NASA
Reference
Publication
1304

1993

Anthropometric Survey of the Astronaut Applicants and Astronauts From 1985 to 1991

Sudhakar L. Rajulu, Ph.D.
Lockheed Engineering & Sciences Company
Houston, Texas

Glenn K. Klute, M.S.
Anthropometry & Biomechanics Lab
Lyndon B. Johnson Space Center
Houston, Texas

National Aeronautics and
Space Administration

Contents

Figures

Tables

Acknowledgments

This study was supported by Contract No. NAS9-17900 from the National Aeronautics and Space Administration and was conducted in the Anthropometry and Biomechanics Laboratory at the Johnson Space Center in Houston, Texas. This work was initiated from an original effort to collect astronaut anthropometric data by William E. Thornton, MD., John T. Jackson, and Gene Coleman, Ph.D., during the period from 1977 to 1979. Anthropometric data were not collected from 1980 to 1984. Individuals who contributed to the data collected from 1985 to 1991 include: Jim Stramler, Ph.D., Ralph Wemhoff, John Probe, Lauren Schafer, and Amy Carroll.

Abstract

The Anthropometry and Biomechanics Laboratory at the Johnson Space Center has been collecting anthropometric data from astronaut applicants since 1977. These anthropometric data include various body measurements. As of January 1992, anthropometric measurements had been taken from 473 applicants. Based on the position they applied for, these applicants were classified as either mission specialists, payload specialists, pilots, or observers. The main objective of this report was to document the variations among these applicants and tabulate the percentile data for each anthropometric dimension. The percentile and the descriptive statistics data were tabulated and graphed for the whole astronaut candidate population; for the male and female groups; for each subject classification such as pilot, mission specialist, and payload specialist; and finally, for those who were selected as astronauts.

1.0 Introduction

The Anthropometry and Biomechanics Laboratory (ABL) at the Johnson Space Center has been collecting anthropometric data from the astronaut applicants[1] since 1977. This work was initiated originally by William E. Thornton, MD., John T. Jackson, and Dr. Gene Coleman. They were instrumental in helping the National Aeronautics and Space Administration (NASA) to collect and use anthropometric and strength data in the space program. In 1985, it was decided by NASA to collect anthropometric and strength data from the astronaut applicants during the selection process. As of January 1992, 14 anthropometric measurements had been taken from a total of 473 subjects.

The astronaut applicants were classified under the position they were applying for, such as pilot, mission specialist, or payload specialist. Out of these 473 applicants, 82 were selected as astronauts. This report is based on the anthropometric data base of the astronaut applicants as well as the astronauts.

There are several benefits to collecting the anthropometric data. For instance, the data base contains information that can be used while designing a workplace or equipment. Human factors engineers and others who are involved with the design aspects of the Space Shuttle, and other space-related projects, have to ensure that the work space and equipment allow easy accessibility to the astronauts. Providing easy accessibility requires accommodating wide variations in body dimensions. For example, NASA requires that a design be able to accommodate a 5th percentile Japanese female and a 95th percentile American male. This percentile information is currently obtained from NASA Reference Publication 1024 (Webb Associates, 1978), or the NASA-STD-3000. While it is necessary to include the 5th percentile Japanese female and the 95th percentile American male, the cost of providing such wide variations in the design of equipment and workspace at times could be astronomical (example: design of the pilot seat and the cockpit module). In such cases, it is cost effective to use information that is specific with respect to the people who will be using the work space and the equipment more frequently. Under these circumstances, it is necessary to have percentile information that is specific to a particular assignment or position to which an astronaut has been designated. Hence, the percentile data for each subject classification will help reduce the cost of designing workspaces and equipment.

---

[1] Astronaut applicant is the title given to an individual who is applying for a position as a NASA astronaut. If the astronaut applicant is selected for astronaut training, the individual is given the title of astronaut candidate. After completing one year of astronaut training, the individual is given the title of astronaut. In this report, the candidates were lumped together with the astronauts as a group.

2.0 Objectives

The major objective of this study was to tabulate the percentile information on various anthropometric characteristics for the whole astronaut applicant population, for the male and female groups, and for each subject classification. The percentile information included 1st, 5th, 10th, 50th, 90th, 95th, and 99th percentiles.

3.0 Methodology

3.1 Subjects

Anthropometric measurements were taken from a total of 473 subjects. There were 399 males and 74 females. Of those 473 applicants, 297 applied for the mission specialist position, 47 for the payload specialist position, and 120 for the pilot position. The remaining 9 applicants were those who were selected as observers. Table 1 provides a breakdown of the subjects. Only 82 of these applicants were chosen by the selection committee as astronauts. The final selection included 12 female and 42 male mission specialists, 1 female[1] and 28 male pilots, and 9 observers[2].

Table 1. Subject Classification

Subject Pool	Male	Female	Total
Mission Specialist	236	61	297
Payload Specialist	42	5	47
Pilot	118	2	120
Observer	3	6	9
Total	399	74	473

3.2 Apparatus

The body dimensions were measured with the GPM anthropometer (fig. 1). The GPM anthropometer (Seritex Inc., Carlsdat, NJ) is a specially designed instrument

---

[1] Since there was only one female pilot, statistics were not performed for the female pilot category.

[2] Observers are those selected by NASA to fly with the crewmembers. Since there were only 9 observers, statistics were not performed on the observers' data.

that measures body dimensions accurately to one tenth of a centimeter. The anthropometer was used extensively to measure various heights and body segment lengths. A weighing scale was used to measure the weight of the subjects.

3.3 Experimental Design

The anthropometric data were collected from each subject in the same sequence. The data collection included 14 body dimensions, weight, and the age of the subjects. These measurements are tabulated in Table 2.

Table 2. Anthropometric Measurements Taken from the Astronaut Applicants

Age	Arm length
Weight	Upper arm length
Standing height	Forearm length
Sitting height	Hand length
Sitting eye height	Buttock-knee length
Waist height	Foot length
Crotch height	Bideltoid breadth
Popliteal height	Hip breadth

3.4 Experimental Procedure

The subjects were tested at the ABL, in Building 29, at the Johnson Space Center. The subjects wore shorts and a t-shirt during data collection. First, their weights were taken without their shoes. Their standing height, arm length, waist height, and crotch height were taken with the subjects standing in an erect posture. Their sitting height, sitting eye height, popliteal height, forearm length, shoulder to elbow length, hand length, and foot length were measured with the subjects sitting on a bench. The bideltoid breadth and hip breadth were then taken with the subjects in a standing posture. Appendix A contains pictures showing each measurement procedure. Their birth date, nationality, sex, and the position they were applying for were also obtained from them during data collection. All information was recorded on a standard form along with the test date and an identification number that was assigned to each subject.

3.5 Data Treatment

The anthropometric data as well as the subjects' classification data were entered into a data base. The compiled data were then sent electronically to the mainframe computer for statistical analyses.

3.6 Statistical Analyses

Statistical analyses were first performed on the data to identify any typographical errors. Skewness and kurtosis were used to locate any spurious data within the data set. Once errors were identified and removed or modified, statistics were performed on the whole astronaut candidate population data. Then statistics were performed on the male population and on the female population. The next analysis divided the data into different subject classifications. Within each classification statistics were performed for male and female groups separately. Finally, statistics were performed on the data from the subjects who were selected as astronauts.

Descriptive statistics included the mean, standard deviation, minimum, maximum, skewness, kurtosis, 1st percentile, 5th percentile, 10th percentile, 50th percentile, 90th percentile, 95th percentile, and 99th percentile.

4.0 Results

Tables 3 and 4 present the statistics and percentile data for the whole group. Tables 5 and 6 present the statistics and percentile data for the female applicants, and tables 7 and 8 present the statistics and percentile data for the male applicants. Figures 1 through 16 present the variations in the 5th, 50th, and 95th percentiles for each anthropometric dimension among the male, female, and the whole group.

Tables 9 and 10 present the statistics and percentile data for the mission specialist applicants. Tables 11 and 12 present the statistics and percentile data for the payload specialist applicants. Tables 13 and 14 present the statistics and percentile data for the pilot applicants. Figures 17 through 32 present the variations in the 5th, 50th, and 95th percentiles for each anthropometric dimension among the mission specialist, payload specialist, and pilot applicants.

Tables 15 and 16 present the statistics and percentile data for the female mission specialist applicants. Tables 17 and 18 present the statistics and percentile data for the male mission specialist applicants. Tables 19 and 20 present the statistics and percentile data for the female payload specialist applicants. Tables 21 and 22 present the statistics and percentile data for the male payload specialist applicants. Tables 23 and 24 present the statistics and percentile data for the male pilot applicants. There were no female pilot applicants.

Tables 25, 26, 27, and 28 present the statistics and percentile data for the female and male astronaut groups respectively. Because of a limited number of female astronauts, caution should be exercised when using the percentile data from tables 25 and 26.

Tables 29, 30, 31, 32, 33, and 34 present the statistics and percentile data for the female mission specialists, male mission specialists, and male pilots. These tables provide information that is specific to the astronaut position and are based on those who were selected as astronauts.

From these tables, it was observed that the males tended to be heavier (76 kg. vs. 58 kg., tables 5 and 7), older (39 yrs. vs. 38 yrs., tables 5 and 7), taller (178 cm. vs. 165 cm., tables 5 and 7), and reach farther (87 cm. vs. 79 cm., tables 5 and 7) than females.

Pilot applicants were comparatively heavier (77 kg., table 13) than the mission specialist (73 kg., table 9), and payload specialist applicants(72 kg., table 11).

Payload specialist applicants were older (44 yrs., table 11) than pilots (40 yrs., table 13) and mission specialist (38 yrs., table 9) applicants.

Pilot applicants were taller (179 cm., table 13) than mission specialist (176 cm., table 9) and payload specialist (175 cm., table 11) applicants. Additionally, the pilot applicants were larger in all anthropometric dimensions (table 13) when compared to other applicants (tables 9 and 11).

The female astronauts were heavier (62 kg. vs. 58 kg.), younger (36 yrs. vs. 38 yrs.), and taller (167 cm. vs. 165 cm.) than the female applicants (tables 5 and 25). The male astronauts were slightly lighter (75 kg. vs. 76 kg.), the same age (39 yrs.), and same height (178 cm.) when compared to the male applicant population (tables 7 and 27).

5.0 Discussion and Conclusions

The primary objective of this report was to document the statistics and percentile data for the whole astronaut applicant population as well as for different subject classifications. Tables were created to tabulate these results.

While care was taken to eliminate any errors, it should be kept in mind that the percentile data, as well as statistical data, are meaningful only when taken from a large sample of subjects. Hence, caution must be exercised when using percentile data that are based on less than 30 subjects.

TABLE 3
Descriptive Statistics on the Anthropometry of the Astronaut Applicants (1985 - 1991) Based on Whole Population.

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	310	73.42	10.210	45.00	105.90	-0.231	0.194
Age	466	39.10	4.892	26.00	63.00	0.691	1.720
HEIGHTS (cm.)							
Standing	473	176.39	7.864	150.40	192.80	-0.465	0.007
Sitting	472	92.57	3.922	81.70	102.30	-0.374	-0.187
Eye (sitting)	473	81.68	4.049	64.10	97.70	-0.308	0.759
Waist	473	104.93	5.370	90.30	118.50	-0.138	-0.252
Crotch	473	84.96	4.948	69.90	97.90	-0.166	0.065
Popliteal	473	44.36	2.514	30.90	50.50	-1.010	3.053
LENGTHS (cm.)							
Arm	473	85.41	4.670	71.90	97.70	-0.273	-0.023
Upper arm	473	36.88	2.405	31.00	48.50	0.828	3.224
Forearm	472	48.29	2.812	36.80	58.30	-0.510	0.654
Hand	473	19.08	1.100	15.25	23.00	-0.303	0.484
Buttock-Knee	470	60.60	3.103	48.10	69.70	-0.197	0.273
Foot	473	26.27	1.624	20.00	30.30	-0.519	0.264
BREADTHS (cm.)							
Bideltoid	471	45.03	3.847	34.70	54.30	-0.161	-0.537
Hip	473	34.62	2.330	29.20	47.90	1.090	3.883

TABLE 4
Anthropometric Percentile Data of the Astronaut Applicants (1985 - 1991) Based on Whole Population.

Anthropometric Variable	N	<---------- Percentile ----------> 1 st	5 th	10 th	50 th	90 th	95 th	99 th
Weight	310	47.17	54.41	59.01	74.10	85.45	89.28	95.77
Age	466	29.00	32.00	33.70	39.00	45.00	48.00	52.33
HEIGHTS (cm.)								
Standing	473	155.99	161.90	165.58	177.30	186.40	188.19	191.70
Sitting	472	83.29	85.19	86.96	93.00	97.10	98.50	100.87
Eye (sitting)	473	72.00	74.57	76.00	82.10	86.30	87.83	91.10
Waist	473	91.17	96.01	98.10	104.90	111.98	113.76	116.45
Crotch	473	71.74	76.20	78.94	85.10	91.20	92.93	96.80
Popliteal	473	36.29	40.40	41.57	44.60	47.40	48.13	49.13
LENGTHS (cm.)								
Arm	473	73.91	76.87	78.90	85.80	91.00	92.86	95.78
Upper arm	473	31.78	33.10	33.72	36.90	39.50	40.30	46.66
Forearm	472	41.00	42.76	44.30	48.70	51.70	52.30	53.49
Hand	473	16.20	17.07	17.70	19.15	20.30	20.72	21.53
Buttock-Knee	470	52.60	55.56	56.50	60.60	64.89	65.50	67.30
Foot	473	21.87	23.27	24.00	26.50	28.13	28.63	29.75
BREADTHS (cm.)								
Bideltoid	471	35.44	38.64	40.20	45.10	49.88	51.14	53.00
Hip	473	29.80	31.10	32.00	34.40	37.20	38.50	43.73

TABLE 5
Descriptive Statistics on the Anthropometry of the Astronaut Applicants (1985 - 1991) Based on Female Applicants.

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	44	57.54	6.885	45.00	78.10	0.577	0.640
Age	72	37.62	4.545	29.00	52.00	0.742	1.356
HEIGHTS (cm.)							
Standing	74	165.17	6.238	150.40	180.00	0.077	-0.282
Sitting	74	87.39	3.173	81.70	95.30	0.446	-0.533
Eye (sitting)	74	76.41	3.046	71.25	83.40	0.419	-0.627
Waist	74	99.08	4.470	90.30	110.80	0.086	-0.081
Crotch	74	78.90	3.919	69.90	88.50	-0.076	0.233
Popliteal	74	41.78	2.409	30.90	45.20	-1.571	4.604
LENGTHS (cm.)							
Arm	74	79.29	3.538	71.90	89.10	0.399	-0.074
Upper arm	74	34.18	1.489	31.00	37.90	0.236	-0.149
Forearm	74	44.36	2.200	39.75	50.30	0.590	0.182
Hand	74	17.57	0.870	15.25	19.50	-0.004	-0.012
Buttock-Knee	74	57.43	2.721	48.10	62.40	-0.537	0.900
Foot	74	23.94	1.162	21.50	27.10	0.332	0.342
BREADTHS (cm.)							
Bideltoid	74	40.52	2.849	34.70	47.90	0.032	-0.133
Hip	74	34.76	2.769	29.30	43.40	0.508	0.213

TABLE 6
Anthropometric Percentile Data of the Astronaut Applicants (1985 - 1991) Based on Female Applicants.

Anthropometric Variable	N	<---------- Percentile ----------> 1 st	5 th	10 th	50 th	90 th	95 th	99 th
Weight	44	45.00	46.86	48.26	57.30	67.32	69.52	78.10
Age	72	29.00	31.00	32.00	38.00	43.00	45.05	52.00
HEIGHTS (cm.)								
Standing	74	150.40	155.07	156.70	165.05	174.40	176.15	180.00
Sitting	74	81.70	83.04	83.53	87.00	92.25	93.06	95.30
Eye (sitting)	74	71.25	72.00	72.45	75.80	81.00	81.85	83.40
Waist	74	90.30	91.05	92.40	99.20	105.15	106.85	110.80
Crotch	74	69.90	70.97	73.85	79.40	83.45	85.47	88.50
Popliteal	74	30.90	37.45	38.15	42.30	44.35	45.10	45.20
LENGTHS (cm.)								
Arm	74	71.90	73.91	75.05	78.80	84.15	85.45	89.10
Upper arm	74	31.00	31.55	32.35	34.20	36.50	37.00	37.90
Forearm	74	39.75	41.15	41.95	44.00	47.60	48.60	50.30
Hand	74	15.25	16.17	16.50	17.65	18.70	19.23	19.50
Buttock-Knee	74	48.10	52.62	53.75	57.55	61.20	61.85	62.40
Foot	74	21.50	21.87	22.50	23.95	25.30	26.17	27.10
BREADTHS (cm.)								
Bideltoid	74	34.70	35.28	36.15	40.45	44.40	45.05	47.90
Hip	74	29.30	30.75	31.35	34.90	38.85	39.72	43.40

TABLE 7
Descriptive Statistics on the Anthropometry of the Astronaut Applicants (1985 - 1991) Based on Male Applicants.

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	266	75.98	8.141	56.80	105.90	0.311	0.357
Age	393	39.37	4.911	26.00	63.00	0.685	1.828
HEIGHTS (cm.)							
Standing	399	178.47	6.199	162.10	192.80	-0.068	-0.450
Sitting	398	93.53	3.236	84.70	102.30	-0.168	-0.022
Eye (sitting)	399	82.66	3.407	64.10	97.70	-0.179	2.470
Waist	399	106.01	4.797	92.10	118.50	-0.013	-0.345
Crotch	399	86.08	4.258	73.90	97.90	0.093	-0.030
Popliteal	399	44.83	2.228	33.30	50.50	-0.985	3.679
LENGTHS (cm.)							
Arm	399	86.54	3.912	71.90	97.70	-0.079	0.397
Upper arm	399	37.37	2.204	32.10	48.50	1.219	4.852
Forearm	398	49.03	2.253	36.80	58.30	-0.371	2.588
Hand	399	19.36	0.891	16.20	23.00	0.147	0.750
Buttock-Knee	396	61.20	2.798	51.60	69.70	-0.007	-0.077
Foot	399	26.70	1.299	20.00	30.30	-0.418	1.509
BREADTHS (cm.)							
Bideltoid	397	45.87	3.399	37.40	54.30	-0.085	-0.686
Hip	399	34.60	2.243	29.20	47.90	1.262	5.219

TABLE 8
Anthropometric Percentile Data of the Astronaut Applicants (1985 - 1991) Based on Male Applicants.

Anthropometric Variable	N	<---------- Percentile ----------> 1 st	5 th	10 th	50 th	90 th	95 th	99 th
Weight	266	57.41	62.90	66.30	75.00	86.24	90.22	96.41
Age	393	28.95	32.00	34.00	39.00	46.00	48.00	53.15
HEIGHTS (cm.)								
Standing	399	164.50	167.70	170.40	178.50	186.60	188.90	191.70
Sitting	398	85.54	87.70	89.00	93.60	97.41	98.90	101.05
Eye (sitting)	399	75.10	77.10	78.50	82.70	86.60	88.10	91.40
Waist	399	95.10	98.10	99.80	106.20	112.40	114.30	116.60
Crotch	399	76.20	79.50	80.60	86.10	91.50	93.50	96.80
Popliteal	399	36.50	41.60	42.10	45.10	47.60	48.20	49.50
LENGTHS (cm.)								
Arm	399	77.40	79.70	81.40	86.50	91.40	93.20	96.00
Upper arm	399	32.60	34.10	34.90	37.30	39.60	40.40	47.10
Forearm	398	42.60	45.49	46.30	49.00	51.90	52.60	54.00
Hand	399	17.30	17.90	18.30	19.30	20.50	20.80	21.60
Buttock-Knee	396	55.19	56.40	57.74	61.12	65.00	65.70	67.32
Foot	399	23.50	24.60	25.00	26.80	28.20	28.80	29.90
BREADTHS (cm.)								
Bideltoid	397	38.39	40.60	41.38	46.30	50.02	51.40	53.00
Hip	399	29.80	31.40	32.10	34.40	37.10	38.10	44.10

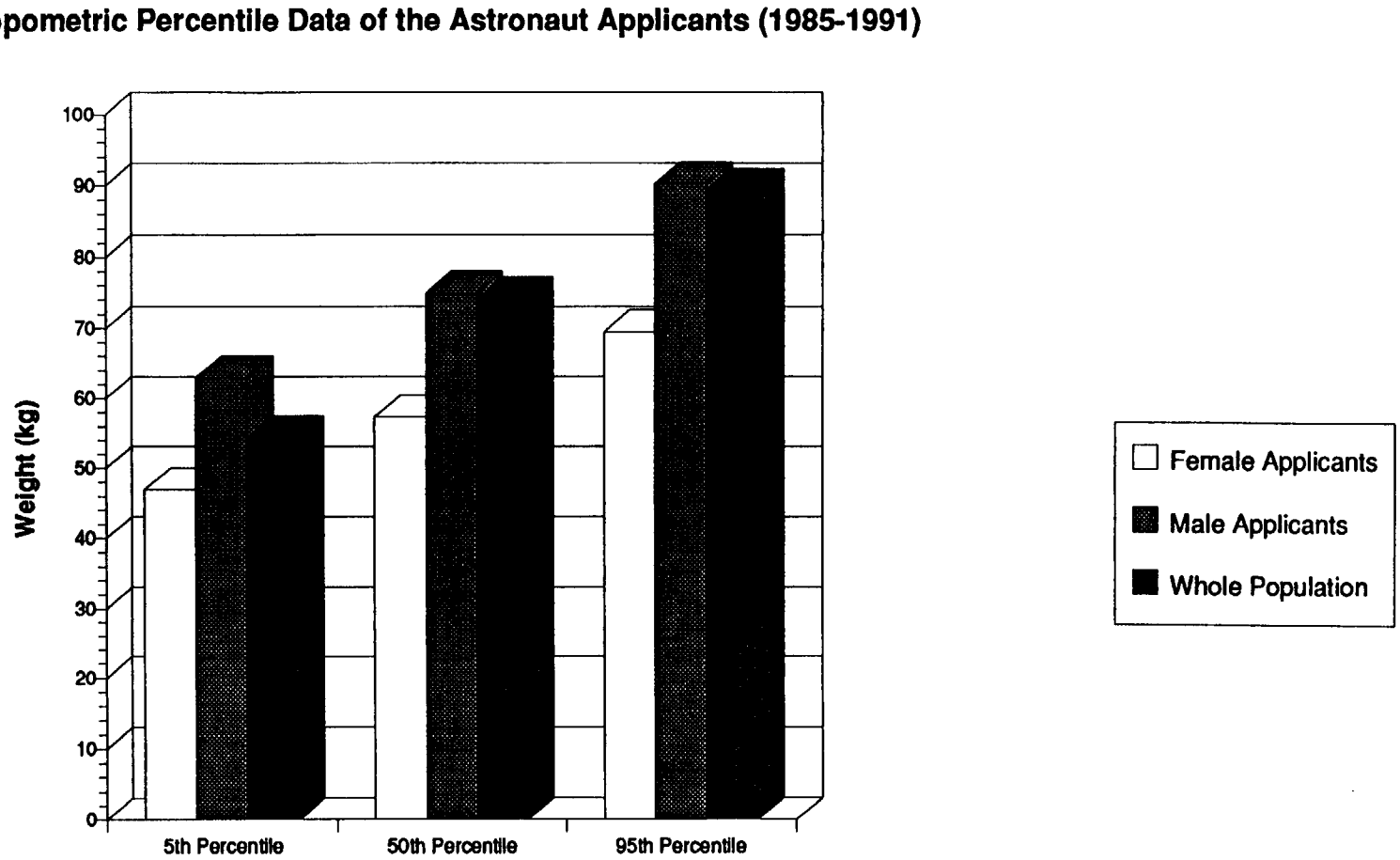

Figure 1. Differences in Weight Among Male Applicants, Female Applicants, and the Whole Population

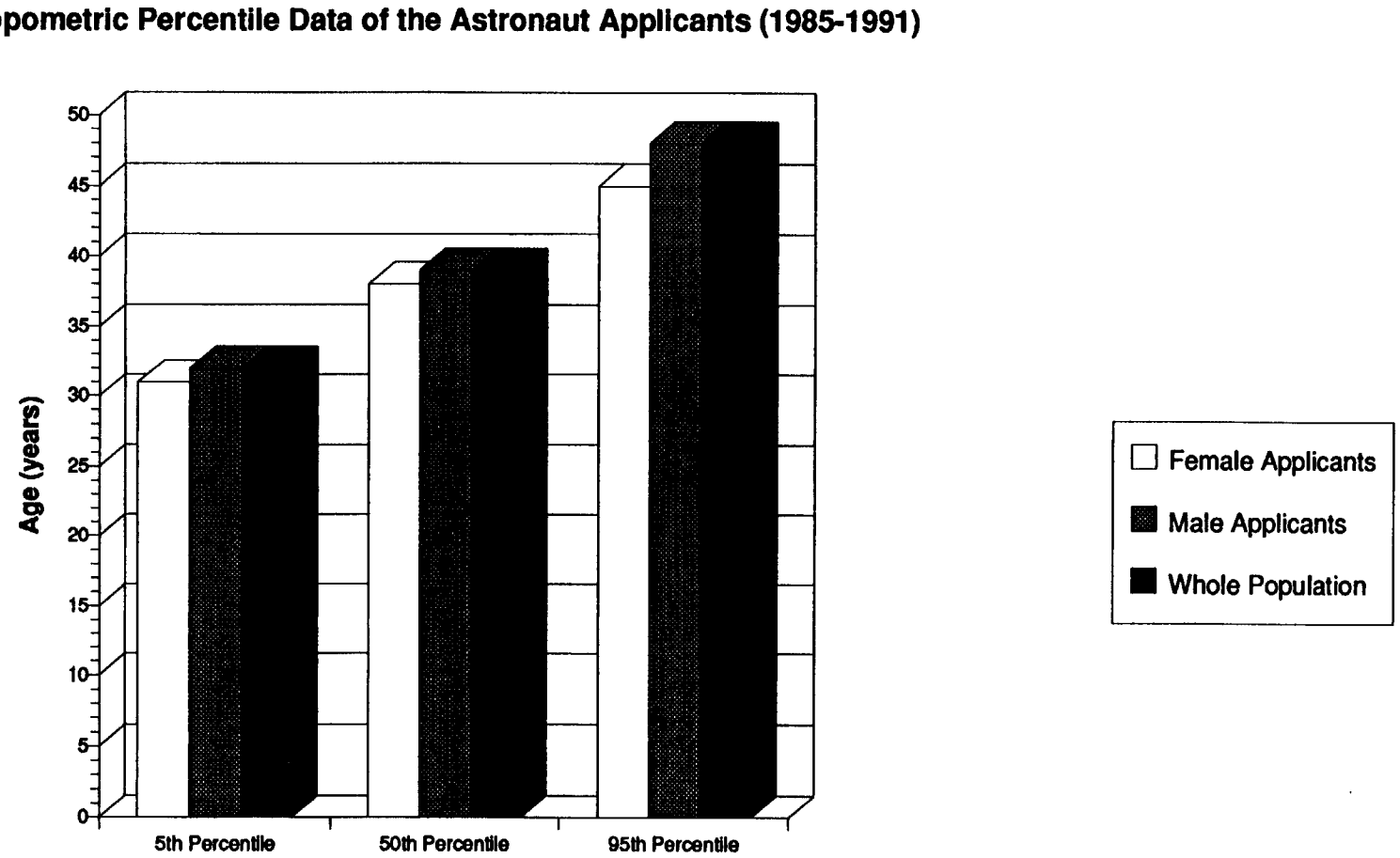

Figure 2. Differences in Age Among Male Applicants, Female Applicants, and the Whole Population

