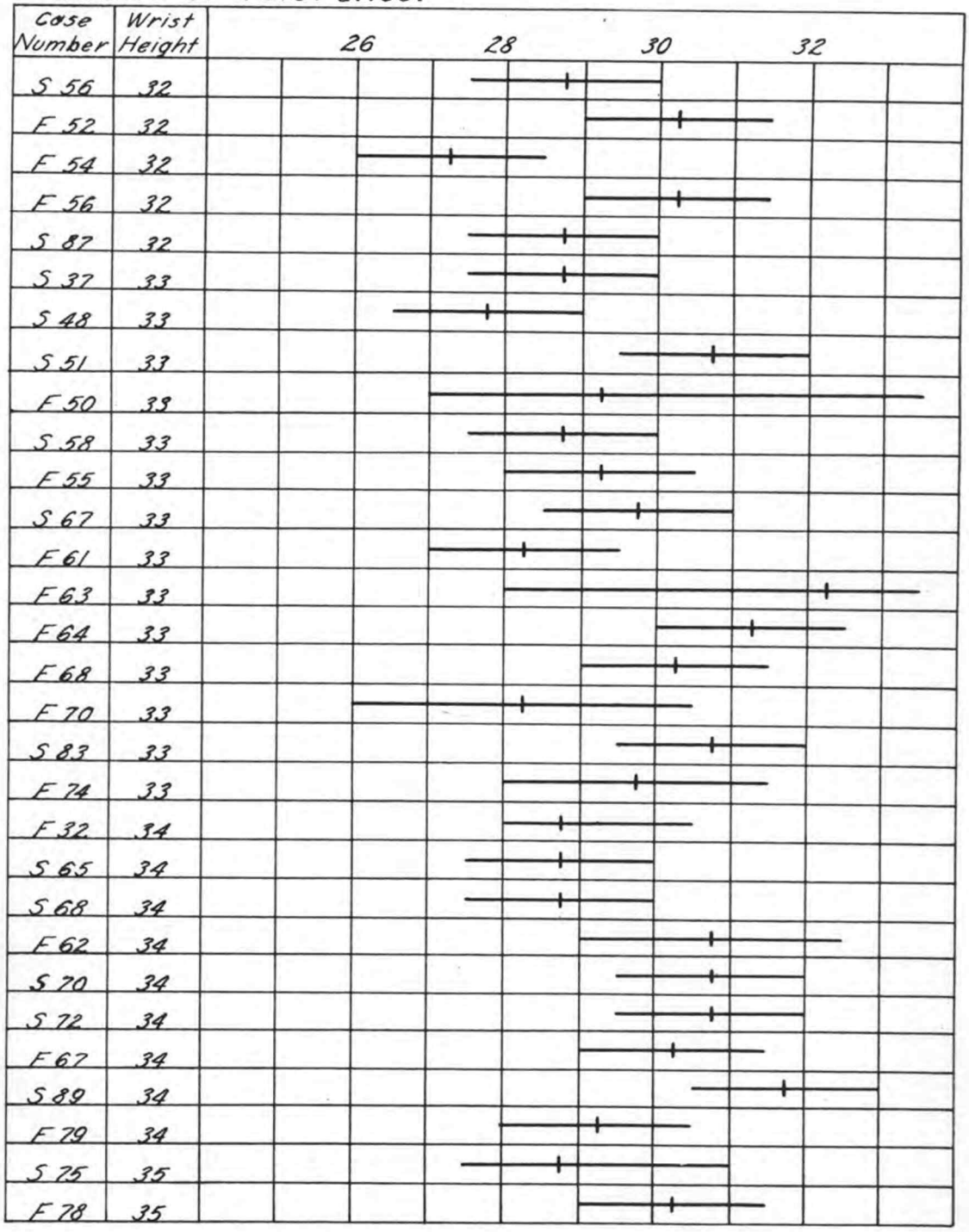


Figure II Continued. Heights Preferred by 60 Girls for Washing Dishes in a Sink With Upper and Lower Limits of Tolerance.

Case Number	Wrist Height
S 56	32
F 52	32
F 54	32
F 56	32
S 87	32
S 37	33
S 48	33
S 51	33
F 50	33
S 58	33
F 55	33
S 67	33
F 61	33
F 63	33
F 64	33
F 68	33
F 70	33
S 83	33
F 74	33
F 32	34
S 65	34
S 68	34
F 62	34
S 70	34
S 72	34
F 67	34
S 89	34
F 79	34
S 75	35
F 78	35



Low	56	52	48	41	26	17	15	7	2	1	0	
High						2	4	7	10	28	34	37	47	52	57	58
Choice	4	2	4	5	17	7	5	5	7	2	1	1

Figure III. Heights Preferred by 60 Girls for Washing Dishes in a Pan With Upper and Lower Limits of Tolerance.

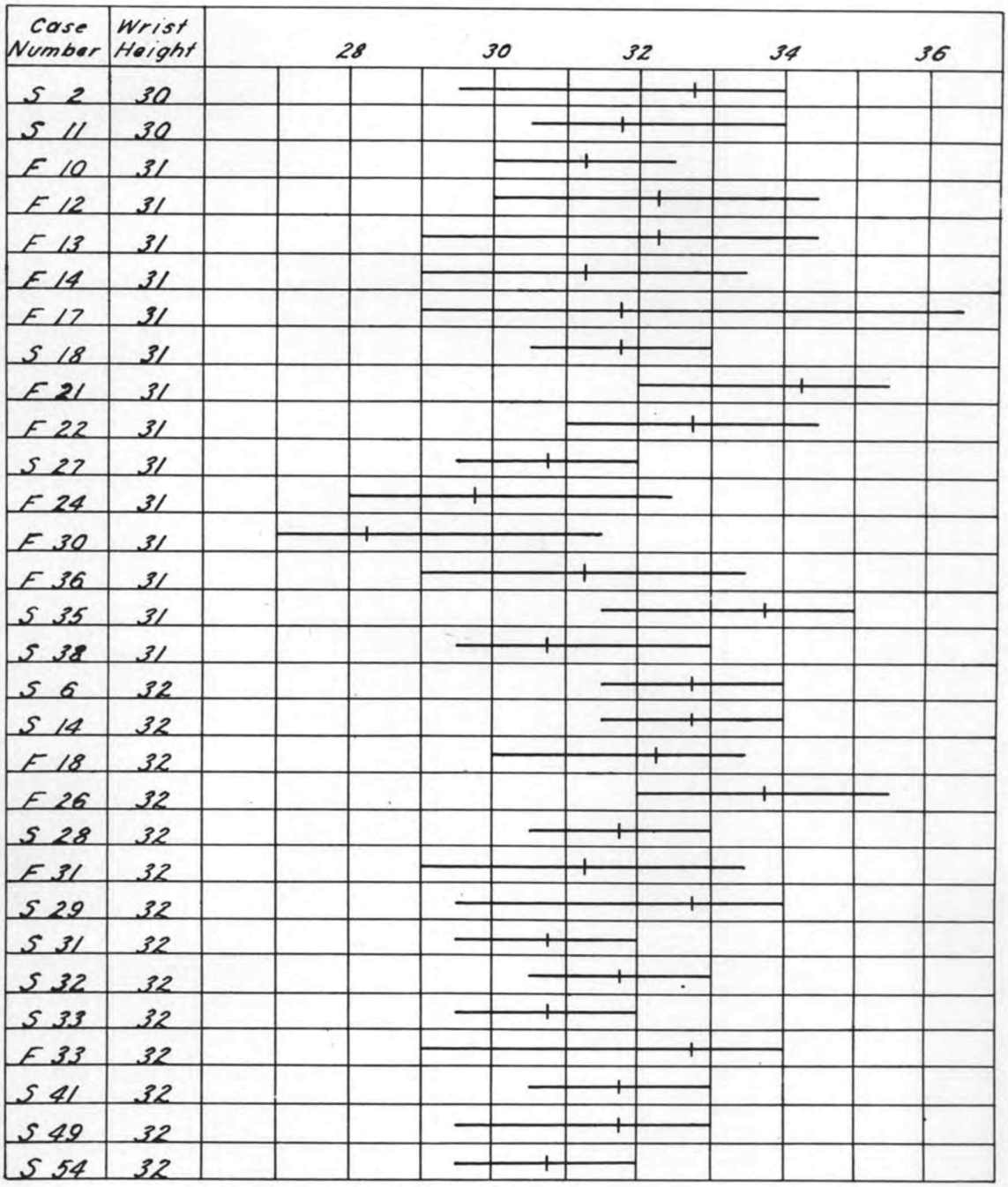


Figure III Continued. Heights Preferred by 60 Girls for Washing Dishes in a Pan With Upper and Lower Limits of Tolerance.

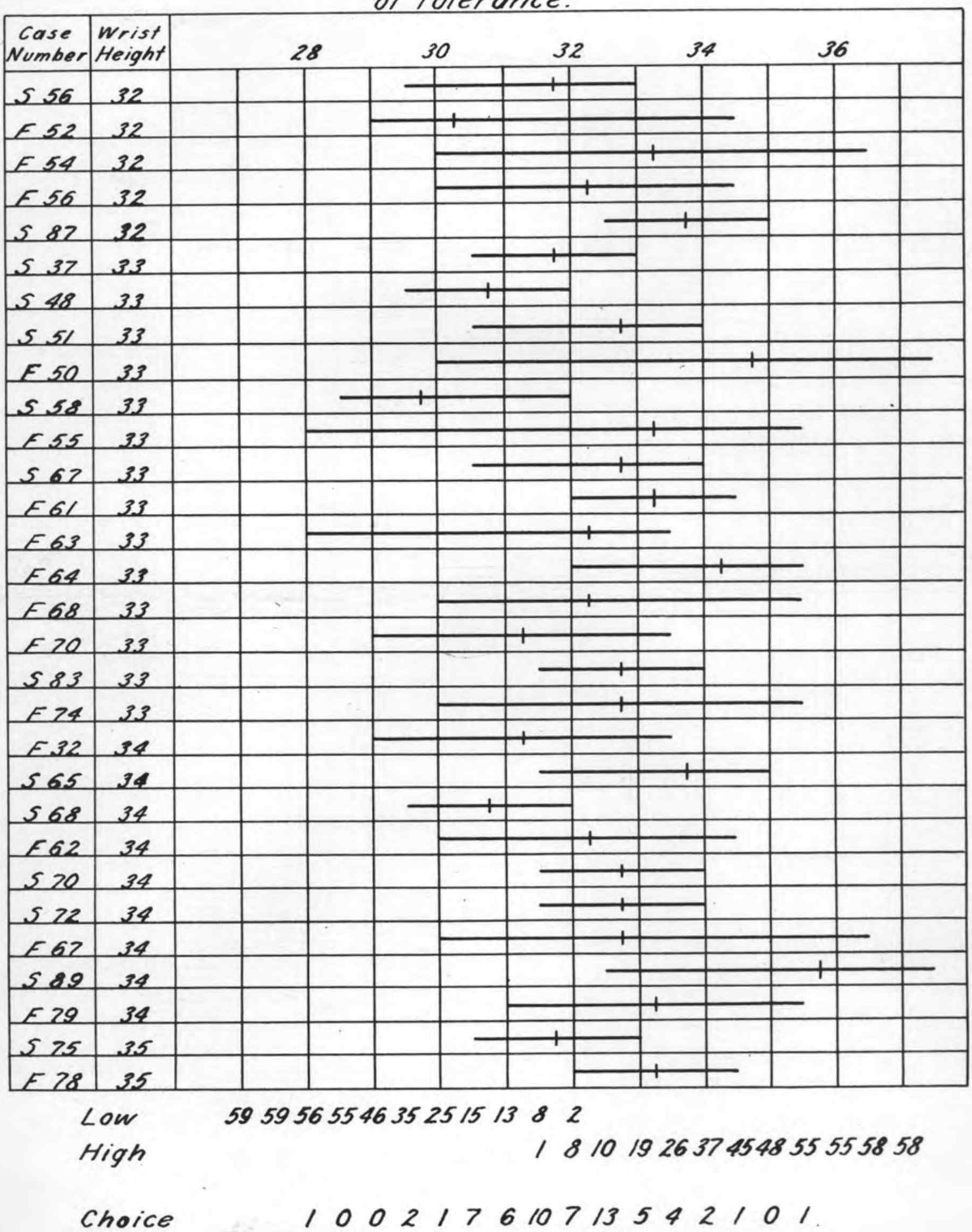


Figure IV. Heights Preferred by 60 Girls for Stirring in a Bowl With Upper and Lower Limits of Tolerance.

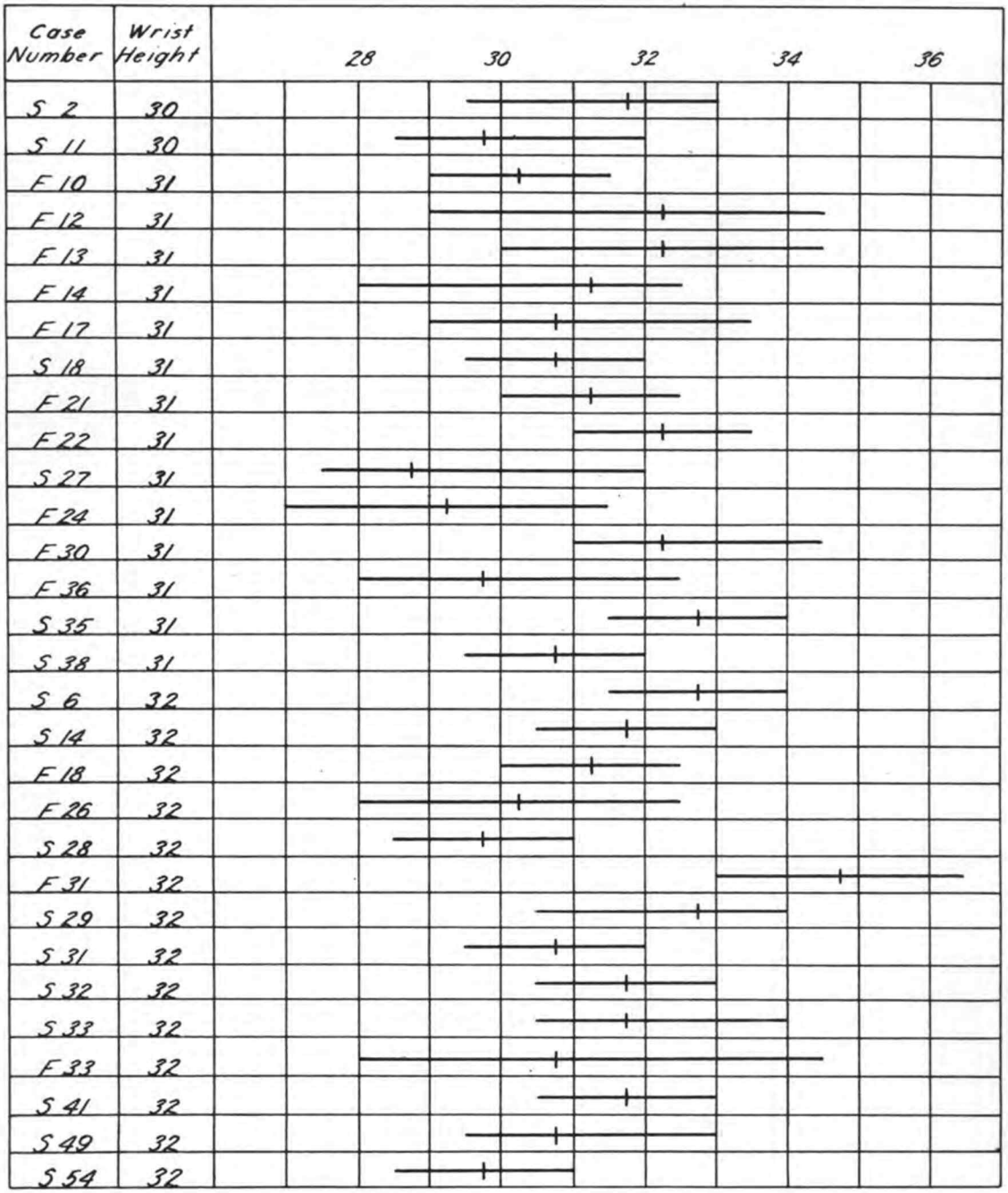
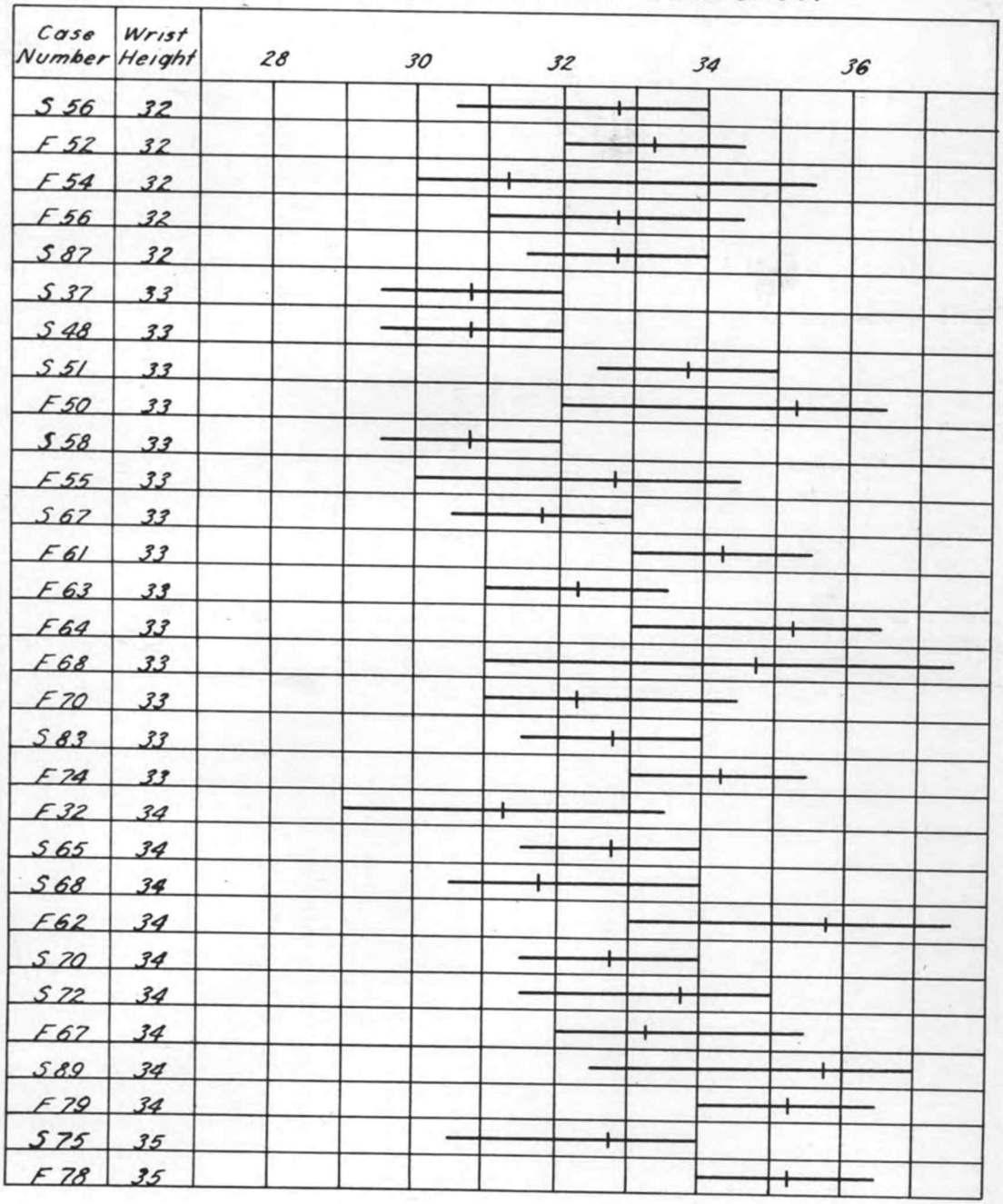


Figure IV Continued. Heights Preferred by 60 Girls for Stirring in a Bowl With Upper and Lower Limits of Tolerance.



Low	59	58	53	47	42	32	26	16	11	7	3	3
High								5	7	11	20	32
	39	44	52	52	56	57						
Choices	1	1	7	4	8	5	13	6	5	2	1	4	3

Figure V. Heights Preferred by 60 Girls for Rolling With Upper and Lower Limits of Tolerance.