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

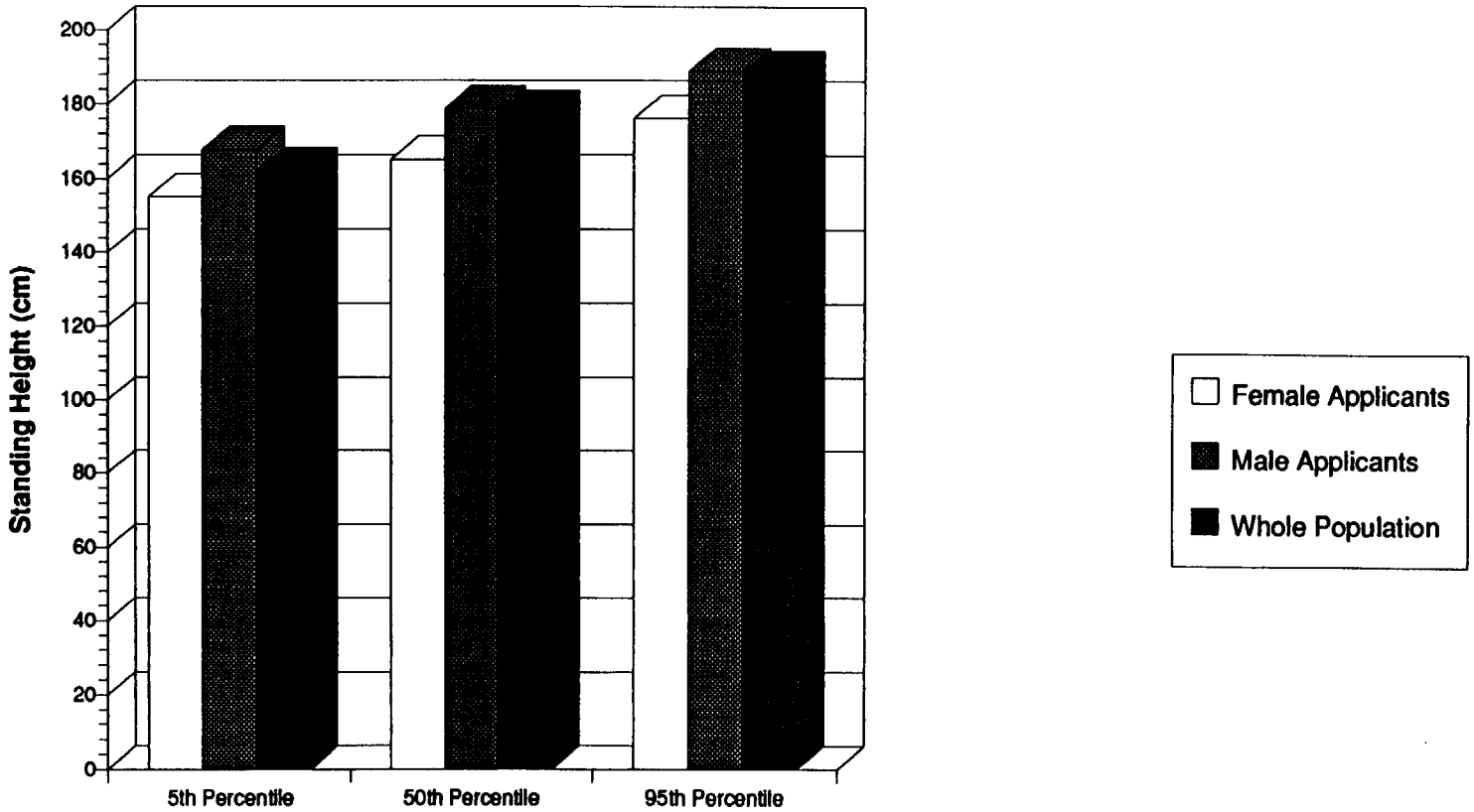

Figure 3. Differences in Standing Height Among Male Applicants, Female Applicants, and the Whole Population

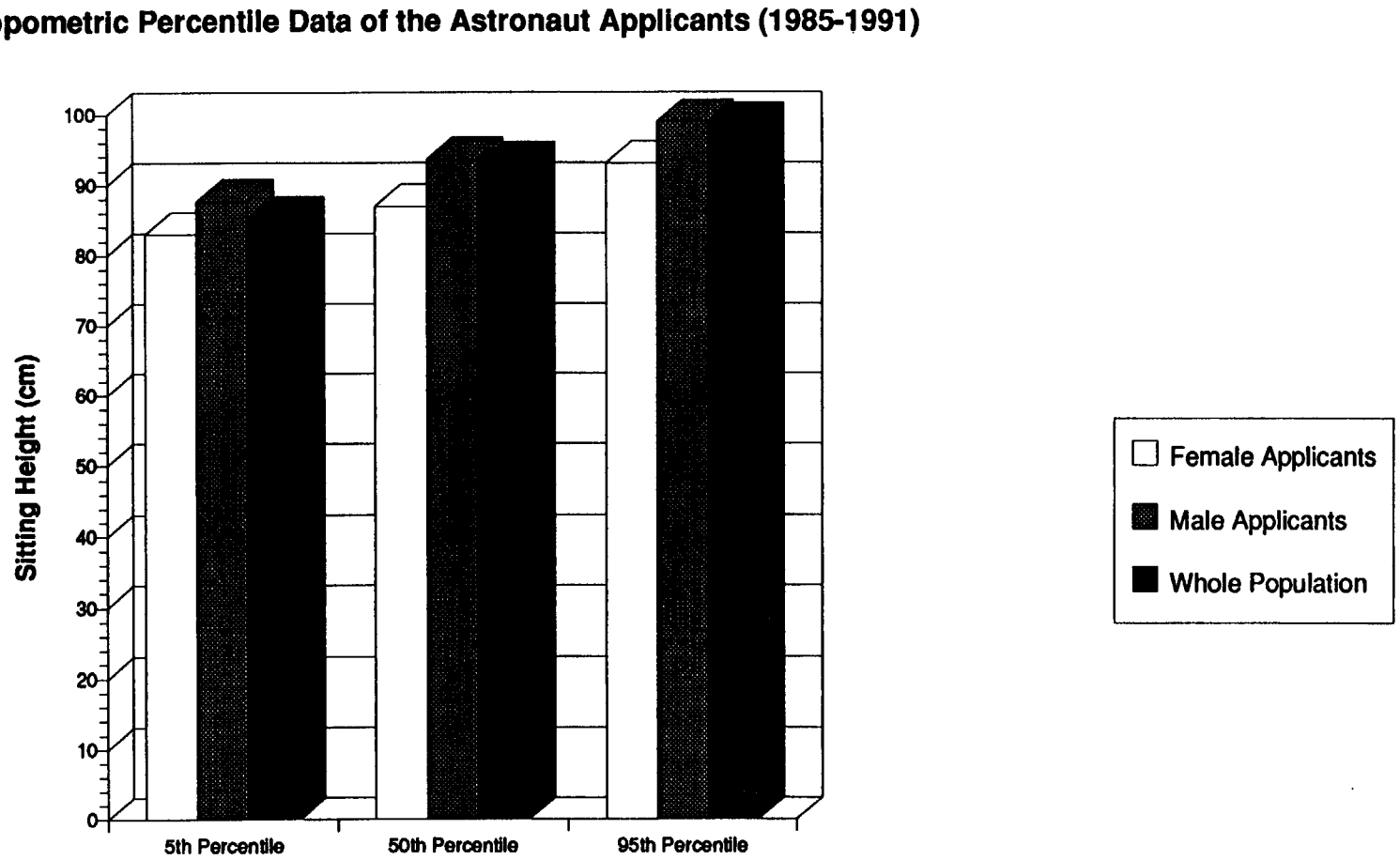

Figure 4. Differences in Sitting Height Among Male Applicants, Female Applicants, and the Whole Population

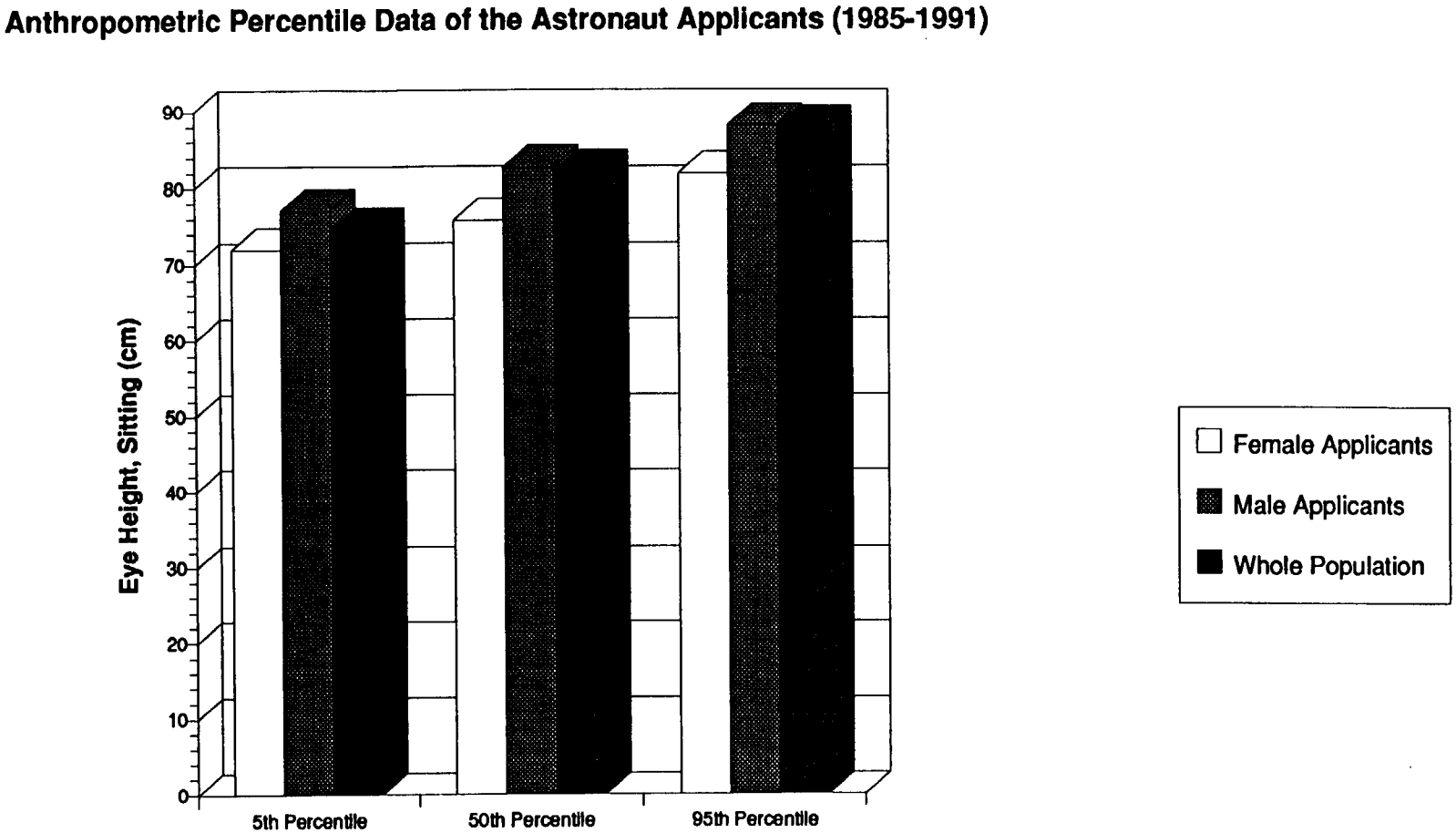

Figure 5. Differences in Eye Height Among Male Applicants, Female Applicants, and the Whole Population

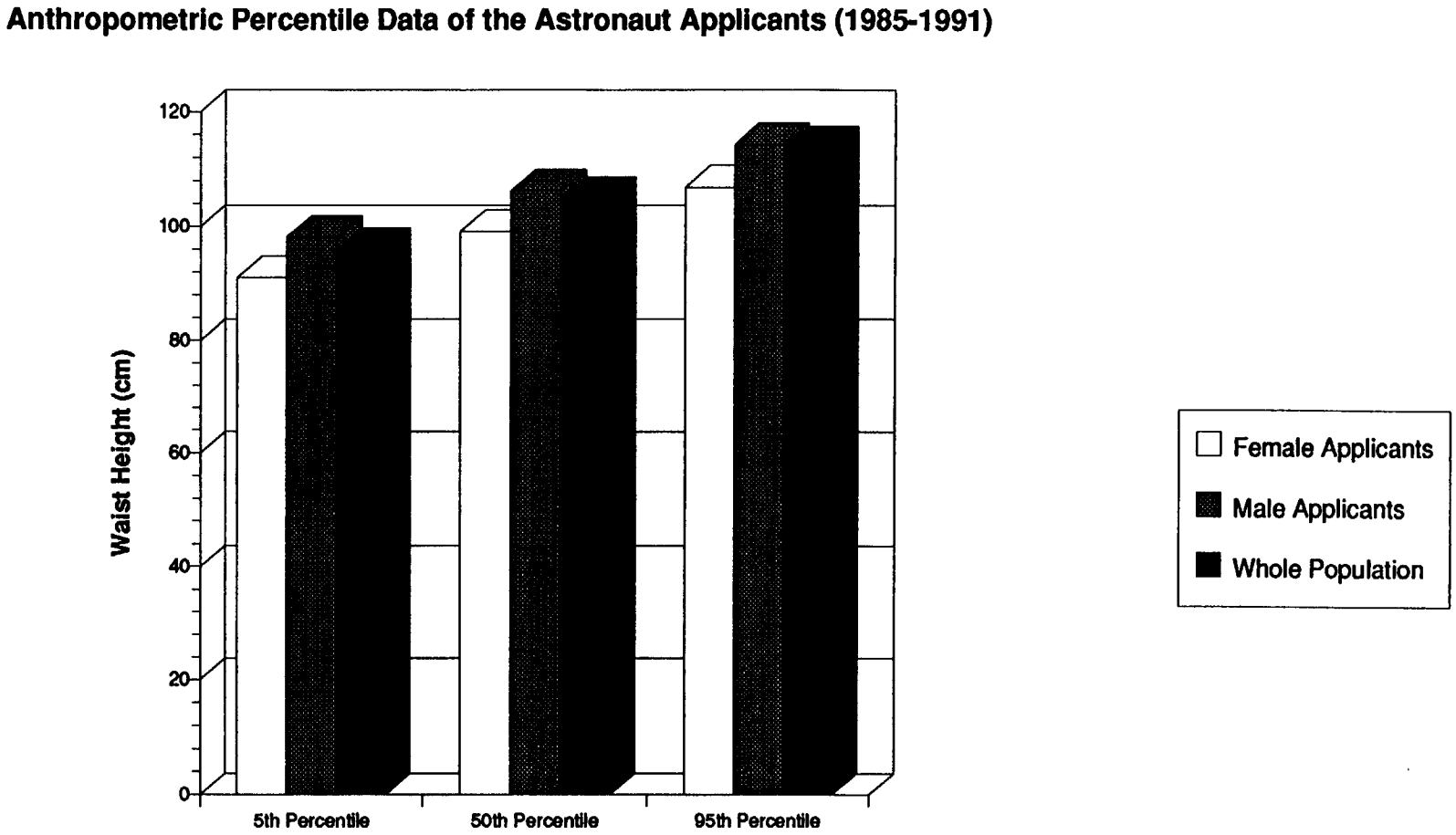

Figure 6. Differences in Waist Height Among Male Applicants, Female Applicants, and the Whole Population

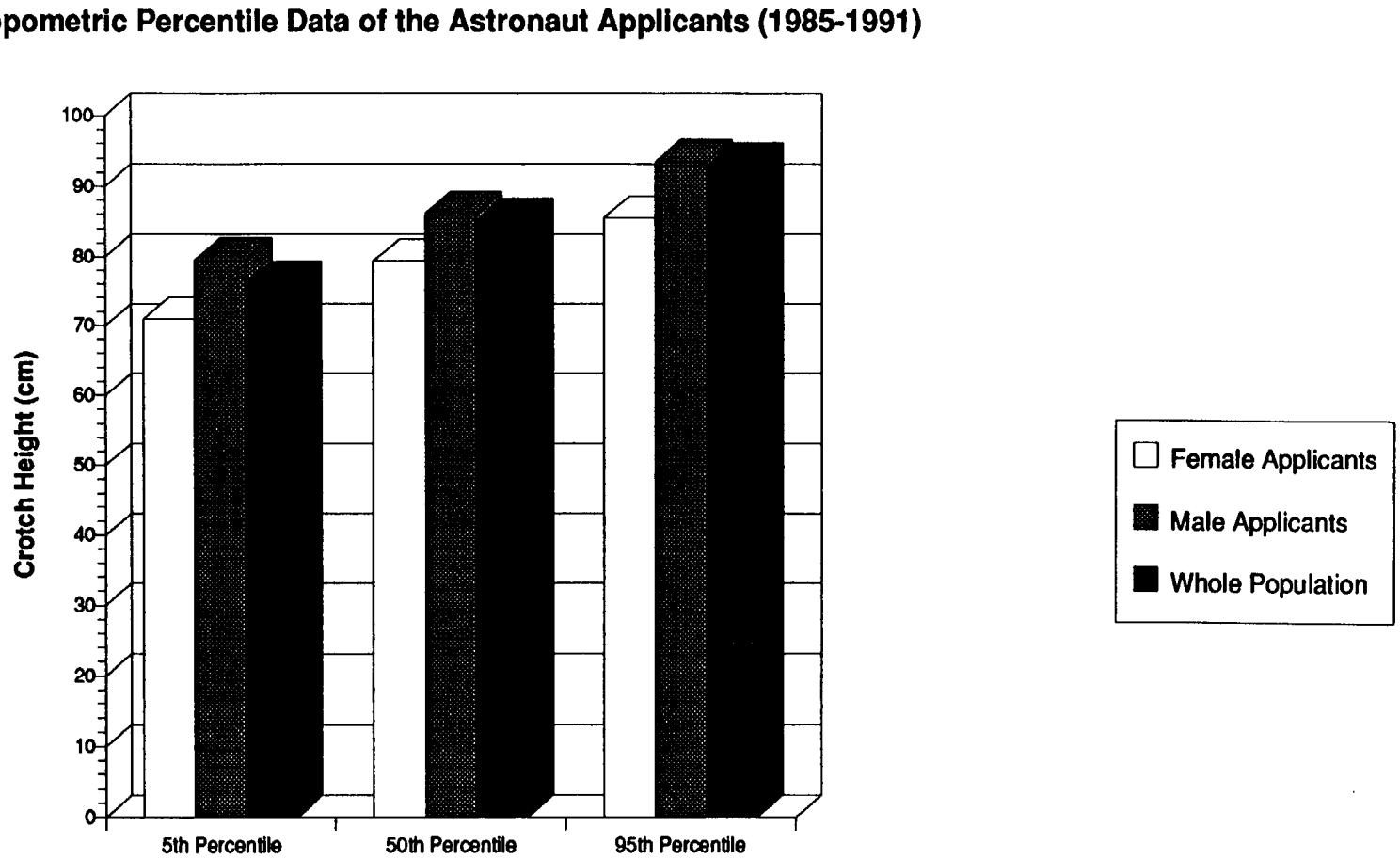

Figure 7. Differences in Crotch Height Among Male Applicants, Female Applicants, and the Whole Population

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

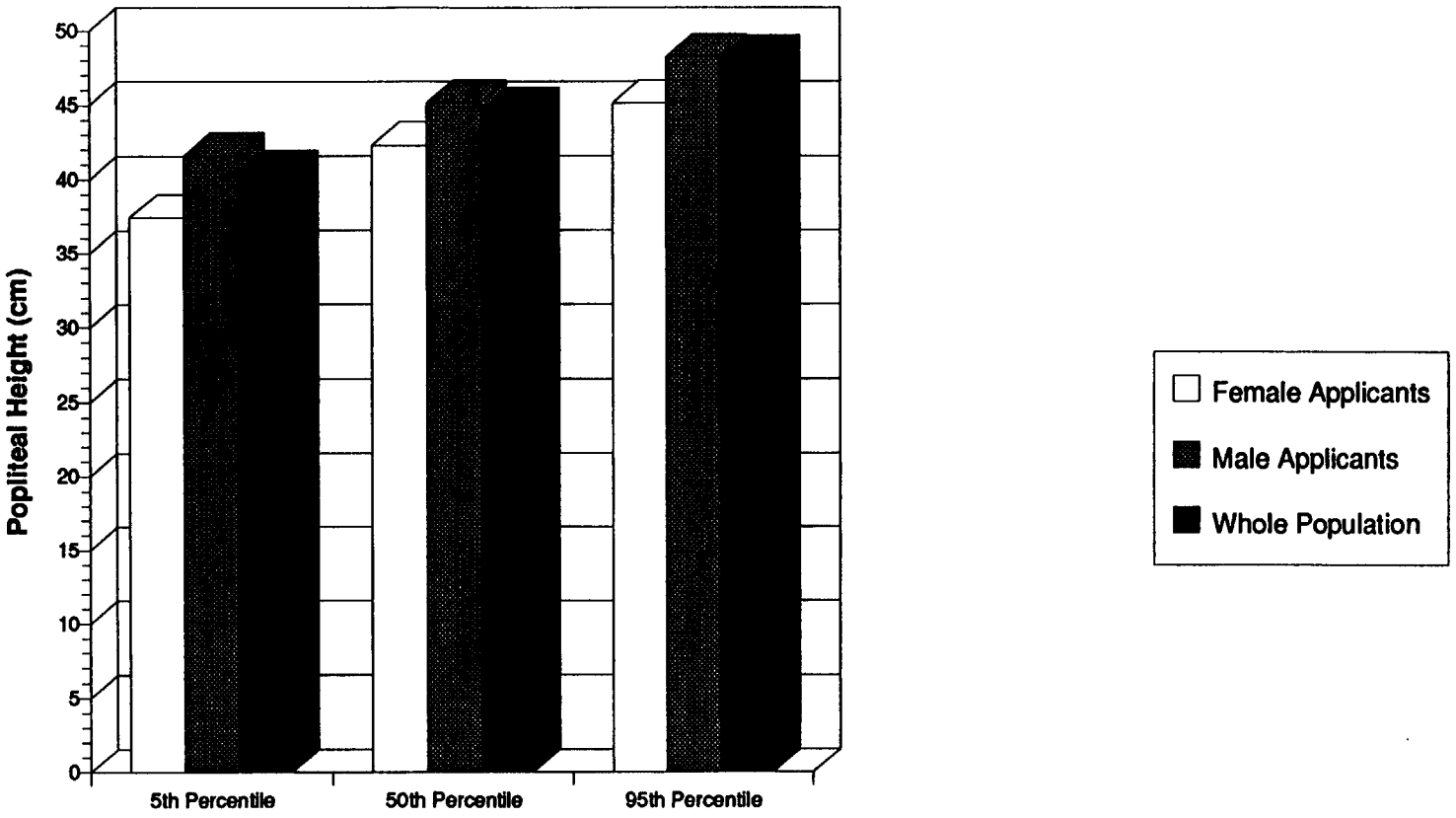

Figure 8. Differences in Popliteal Height Among Male Applicants, Female Applicants, and the Whole Population

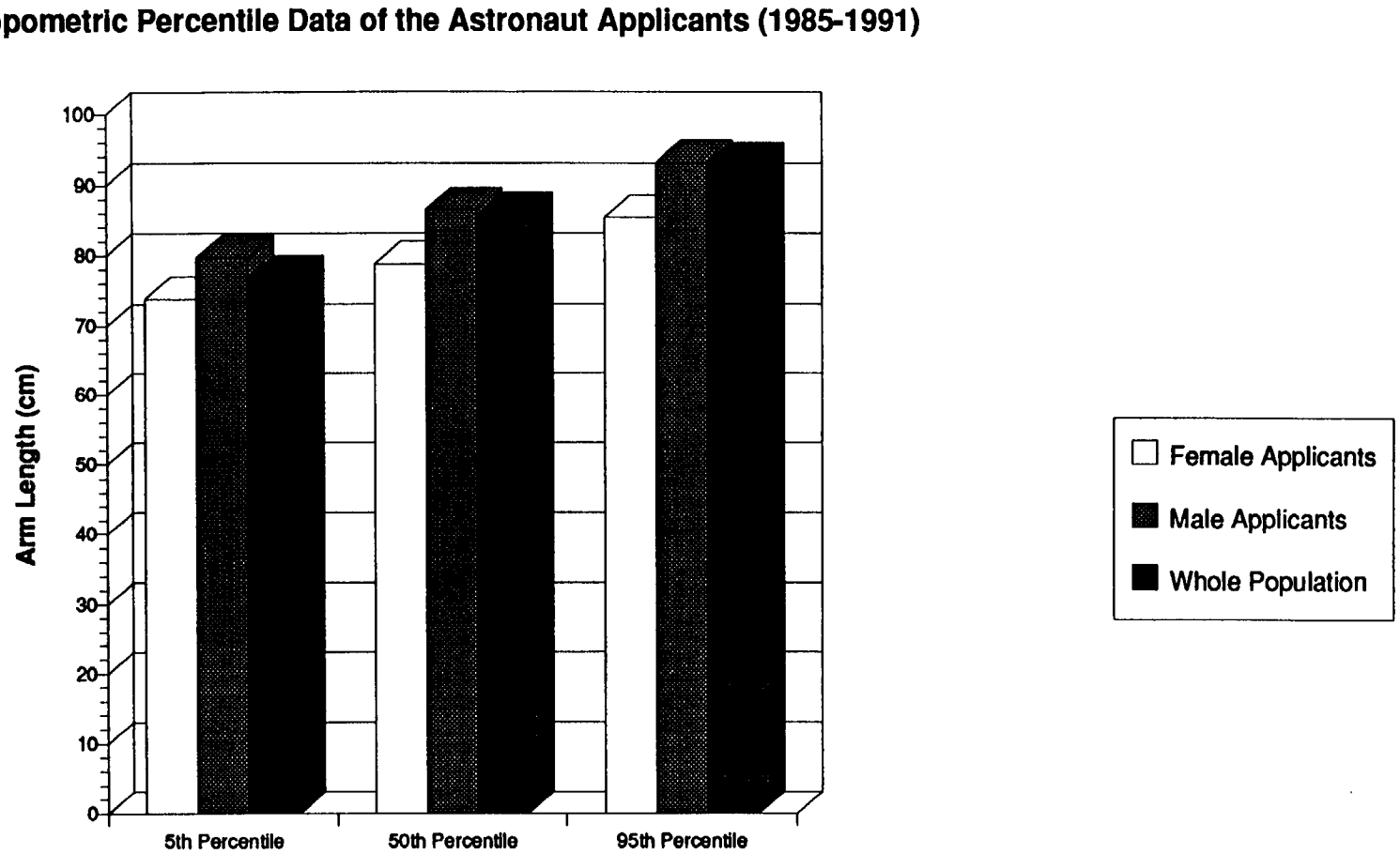

Figure 9. Differences in Arm Length Among Male Applicants, Female Applicants, and the Whole Population

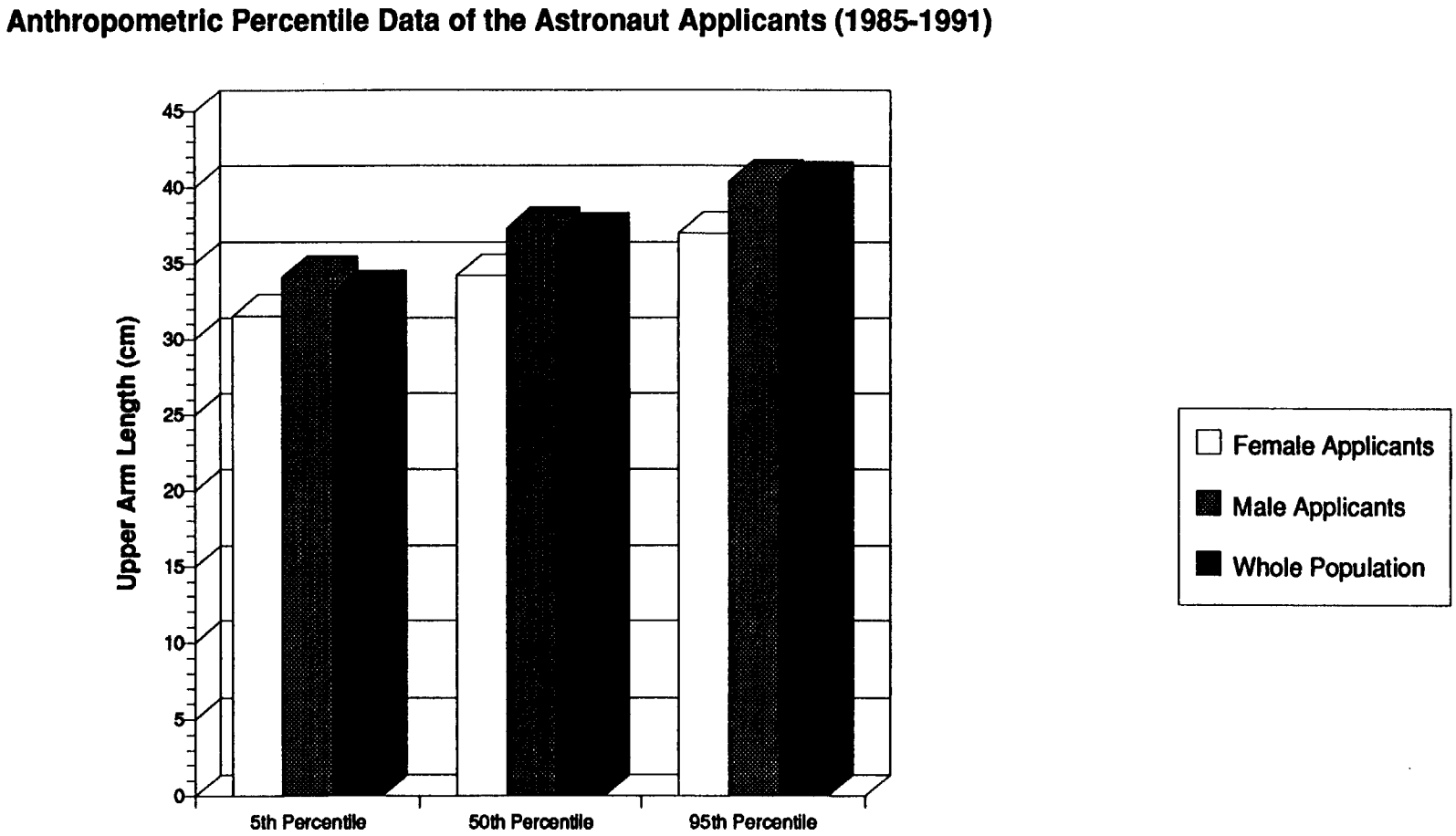

Figure 10. Differences in Upper Arm Length Among Male Applicants, Female Applicants, and the Whole Population

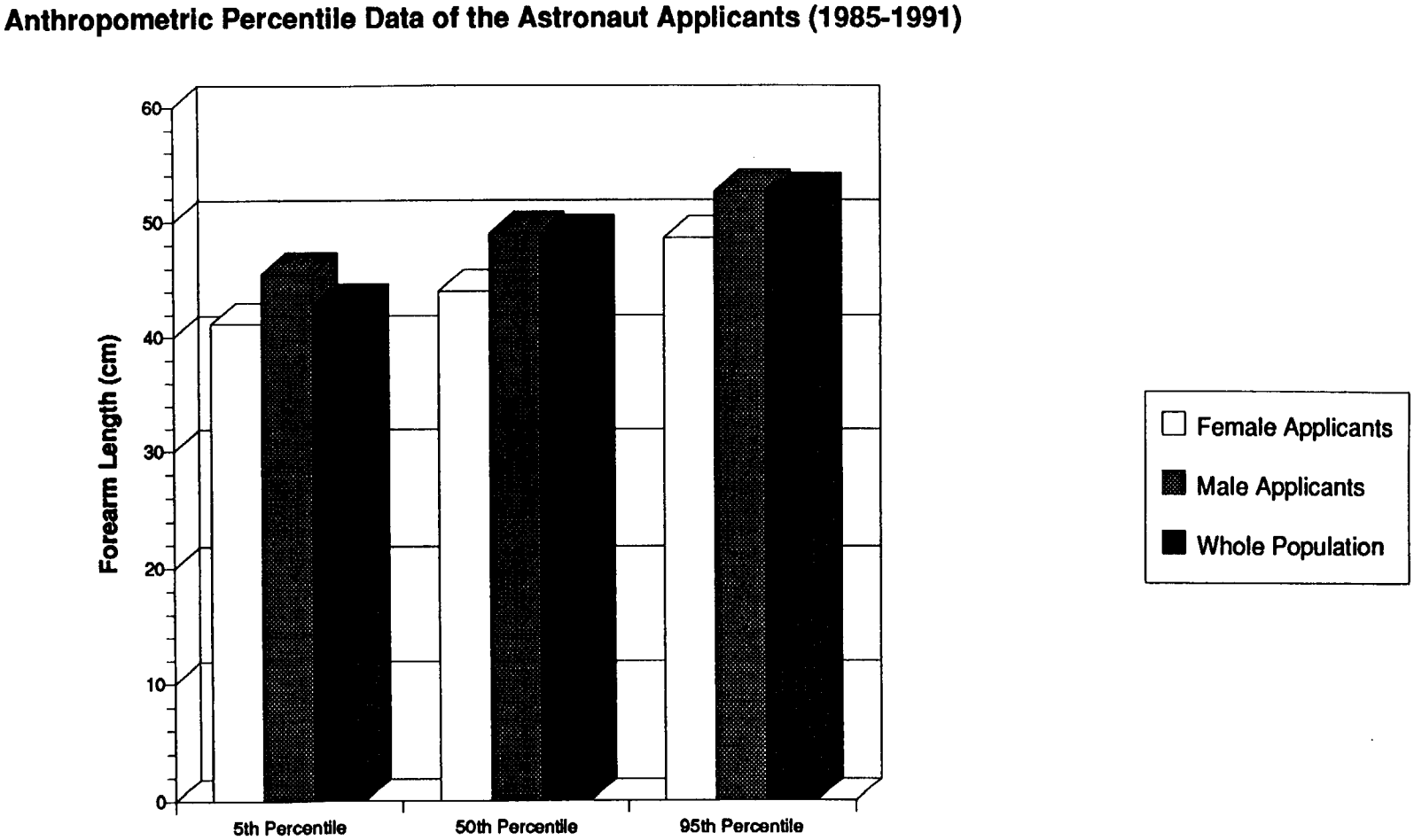

Figure 11. Differences in Forearm Length Among Male Applicants, Female Applicants, and the Whole Population

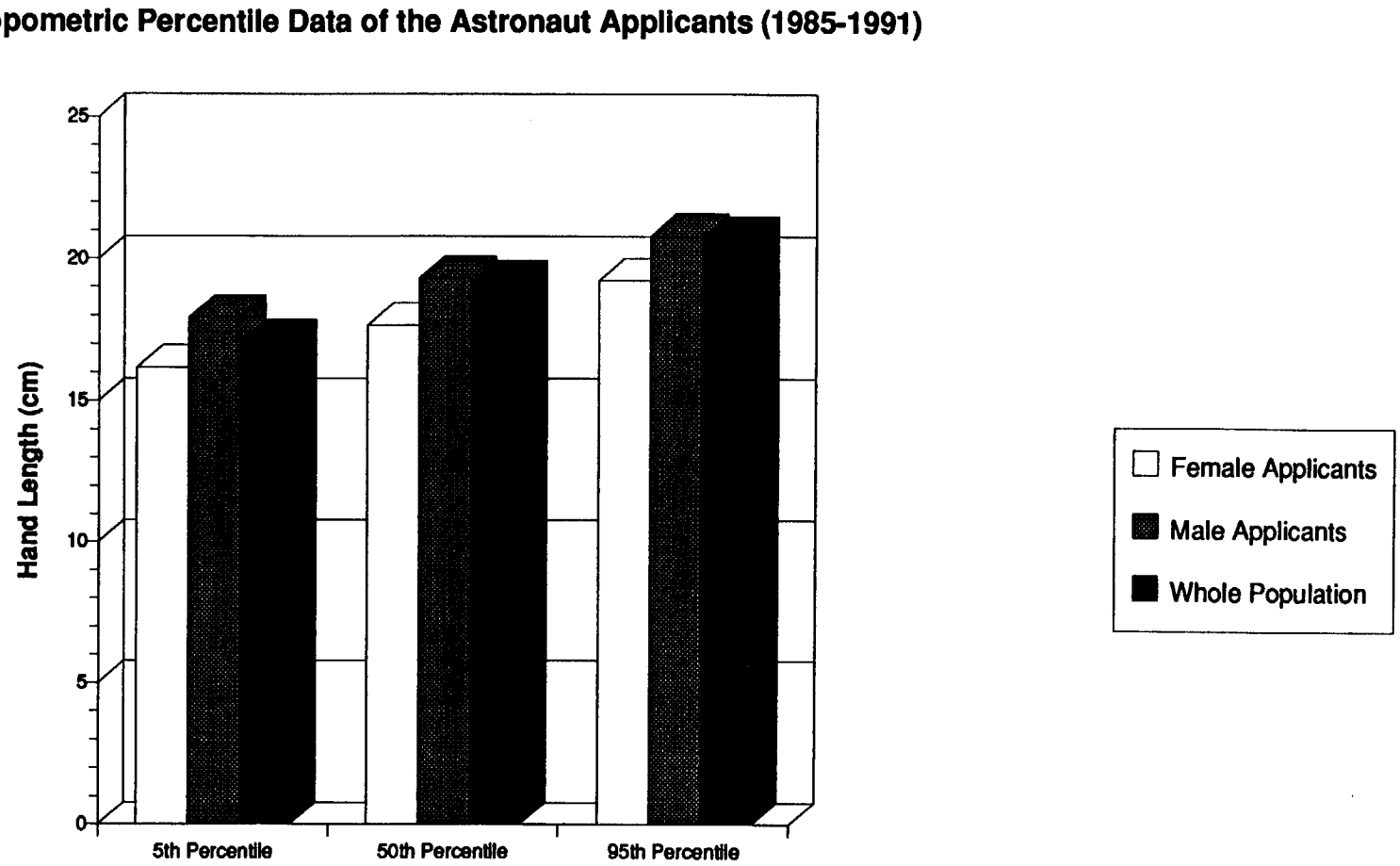

Figure 12. Differences in Hand Length Among Male Applicants, Female Applicants, and the Whole Population

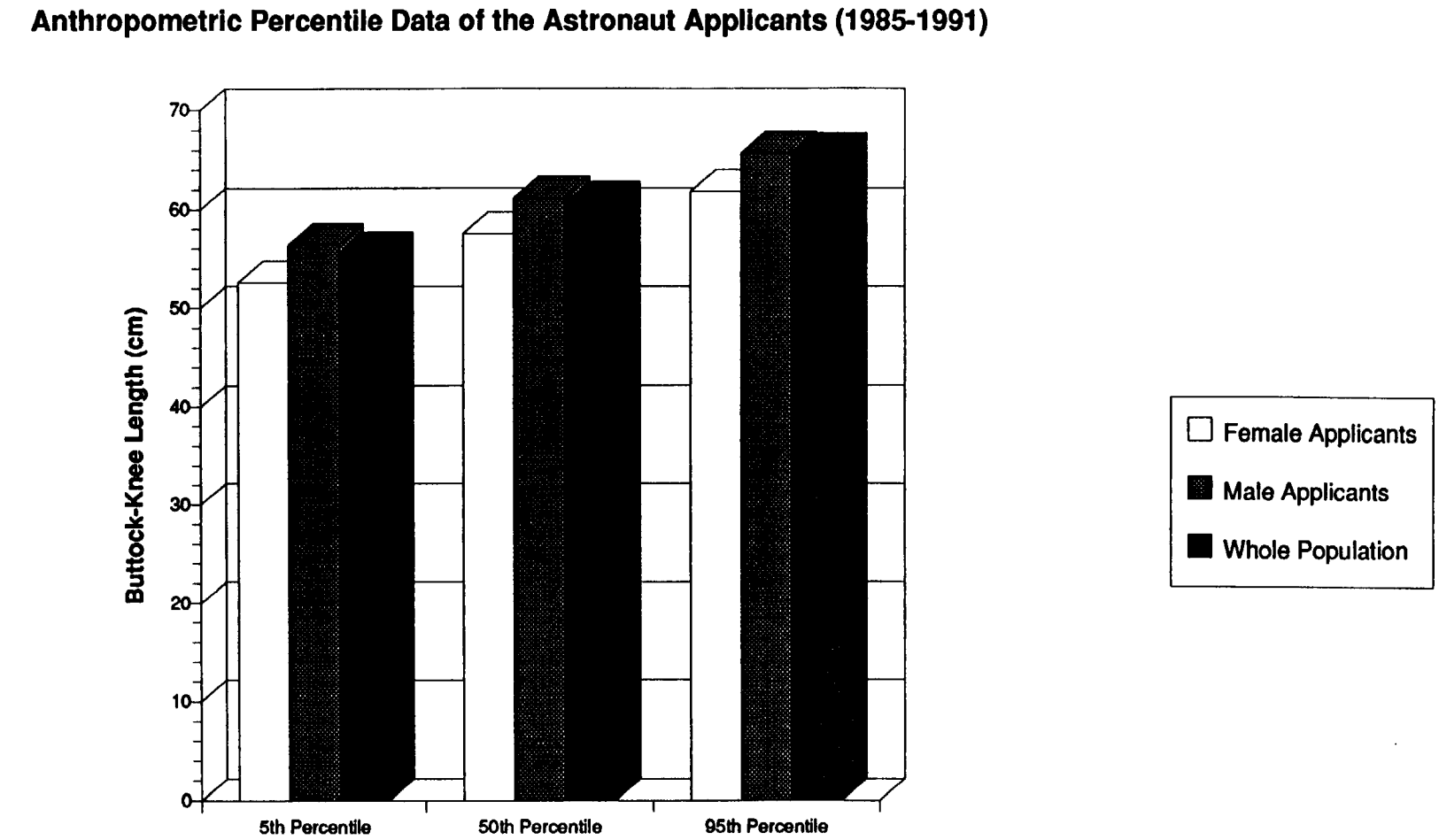

Figure 13. Differences in Buttock-Knee Length Among Male Applicants, Female Applicants, and the Whole Population

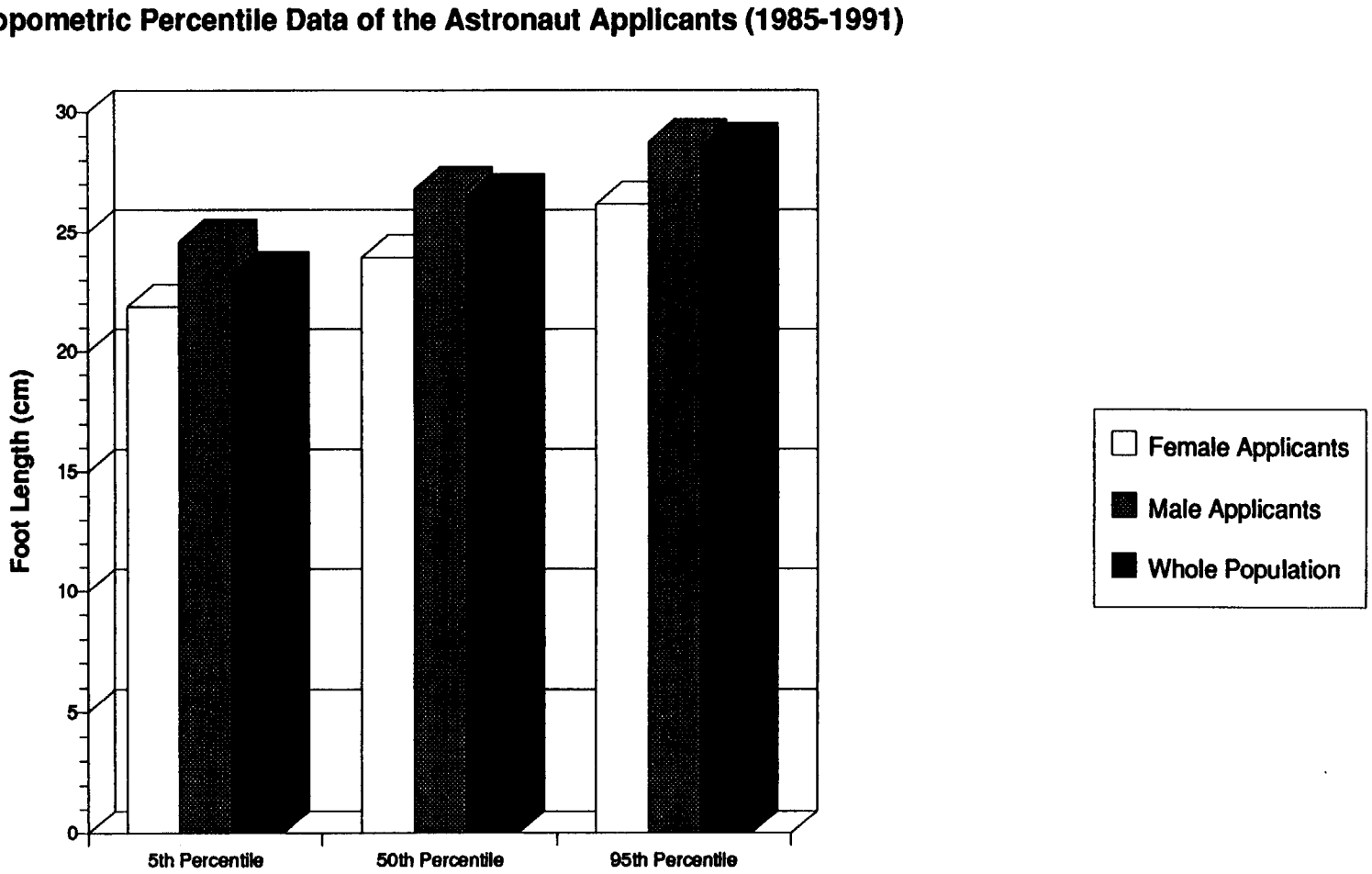

Figure 14. Differences in Foot Length Among Male Applicants, Female Applicants, and the Whole Population

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

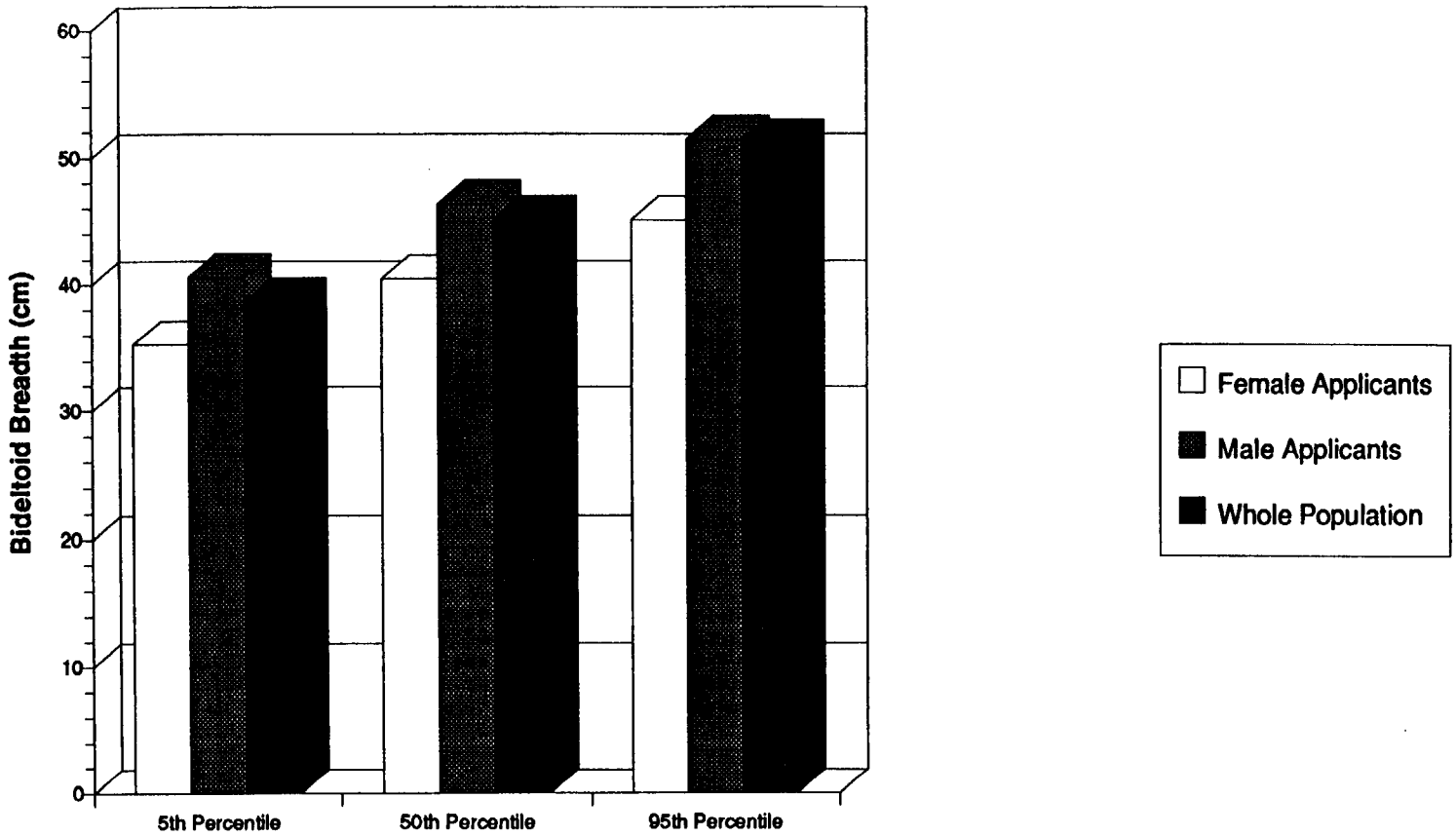

Figure 15. Differences in Bideltoid Breadth Among Male Applicants, Female Applicants, and the Whole Population

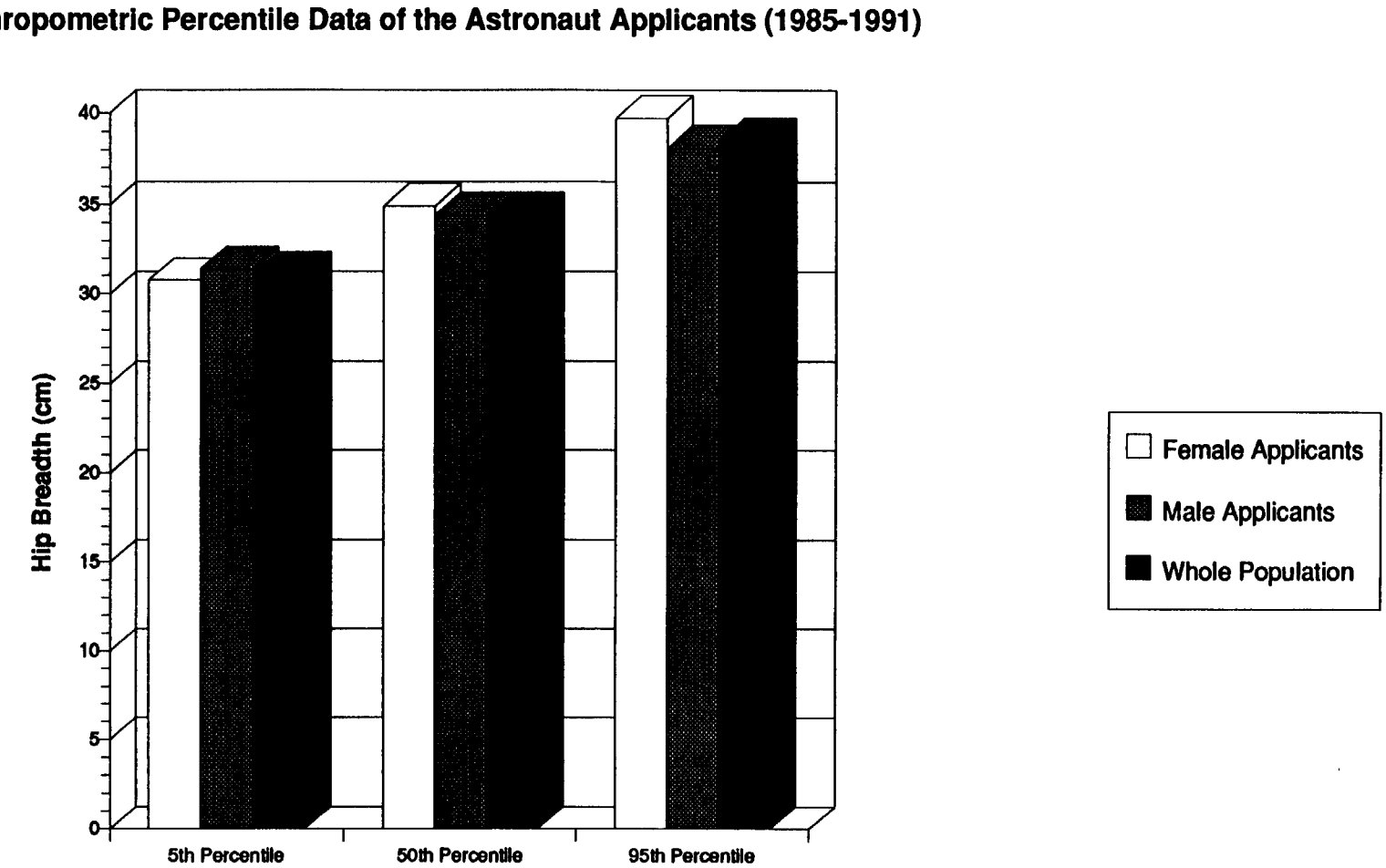

Figure 16. Differences in Hip Breadth Among Male Applicants, Female Applicants, and the Whole Population

TABLE 9
Descriptive statistics on the Anthropometry of the Astronaut Applicants (1985 - 1991) Based on Mission Specialist Applicants.