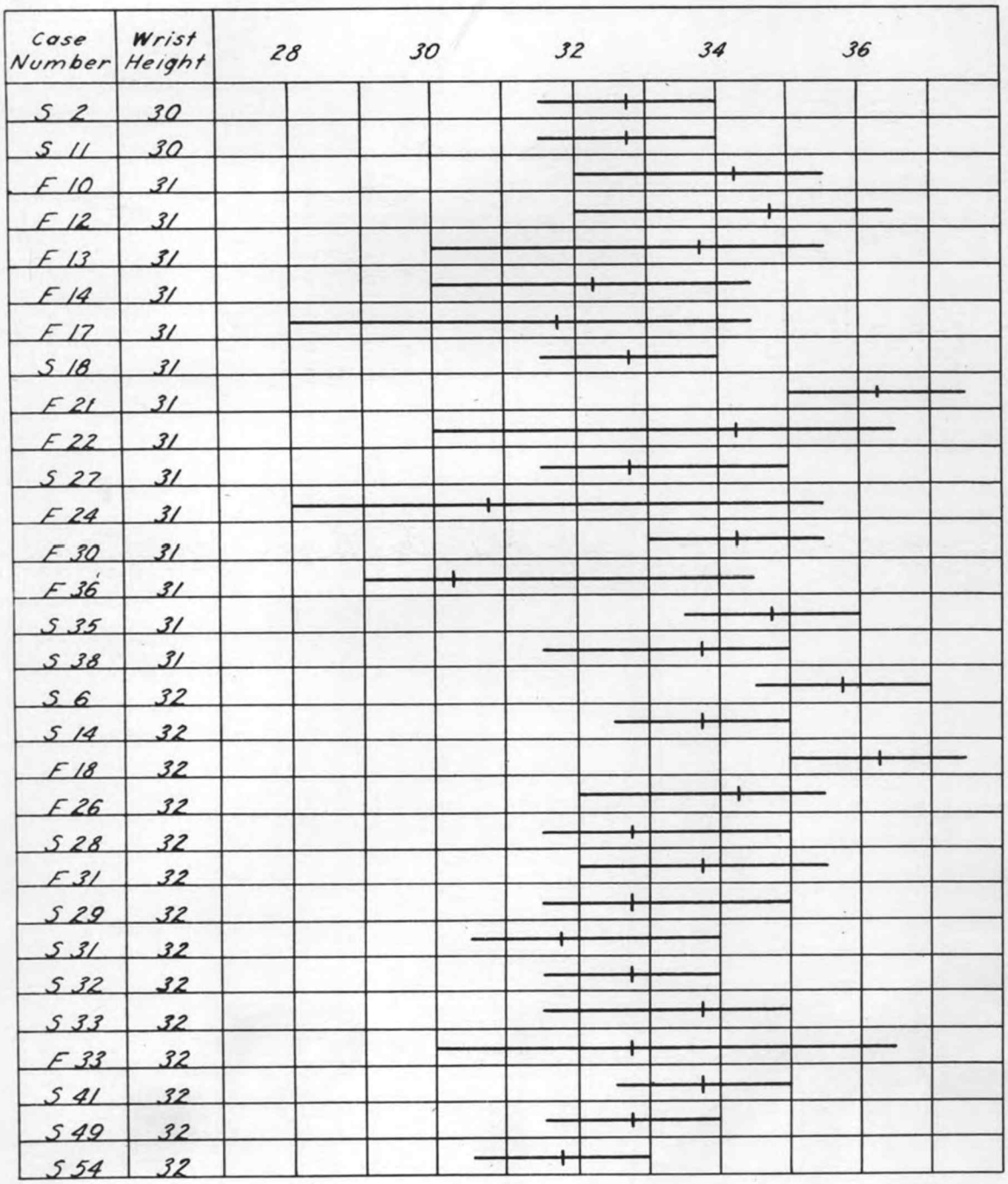
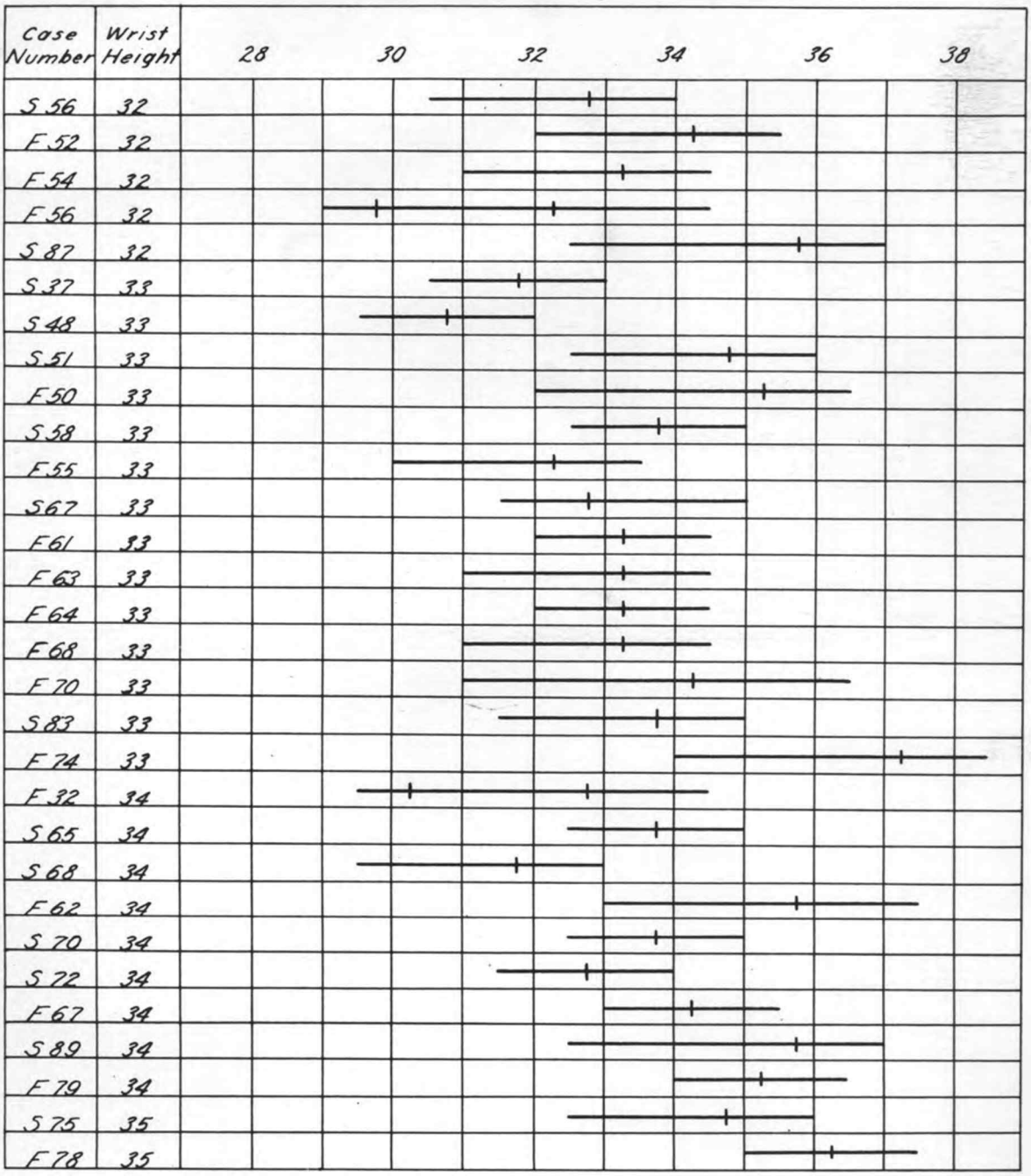


Figure V. Continued. Heights Preferred by 60 Girls for Rolling With Upper and Lower Limits of Tolerance.



Low	58	58	57	55	49	45	40	27	19	10	7	6	4	3	
High								1	1	4	5	13	24	35	43	46	52	55	59	59
Choices	1	2	0	5	3	13	5	10	7	4	2	4	3	0	1

Figure VI Heights Preferred by 60 Girls for Frying and Stirring in a Double Boiler With Upper and Lower Limits of Tolerance for Stove Height.

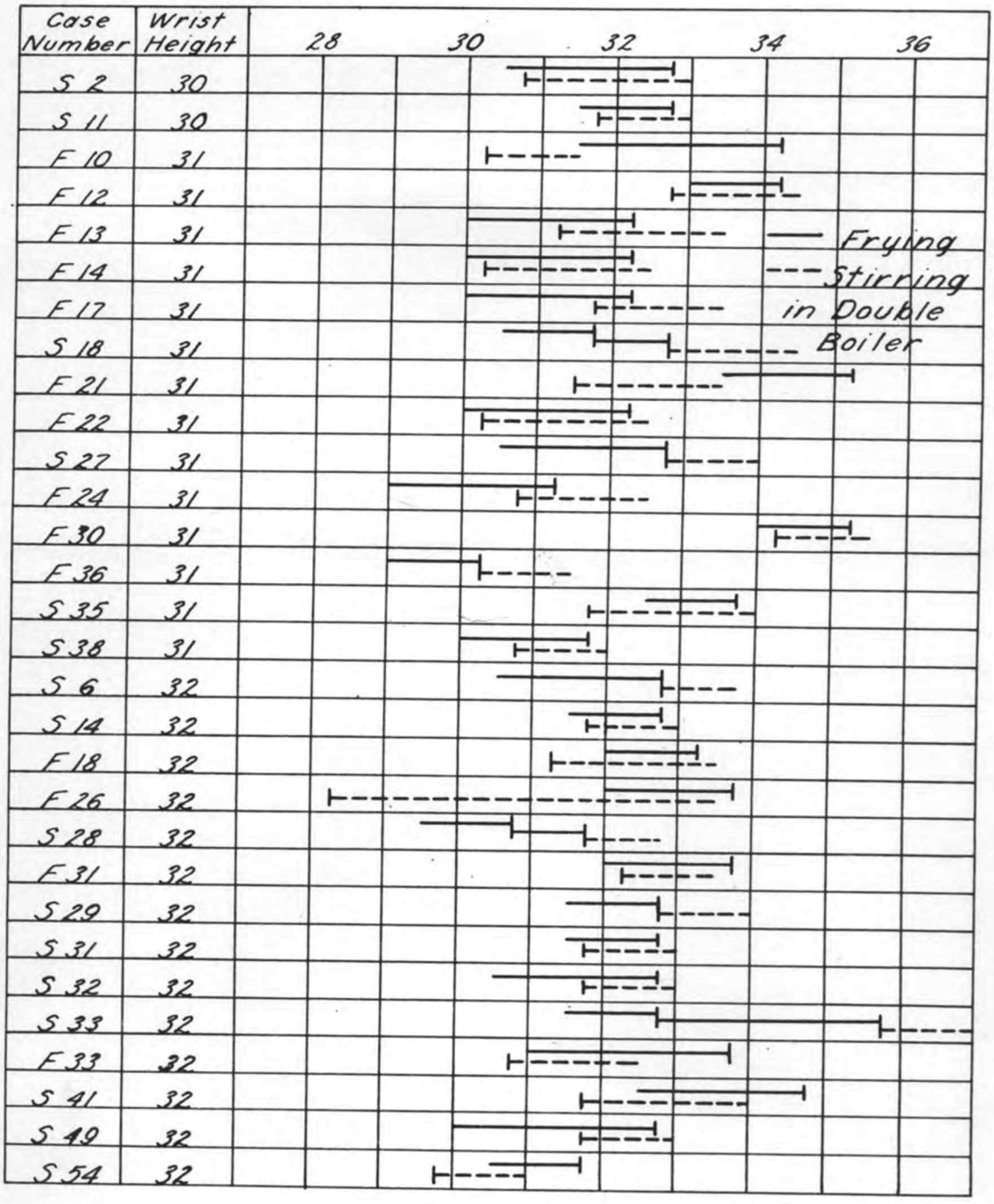


Figure VI Continued. Heights Preferred by 60 Girls for Frying and Stirring in a Double Boiler With Upper and Lower Limits of Tolerance for Stove Height.

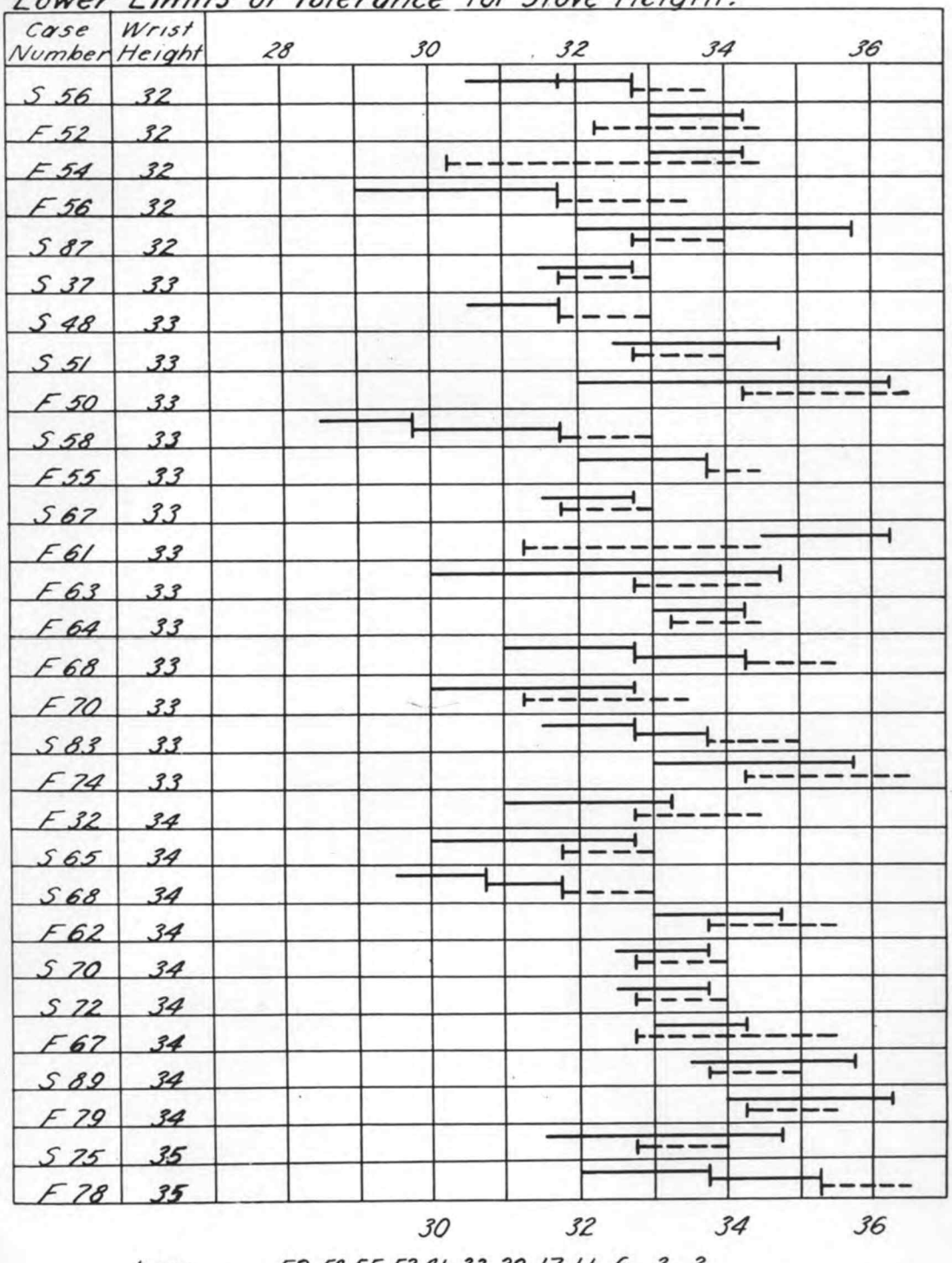


Figure VII. Heights Preferred by 60 Girls for Eating at a Table With Upper and Lower Limits of Tolerance.

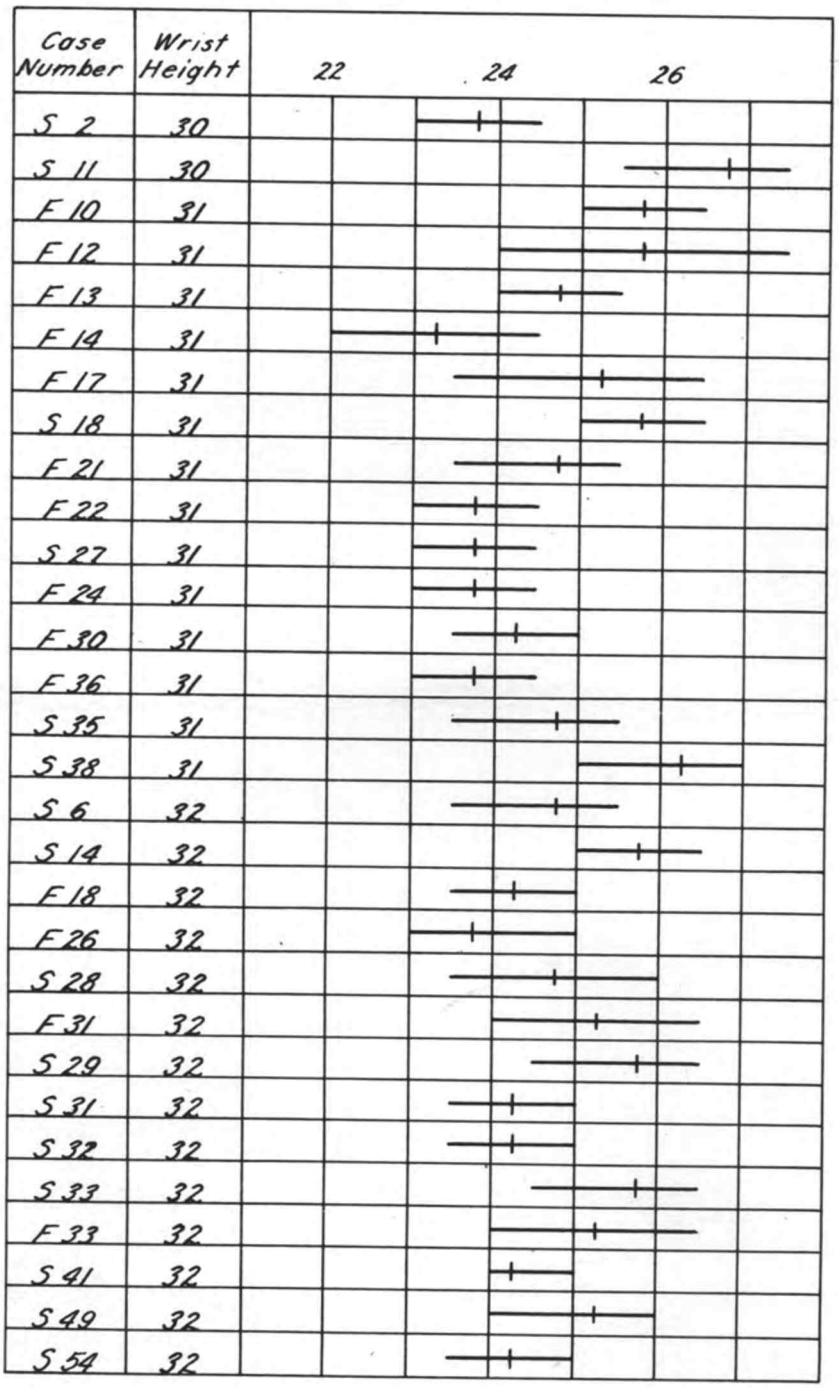


Figure VII Continued. Heights Preferred by 60 Girls for Eating at a Table With Upper and Lower Limits of Tolerance.

Case Number	Wrist Height	22	24	26	28
S 56	32				
F 52	32				
F 54	32				
F 56	32				
S 87	32				
S 37	33				
S 48	33				
S 51	33				
F 50	33				
S 58	33				
F 55	33				
S 67	33				
F 61	33				
F 63	33				
F 64	33				
F 68	33				
F 70	33				
S 83	33				
F 74	33				
F 32	34				
S 65	34				
S 68	34				
F 62	34				
S 70	34				
S 72	34				
F 67	34				
S 89	34				
F 79	34				
S 75	35				
F 78	35				

Low	58	58	50	39	24	18	4	1	1	
High						8	17	25	30	47	52	59	59
Choices	2	8	7	9	7	16	6	4	0	1

APPENDIX PART I

METHODS FOR TAKING BODY MEASUREMENTS AND EQUIPMENT USED

The methods used in taking body measurements for this study were based on those set up for the Oregon-Washington Purnell study and were modified for this study upon the advice of Miss Laura McAllester. The same equipment was used throughout the entire study. All measurements were taken and repeated immediately following the completion of the entire list (See Data Sheet I). Measurements were recorded as the nearest tenth of an inch. The investigator was checked by her assistant as to accuracy of taking measurements for the first twenty cases. Following these, the investigator took all the measurements while the recorder checked to see that each was within one-half inch of the first. The average of the two was used in computation. If the second measurement was not within one-half inch of the first, the operator continued measuring until two measurements within one-half inch were secured.

The apparatus used for the measurements are listed as follows:

Stadiometer. This piece of equipment was made by the Narragansett Machine Company, Providence, Rhode Island.

The base is 18 inches square and 15 inches high. The maple rod is graduated to inches and tenths and reads up to 78 inches above the box.

Shoulder Calipers. This was made by the Narragansett Machine Company. It is of maple and is graduated to inches and tenths. Measurements are taken by means of a sliding arm on the instrument.

Yardstick. This was checked for accuracy with the above stadiometer. It was mounted on the wall 60 inches from the floor and was used in determining the height of reach.

Yardstick. The yardstick was used by the subject for the under knee measurement. The subject was directed to hold it under her knees while the investigator measured from the top to the floor.

Chair. This piece of equipment was used in all measurements in the sitting position except sitting height. The seat is 16 by 18 inches, is 18 inches from the floor and is flat. The chair has a removable back. Inch boards were placed under the feet of the subjects to adjust chair height.

Record Sheet. This sheet was used in recording and computing physical measurements for each girl. See Data Sheet I.