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	191	73.08	10.407	45.00	97.70	-0.368	0.059
Age	296	37.97	4.344	26.00	53.00	0.139	0.041
HEIGHTS (cm.)							
Standing	297	175.65	8.312	150.40	192.80	-0.443	-0.135
Sitting	296	92.26	4.113	81.70	101.40	-0.328	-0.380
Eye (sitting)	297	81.28	4.231	64.10	97.70	-0.257	0.841
Waist	297	104.33	5.541	90.75	118.50	-0.085	-0.270
Crotch	297	84.64	5.230	69.90	97.90	-0.146	-0.066
Popliteal	297	44.17	2.510	30.90	50.00	-0.758	2.500
LENGTHS (cm.)							
Arm	297	84.86	4.826	71.90	97.70	-0.247	-0.032
Upper arm	297	36.74	2.530	31.00	47.60	0.986	3.199
Forearm	297	48.05	3.022	36.80	58.30	-0.396	0.514
Hand	297	18.97	1.175	15.25	22.30	-0.372	0.049
Buttock-Knee	295	60.42	3.216	48.10	69.70	-0.167	0.452
Foot	297	26.17	1.698	21.50	30.20	-0.443	-0.192
BREADTHS (cm.)							
Bideltoid	295	44.62	4.012	34.70	54.30	-0.103	-0.551
Hip	297	34.53	2.148	29.20	44.40	0.675	1.985

TABLE 10
Anthropometric Percentile Data of the Astronaut Applicants (1985 - 1991) Based on Mission Specialist Applicants.

Anthropometric Variable	N	<---------- Percentile ----------> 1 st	5 th	10 th	50 th	90 th	95 th	99 th
Weight	191	46.64	53.15	57.39	74.10	85.86	89.77	95.70
Age	297	28.00	31.00	32.00	38.00	44.00	45.00	48.06
HEIGHTS (cm.)								
Standing	297	154.04	160.10	163.87	176.65	186.53	188.61	190.92
Sitting	296	82.38	84.56	86.22	92.90	97.30	98.54	100.81
Eye (sitting)	297	71.49	73.99	75.57	81.60	86.23	87.92	89.96
Waist	297	91.09	95.06	97.34	104.50	111.16	113.94	116.62
Crotch	297	71.00	75.00	78.17	84.90	91.13	93.26	96.81
Popliteal	297	36.79	40.07	41.27	44.25	47.40	48.21	49.01
LENGTHS (cm.)								
Arm	297	72.77	76.04	77.94	85.25	90.63	92.32	96.62
Upper arm	297	31.59	32.90	33.50	36.80	39.43	40.31	47.10
Forearm	297	40.57	42.43	43.47	48.50	51.73	52.62	54.15
Hand	297	16.09	16.80	17.30	19.10	20.30	20.76	21.41
Buttock-Knee	295	52.08	55.28	56.35	60.20	64.75	65.70	67.87
Foot	297	21.80	23.07	23.78	26.50	28.03	28.44	29.90
BREADTHS (cm.)								
Bideltoid	295	35.19	37.95	39.55	44.60	49.55	51.10	53.01
Hip	297	29.78	31.27	32.00	34.35	37.20	38.50	40.49

TABLE 11
Descriptive Statistics on the Anthropometry of the Astronaut Applicants (1985 - 1991) Based on Payload Specialist Applicants.

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	35	71.69	9.302	52.30	90.30	-0.002	-0.673
Age	40	43.51	6.233	33.00	60.00	0.576	-0.258
HEIGHTS (cm.)							
Standing	47	174.61	7.019	156.70	188.40	-0.151	-0.164
Sitting	47	91.45	3.291	83.80	96.50	-0.406	-0.463
Eye (sitting)	47	81.14	3.363	72.10	85.80	-0.749	-0.045
Waist	47	104.15	5.321	90.30	115.00	-0.026	-0.134
Crotch	47	84.26	4.825	70.60	94.80	-0.109	0.398
Popliteal	47	43.77	2.381	36.70	47.90	-0.703	0.864
LENGTHS (cm.)							
Arm	47	85.59	5.061	75.10	95.70	-0.099	-0.720
Upper arm	47	36.09	1.998	31.40	39.90	-0.118	-0.244
Forearm	46	48.07	2.542	41.20	52.20	-0.420	-0.177
Hand	47	19.07	0.798	17.20	20.40	-0.112	-0.821
Buttock-Knee	46	59.63	3.023	51.80	65.90	-0.002	-0.214
Foot	47	25.95	1.451	22.80	28.80	-0.126	-0.575
BREADTHS (cm.)							
Bideltoid	47	44.38	3.027	37.40	51.40	0.008	-0.052
Hip	47	33.69	2.047	29.40	39.40	0.208	0.286

TABLE 12
Anthropometric Percentile Data of the Astronaut Applicants (1985 - 1991) Based on Payload Specialist Applicants.

Anthropometric Variable	N	<---------- Percentile ----------> 1 st	5 th	10 th	50 th	90 th	95 th	99 th
Weight	35	52.30	56.81	59.38	70.30	83.30	89.28	90.30
Age	40	33.00	35.00	36.20	42.00	51.80	55.60	60.00
HEIGHTS (cm.)								
Standing	47	156.70	162.62	165.87	174.30	183.35	187.26	188.40
Sitting	47	83.80	84.79	86.89	91.85	95.92	96.41	96.50
Eye (sitting)	47	72.10	74.42	75.97	81.85	84.93	85.56	85.80
Waist	47	90.30	95.67	97.44	103.75	110.42	114.46	115.00
Crotch	47	70.60	76.46	79.08	84.50	90.69	93.14	94.80
Popliteal	47	36.70	38.77	41.18	43.75	46.34	47.61	47.90
LENGTHS (cm.)								
Arm	47	75.10	77.24	78.50	86.10	91.59	94.78	95.70
Upper arm	47	31.40	32.37	33.38	36.00	38.96	39.71	39.90
Forearm	46	41.20	43.40	45.08	48.50	51.34	51.90	52.20
Hand	47	17.20	17.84	17.99	19.05	20.20	20.25	20.40
Buttock-Knee	46	51.80	55.32	55.78	59.00	63.42	65.22	65.90
Foot	47	22.80	23.34	23.95	26.00	27.80	28.45	28.80
BREADTHS (cm.)								
Bideltoid	47	37.40	38.89	40.16	44.55	48.26	50.06	51.40
Hip	47	29.40	30.25	30.96	33.95	36.01	37.24	39.40

TABLE 13
Descriptive Statistics on the Anthropometry of the Astronaut Applicants (1985 - 1991) Based on Pilot Applicants.

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	75	76.59	8.853	56.80	105.90	0.447	0.918
Age	120	39.90	4.343	33.00	63.00	1.378	5.443
HEIGHTS (cm.)							
Standing	120	179.39	5.977	164.50	192.30	-0.115	-0.399
Sitting	120	94.07	3.127	85.60	102.30	-0.239	0.416
Eye (sitting)	120	83.17	3.398	74.10	92.20	-0.050	0.201
Waist	120	106.85	4.501	95.60	118.10	-0.021	-0.492
Crotch	120	86.17	4.128	76.20	97.30	0.017	-0.037
Popliteal	120	45.03	2.520	33.30	50.50	-1.959	7.263
LENGTHS (cm.)							
Arm	120	86.90	3.748	76.60	95.60	-0.050	-0.121
Upper arm	120	37.64	2.039	32.40	48.50	1.017	5.976
Forearm	120	49.15	2.088	41.00	53.20	-0.516	0.957
Hand	120	19.43	0.910	17.30	23.00	0.526	1.322
Buttock-Knee	120	61.57	2.595	54.40	67.20	-0.104	-0.277
Foot	120	26.77	1.346	20.00	30.30	-0.930	4.454
BREADTHS (cm.)							
Bideltoid	120	46.48	3.391	38.40	53.00	-0.309	-0.723
Hip	120	35.15	2.731	30.20	47.90	1.641	5.079

TABLE 14
Anthropometric Percentile Data of the Astronaut Applicants (1985 - 1991) Based on Pilot Applicants.

Anthropometric Variable	N	<---------- Percentile ----------> 1 st	5 th	10 th	50 th	90 th	95 th	99 th
Weight	75	56.80	62.02	65.36	75.00	86.74	94.76	105.90
Age	120	33.00	34.00	35.00	40.00	45.00	46.95	60.06
HEIGHTS (cm.)								
Standing	120	164.86	169.11	170.64	179.40	186.40	189.83	192.26
Sitting	120	85.60	88.66	89.50	94.30	97.88	99.19	102.19
Eye (sitting)	120	74.31	77.02	78.91	83.25	87.19	88.97	92.03
Waist	120	96.00	99.43	101.32	107.10	112.80	113.70	117.74
Crotch	120	76.20	79.32	80.56	86.05	91.48	93.26	96.92
Popliteal	120	33.38	41.85	42.43	45.50	47.40	48.20	50.33
LENGTHS (cm.)								
Arm	120	76.94	80.61	82.23	86.90	92.45	93.30	95.31
Upper arm	120	32.51	34.51	35.41	37.50	39.88	40.58	47.18
Forearm	120	41.61	45.71	46.52	49.20	51.80	52.59	53.10
Hand	120	17.32	17.95	18.41	19.40	20.60	20.90	22.71
Buttock-Knee	120	54.69	57.40	58.01	61.50	65.20	65.50	67.14
Foot	120	20.78	24.76	25.10	26.80	28.48	28.80	30.11
BREADTHS (cm.)								
Bideltoid	120	38.57	40.50	41.46	47.10	50.30	51.90	52.87
Hip	120	30.28	31.50	32.31	35.00	37.97	39.49	47.21

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

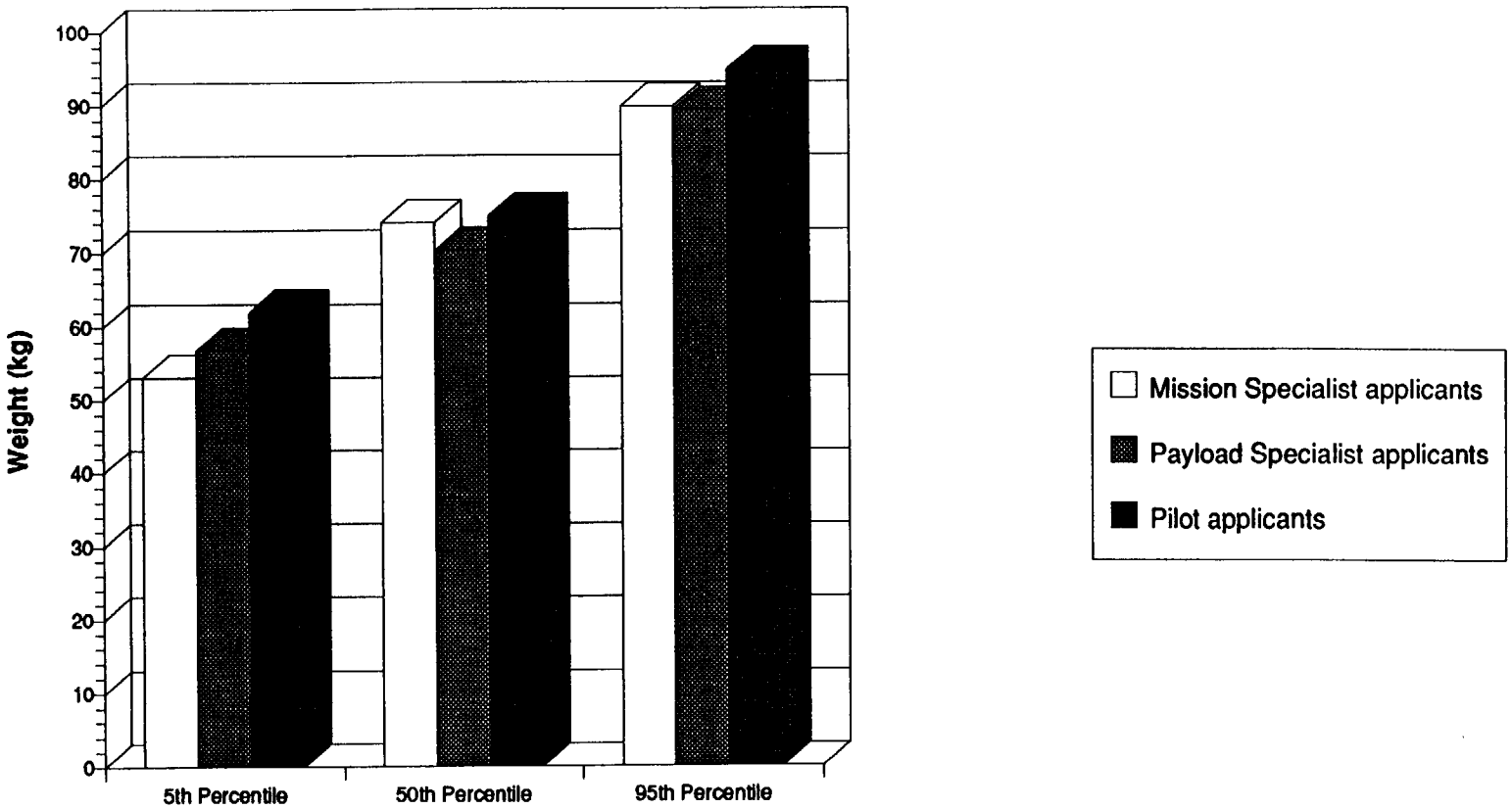

Figure 17. Differences in Weight Among Mission Specialists, Payload Specialists, and Pilots

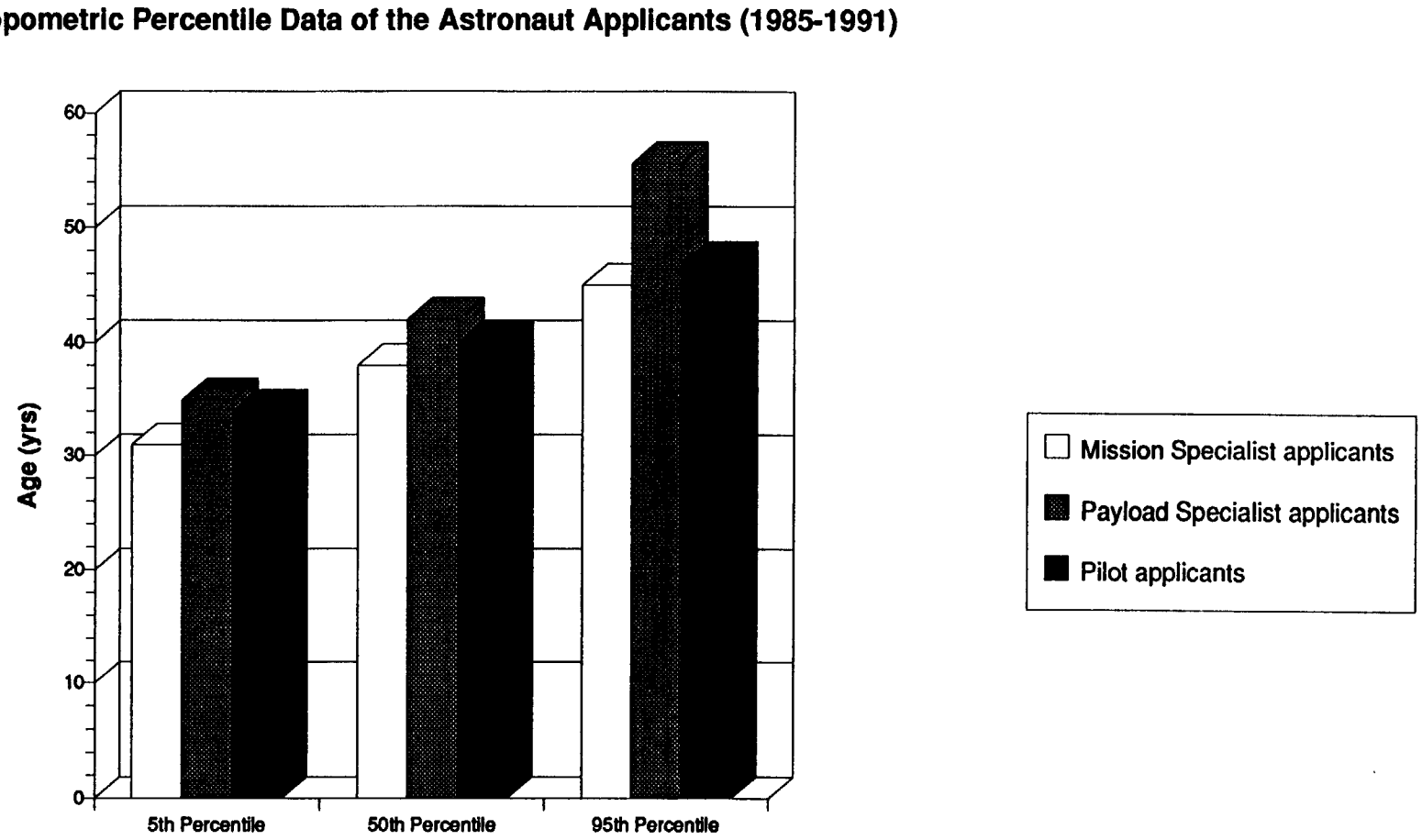

Figure 18. Differences in Age Among Mission Specialists, Payload Specialists, and Pilots

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

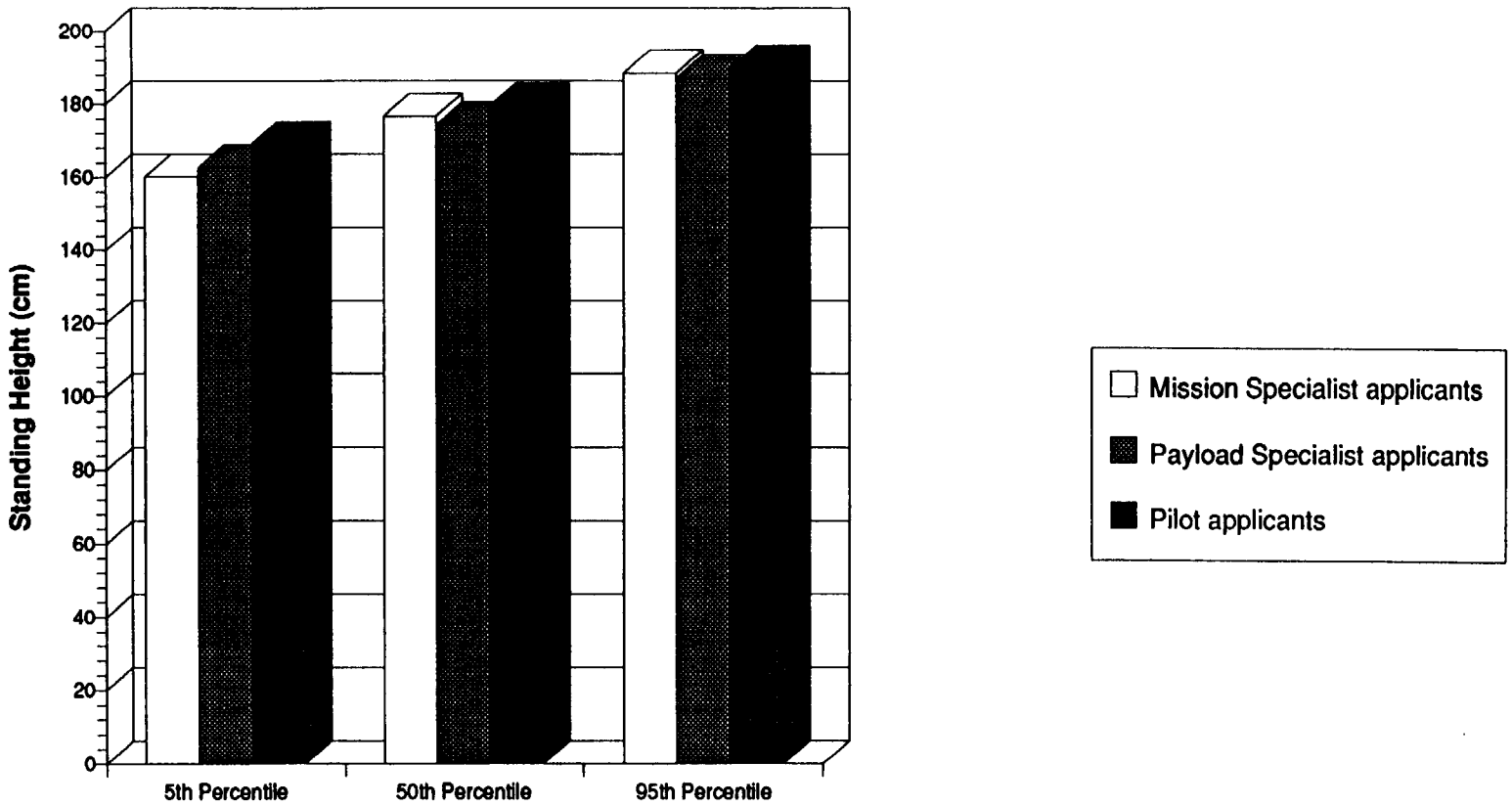

Figure 19. Differences in Standing Height Among Mission Specialists, Payload Specialists, and Pilots

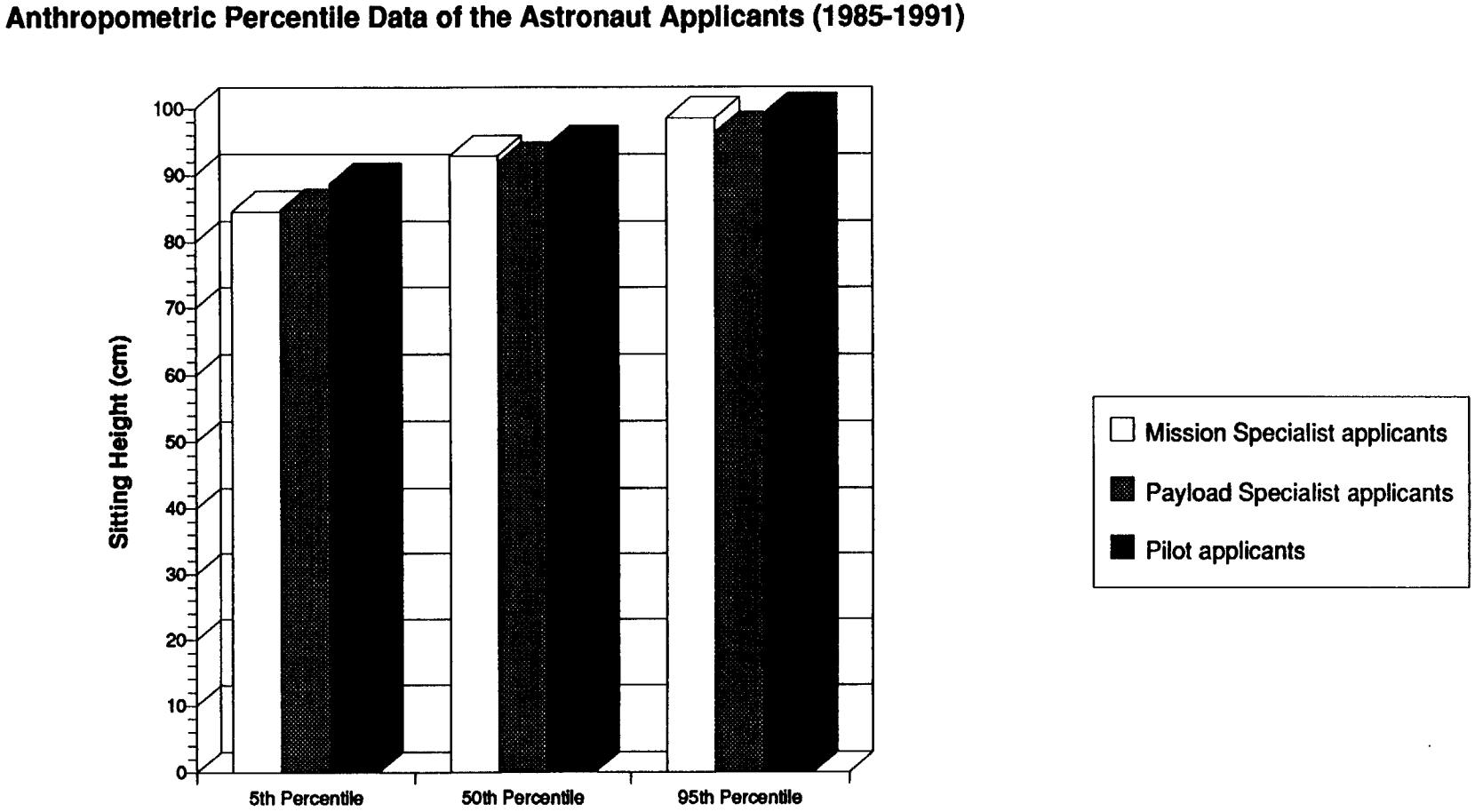

Figure 20. Differences in Sitting Height Among Mission Specialists, Payload Specialists, and Pilots

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

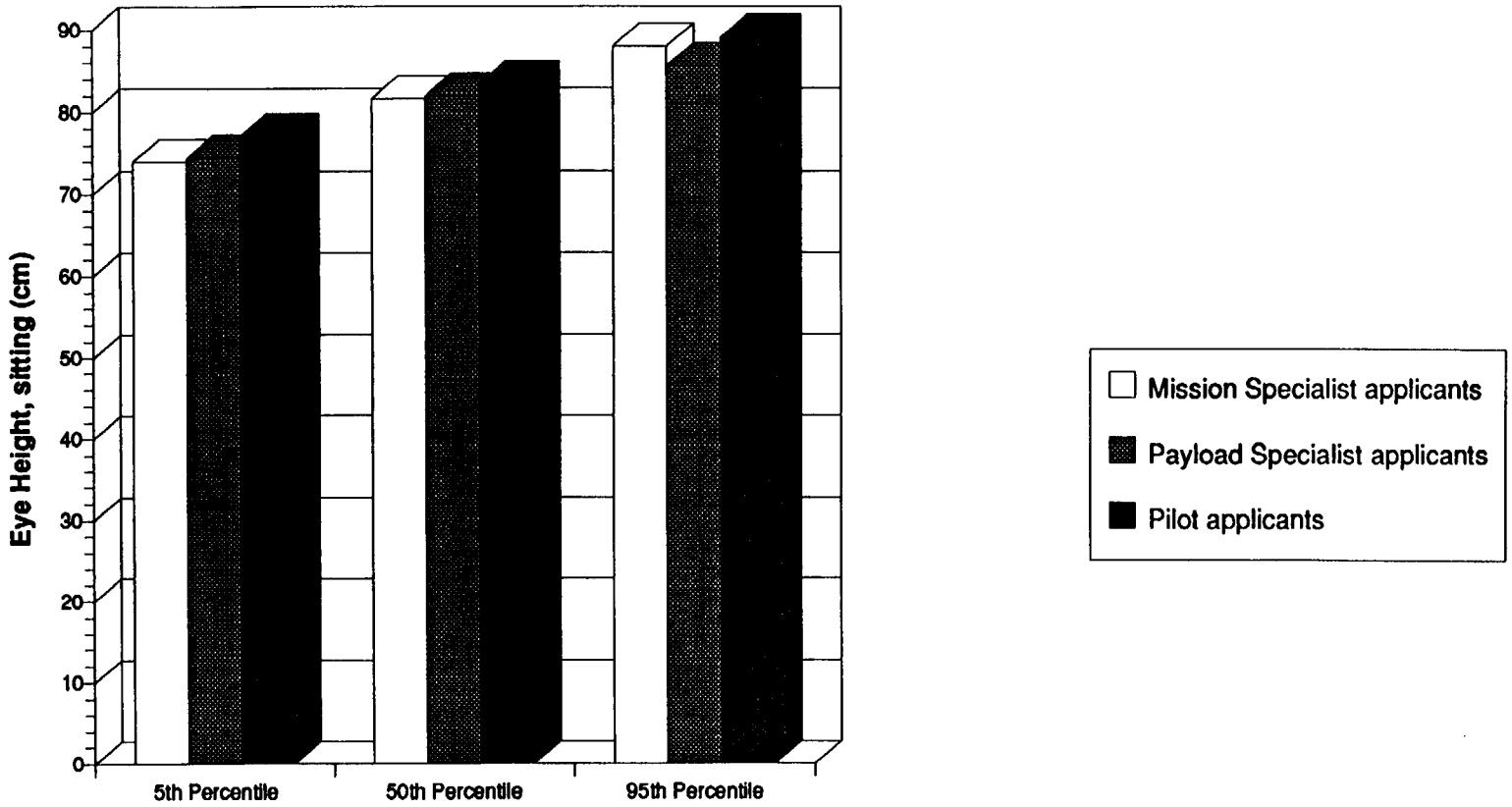

Figure 21. Differences in Eye Height Among Mission Specialists, Payload Specialists, and Pilots