Before listing the methods for taking each measurement, it is necessary to explain the reason for repeating the measurement of standing height, a measurement which is easily secured for girls of all ages. While figures for the stature of ninth grade girls were obtained as a part of the preliminary study and it was possible to obtain the same measurements of twelfth grade girls taken when they were juniors in high school, the measurement of stature was repeated in all cases due to the difference in

methods used. All measurements in the present study were taken with the subject standing against the rod of the stadiometer while measurements obtained from the physical education departments of the Corvallis junior and senior high schools were taken with the subject standing unsupported on a scales with the measuring bar brought down over the head. Further, measurements obtained in this study were taken with the girls wearing clothing and shoes with heels from one-half to one and one-half inches high while those obtained from the physical education departments were taken without clothing. Thus, it was important to retake the standing height for each girl from the standpoint of gaining a correct relationship between this and other measurements and also because calculations were to be made from the measurement of standing height and other measurements obtained in this study.

The method of taking each measurement is described as follows:

> Standing height, or stature. The subject was directed to stand on the box of the stadiometer with heels, hips, and back of head against the bar and top of head level. The operator pressed down the crossbar and read the measurement to the recorder who entered it on the data sheet.
>
> Eye level. The subject was directed to stand on the

box of the stadiometer facing the operator and to look straight ahead while the operator brought the crossbar down to the level of the lower eyelid. The measurement was read and recorded.

Shoulder height. The subject was asked to stand to one side of and facing the vertical bar of the stadiometer while the operator brought the crossbar down, measuring the height of the tip of the acromion on the left shoulder.

Forearm height. The subject was directed to stand as in the measurement for shoulder height. The operator grasped the subject's arm and bent it to a right angle at the elbow; holding the arm in position, the operator brought the crossbar of the stadiometer up under the forearm so that it rested along the top of the bar. This measurement was read at the top of the crossbar.

Wrist height. The subject remained standing as she had in the previous measurement. The operator grasped the subject's left wrist lightly to locate the distal end of the radius and brought the crossbar down to that point.

Sitting height. This measurement was taken with the subject sitting on the base of the stadiometer against the vertical bar. The subject was directed to place her back and head, top of head level, against the bar while the operator brought the crossbar down and read the measurement to the recorder.

Breadth of shoulders. The subject was directed to stand with her back to the operator. Grasping one crossbar of the calipers in each hand, the operator located the tips of the acromion with the forefingers and then placed the crossbars in contact with them.

Breadth at elbows, arms akimbo. Standing with her back to the operator, the subject was directed to place her hands on her hips with her elbows as far as possible from her body. The operator grasped the crossbars of the calipers as for breadth of shoulders, located the tips of the elbows, and placed the crossbars in contact with them.

At this point, the subject was directed to sit erect on the chair as far back on the seat as the operator indicated. The operator adjusted the chair height by placing as many one-inch boards as were necessary under the feet of the subject until the operator could feel no pressure between the subject's thigh and the seat. In the case of the tallest girls, no adjustment was necessary; in one case, a one-inch board was placed on the seat to raise the chair height. The chair height was recorded.

Breadth of thigh. The subject was seated in the adjusted chair. The operator measured with the calipers over the greatest breadth of thighs.

Length of thigh. The end of the calipers was placed at the back of the thigh and the other end adjusted to the front of the patella.

Under knee height. The subject was directed to grasp a yardstick and hold it firmly under her knees with both hands, one on each side of her knees. The operator measured with calipers the distance from the top of the yardstick to the floor. Whenever the calipers were used with one crossarm on the floor, a correction of .6 inch was made for the width of the crossarm.

Height of thigh. The operator placed one crossbar of the calipers on the floor and adjusted the other to the highest part of the thigh, bringing it down gently to get the maximum height of thigh for each subject. In calculating the height of the thigh over the chair seat, the difference between the height of thigh from the floor and the chair height were used.

Height of hip. Using the same procedure as that for finding the height of thigh, the operator found the top of the hip bone and placed the crossbar of the calipers firmly on that point. From this measurement, the height of hip over the chair seat was calculated by subtracting the height of the chair seat from the height of hip.

Length from back of hip to extended foot. The subject was directed to extend her feet and let them drop back on the floor. The measurement from the front of the chair to the extended feet was recorded; in computation, the length of the chair was added for each case.

Reaching height. The subject was directed to stand with her toes against the wall and reach up with both hands as far as possible without stretching. The measurement was recorded for the height of the thumb tip of the lower hand to the nearest half inch.

Calculations were made from several measurements. Among these were the following:

Eye level at sitting height. The difference between the eye level taken in the standing position and standing height was subtracted from sitting height to obtain the eye level for the sitting position.

Shoulder and forearm heights for the sitting position. These measurements were obtained by subtracting the differences between each and standing height from the sitting height to obtain the shoulder and forearm heights for the sitting position, respectively.

Arm length. This measurement was obtained from the difference between shoulder and wrist heights for each case.

Age was recorded to the nearest birthdate. If the subject wore glasses, this was recorded because it might influence the judgments or the requirements of the girls as to dimensions. Weight and residence were also recorded.

Reference has been made to the crouching position. It may be said that this refers to a stooped position in which the limbs are close to the body. From observations the investigator found that the maximum front to back measurement in this position was the same as the length

of thigh in the sitting position. The maximum side to side measurement included an area determined by the length of arm in an efficient working position; for the purposes of this study, the breadth at elbows, arms akimbo, satisfied the maximum side to side requirement for floor area.

APPENDIX PART II

METHODS FOR OBTAINING JUDGMENTS AND EQUIPMENT USED

Because measurements alone did not provide sufficient evidence for the planning of dimension standards, judgments as to preferred heights for various activities were obtained from 60 girls most typical of the entire group on the basis of wrist height, breadth of thighs and age.

Activities for which judgments were given were chosen on the basis of relative body postures required. The activities which satisfied the various postures were beating eggs, washing dishes in a sink, washing dishes in a pan, stirring in a bowl, rolling with a rolling pin, frying in a pan on the back of the stove, stirring in a double boiler on the front burner of the stove, and eating at a table. In addition to obtaining these preferred heights, the investigator observed the amount of floor space used by the girls in opening the oven door.

Before any judgments were secured, the purpose and methods were explained to all the girls by means of a demonstration. This took the form of an assembly for the ninth grade girls selected to give judgments and an explanation before each group of twelfth grade girls.

At the time of the demonstration, posture standards were set up to aid in evaluating girls' positions as they chose heights for working surfaces.

For each of the activities for which choices were made, the girl was given the equipment necessary for performing the activity and told to select the best height and one that seemed too high and another that seemed too low. Each girl was given as much time as she needed for performing all the activities and making selections. The observer made no suggestions as to choices; however, she did ask the girl to improve her posture when necessary. Insofar as it was possible, the testing room was free from distractions so the girl could give all her attention to the activity at hand. Each girl selected the heights she thought best for her; although no further comment on the assembly presentation was made, the investigator noted a definite carry-over value.

The study of judgments was made in the foods and clothing laboratories in the junior high school and in the small room near the library in the senior high school. For the first 20 freshmen girls, judgments were obtained; after a period of two days, the same girls were asked to give their judgments again. The differences in the two sets of choices for each girl were so slight that it was not necessary to continue obtaining two sets of judgments from each girl.

For the first 20 cases, the fact that there was a space of two days between the first selection of preferred heights and the second and that the activity center was moved to a different part of the room helped assure the investigator that first judgments were not remembered. In extreme cases of similarity between the first and second choices, the subject was asked if she remembered what choice she had made the first time. Each case consistently answered "No"; that this was the correct answer was not known to the girl at the time. For the remaining forty cases, judgments were obtained only once from each girl.

Judgments as to activities were made with the same equipment used for all cases. In the junior high school, the work surface in the foods laboratory was 32 inches high; that in the clothing laboratory was used for only six cases, all of which gave their second judgments in the foods laboratory. In the senior high school, the work surface was 29.5 inches high. Step tables consisting of boxes 18 inches square and ranging in height from one to five inches were used to vary the working surface height. Girls travelled from one step table to the next, selecting the optimum working height, and one which was too high and another which was too low. The investigator recorded the selected height and the maximum

tolerance range (heights lower by one inch than that too high and higher by one inch than that selected as being too low). When it was necessary to adjust the step tables to suit the individual, one or more one-inch boards were placed under the feet of the shorter girls, and one or more boxes were placed on top of the five-inch box to raise the surface for taller girls.

In choosing the height for the eating table, the girl sat on an adjusted chair and pulled the table as close as she desired. A cover was set and a cake served to each girl; while the girl ate, the table height was raised by placing one-half inch boards under the cover until the girl found one too low, too high and one of optimum height for her. In order to test the tolerance for the lowest table, it was necessary to place one-inch boards on the chair seats for two girls. In calculating the results of these choices it was necessary to subtract the correction for chair height from the table height chosen.

Tools used for making the various tests for the judgment study were as follows:

Beating. Bowl-7½ inches in diameter at top, 3-3/4 inches deep. Bottom of bowl ½ inch thick. Ball-bearing dover beater 12 inches high.

Washing dishes in a sink. Sink--13 inches wide, 18 inches long, 8½ inches deep. (Allowance for construction at the front of sink--2½ inches).

Dish Cloth.
Cup (used for washing) 3½ inches in diameter and 2 inches deep.

Washing dishes in a pan. Pan--16 inches in diameter and 4 inches deep.
Same utensils as for washing dishes in a sink.

Rolling. Rolling pin--19 inches long. Two handles; distance from table to top of handle 1½ inches.
Pie crust 10 inches in diameter placed not less than 1½ inches from front edge of work surface; made of cardboard.

Stirring in a bowl. Bowl same as used for beating.
Wooden spoon with bowl 4 inches long and handle 10 inches long.

Frying. Frying pan--8½ inches in diameter, 2 inches deep; handle 8½ inches long.
Pancake 5½ inches in diameter and made of blotting paper.
Spatula with blade 6 inches long and 2½ inches wide; handle 4½ inches long.

Stirring in a double boiler. Double boiler 7¼ inches high. Top of boiler 5½ inches deep. Handles 5½ inches long.
Wooden spoon same as used for stirring in a bowl.

Eating at a table. Card table 29 inches square and 26 inches high.
Chair same as used in measurements study with chair back in position.
Plate 8½ inches in diameter.
Knife and fork. (Knife used for first choices given by first twenty cases; used to cut cake as the girl would have cut meat).
Cakes--one for each girl giving judgments.

In addition to the equipment just listed, a yard-stick was used for measuring table heights and for taking the observation. A record sheet was also used for each subject in this study (See Exhibit II).

APPENDIX PART III

METHOD USED FOR DETERMINING WIDTHS BETWEEN UPPER AND LOWER CABINETS

In planning for the minimum distance between cabinets for the average cooperator in this study, the formula set up in the Oregon-Washington Purnell study (22, p. 54) was used as a basis for the determinations. This formula, $X = \frac{ab}{c}$ in which X= the minimum distance between the two cabinets, a= the eye level - one inch (posture correction) - height of working surface, b= width of the upper cabinet, and c= the width of the lower cabinet, may be used wherever deviations from the average heights of girls for this study would necessarily influence the planning of a foods laboratory. Hence, it is included here to aid in the application of this study.

APPENDIX PART IV

METHOD USED FOR DETERMINING RELATIONSHIP BETWEEN THIS STUDY AND OREGON-WASHINGTON PURNELL STUDY

In interpreting the relationship of statures for this study and the Oregon-Washington Purnell study, the X^2 (Chi square) formula (13, pp. 108-9) was used to determine how well the observed frequency distribution fits a theoretical distribution. In this case, the Oregon-Washington Purnell Study does not represent a theory, but is an actual distribution. The formula, $X^2 = \sum \frac{(f_o - f)^2}{f}$ is applied to the percentages shown in Figure 1; the first step involved in solving this formula is to get the f_o's and f's into similar terms--in this case, in relation to the 187 girls involved in this study. The solution for the problem follows:

Computation of X^2

Classes Heights in Inches	Number of girls f_o observed frequency	f theoretical frequency	fo-f	$(f_o-f)^2$	$\frac{(f_o-f)^2}{f}$
59	2	3	1	1	.33
60	6	5	1	1	.25
61	11	9	2	4	.44
62	19	16	3	9	.56
63	33	24	9	81	3.37
64	21	30	-9	81	2.70
65	24	30	-6	36	1.20
66	26	30	-4	16	.53
67	28	19	9	81	4.30
68	10	10	0	0	0.00
69	6	5	1	1	.20
70	1	6	-5	25	4.16
	187	187			18.04

$X^2 = 18.04$

Where f_o is the observed frequency distribution and represents this study and f is the theoretical or expected frequency and represents the Oregon-Washington Purnell study, the formula is solved by obtaining the difference between the two figures in each class of Figure 1, squaring the difference, dividing the difference squared by f and obtaining the sum of all results to obtain X^2. The significance of X^2 is determined from the use of a X^2 table. In using the table, the number of degrees of freedom is the number of classes less the number of constants in which the theoretical distribution has been forced to agree with the observed; in this case, it is one less than the number of

classes which were used in computation (for this problem, the figure is 11). If the figure obtained from the reading is greater than that obtained for X^2 in this study, the fit of the two studies is not good. For this study, X^2 was 18.04 while the reading from the table was 19.675 (13, p. 202). Thus, it may be seen that the differences between the statures for the two studies shows that there is goodness of fit between the two. Further, were as many cases used in this study as were used in the Oregon-Washington Purnell study, it may be assumed that a closer relationship between the results of the two studies would follow.

APPENDIX PART V

STUDY OF PHYSICAL MEASUREMENTS USED IN CALCULATION AND COMPARISON

This section deals with the results of physical measurements which were used in calculation of or comparison with certain other measurements related to this study.

According to Table 7, the average standing height of girls in this study was 64.95 inches. Figure 4 shows that the range in heights for the 187 girls was from 58-72.9 inches; of the two groups, the seniors included both the shortest and tallest girls.

Further, it may be seen from Figure 2 that 86 per cent of the senior group and 74.7 per cent of the freshmen are included in a range of heights from 62-67.9 inches. Of the 187 girls, 81.8 per cent are included in this range. Figure 2 indicates that the freshman group has more girls shorter than 62 inches than has the senior group, but it also has a greater number of cases above 67.9 inches. This accounts for the fact that a smaller number of girls is to be found within the height range from 62-67.9 inches than is to be found among the seniors. The difference becomes less significant in determining standards since it does not indicate a need for separate standards for the classes.

The difference between standing height and the eye level was used in calculating the eye level in the sitting position. From Table 7 it will be seen that the average height of the eye level taken at the lower eyelid for the freshmen group was 60.03 and for the seniors, 60.50 inches. Figure 2 indicates that 76 per cent of the seniors have an eye level at standing height of from 58-62 inches and that 71.4 of the freshmen show the same range. The actual range for the two groups was 53-67 inches and the average was 60.28 inches.

The measurement of the shoulder height from the floor

was used in the calculation of the shoulder height in the sitting position. Table 7 indicates that the average shoulder height for the entire group was 53.99 inches. From Figure 2 it may be seen that 79.4 per cent of the freshmen and 87 per cent of the seniors had shoulder heights of 51-56.9 inches. The measurement for shoulder height was also used with wrist height in determining the arm length for all the girls.

The height of the underforearm was used in determining the underforearm height in the sitting position. Table 7 indicates that the average height of the underforearm was 40.36 inches for the entire group. Figure 2 shows that the underforearm heights for 82.8 per cent of the freshmen and 89 per cent of the seniors were from 38-42.9 inches.

The difference between wrist height and shoulder height determined the arm length for each girl. Table 7 shows that the average wrist height for the 187 girls was 33.76 inches from the floor. From Figure 2 it may be seen that the wrist heights for 85.1 per cent of the freshmen and 80 per cent of the seniors were from 31-34.9 inches.

The measurement for sitting height was not important in itself but was necessary for use in calculations.

Table 7 shows that the average sitting height for the 187 cases was 33.60 inches. Figure 3 indicates that 76 per cent of the freshmen and 75 per cent of the seniors had sitting heights between 32-34.9 inches.

Measurements which were calculated from sitting height were eye level, shoulder and underforearm heights. The heights for eye level and shoulder were not used in the body of the thesis but were used in the comparison study in connection with opinions of girls as to table heights for eating purposes.

Tables III and IX indicate that 80.4 per cent of the freshmen and 89 per cent of the seniors had eye levels 27-29.9 inches above the chair seat. Table 7 indicates that the average eye level for the 187 girls was 28.91 inches.

From Table 7 it will be seen that the average shoulder height for the two groups was 22.64 inches. Tables III and IX show that 78.1 per cent of the freshmen and 80 per cent of the seniors had shoulder heights from 21-23.9 inches.

The forearm measurement was useful in determining the thickness of the table top. Table 7 indicates that the average height for the underforearm was 9.04 inches. From Figure 3 it will be seen that 96.6 per cent of the freshmen and 96 per cent of the seniors had forearm heights 7-10.9 inches from the chair seat.

The height of the thigh over the chair seat was used with the underforearm measurement to determine the thickness of the table top. From Table 7 it will be seen that the average height of thigh was 5.53 inches above the chair seat. Figure 3 indicates that 63.2 per cent of the freshmen and 60 per cent of the seniors had thigh heights 5-5.9 inches above the chair seat.

Weight was obtained for each girl in this study because it might furnish reasons for variations in certain physical measurements and might aid in determining dimension standards where the size of the girl would necessarily influence what choice might be made as to dimensions for the entire group. From Table 7 it will be seen that weights of girls ranged from 70-230 pounds. Further, the average weight for the freshmen was 119.16 pounds and for the seniors, was 126.40 pounds. For the total group, the average was 123.02 pounds.

Physical measurements which were used in comparison or calculation and which were not treated in the body of the thesis are described in this section in order to show their relationship and importance to the entire study.

APPENDIX PART VI

COMPARISON OF PREFERRED HEIGHTS AND PHYSICAL MEASUREMENTS

A comparison of preferred heights with certain physical measurements of girls is of interest to this study in determining whether any actual relationship exists between the two or whether the heights selected by girls in this study were dependent upon their likes and dislikes rather than on their related physical measurements. Since postures of the girls influence their choice, it is of importance to note that, while posture standards were set for the girls in introducing this study to them, the investigator did not refer to these standards again excepy in cases which were the result of careless posture habits.

Table XVI was devised in order to show the relationship between preferred heights and certain physical measurements in this study.

Table XVI. Relation Between Preferred Heights and Average Physical Measurements

Preferred Height in Inches	Average Preferred Height	Number Cases	Stature	Eye Level	Shoulder	Forearm	Wrist	Arm Length
			Beating Eggs					
28	28.38	8	64.17	59.64	53.17	39.51	32.21	20.95
29	29.27	11	63.93	59.25	53.02	39.50	32.19	20.83
30	30.41	16	64.44	59.71	53.77	40.29	33.02	20.75
31	31.36	14	65.13	60.41	53.93	40.30	32.87	21.12
32	32.25	6	65.68	60.87	54.39	41.17	33.44	20.95
33	33.25	4	65.62	60.95	54.70	40.89	33.51	21.18
34	34.50	1	67.65	62.95	56.25	42.60	34.95	21.30
			Washing Dishes in Sink					
26	26.50	4	62.71	58.22	51.58	38.80	31.91	19.66
27	27.33	6	64.62	59.81	53.48	40.02	32.35	21.12
28	28.39	22	64.35	59.70	53.62	40.05	32.72	20.90
29	29.21	12	64.39	59.63	53.59	39.91	32.63	20.96
30	30.29	12	65.27	61.38	54.99	41.17	33.64	21.19
31	31.16	3	65.72	61.03	54.40	40.58	33.20	21.20
32	32.00	1	66.35	62.10	55.70	41.40	33.50	22.20
			Washing Dishes in Pan					
28	28.00	1	63.55	58.20	51.80	39.40	31.70	20.10
29	29.50	2	64.52	59.65	53.05	39.32	32.20	20.85
30	30.44	8	64.65	60.00	53.61	39.92	32.53	21.07
31	31.31	16	63.97	61.79	53.35	39.83	32.56	20.79
32	32.32	20	64.66	60.09	53.69	40.32	32.90	21.78
33	33.22	9	66.09	61.22	54.99	41.02	33.47	21.52
34	34.16	3	64.93	60.05	53.60	39.98	32.80	20.80
35	35.50	1	67.65	62.95	56.25	42.60	34.95	21.30

Table XVI. Relation Between Preferred Heights and Average Physical Measurements (continued)