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

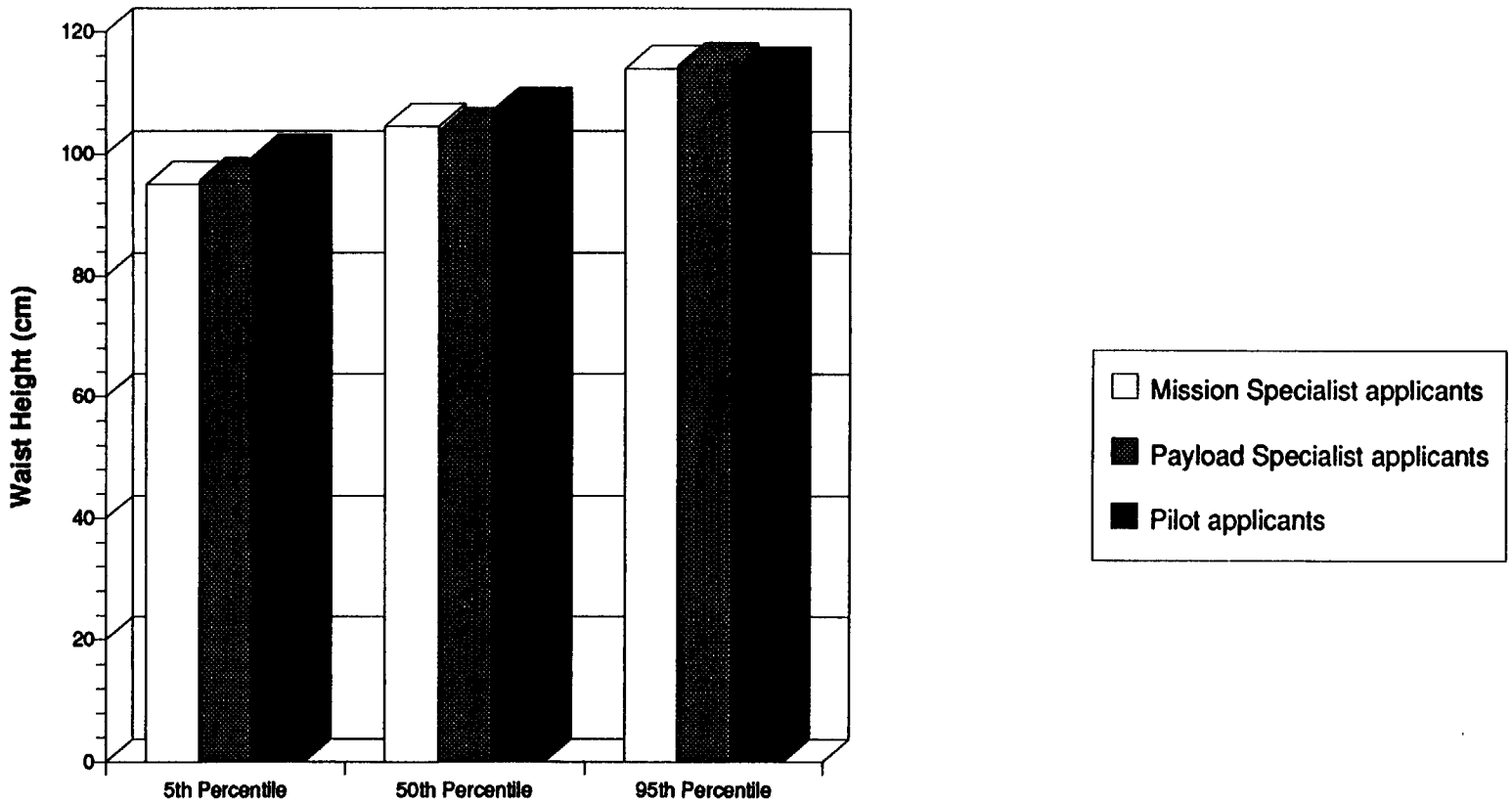

Figure 22. Differences in Waist Height Among Mission Specialists, Payload Specialists, and Pilots

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

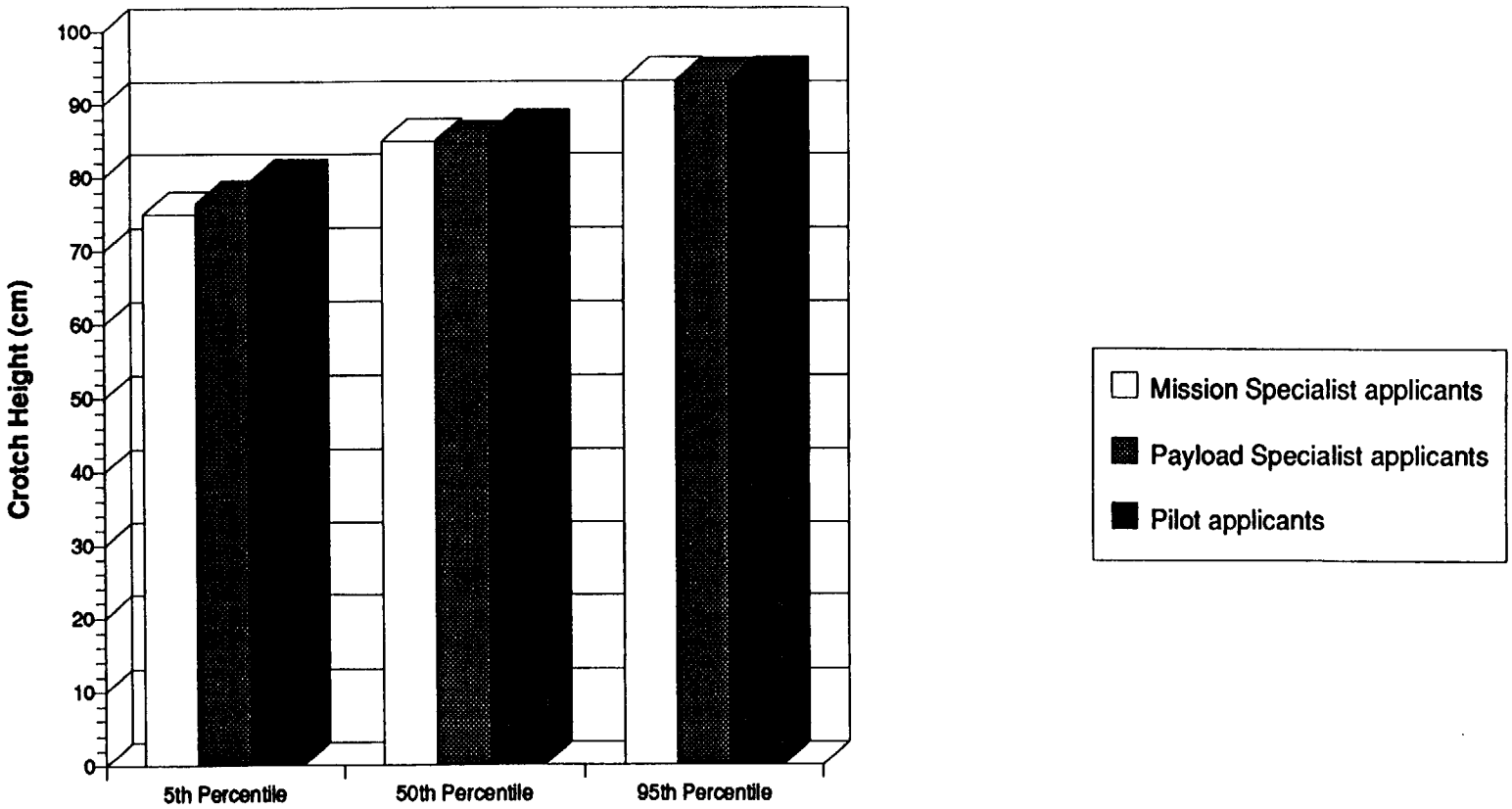

Figure 23. Differences in Crotch Height Among Mission Specialists, Payload Specialists, and Pilots

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

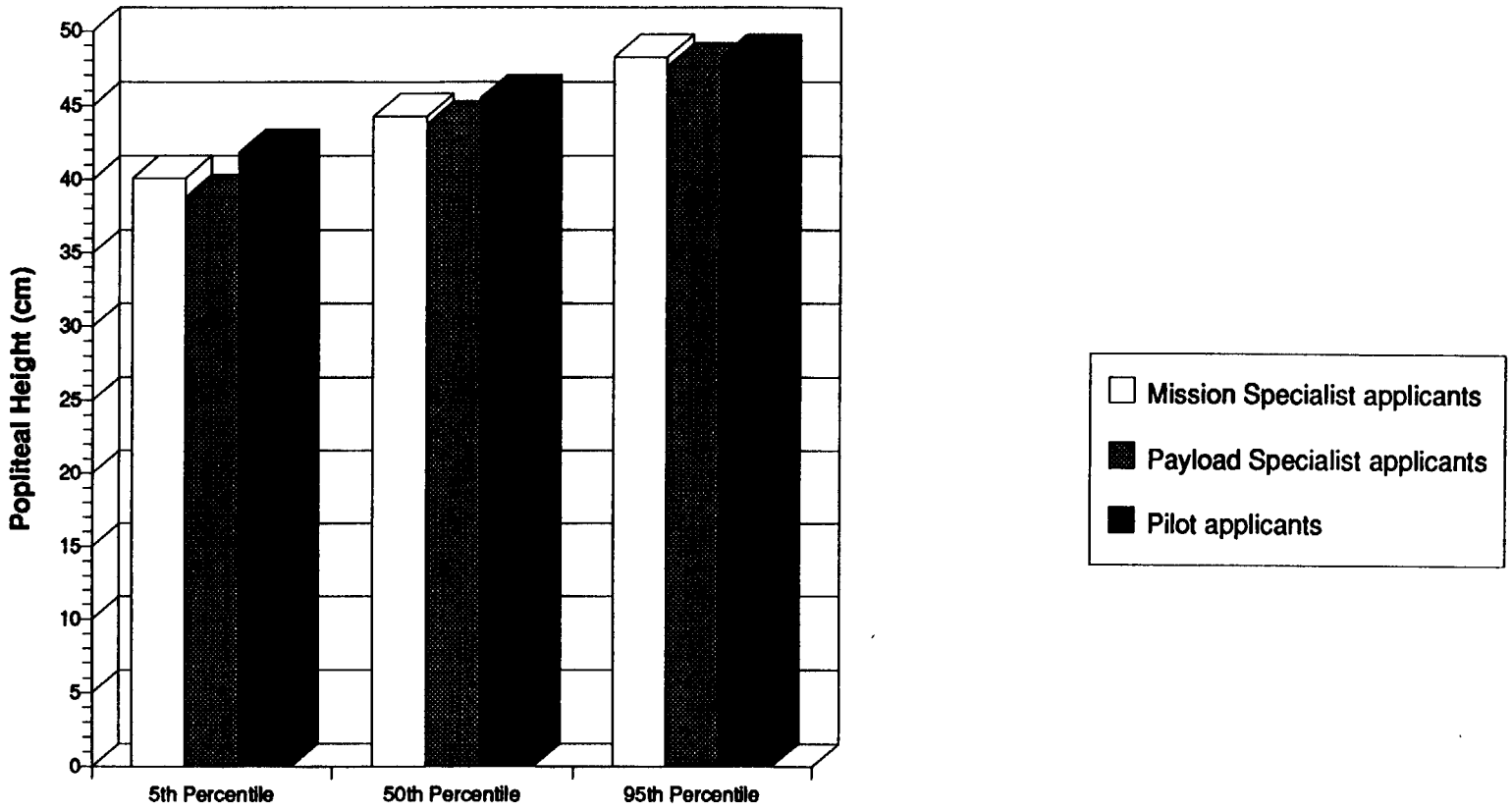

Figure 24. Differences in Popliteal Height Among Mission Specialists, Payload Specialists, and Pilots

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

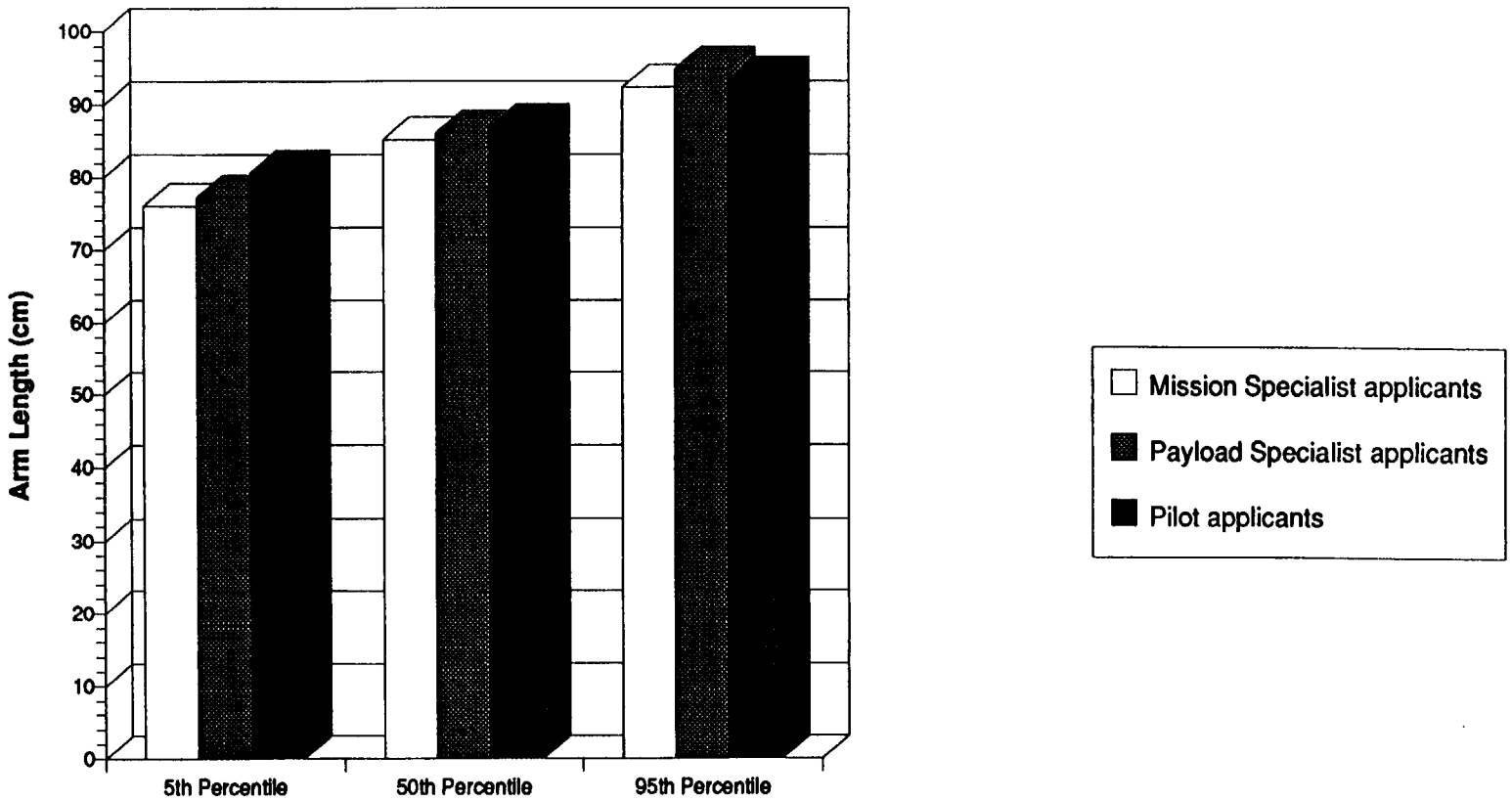

Figure 25. Differences in Arm Length Among Mission Specialists, Payload Specialists, and Pilots

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

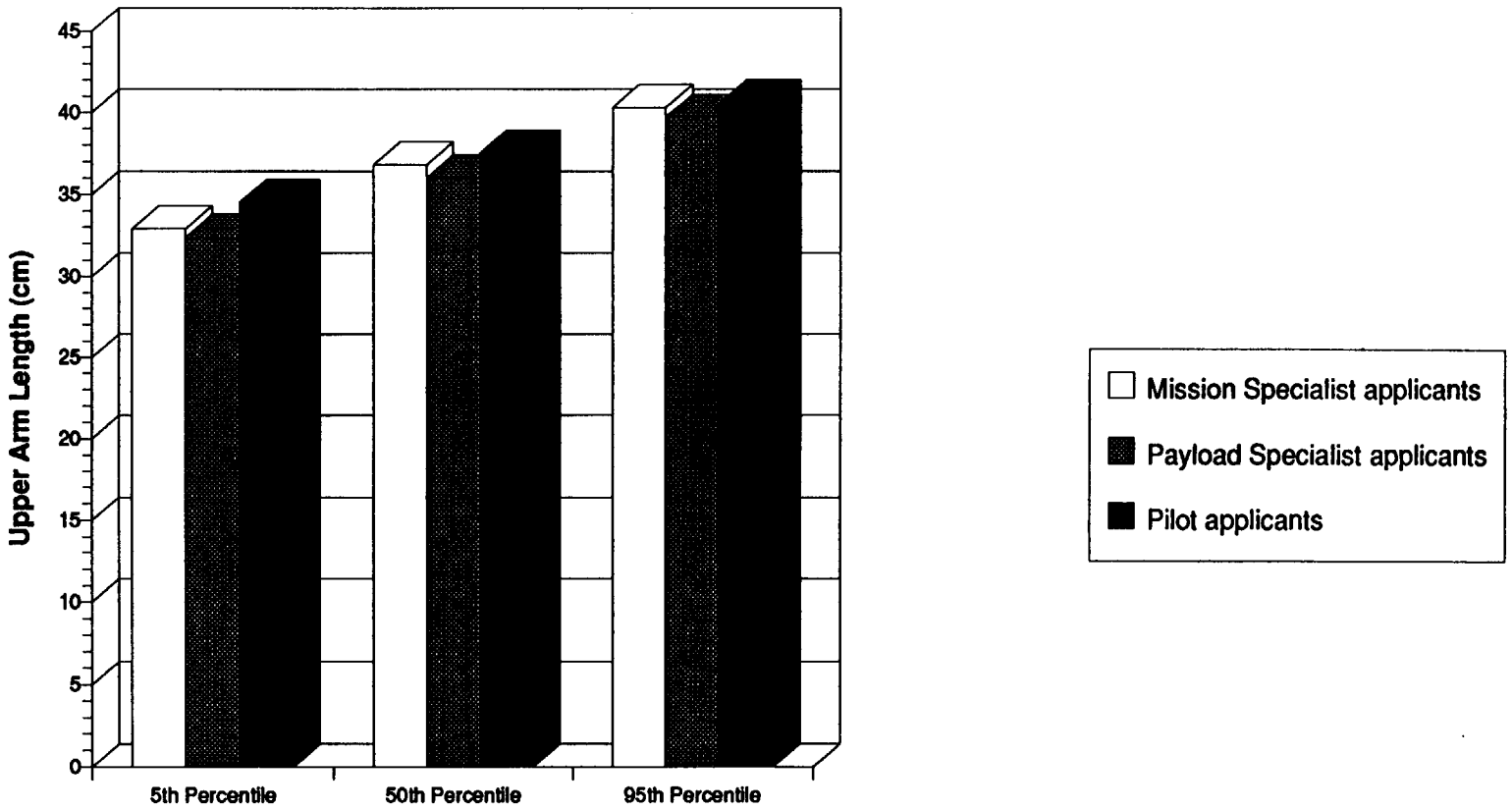

Figure 26. Differences in Upper Arm Length Among Mission Specialists, Payload Specialists, and Pilots

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

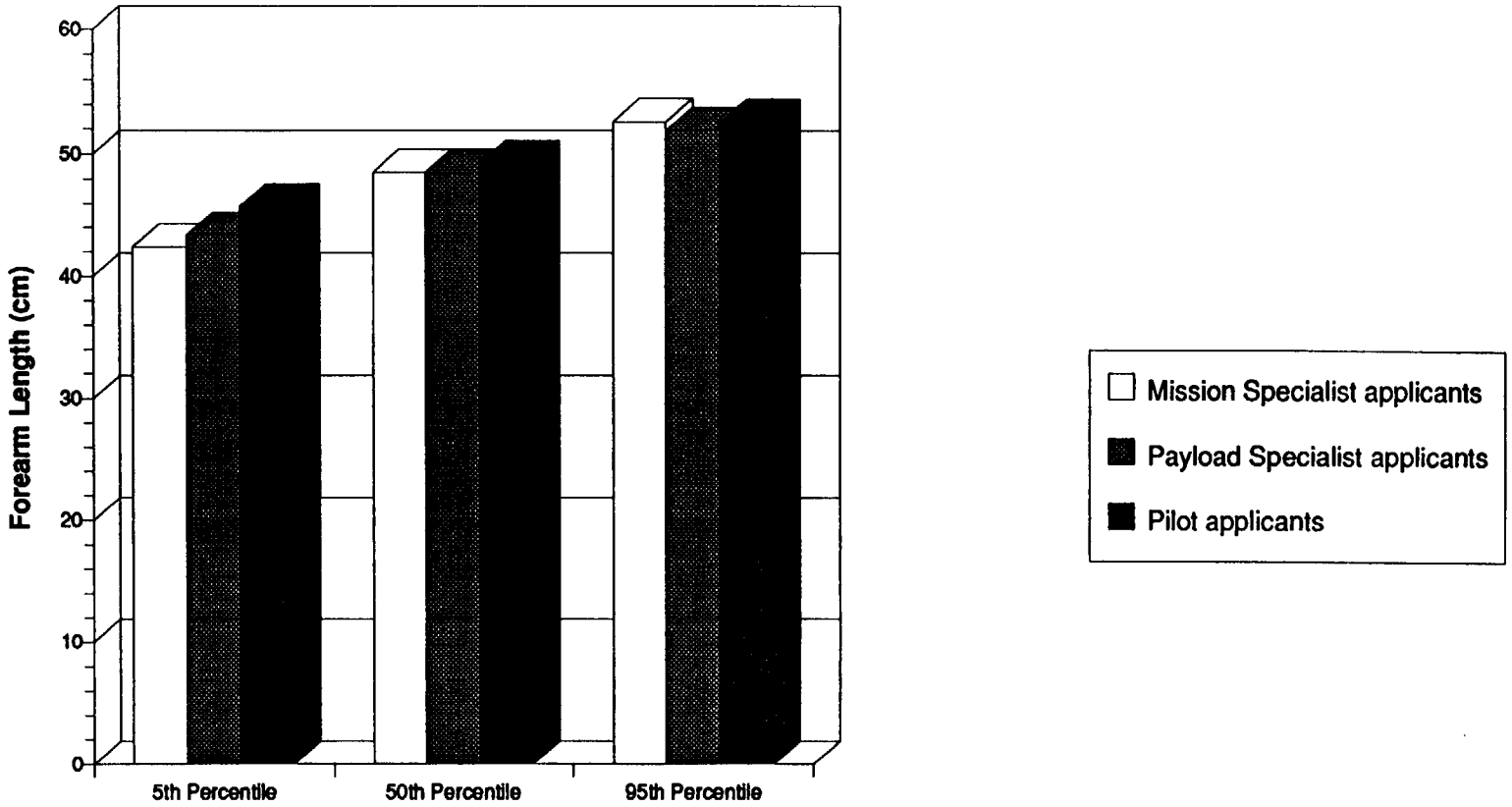

Figure 27. Differences in Forearm Length Among Mission Specialists, Payload Specialists, and Pilots

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

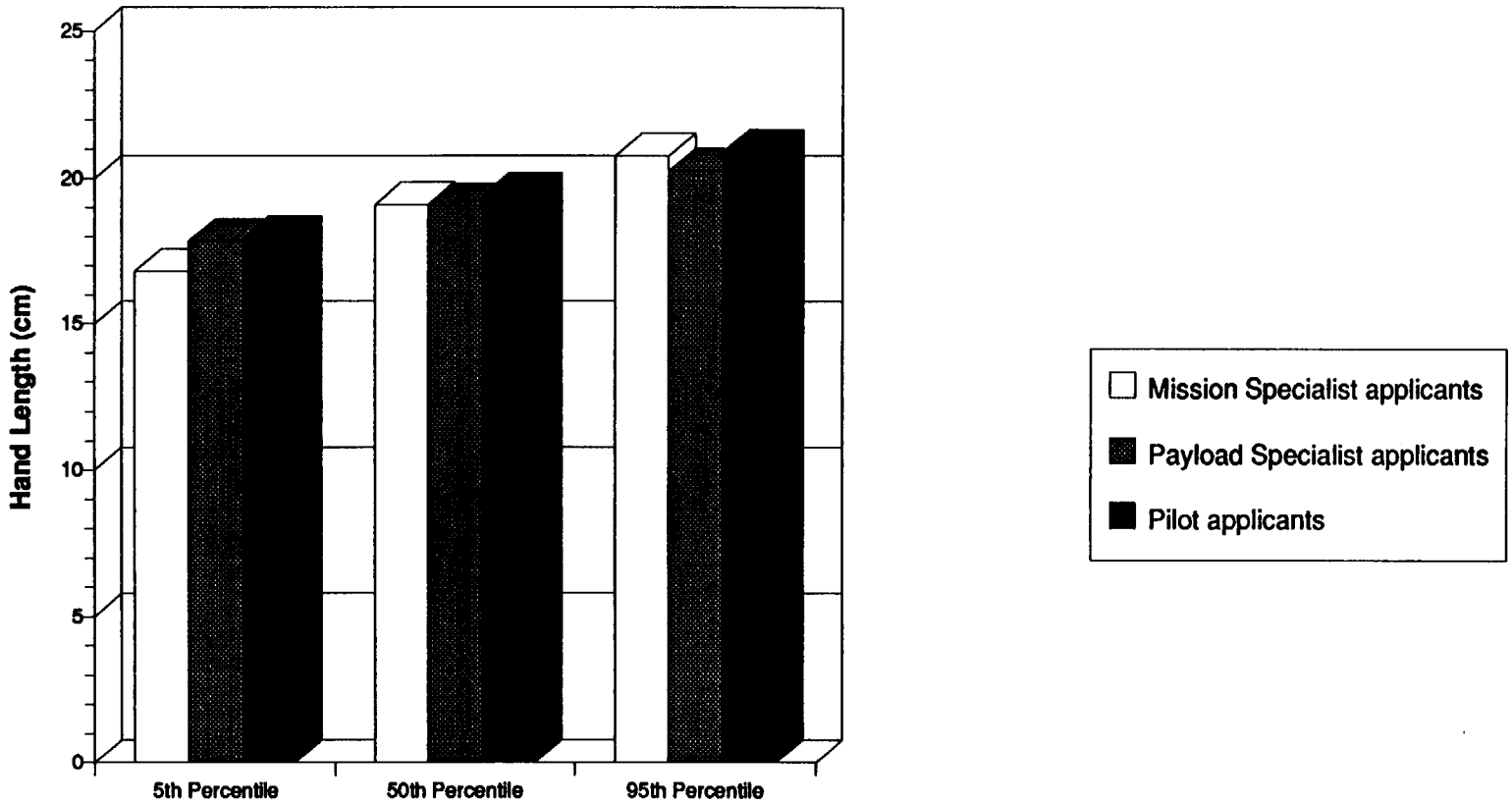

Figure 28. Differences in Hand Length Among Mission Specialists, Payload Specialists, and Pilots