Preferred Height in Inches	Average Preferred Height	Number Cases	Stature	Eye Level	Shoulder	Forearm	Wrist	Arm Length
				Rolling				
30	30.33	3	64.08	59.18	52.78	39.15	32.18	20.60
31	31.50	5	64.43	59.91	53.83	40.38	32.99	20.83
32	32.42	16	63.98	59.34	53.20	39.78	32.43	20.77
33	33.33	15	65.22	60.46	54.24	40.54	33.09	21.15
34	34.18	11	64.47	59.72	53.45	39.96	32.54	20.90
35	35.30	6	66.08	61.34	54.92	41.18	33.79	21.12
36	36.00	3	64.66	60.03	53.60	40.26	33.01	20.58
37	37.00	1	67.30	62.35	56.00	41.35	33.35	22.65
				Stirring in Bowl				
29	29.50	1	63.40	59.45	53.60	39.35	31.20	22.40
30	30.44	8	64.17	59.41	53.02	39.56	32.45	20.56
31	31.33	12	64.09	59.49	53.47	39.85	32.44	21.03
32	32.36	18	64.87	60.20	53.76	40.29	32.93	20.83
33	33.23	11	64.03	59.32	53.03	39.81	32.48	20.55
34	34.16	3	66.85	61.88	55.85	41.52	33.62	22.23
35	35.21	7	66.48	61.67	55.46	41.58	34.14	21.32
				Stirring in Double Boiler				
28	28.00	1	63.45	58.50	52.10	38.80	32.05	20.05
29	29.50	1	65.20	59.95	53.05	39.55	32.50	20.50
30	30.21	9	63.15	58.52	52.30	38.83	31.62	20.78
31	31.38	21	64.43	59.84	53.46	40.06	32.75	20.71
32	32.44	16	64.83	60.13	54.14	40.47	33.11	21.03
33	33.40	5	66.65	61.78	55.04	41.46	33.86	21.18
34	34.00	5	66.27	61.25	55.24	41.31	33.46	21.78
35	35.25	2	65.92	61.55	54.92	41.15	33.80	21.12

Table XVI. Relation Between Preferred Heights and Average Physical Measurements (continued)

Frying

Preferred Height in Inches	Average Preferred	Number	Stature	Eye Level	Shoulder	Forearm	Wrist	Arm Length
29	29.50	1	65.65	60.70	54.75	40.70	33.30	21.45
30	30.33	3	64.55	59.76	53.76	40.15	33.02	22.42
31	31.43	7	64.58	59.72	53.24	39.48	32.19	21.03
32	32.40	20	63.91	59.46	53.15	39.84	32.44	20.71
33	33.40	10	64.80	60.10	54.02	40.52	33.23	20.80
34	34.23	11	65.19	60.44	54.15	40.50	33.13	20.03
35	35.30	5	65.82	60.82	54.21	40.56	32.87	21.34
36	36.00	3	66.53	61.60	55.78	41.63	34.08	21.69

From Table XVI it may be seen that there is some variation in the comparison of preferred heights with those of average physical measurements. From the data given in Table XVI, Table XVII was constructed to show the differences between average body measurements and preferred heights.

Table XVII. Differences Between Average Body Measurements and Preferred Heights for Various Activities

Height of Work Surface	Stature	Eye Level	Shoulder	Forearm	Wrist
		Beating Eggs			
28	36.17	31.64	25.17	11.51	4.21
29	34.93	30.25	24.02	10.50	3.19
30	34.44	29.71	23.77	10.29	3.02
31	34.13	29.41	22.93	9.30	1.87
32	33.68	28.87	22.39	9.17	1.44
33	32.62	27.95	21.70	7.89	.51
34	33.65	28.95	22.25	8.60	.95
		Washing Dishes Sink			
26	36.71	32.22	25.58	12.80	5.91
27	37.62	32.81	26.48	13.02	5.35
28	36.35	31.70	25.62	12.05	4.72
29	35.39	30.63	24.59	10.91	3.63
30	35.27	31.38	24.99	11.17	3.64
31	34.72	30.03	23.40	9.58	2.20
32	34.35	30.10	23.70	9.40	1.50
		Washing Dishes in Pan			
28	35.55	30.20	23.80	11.40	3.70
29	35.52	30.65	24.05	10.32	3.20
30	34.65	30.00	23.61	9.92	2.53
31	32.97	30.79	22.35	8.83	1.56
32	32.66	28.09	21.69	8.32	.90
33	33.09	28.22	21.99	8.02	.47
34	30.93	26.05	19.60	5.98	-1.20
35	32.65	27.95	21.25	7.60	- .05
		Rolling			
30	34.08	29.18	22.78	9.15	2.18
31	33.43	28.91	22.83	9.38	1.99
32	31.98	27.34	21.20	7.78	.43
33	32.22	27.46	21.24	7.54	.09
34	30.47	25.72	19.45	5.96	-1.46
35	31.08	26.34	19.92	6.18	-1.21
36	28.66	24.03	17.60	4.26	-2.99
37	30.30	25.35	19.00	4.35	-3.65
		Stirring in Bowl			
29	34.40	30.45	24.60	10.35	2.20
30	34.17	29.41	23.02	9.56	2.45
31	33.09	28.49	22.47	8.85	1.44
32	32.87	28.20	21.76	8.29	.93
33	31.03	26.32	20.03	6.81	- .52
34	32.85	29.88	21.85	7.52	- .38
35	31.48	26.67	20.46	6.58	- .86

Table XVII. (continued) Differences Between Average Body Measurements and Preferred Heights for Various Activities

Height of Work Surface	Stature	Eye Level	Shoulder	Forearm	Wrist
		Stirring in Double Boiler			
28	35.45	30.50	24.10	10.80	4.05
29	36.20	30.95	24.05	10.55	3.50
30	33.15	28.52	22.30	8.83	1.52
31	33.43	28.84	22.46	9.06	1.75
32	32.83	28.13	22.14	8.47	1.11
33	33.65	28.78	22.04	8.46	.86
34	32.27	27.25	21.24	7.31	- .54
35	30.92	26.55	19.92	6.15	-1.20
		Frying			
29	36.65	31.70	25.75	11.70	4.30
30	34.55	29.76	23.76	10.15	3.02
31	33.58	28.72	22.24	8.48	1.19
32	31.91	27.46	21.15	7.84	.44
33	31.80	27.10	21.02	7.52	.23
34	31.19	26.44	20.15	6.50	- .87
35	30.82	25.82	19.21	5.56	-2.13
36	30.53	25.60	19.78	5.63	-1.92

From Table XVII it may be more clearly seen the relationship between body measurements and preferred heights. Because of the small number of cases included in this study, variations in differences between preferred heights and average body measurements are greater. This study is not without significance, however, since it shows that relationship is fairly constant between each body measurement as it concerns each preferred height.

From Table XVII, Table XVIII was devised to show the differences between the smallest and greatest measurements in each section of the table.

Table XVIII. Differences Between Smallest and Greatest Measurements in Each Section of Table (Based on Table XVII)

Activity	Maximum Variation in Given Measurements				
	Stature	Eye Level	Shoulder	Forearm	Wrist
Beating Eggs	3.55	3.69	3.47	3.62	3.70
Washing Dishes in Sink	3.27	2.78	3.08	3.62	4.41
Washing Dishes in Pan	4.62	4.60	4.45	5.42	4.90
Rolling	2.78	4.83	5.23	5.12	5.83
Stirring in Bowl	3.37	4.13	4.57	3.77	3.31
Stirring in Double Boiler	5.28	4.40	4.18	4.65	5.25
Frying	6.12	6.10	6.54	6.14	6.43

Table XVIII shows that the least variation in differences in the given measurements occurred in beating eggs and in frying. The remaining activities showing the least differences are in order as follows: washing dishes in a pan, stirring in a bowl, stirring in a double boiler, washing dishes in a sink and rolling.

Table XIX was devised to show the relationship between various physical measurements taken in the sitting position with preferred heights for tables for eating purposes.

Table XIX. Relationship of Physical Measurements to Preferred Heights for a Table Used for Eating Purposes

Preferred Height	Av. Ht.	No. Cases	Sitting Height	Eye Level	Shoulder Height	Forearm Height	Arm Length	Under Knee	Thigh Height	Hip Height
23	23.4	10	49.06	44.45	38.10	24.78	20.54	16.66	21.44	24.21
24	24.28	16	49.59	44.91	38.47	25.29	20.55	16.94	21.51	24.61
25	25.35	23	49.49	44.90	38.80	25.10	21.28	17.15	21.48	24.87
26	26.2	10	49.76	45.01	38.62	24.99	21.01	17.62	21.48	24.52
27	27.5	1	51.80	46.70	39.45	24.95	22.25	17.15	22.00	25.40

From the data in Table XIX, Table XX was set up to show the differences between average body measurements and preferred heights and the maximum variation in given measurements.

From these tables, it may be seen that physical measurements alone do not determine the choices as to table heights. The least maximum variation in differences between physical measurements and preferred heights was 2.30 inches for sitting height. Table XX shows that the least difference between any preferred height and average physical measurement was that between the height of 25 inches and the forearm of .10 inches.

Table XX. Differences Between Average Body Measurements and the Preferred Height for a Table for Eating

Pref. Height	Sitting	Eye	Shoulder	Forearm	Knee	Thigh	Hip
23	26.06	21.45	15.10	1.78	-6.34	-1.56	1.21
24	25.59	20.91	14.47	1.29	-7.06	-2.49	.61
25	24.49	19.90	13.80	.10	-7.85	-3.52	.13
26	23.76	19.01	12.62	-1.01	-8.38	-4.52	-1.48
27	24.80	19.70	12.45	-2.05	-9.85	-5.00	-1.60

Figure VIII shows the differences between average wrist heights and preferred heights for beating, rolling, stirring in a bowl and washing dishes in a pan and in a sink, respectively.