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

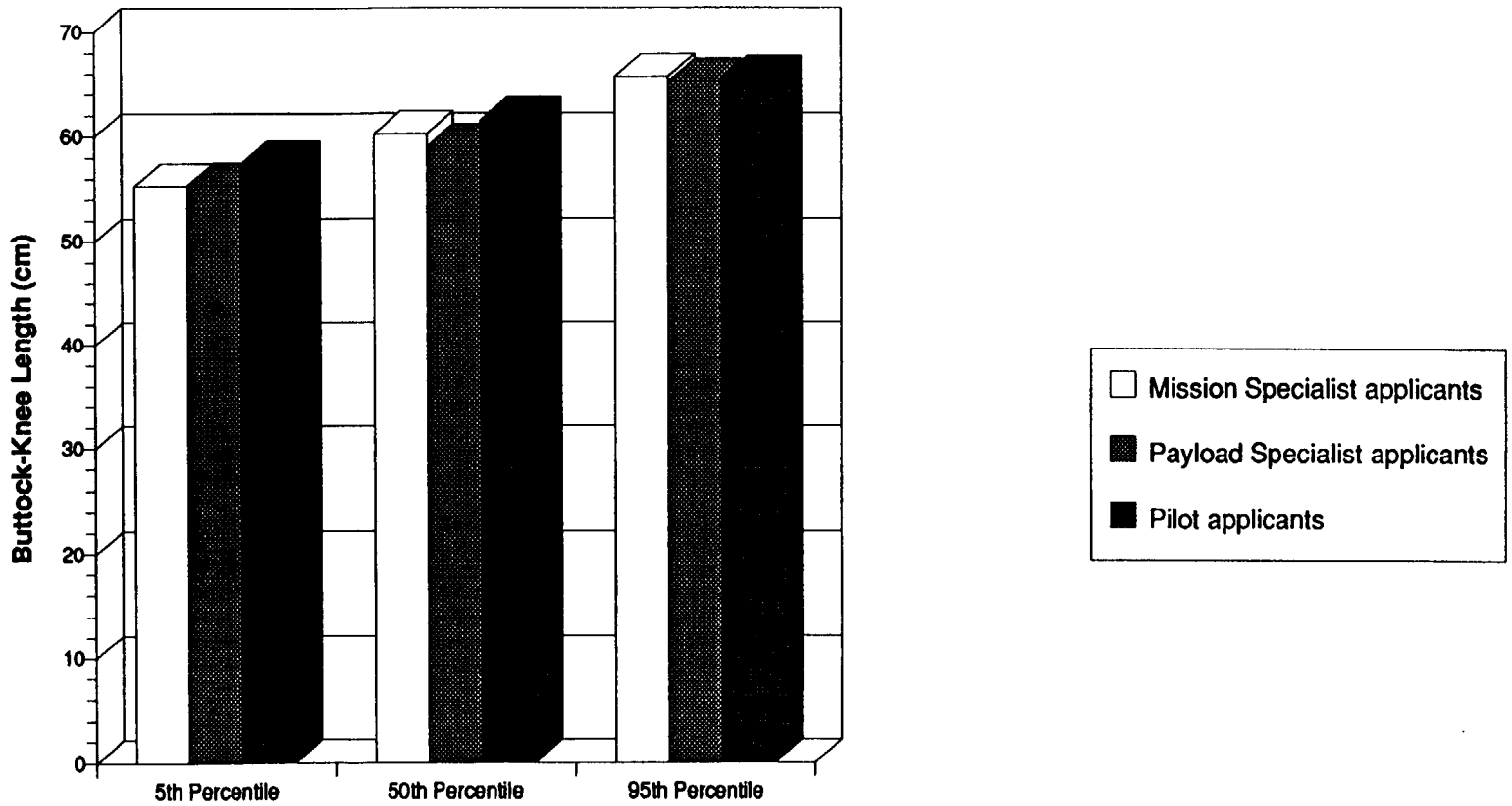

Figure 29. Differences in Buttock-Knee Length Among Mission Specialists, Payload Specialists, and Pilots

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

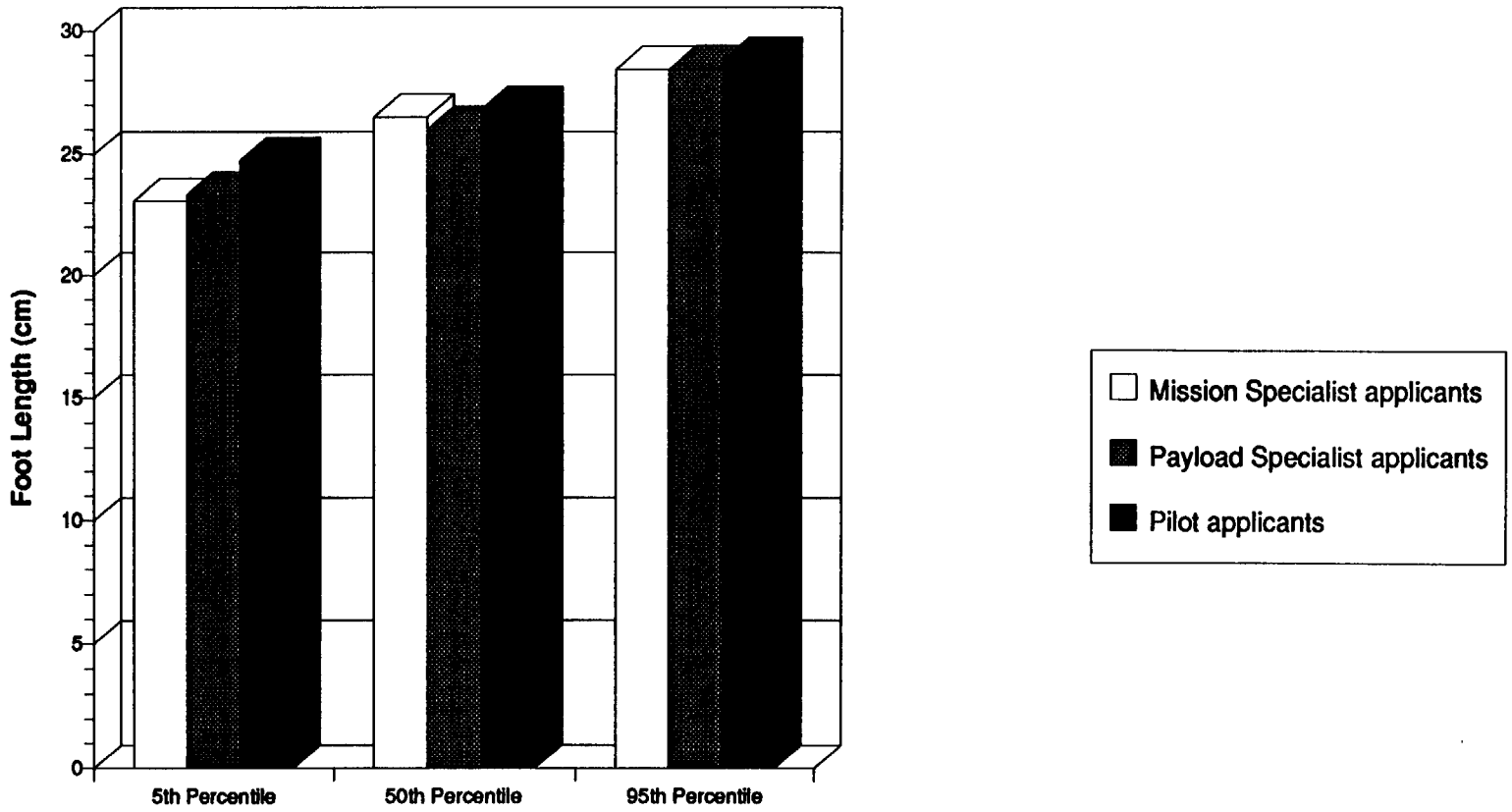

Figure 30. Differences in Foot Length Among Mission Specialists, Payload Specialists, and Pilots

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

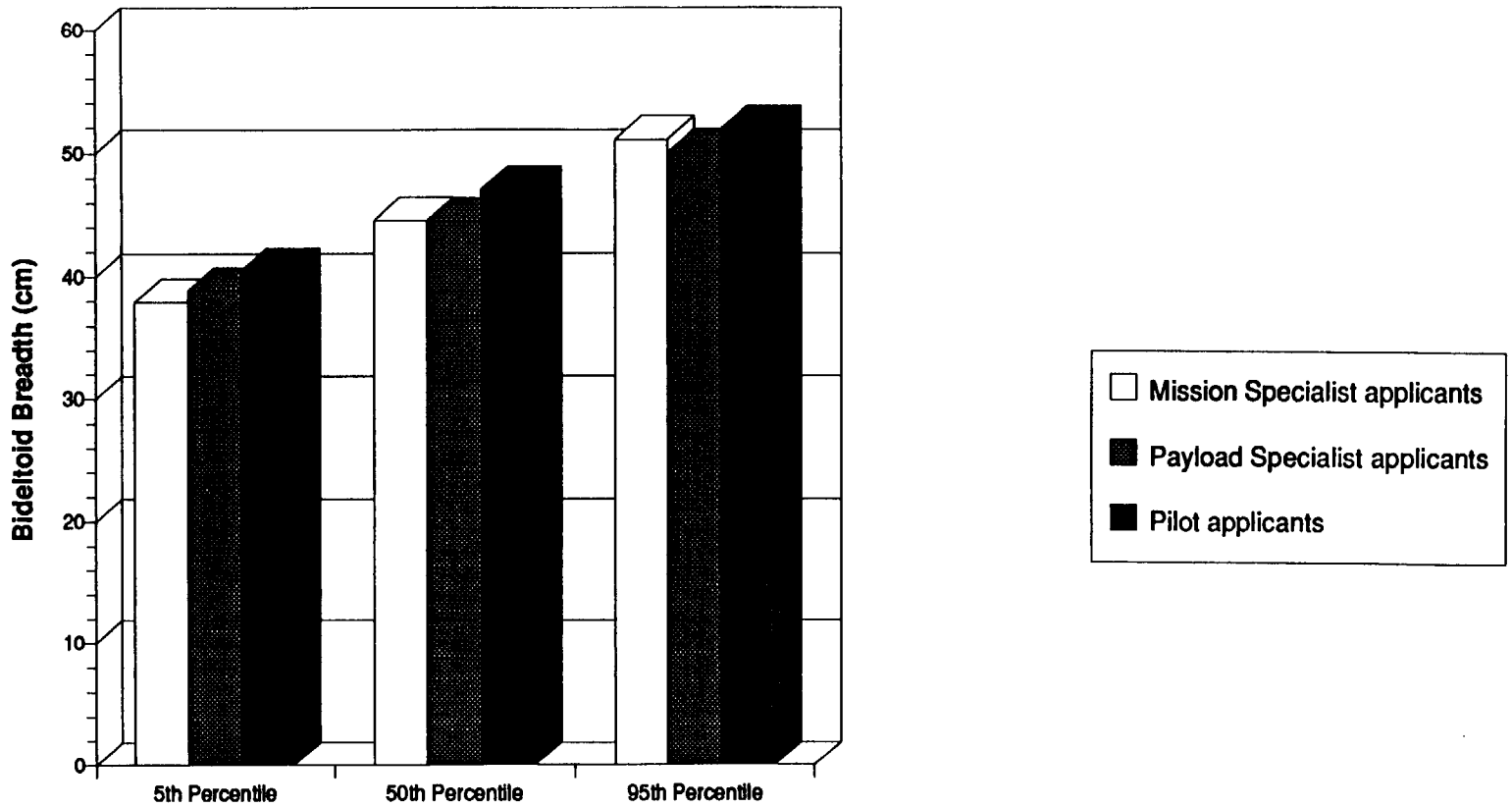

Figure 31. Differences in Bideltoid Breadth Among Mission Specialists, Payload Specialists, and Pilots

Anthropometric Percentile Data of the Astronaut Applicants (1985-1991)

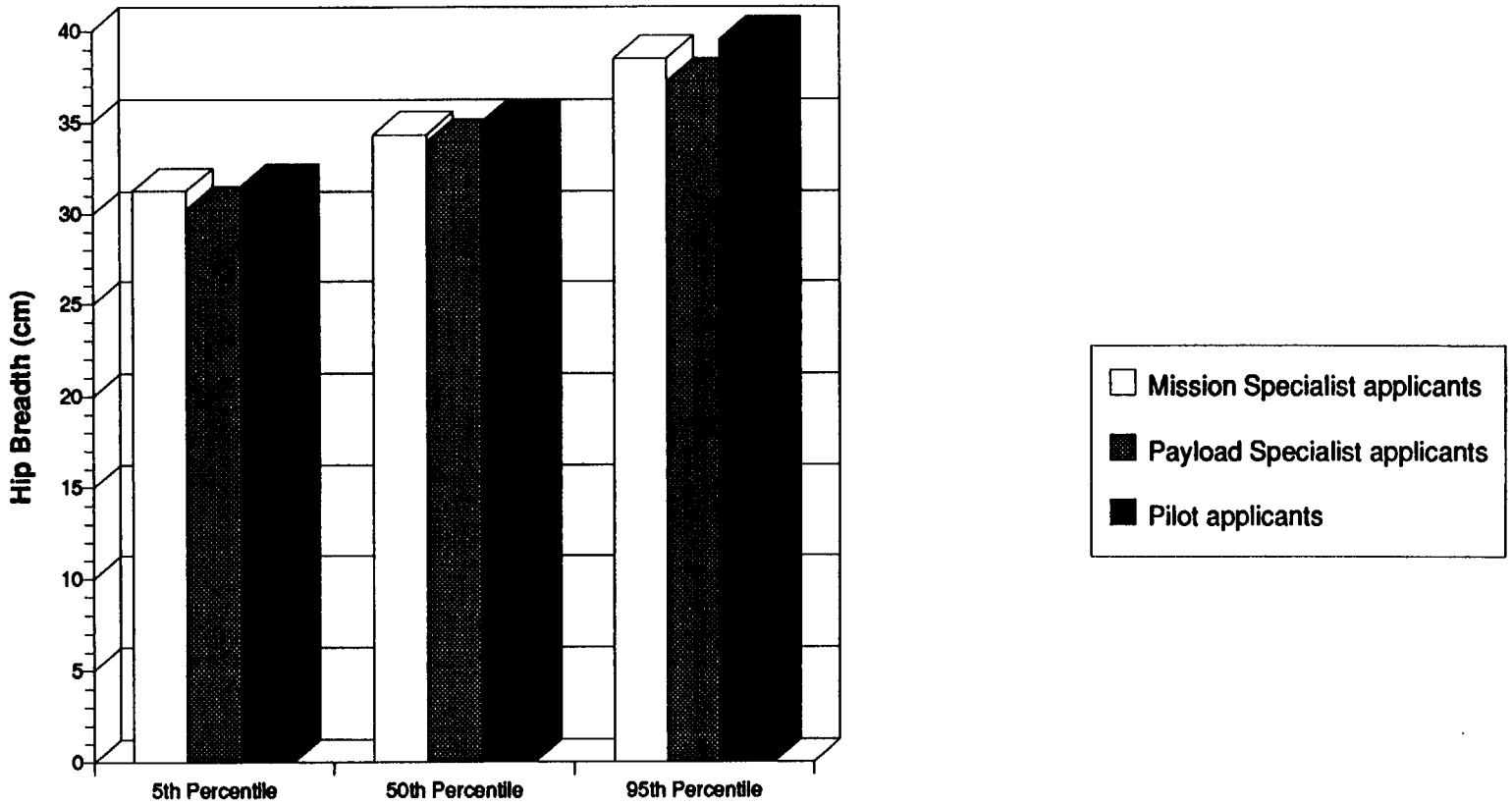

Figure 32. Differences in Hip Breadth Among Mission Specialists, Payload Specialists, and Pilots

TABLE 15
Descriptive Statistics on the Anthropometry of the Astronaut Applicants (1985 - 1991) Based on Female Mission Specialist Applicants.

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	34	57.75	7.277	45.00	78.10	0.585	0.563
Age	61	36.62	3.544	29.00	44.00	-0.079	-0.635
HEIGHTS (cm.)							
Standing	61	164.94	6.246	150.40	180.00	0.069	-0.143
Sitting	61	87.32	3.199	81.70	95.30	0.496	-0.415
Eye (sitting)	61	76.35	3.021	71.25	83.40	0.480	-0.486
Waist	61	98.80	4.350	90.75	110.80	0.140	-0.028
Crotch	61	78.55	3.776	69.90	88.50	0.023	0.335
Popliteal	61	41.61	2.420	36.00	45.10	-1.676	-0.027
LENGTHS (cm.)							
Arm	61	79.19	3.646	71.90	89.10	0.472	-0.003
Upper arm	61	34.13	1.465	31.00	37.90	0.379	0.039
Forearm	61	44.24	2.136	39.75	50.30	0.607	0.255
Hand	61	17.52	0.886	15.25	19.50	0.041	-0.017
Buttock-Knee	61	57.39	2.690	48.10	62.30	-0.629	1.144
Foot	61	23.91	1.192	21.50	27.10	0.366	0.399
BREADTHS (cm.)							
Bideltoid	61	40.40	2.966	34.70	47.90	0.076	-0.261
Hip	61	34.60	2.826	29.30	43.40	0.618	0.442

TABLE 16
Anthropometric Percentile Data of the Astronaut Applicants (1985 - 1991) Based on Female Mission Specialist Applicants.

Anthropometric Variable	N	<---------- Percentile ----------> 1 st	5 th	10 th	50 th	90 th	95 th	99 th
Weight	34	45.00	46.35	47.40	56.85	68.00	71.87	78.10
Age	61	29.00	31.00	31.40	36.00	41.60	42.80	44.00
HEIGHTS (cm.)								
Standing	61	150.40	154.36	156.52	164.90	173.72	175.98	180.00
Sitting	61	81.70	82.57	83.50	87.00	92.60	93.09	95.30
Eye (sitting)	61	71.25	71.82	72.54	75.80	81.02	81.92	83.40
Waist	61	90.75	91.12	92.34	99.00	104.80	106.38	110.80
Crotch	61	69.90	71.20	73.84	79.10	82.86	84.50	88.50
Popliteal	61	36.80	37.13	38.08	42.00	44.08	44.66	45.10
LENGTHS (cm.)								
Arm	61	71.90	73.61	75.00	78.70	84.16	86.00	89.10
Upper arm	61	31.00	31.65	32.48	33.80	36.54	36.96	37.90
Forearm	61	39.75	41.14	41.94	43.80	47.36	48.48	50.30
Hand	61	15.25	16.12	16.50	17.50	18.66	19.22	19.50
Buttock-Knee	61	48.10	52.82	53.66	57.40	61.12	61.52	62.30
Foot	61	21.50	21.82	22.44	23.90	25.32	26.46	27.10
BREADTHS (cm.)								
Bideltoid	61	34.70	35.22	35.94	40.30	44.42	44.86	47.90
Hip	61	29.30	30.64	31.09	34.90	38.92	39.78	43.40

TABLE 17
Descriptive Statistics on the Anthropometry of the Astronaut Applicants (1985 - 1991) Based on Male Mission Specialist Applicants.

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	157	76.42	7.620	57.00	97.70	0.325	0.029
Age	235	38.33	4.473	26.00	53.00	0.086	0.029
HEIGHTS (cm.)							
Standing	236	178.54	6.156	162.10	192.80	-0.048	-0.383
Sitting	235	93.60	3.216	84.70	101.40	-0.110	-0.147
Eye (sitting)	236	82.61	3.457	64.10	97.70	-0.236	3.896
Waist	236	105.83	4.840	92.10	118.50	0.002	-0.172
Crotch	236	86.29	4.264	73.90	97.90	0.129	0.100
Popliteal	236	44.86	2.048	36.50	50.00	-0.174	0.551
LENGTHS (cm.)							
Arm	236	86.39	3.870	71.90	97.70	-0.063	0.925
Upper arm	236	37.44	2.283	32.40	47.60	1.508	5.098
Forearm	236	49.08	2.318	36.80	58.30	-0.327	3.775
Hand	236	19.36	0.906	16.20	22.30	-0.074	0.538
Buttock-Knee	234	61.24	2.834	51.60	69.70	0.044	0.214
Foot	236	26.77	1.238	23.10	30.20	-0.130	0.255
BREADTHS (cm.)							
Bideltoid	234	45.77	3.456	37.80	54.30	-0.028	-0.695
Hip	236	34.52	1.932	29.20	44.40	0.646	2.620

TABLE 18
Anthropometric Percentile Data of the Astronaut Applicants (1985 - 1991) Based on Male Mission Specialist Applicants.

Anthropometric Variable	N	<---------- Percentile ----------> 1 st	5 th	10 th	50 th	90 th	95 th	99 th
Weight	157	58.42	64.67	66.97	75.70	86.70	90.44	96.45
Age	235	28.00	31.00	33.00	38.00	44.00	46.00	49.32
HEIGHTS (cm.)								
Standing	236	163.45	168.05	171.00	178.50	187.18	189.20	191.43
Sitting	235	85.67	88.10	89.29	93.60	97.64	98.97	100.97
Eye (sitting)	236	75.55	77.81	78.50	82.70	86.66	88.13	91.12
Waist	236	93.52	98.10	99.40	105.90	112.16	114.33	117.06
Crotch	236	75.21	79.90	80.80	86.30	91.82	93.79	96.93
Popliteal	236	39.67	41.67	42.18	44.80	47.70	48.30	49.33
LENGTHS (cm.)								
Arm	236	75.62	79.87	81.54	86.30	91.00	92.63	97.13
Upper arm	236	32.74	34.24	34.90	37.20	39.60	40.62	47.10
Forearm	236	42.81	45.67	46.40	49.00	52.10	52.83	55.29
Hand	236	16.84	17.90	18.10	19.30	20.56	20.90	21.53
Buttock-Knee	234	54.99	56.52	57.94	61.00	65.00	65.94	68.09
Foot	236	23.72	24.57	25.00	26.80	28.20	28.80	29.97
BREADTHS (cm.)								
Bideltoid	234	38.20	40.60	41.22	46.30	49.90	51.28	53.14
Hip	236	29.80	31.57	32.30	34.30	37.06	37.73	39.46

TABLE 19
Descriptive Statistics on the Anthropometry of the Astronaut Applicants (1985 - 1991) Based on Female Payload Specialist Applicants.

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	3	58.60	6.065	52.30	64.40	-0.368	0.000
Age	3	42.33	4.041	40.00	47.00	1.732	0.000
HEIGHTS (cm.)							
Standing	5	166.06	7.464	156.70	176.10	0.135	-0.564
Sitting	5	88.34	3.430	83.80	92.20	-0.142	-1.420
Eye (sitting)	5	77.04	3.953	72.10	81.80	0.096	-1.683
Waist	5	100.10	6.479	90.30	108.50	-0.532	2.074
Crotch	5	80.40	6.206	70.60	87.80	-0.925	2.306
Popliteal	5	41.10	2.088	37.60	42.80	-1.583	2.750
LENGTHS (cm.)							
Arm	5	79.04	3.515	75.10	84.40	0.830	0.855
Upper arm	5	34.52	2.043	31.40	37.00	-0.706	1.565
Forearm	5	45.62	3.147	41.20	50.10	0.048	2.001
Hand	5	18.22	0.789	17.20	19.20	0.027	-1.115
Buttock-Knee	5	57.48	3.785	51.80	62.40	-0.490	1.909
Foot	5	24.36	1.163	23.30	26.00	0.713	-1.402
BREADTHS (cm.)							
Bideltoid	5	41.40	2.729	38.80	45.50	0.775	0.154
Hip	5	35.64	2.882	33.00	39.40	0.605	-2.440

TABLE 20
Anthropometric Percentile Data of the Astronaut Applicants (1985 - 1991) Based on Female Payload Specialist Applicants.

Anthropometric Variable	N	<---------- Percentile ----------> 1 st	5 th	10 th	50 th	90 th	95 th	99 th
Weight	3	52.30	52.30	52.30	59.10	64.40	64.40	64.40
Age	3	40.00	40.00	40.00	40.00	47.00	47.00	47.00
HEIGHTS (cm.)								
Standing	5	156.70	156.70	156.70	166.50	176.10	176.10	176.10
Sitting	5	83.80	83.80	83.80	87.50	92.20	92.20	92.20
Eye {sitting}	5	72.10	72.10	72.10	75.70	81.80	81.80	81.80
Waist	5	90.30	90.30	90.30	100.90	108.50	108.50	108.50
Crotch	5	70.60	70.60	70.60	81.00	87.80	87.80	87.80
Popliteal	5	37.60	37.60	37.60	41.30	42.80	42.80	42.80
LENGTHS (cm.)								
Arm	5	75.10	75.10	75.10	78.50	84.40	84.40	84.40
Upper arm	5	31.40	31.40	31.40	34.40	37.00	37.00	37.00
Forearm	5	41.20	41.20	41.20	45.60	50.10	50.10	50.10
Hand	5	17.20	17.20	17.20	18.00	19.20	19.20	19.20
Buttock-Knee	5	51.80	51.80	51.80	57.90	62.40	62.40	62.40
Foot	5	23.30	23.30	23.30	24.00	26.00	26.00	26.00
BREADTHS (cm.)								
Bideltoid	5	38.80	38.80	38.80	41.70	45.50	45.50	45.50
Hip	5	33.00	33.00	33.00	34.40	39.40	39.40	39.40

TABLE 21
Descriptive Statistics on the Anthropometry of the Astronaut Applicants (1985 - 1991) Based on Male Payload Specialist Applicants.

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	32	72.88	8.650	57.60	90.30	0.053	-0.745
Age	37	43.60	6.403	33.00	60.00	0.535	-0.375
HEIGHTS (cm.)							
Standing	42	175.60	6.334	164.10	188.40	0.127	-0.640
Sitting	42	91.81	3.117	84.70	96.50	-0.407	-0.437
Eye (sitting)	42	81.61	2.990	73.70	85.80	-0.679	-0.176
Waist	42	104.62	5.050	94.90	115.00	0.199	-0.666
Crotch	42	84.71	4.517	76.10	94.80	0.242	-0.408
Popliteal	42	44.08	2.232	36.70	47.90	-0.795	1.412
LENGTHS (cm.)							
Arm	42	86.35	4.667	77.40	95.70	-0.097	-0.646
Upper arm	42	36.28	1.934	32.10	39.90	-0.056	-0.426
Forearm	41	48.36	2.337	42.60	52.20	-0.281	-0.586
Hand	42	19.17	0.747	17.80	20.40	-0.012	-1.170
Buttock-Knee	41	59.89	2.867	55.20	65.90	0.240	-0.789
Foot	42	26.14	1.375	22.80	28.80	-0.176	-0.369
BREADTHS (cm.)							
Bideltoid	42	44.72	2.893	37.40	51.40	0.003	0.222
Hip	42	33.47	1.842	29.40	36.30	-0.353	-0.837

TABLE 22
Anthropometric Percentile Data of the Astronaut Applicants (1985 - 1991) Based on Male Payload Specialist Applicants.

Anthropometric Variable	N	<---------- Percentile ----------> 1 st	5 th	10 th	50 th	90 th	95 th	99 th
Weight	32	57.60	58.93	59.88	72.40	83.60	89.46	90.30
Age	37	33.00	34.90	35.90	42.00	52.00	56.20	60.00
HEIGHTS (cm.)								
Standing	42	164.10	164.96	166.52	175.40	184.60	187.28	188.40
Sitting	42	84.70	85.28	87.26	91.90	96.02	96.46	96.50
Eye (sitting)	42	73.70	76.04	76.82	82.20	85.08	85.58	85.80
Waist	42	94.90	96.66	98.02	104.30	110.52	114.48	115.00
Crotch	42	76.10	77.12	79.32	84.80	91.14	93.84	94.80
Popliteal	42	36.70	40.36	41.48	44.30	46.54	47.66	47.90
LENGTHS (cm.)								
Arm	42	77.40	78.58	79.22	87.20	92.04	95.18	95.70
Upper arm	42	32.10	32.80	33.48	36.20	39.26	39.76	39.90
Forearm	41	42.60	44.66	45.16	48.55	51.44	52.03	52.20
Hand	42	17.80	17.92	18.14	19.20	20.20	20.28	20.40
Buttock-Knee	41	55.20	55.53	55.89	59.85	64.22	65.39	65.90
Foot	42	22.80	23.64	24.32	26.30	27.80	28.48	28.80
BREADTHS (cm.)								
Bideltoid	42	37.40	39.88	41.10	44.60	48.56	50.14	51.40
Hip	42	29.40	30.22	30.76	33.90	35.82	36.08	36.30

TABLE 23
Descriptive Statistics on the Anthropometry of the Astronaut Applicants (1985 - 1991) Based on Male Pilot Applicants.

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	74	76.59	8.853	56.80	105.90	0.447	0.918
Age	118	39.90	4.343	33.00	63.00	1.378	5.443
HEIGHTS (cm.)							
Standing	118	179.39	5.977	164.50	192.30	-0.115	-0.399
Sitting	118	94.07	3.127	85.60	102.30	-0.239	0.416
Eye (sitting)	118	83.17	3.398	74.10	92.20	-0.050	0.201
Waist	118	106.85	4.501	95.60	118.10	-0.021	-0.492
Crotch	118	86.17	4.128	76.20	97.30	0.017	-0.037
Popliteal	118	45.03	2.520	33.30	50.50	-1.959	7.263
LENGTHS (cm.)							
Arm	118	86.90	3.748	76.60	95.60	-0.050	-0.121
Upper arm	118	37.64	2.039	32.40	48.50	1.017	5.976
Forearm	118	49.15	2.088	41.00	53.20	-0.516	0.957
Hand	118	19.43	0.910	17.30	23.00	0.526	1.322
Buttock-Knee	118	61.57	2.595	54.40	67.20	-0.104	-0.277
Foot	118	26.77	1.346	20.00	30.30	-0.930	4.454
BREADTHS (cm.)							
Bideltoid	118	46.48	3.391	38.40	53.00	-0.309	-0.723
Hip	118	35.15	2.731	30.20	47.90	1.641	5.079

TABLE 24
Anthropometric Percentile Data of the Astronaut Applicants (1985 - 1991) Based on Male Pilot Applicants.

Anthropometric Variable	N	<---------- Percentile ----------> 1 st	5 th	10 th	50 th	90 th	95 th	99 th
Weight	74	56.80	62.02	65.36	75.00	86.74	94.76	105.90
Age	118	33.00	34.00	35.00	40.00	45.00	46.95	60.06
HEIGHTS (cm.)								
Standing	118	164.86	169.11	170.64	179.40	186.40	189.83	192.26
Sitting	118	85.60	88.66	89.50	94.30	97.88	99.19	102.19
Eye (sitting)	118	74.31	77.02	78.91	83.25	87.19	88.97	92.03
Waist	118	96.00	99.43	101.32	107.10	112.80	113.70	117.74
Crotch	118	76.20	79.32	80.56	86.05	91.48	93.26	96.92
Popliteal	118	33.38	41.85	42.43	45.50	47.40	48.20	50.33
LENGTHS (cm.)								
Arm	118	76.94	80.61	82.23	86.90	92.45	93.30	95.31
Upper arm	118	32.51	34.51	35.41	37.50	39.88	40.58	47.18
Forearm	118	41.61	45.71	46.52	49.20	51.80	52.59	53.10
Hand	118	17.32	17.95	18.41	19.40	20.60	20.90	22.71
Buttock-Knee	118	54.69	57.40	58.01	61.50	65.20	65.50	67.14
Foot	118	20.78	24.76	25.10	26.80	28.48	28.80	30.11
BREADTHS (cm.)								
Bideltoid	118	38.57	40.50	41.46	47.10	50.30	51.90	52.87
Hip	118	30.28	31.50	32.31	35.00	37.97	39.49	47.21

TABLE 25
Descriptive Statistics on the Anthropometry of the Astronauts (1985 - 1991) Based on Female Astronauts

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	6	55.43	7.186	46.80	68.40	1.209	2.674
Age	12	35.50	3.398	30.00	41.10	0.317	-0.659
HEIGHTS (cm.)							
Standing	12	164.23	5.719	152.10	172.10	-0.765	0.699
Sitting	12	86.99	2.918	81.70	92.30	-0.021	0.129
Eye (sitting)	12	75.78	2.653	71.25	79.60	-0.146	-0.853
Waist	12	97.79	4.463	90.75	103.50	-0.522	-1.067
Crotch	12	78.51	2.996	73.90	83.10	-0.268	-1.099
Popliteal	12	40.36	3.589	30.90	44.12	-1.828	4.041
LENGTHS (cm.)							
Arm	12	78.15	2.972	73.50	84.10	0.377	-0.068
Upper arm	12	33.90	1.015	32.80	36.00	0.994	0.022
Forearm	9	44.06	1.997	41.90	48.40	0.983	0.374
Hand	9	17.58	1.037	15.70	19.30	-0.103	-0.455
Buttock-Knee	9	56.64	3.358	48.10	61.20	-1.495	3.427
Foot	9	23.91	1.479	21.80	26.90	0.499	-0.143
BREADTHS (cm.)							
Bideltoid	9	39.29	2.715	35.30	44.90	0.772	0.308
Hip	9	33.58	2.610	29.30	39.20	0.714	0.848

TABLE 26
Anthropometric Percentile Data of the Astronauts (1985 - 1991) Based on Female Astronauts

Anthropometric Variable	N	<---------- Percentile ----------> 1 st	5 th	10 th	50 th	90 th	95 th	99 th
Weight	6	46.80	46.80	46.80	54.55	68.40	68.40	68.40
Age	12	30.00	30.00	30.60	35.00	40.70	41.00	41.00
HEIGHTS (cm.)								
Standing	12	152.10	152.10	152.39	164.20	171.71	172.10	172.10
Sitting	12	81.70	81.70	81.70	87.70	93.00	93.00	93.00
Eye (sitting)	12	71.25	71.25	71.25	77.30	83.00	83.00	83.00
Waist	12	90.75	90.75	90.75	100.60	110.80	110.80	110.80
Crotch	12	73.90	73.90	73.90	80.80	88.50	88.50	88.50
Popliteal	12	30.90	30.90	30.90	42.30	45.10	45.10	45.10
LENGTHS (cm.)								
Arm	12	76.70	76.70	76.70	80.00	84.20	84.20	84.20
Upper arm	12	32.80	32.80	32.80	34.30	37.00	37.00	37.00
Forearm	12	42.45	42.45	42.45	45.10	50.30	50.30	50.30
Hand	12	16.80	16.80	16.80	18.30	19.30	19.30	19.30
Buttock-Knee	12	48.10	48.10	48.10	58.10	61.60	61.60	61.60
Foot	12	22.40	22.40	22.40	25.10	27.10	27.10	27.10
BREADTHS (cm.)								
Bideltoid	12	37.10	37.10	37.10	39.10	47.90	47.90	47.90
Hip	12	29.30	29.30	29.30	33.00	39.20	39.20	39.20

TABLE 27
Descriptive Statistics on the Anthropometry of the Astronauts (1985 - 1991) Based on Male Astronauts

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	51	75.98	7.775	62.20	95.80	0.826	0.983
Age	70	38.58	3.074	32.00	46.00	0.266	-0.462
HEIGHTS (cm.)							
Standing	70	178.54	6.385	162.85	189.80	-0.257	-0.507
Sitting	70	93.71	3.137	85.55	101.05	-0.139	0.437
Eye (sitting)	70	82.36	3.242	75.40	88.20	-0.090	-0.590
Waist	70	106.32	5.072	95.10	115.20	-0.232	-0.557
Crotch	70	86.03	4.488	78.10	96.80	0.188	-0.370
Popliteal	70	45.09	1.997	41.45	48.90	-0.014	-0.810
LENGTHS (cm.)							
Arm	70	86.17	4.015	74.50	93.30	-0.663	0.524
Upper arm	70	37.70	2.701	32.40	48.50	1.318	5.418
Forearm	70	49.07	2.322	44.40	55.90	0.278	0.641
Hand	70	19.24	0.999	17.35	22.30	0.444	1.060
Buttock-Knee	70	61.26	3.286	54.40	68.20	0.109	-0.231
Foot	70	26.78	1.353	23.75	30.20	-0.119	0.146
BREADTHS (cm.)							
Bideltoid	70	46.50	3.418	38.40	52.60	-0.314	-0.403
Hip	70	34.08	1.892	29.80	39.10	0.281	0.571

TABLE 28
Anthropometric Percentile Data of the Astronauts (1985 - 1991) Based on Male Astronauts

Anthropometric Variable	N	<---------- Percentile ----------> 1 st	5 th	10 th	50 th	90 th	95 th	99 th
Weight	24	62.20	62.33	65.20	73.60	86.15	93.70	95.80
Age	41	32.00	34.10	35.00	38.00	43.00	43.00	46.00
HEIGHTS (cm.)								
Standing	41	162.85	167.80	170.76	178.80	186.98	188.54	189.80
Sitting	41	85.55	88.67	88.96	93.60	97.46	99.52	101.05
Eye (sitting)	41	75.40	76.42	78.02	82.30	87.16	87.94	88.20
Waist	41	95.10	97.25	98.56	106.85	112.76	114.79	115.20
Crotch	41	78.10	78.38	79.94	85.70	91.80	93.96	96.80
Popliteal	41	41.45	41.64	42.14	45.35	48.14	48.48	48.90
LENGTHS (cm.)								
Arm	41	74.50	79.14	79.89	86.00	90.84	92.31	93.30
Upper arm	41	32.40	33.82	34.10	37.80	40.54	41.24	48.50
Forearm	41	44.40	44.90	46.02	49.40	51.90	52.20	55.90
Hand	41	17.35	17.42	17.90	19.30	20.46	20.87	22.30
Buttock-Knee	41	54.40	55.44	56.36	60.70	65.86	67.75	68.20
Foot	41	23.75	24.40	24.92	26.90	28.36	28.93	30.20
BREADTHS (cm.)								
Bideltoid	41	38.40	40.05	41.60	46.90	51.02	52.26	52.60
Hip	41	29.80	30.68	31.64	33.80	36.54	37.96	39.10

TABLE 29
Descriptive Statistics on the Anthropometry of the Astronauts (1985 - 1991) Based on Female Mission Specialists.

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	6	55.43	7.183	46.80	68.40	1.209	2.674
Age	11	35.50	3.398	30.00	41.00	0.317	-0.659
HEIGHTS (cm.)							
Standing	11	164.23	5.719	152.10	172.10	-0.765	0.699
Sitting	11	86.99	2.918	81.70	92.30	-0.475	-0.345
Eye (sitting)	11	77.18	3.509	71.25	83.00	-0.190	0.213
Waist	11	100.94	5.222	90.75	110.80	-0.092	2.744
Crotch	11	80.77	3.856	73.90	88.50	0.402	2.507
Popliteal	11	41.04	4.218	30.90	45.10	-1.988	4.724
LENGTHS (cm.)							
Arm	11	80.21	2.579	76.70	84.20	0.561	-0.484
Upper arm	11	34.52	1.403	32.80	37.00	0.564	-0.605
Forearm	11	45.52	2.534	42.45	50.30	0.850	0.103
Hand	11	18.08	0.905	16.80	19.30	-0.349	-1.235
Buttock-Knee	11	57.33	4.235	48.10	61.60	-1.475	2.207
Foot	11	24.84	1.508	22.40	27.10	0.135	-0.304
BREADTHS (cm.)							
Bideltoid	11	40.70	3.806	37.10	47.90	0.971	-0.192
Hip	11	34.02	2.916	29.30	39.20	0.257	0.174

TABLE 30
Anthropometric Percentile Data of the Astronauts (1985 - 1991) Based on Female Mission Specialists.

Anthropometric Variable	N	<---------- Percentile ----------> 1 st	5 th	10 th	50 th	90 th	95 th	99 th
Weight	6	46.80	46.80	46.80	54.55	68.40	68.40	68.40
Age	12	30.00	30.00	30.60	35.00	40.70	41.00	41.00
HEIGHTS (cm.)								
Standing	12	152.10	152.10	153.39	164.20	171.71	172.10	172.10
Sitting	12	81.70	81.70	82.29	87.70	91.70	92.30	92.30
Eye (sitting)	12	71.25	71.25	71.66	76.20	79.54	79.60	79.60
Waist	12	90.75	90.75	90.89	99.40	103.38	103.50	103.50
Crotch	12	73.90	73.90	74.11	79.20	82.65	83.10	83.10
Popliteal	12	30.90	30.90	32.83	33.60	35.79	36.00	36.00
LENGTHS (cm.)								
Arm	12	73.50	73.50	74.01	78.20	83.08	84.10	84.10
Upper arm	12	32.80	32.80	32.83	33.60	35.79	36.00	36.00
Forearm	12	41.90	41.90	41.93	43.45	47.80	48.40	48.40
Hand	12	15.70	15.70	15.94	17.60	19.12	19.30	19.30
Buttock-Knee	12	48.10	48.10	49.66	57.20	60.84	61.20	61.20
Foot	12	21.80	21.80	21.98	23.85	26.39	26.90	26.90
BREADTHS (cm.)								
Bideltoid	12	35.30	35.30	35.84	38.58	44.33	44.90	44.90
Hip	12	29.30	29.30	30.05	32.85	38.33	39.20	39.20

TABLE 31
Descriptive Statistics on the Anthropometry of the Astronauts (1985 - 1991) Based on Male Mission Specialists.

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	31	74.54	6.950	62.70	87.40	0.446	-0.522
Age	42	38.29	3.355	32.00	46.00	0.462	-0.137
HEIGHTS (cm.)							
Standing	42	177.98	7.059	162.85	189.80	-0.155	-0.602
Sitting	42	93.68	3.304	85.55	101.05	-0.062	1.287
Eye (sitting)	42	82.47	3.116	75.40	88.20	-0.053	0.154
Waist	42	105.91	5.546	95.10	115.20	-0.267	-0.659
Crotch	42	85.73	4.999	78.10	96.80	0.294	-0.401
Popliteal	42	44.97	2.183	41.45	48.90	0.156	-0.939
LENGTHS (cm.)							
Arm	42	85.78	4.300	74.50	92.45	-0.791	0.587
Upper arm	42	37.12	2.205	32.40	41.25	-0.229	0.080
Forearm	42	49.09	2.627	44.40	55.90	0.407	0.683
Hand	42	19.33	1.154	17.35	22.30	0.442	0.556
Buttock-Knee	42	61.00	3.548	55.40	68.20	0.451	-0.364
Foot	42	26.89	1.553	23.75	30.20	-0.140	-0.149
BREADTHS (cm.)							
Bideltoid	42	46.24	3.178	38.40	52.60	-0.460	0.413
Hip	42	34.01	1.714	29.80	36.70	-0.407	0.165

TABLE 32
Anthropometric Percentile Data of the Astronauts (1985 - 1991) Based on Male Mission Specialists.

Anthropometric Variable	N	<---------- Percentile ----------> 1 st	5 th	10 th	50 th	90 th	95 th	99 th
Weight	31	62.70	62.70	65.70	72.40	85.66	87.40	87.40
Age	42	32.00	32.50	34.50	37.00	43.00	45.25	46.00
HEIGHTS (cm.)								
Standing	42	162.85	164.06	169.20	178.55	188.07	189.51	189.80
Sitting	42	85.55	86.39	89.05	93.60	98.50	100.71	101.05
Eye (sitting)	42	75.40	76.03	78.28	82.25	87.50	88.15	88.20
Waist	42	95.10	95.61	97.62	106.53	113.50	115.10	115.20
Crotch	42	78.10	78.15	78.70	85.65	93.00	96.10	96.80
Popliteal	42	41.45	41.49	41.85	45.00	48.28	48.75	48.90
LENGTHS (cm.)								
Arm	42	74.50	75.75	79.65	85.95	90.93	92.09	92.45
Upper arm	42	32.40	32.75	33.95	37.40	40.37	41.24	41.25
Forearm	42	44.40	44.51	45.42	49.08	52.20	54.97	55.90
Hand	42	17.35	17.41	17.75	19.35	20.75	21.95	22.30
Buttock-Knee	42	55.40	55.50	55.85	60.35	66.93	68.11	68.20
Foot	42	23.75	23.91	24.65	27.10	28.87	29.89	30.20
BREADTHS (cm.)								
Bideltoid	42	38.40	39.17	41.75	46.83	49.75	51.92	52.60
Hip	42	29.80	30.20	31.60	33.85	36.37	36.69	36.70

TABLE 33
Descriptive Statistics on the Anthropometry of the Astronauts (1985 - 1991) Based on Male Pilots.

Anthropometric Variable	N	Mean	Std.	Min.	Max.	Skewness	Kurtosis
Weight	20	76.10	9.358	62.20	95.80	1.079	2.220
Age	28	39.00	2.669	35.00	43.00	0.045	-1.343
HEIGHTS (cm.)							
Standing	28	179.34	5.398	168.70	187.10	-0.256	-0.765
Sitting	28	93.74	2.984	88.65	97.90	-0.299	-1.022
Eye (sitting)	28	82.19	3.503	76.35	87.40	-0.105	-1.233
Waist	28	106.91	4.412	99.40	114.70	0.115	-0.944
Crotch	28	86.46	3.756	79.90	93.60	0.139	-0.586
Popliteal	28	45.27	1.751	42.00	48.50	-0.308	-0.359
LENGTHS (cm.)							
Arm	28	86.72	3.632	79.10	93.30	-0.239	-0.065
Upper arm	28	38.53	3.163	34.00	48.50	1.866	5.992
Forearm	28	49.04	1.887	45.40	51.50	-0.297	-0.828
Hand	28	19.10	0.738	17.40	20.10	-0.486	0.050
Buttock-Knee	28	61.62	2.943	54.40	66.90	-0.573	1.150
Foot	28	26.62	1.032	24.40	28.20	-0.681	-0.150
BREADTHS (cm.)							
Bideltoid	28	46.87	3.800	39.90	52.30	-0.308	-0.986
Hip	28	34.17	2.170	30.60	39.10	0.751	0.755

TABLE 34
Anthropometric Percentile Data of the Astronauts (1985 - 1991) Based on Male Pilots.

		<---------- Percentile ---------->						
Anthropometric Variable	**N**	**1 st**	**5 th**	**10 th**	**50 th**	**90 th**	**95 th**	**99 th**
Weight	20	62.20	62.20	62.20	73.80	95.80	95.80	95.80
Age	28	35.00	35.00	35.80	39.00	43.00	43.00	43.00
HEIGHTS (cm.)								
Standing	28	168.70	168.70	171.50	178.80	186.62	187.10	187.10
Sitting	28	88.65	88.65	88.77	93.30	97.58	97.90	97.90
Eye (sitting)	28	76.35	76.35	76.87	82.30	87.24	87.40	87.40
Waist	28	99.40	99.40	101.24	107.70	113.18	114.70	114.70
Crotch	28	79.90	79.90	80.94	85.70	91.52	93.60	93.60
Popliteal	28	42.00	42.00	42.24	45.80	47.30	48.50	48.50
LENGTHS (cm.)								
Arm	28	79.10	79.10	81.02	86.40	91.30	93.30	93.30
Upper arm	28	34.00	34.00	34.56	38.40	42.18	48.50	48.50
Forearm	28	45.40	45.40	46.20	49.40	51.50	51.50	51.50
Hand	28	17.40	17.40	18.12	19.10	20.10	20.10	20.10
Buttock-Knee	28	54.40	54.40	57.44	62.00	65.62	66.90	66.90
Foot	28	24.40	24.40	24.88	26.70	27.72	28.20	28.20
BREADTHS (cm.)								
Bideltoid	28	39.90	39.90	41.10	47.60	51.98	52.30	52.30
Hip	28	30.60	30.60	31.40	33.60	38.30	39.10	39.10

6.0 References

Man-Systems Integration Standards: Lyndon B. Johnson Space Center, Houston, Texas, October 1989. NASA-STD-3000, Revision A.

Webb Associates: Anthropometric Source Book, vol. I: Anthropometry for Designers. National Aeronautics and Space Administration, Washington, D.C., 1978. NASA RP-1024.