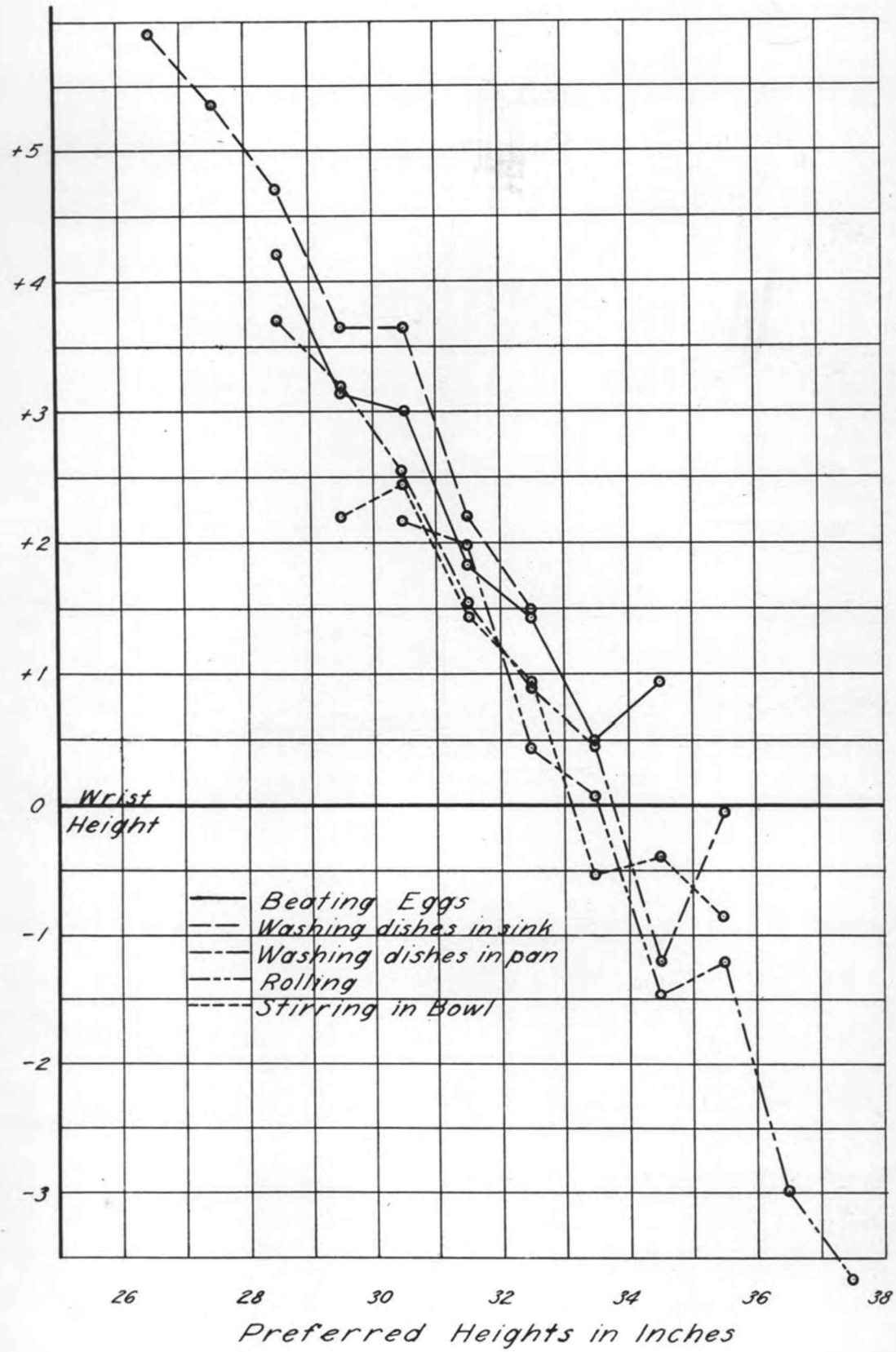


Figure VIII Differences Between Average Preferred Activity Heights and Average Wrist Heights.

From Figure VIII it will be seen that the variation between heights selected by the taller and shorter girls agrees with the Oregon-Washington Purnell study (21, p. 30) that taller girls tend to select working levels lower than their wrist heights and shorter girls tend to select higher levels than their wrist heights.

Whether a selected height bears any constant relationship to body measurements may be seen by testing the validity of certain "rules of thumb" (21, p. 89). Table XXI was set up to show the differences in inches between preferred heights for washing dishes in a pan and average heights of various physical measurements related to certain "rules of thumb" for the sixty cooperators in this study.

Table XXI. Differences in Inches Between Preferred Heights for Washing Dishes in a Pan and Average Heights of Various Physical Measurements for Sixty Co-operators.

Preferred Height In Inches	Cooperators Classed as to One-half Standing Height	Wrist Height	8" below Forearm
28	3.78	3.70	3.40
29	3.26	3.20	2.32
30	2.32	2.53	1.92
31	.98	1.56	.83
32	.33	.90	.32
33	.04	.47	.02
34	-1.54	-1.20	-2.02
35	-1.18	- .05	- .40

From Table XXI, Figure IX was devised to show a graphic representation of the relationship of the differences between preferred heights and body measurements to which rules of thumb have been applied.

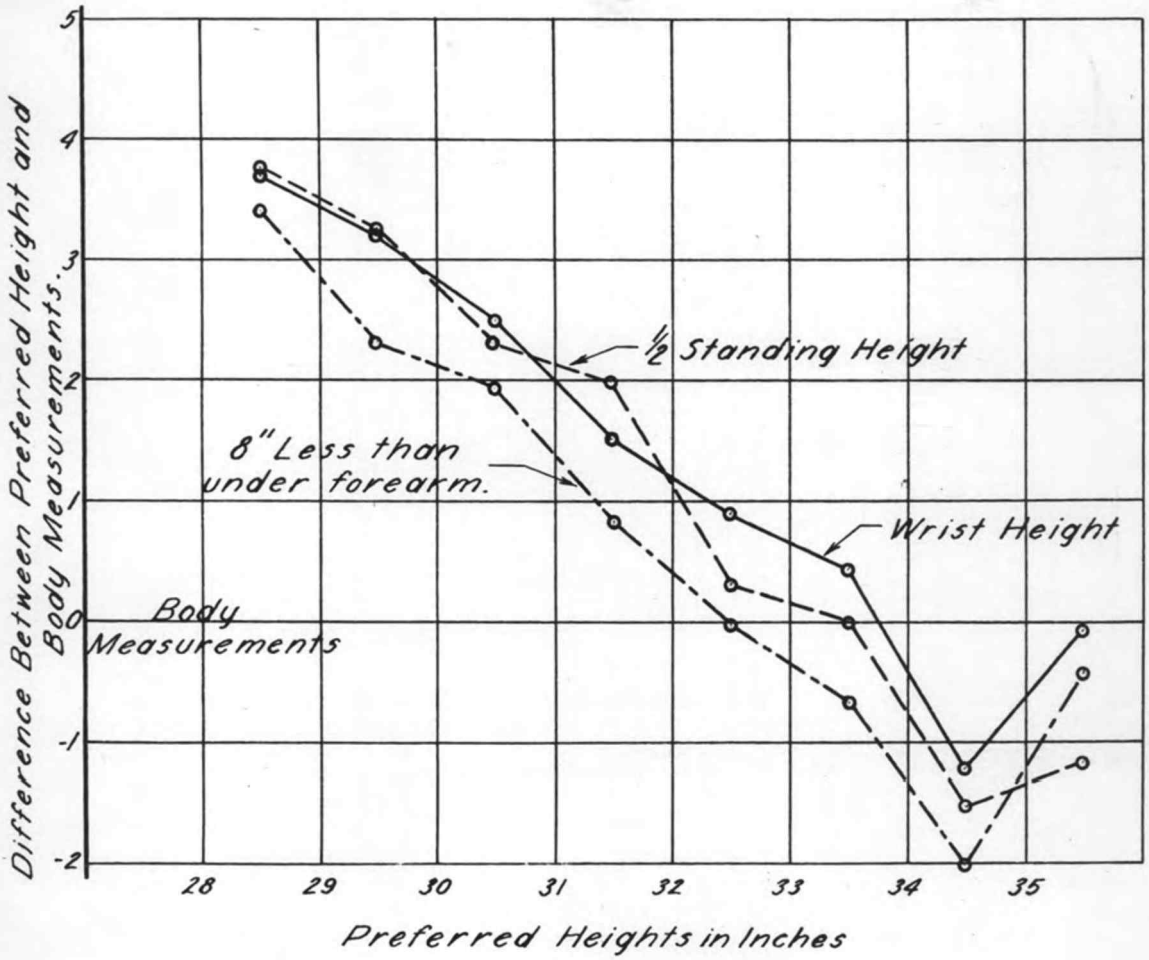


Figure IX Differences Between Average Preferred Heights for Washing Dishes in a Pan and Average Body Measurements.

In comparing the relationships between the preferred table height for washing dishes in a pan and body measurements such as wrist height, one-half standing height and a height eight inches lower than the under forearm, Figure IX shows that except for the higher preferred heights, the height eight inches below the under forearm has the greatest correlation with preferred heights for dishwashing.

Further, Figure IX shows a marked relationship among the body measurements as influenced by the rules of thumb for each preferred height.

From this study on a comparison of related physical measurements with preferred activity heights it may be seen that a definite relationship exists between the two. Maximum variations in the relationship between physical measurements and preferred heights were consistent for the activity concerned. It was found from an analysis of the relationship of wrist height with activity heights that taller girls tend to select working surfaces lower than their wrist heights and the shorter girls, higher than their wrist heights. An application of the various rules of thumb to the preferred heights for dish washing indicated that a table height eight inches less than the underforearm corresponded rather closely with the preferred height for dishwashing.

APPENDIX PART VII

SUMMARY OF LITERATURE

As has been previously stated, literature dealing with dimension standards for high school foods laboratories was not adequate; either standards given were not sufficient or they were without authority. Thus, the purpose of this study was to provide adequate standards where the literature available had failed. A summary of opinions of various authors and agencies as to what dimension standards should be set up for a high school foods laboratory follows:

Vocational Education Bulletin No. 181, "Space and Equipment for Homemaking Instruction", gives the most complete standards available to the investigator. While this bulletin gives the lateral measurements and full descriptions of various types of stoves, it does not set up any standards for the height of the stove. It gives the same type of information adding that "recommended heights for sinks of six-inch depths are 32 to 34 inches from the top of the sink to the floor in junior high schools, and from 36-39 inches in senior high schools." (7, p. 55). Heights for cabinets for use while the worker is standing range "from 30 to 34 inches for junior high school pupils and from 34-38 inches for senior high school pupils." (7, p. 58). It further

states that "since it is impossible in equipping a home-making laboratory to provide for the correct height of working surfaces for each individual who may use them, the heights determined upon should be based upon the average for the students who will use the laboratories." (7, p. 58-59).

Other space requirements set up in this bulletin are as follows: a working area of five feet at cabinets for two pupils, a working area of four feet between desks or tables when used for seating on both sides or for passage-way, a passageway of three feet between furniture and walls when used by only one pupil for sitting or standing, and a passageway of three feet on each side of the dining or breakfast table for seating or serving (7).

Melvin Brodshaug recommends that heights for the bottom of the sink range from 25 to 26 inches in the junior high school and from 26 to 28 inches in the senior high school. He recommends that tables in the junior high school be from 30 to 32 inches in height and that those in the senior high school be from 32 to 34 inches high. (2, p. 96).

That "the height of working surfaces should be based upon the average height for students who will use the laboratories" is the standard proposed by Campbell (3,P1073). This author suggests that a 33-inch table and a 34-inch sink be provided the girl five feet two inches. A 35-inch

table and sink would be adequate for a girl five feet four inches tall and a 38-inch table and sink should be provided for the girl five feet six inches tall. Heywood and Osburn (6, p. 20) give similar standards; they recommend that tables be from 32 to 33½ inches high, that sinks be from 29 to 32 inches high and that stoves be from 32 to 33½ inches high for workers from five to five feet eight inches tall.

Freegard advises that general class work tables be not over 30 inches high (4, p. 436). This author assumes that students be seated on chairs with seats 17 inches high while working. Helen Hawkins states that all work surfaces be 36 inches high to provide optimum working conditions for the high school pupils (5).

That sinks and cabinets be 25½ inches wide is the standard set by M. Brennan in an article on plumbing requirements for the high school foods laboratory (1).

While many more articles may be found pertaining to the planning and equipping of homemaking departments, they give no dimensions which might pertain to or be of value to this study.

This section has presented a summary of the dimension standards found in literature pertaining to high school foods laboratories. The bases upon which these standards have been evolved was not determined by the investigator in this study.

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