APPENDIX

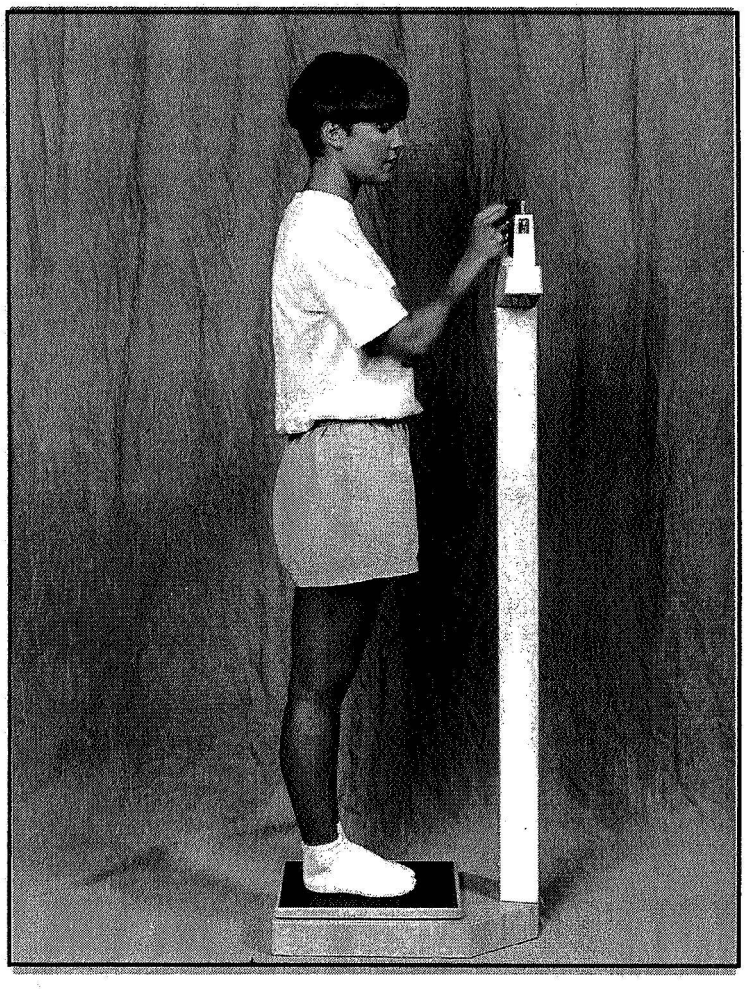

Figure 1. Subject Measuring Her Weight

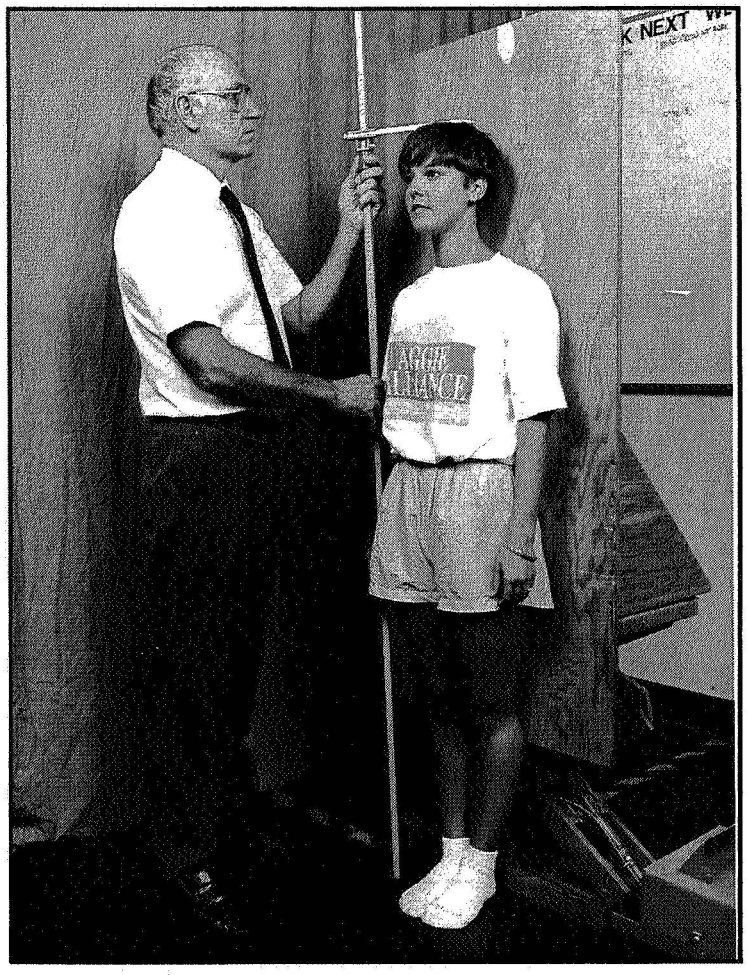

Figure 2. Measurement of the Subject's Standing Height

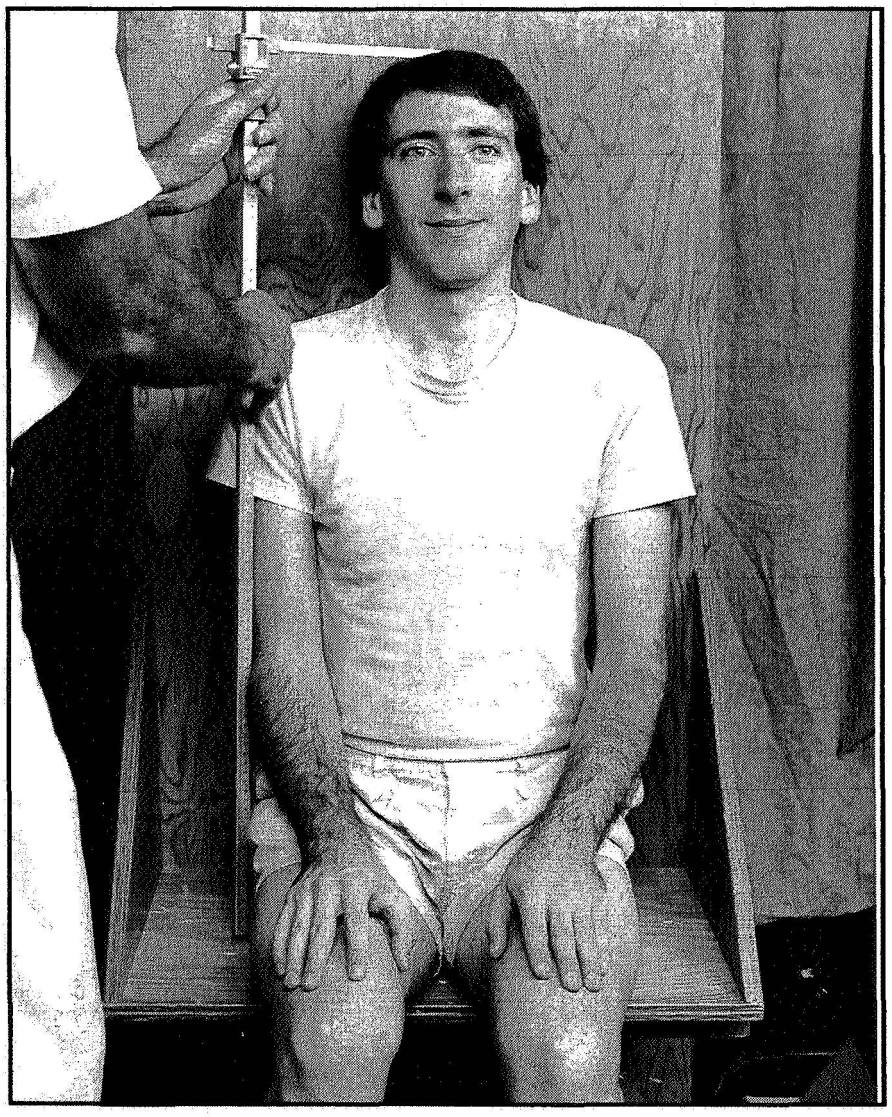

Figure 3. Measurement of the Subject's Sitting Height

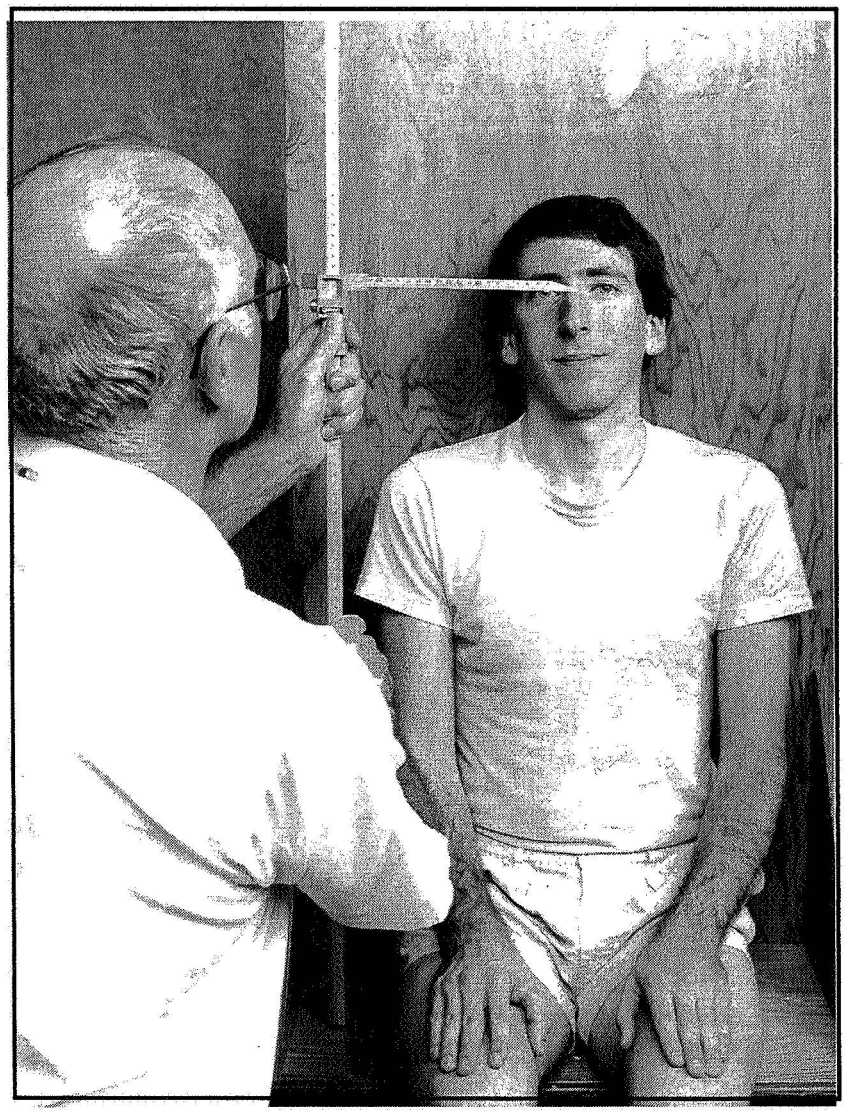

Figure 4. Measurement of the Subject's Sitting Eye Height

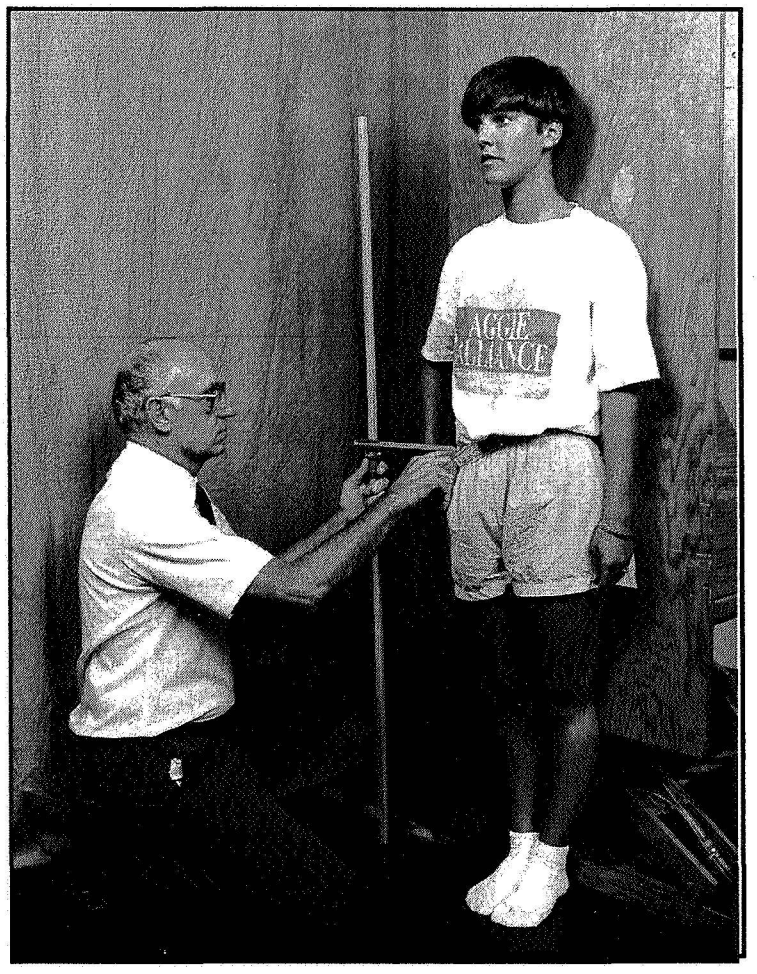

Figure 5. Measurement of the Subject's Waist Height

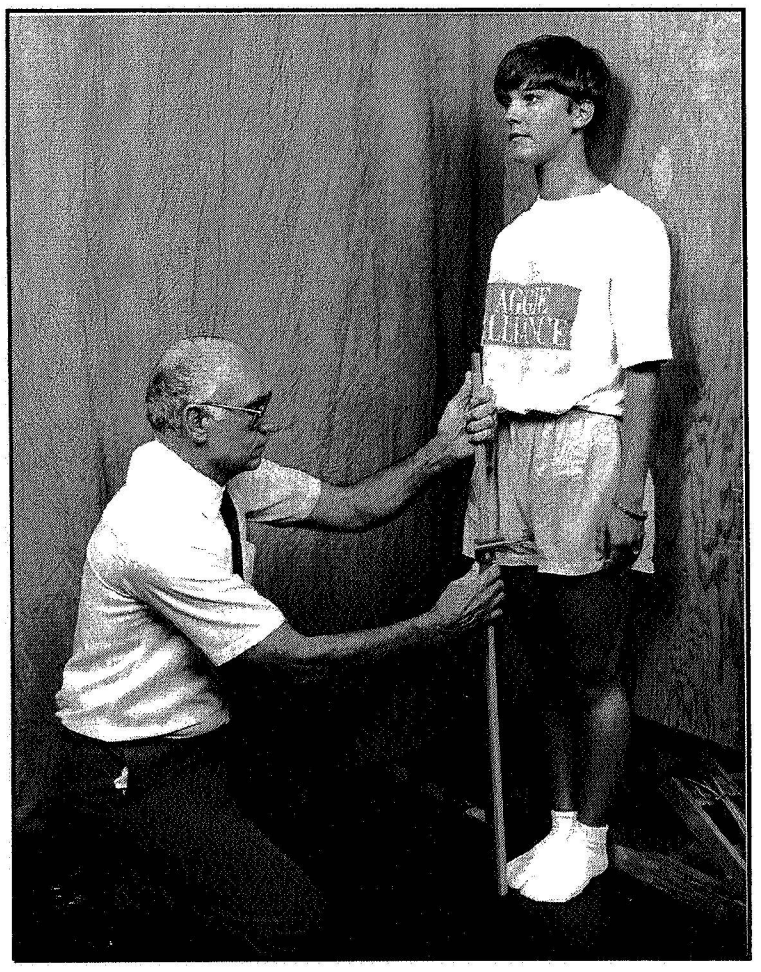

Figure 6. Measurement of the Subject's Crotch Height

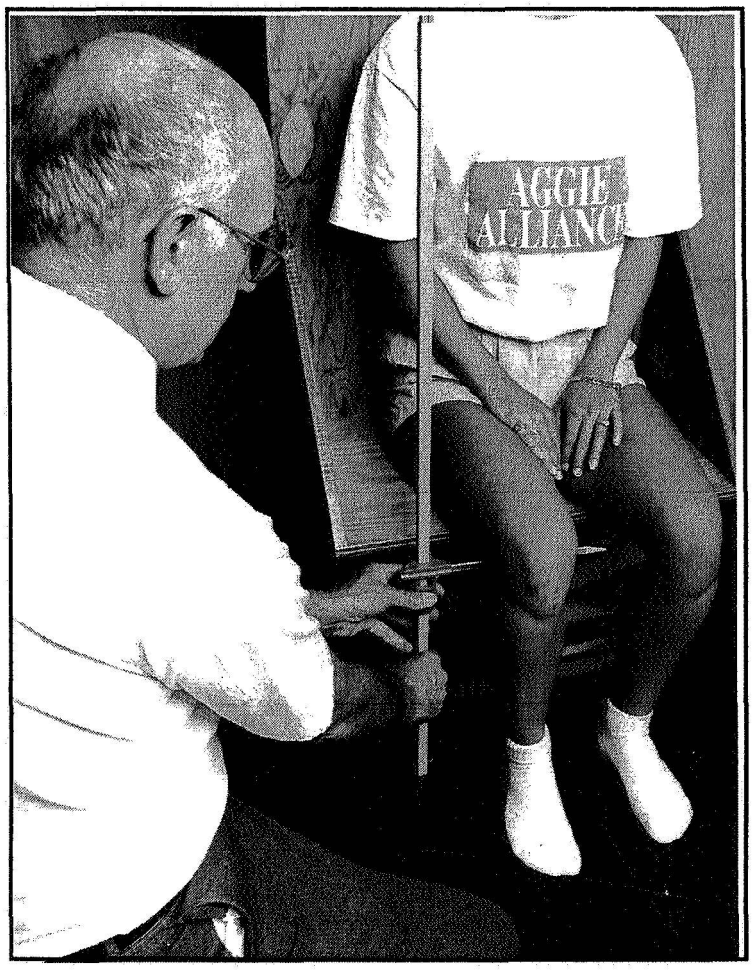

Figure 7. Measurement of the Subject's Popliteal Height

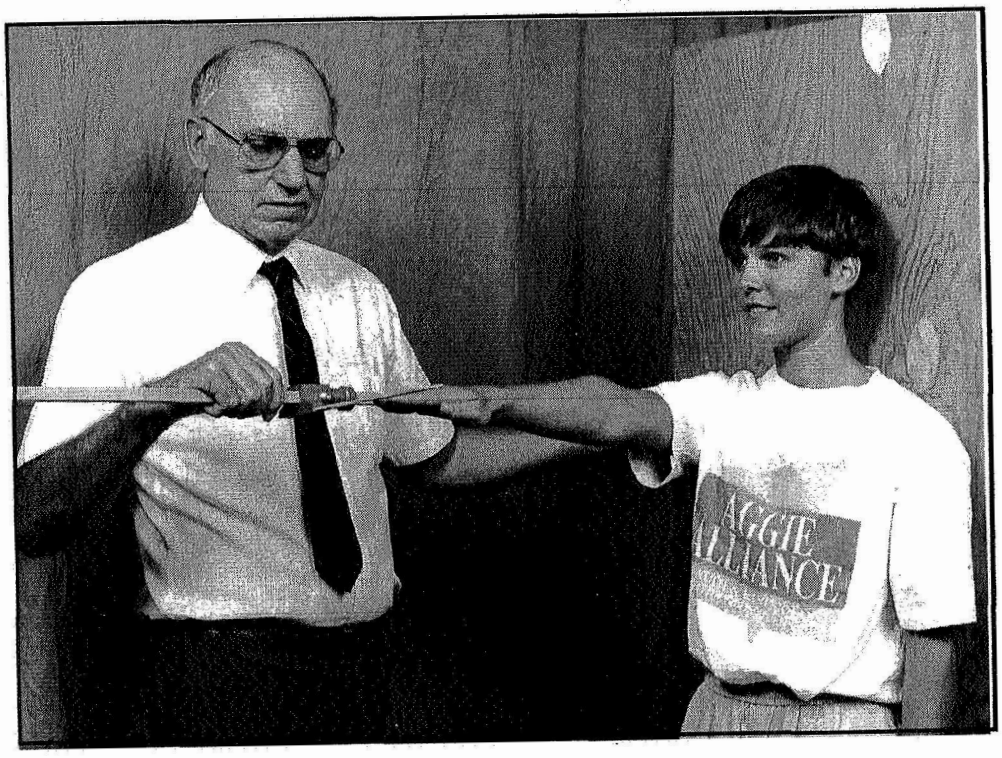

Figure 8. Measurement of the Subject's Arm Length

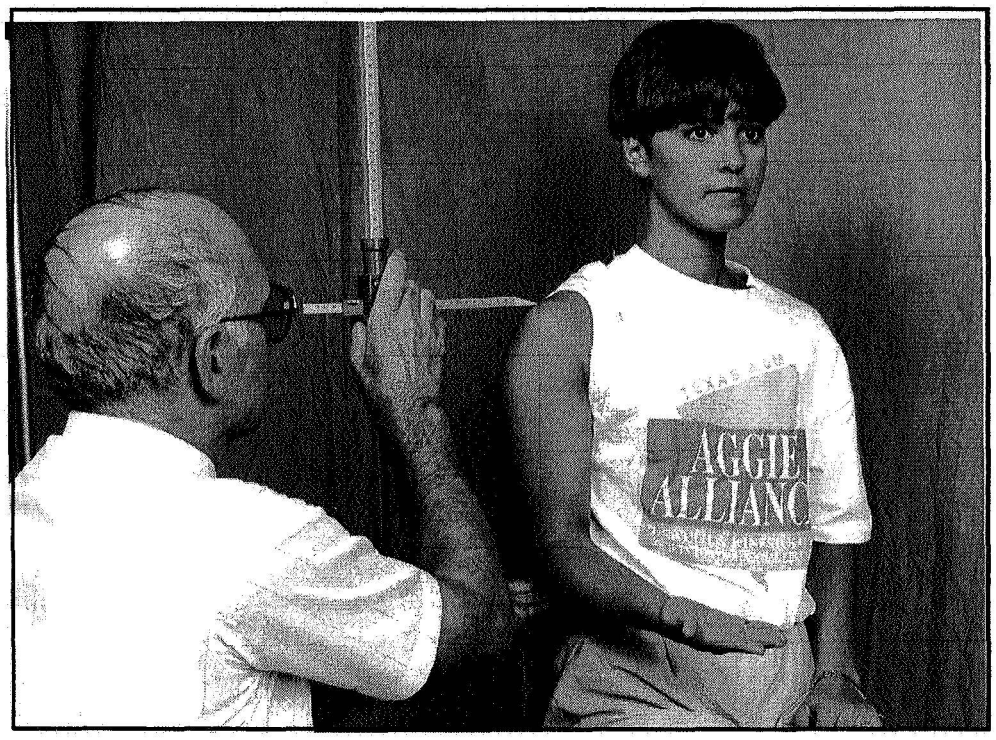

Figure 9. Measurement of the Subject's Upper Arm Length

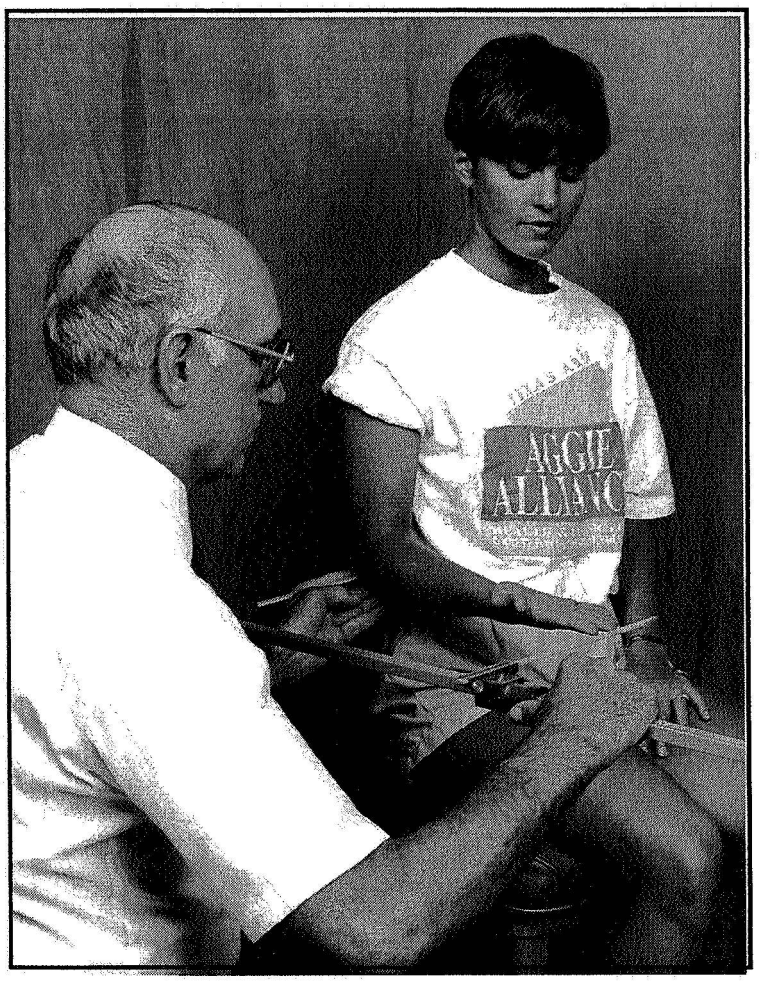

Figure 10. Measurement of the Subject's Forearm Length

Figure 11. Measurement of the Subject's Hand Length

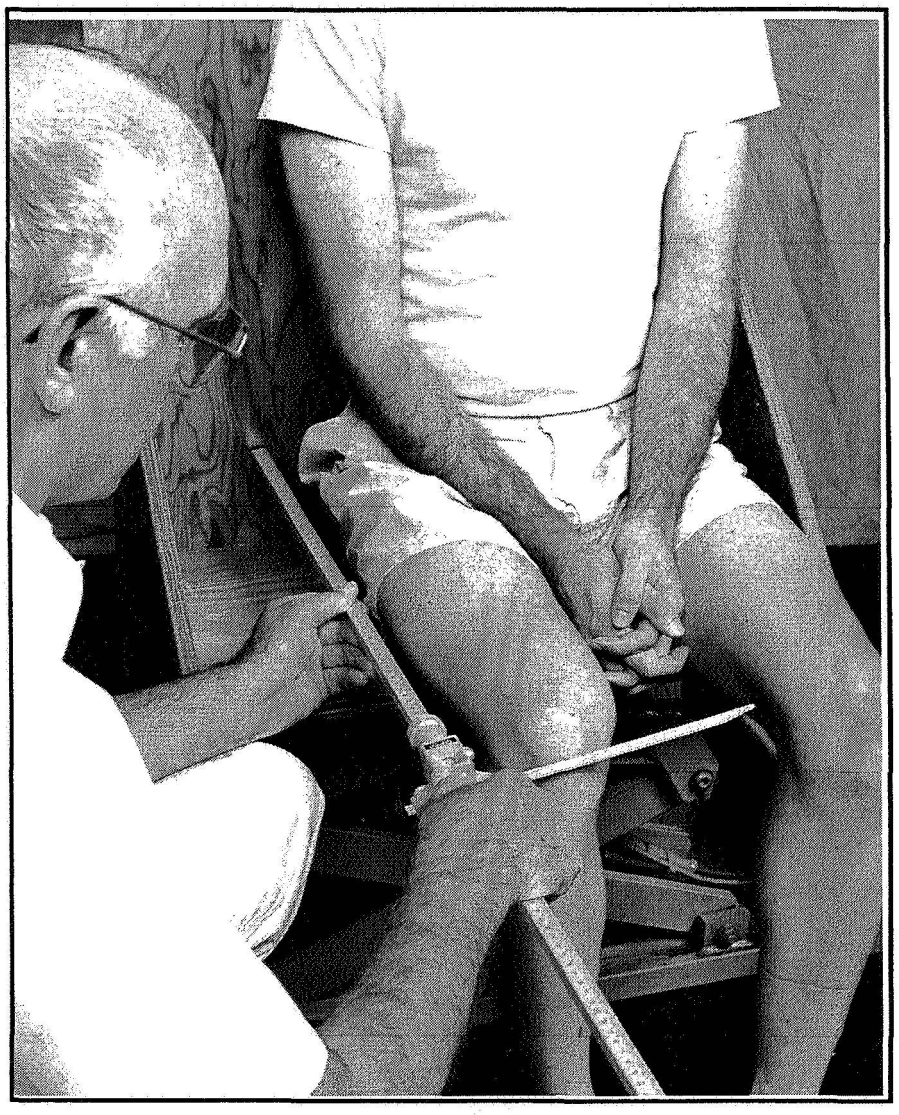

Figure 12. Measurement of the Subject's Buttock to Knee Length

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

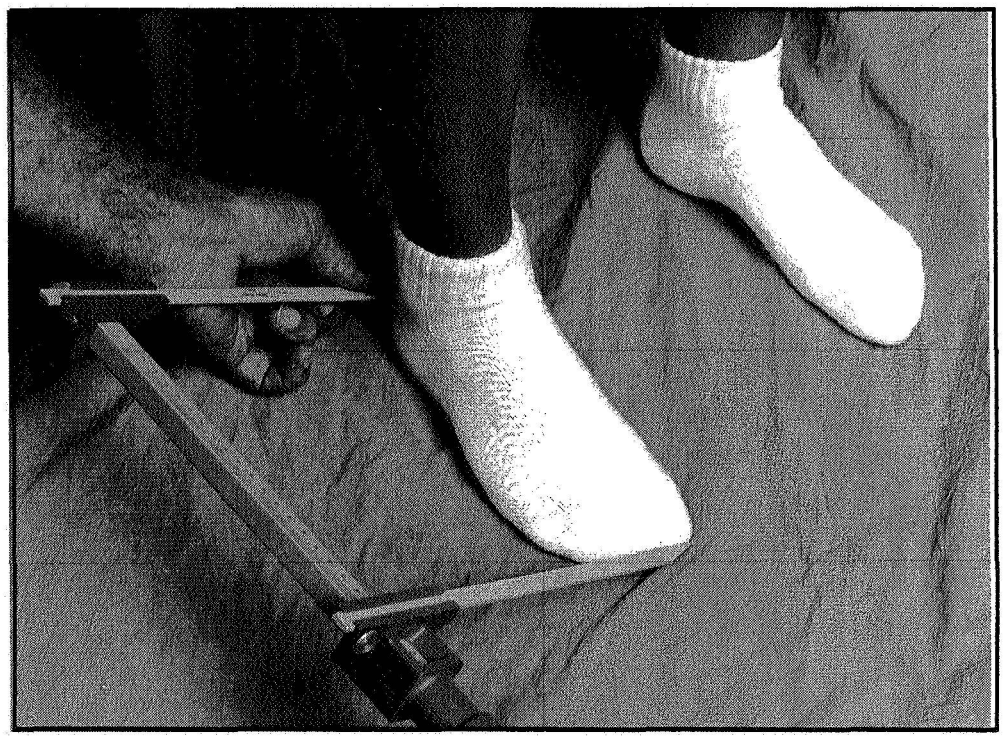

Figure 13. Measurement of the Subject's Foot Length

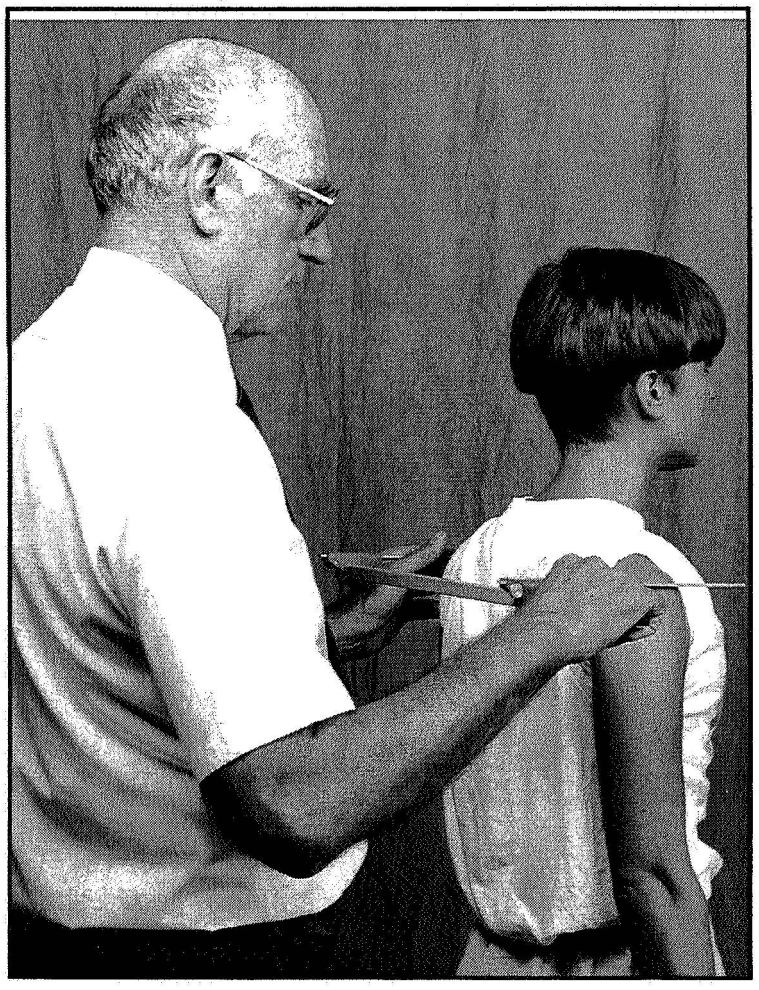

Figure 14. Measurement of the Subject's Bideltoid Breadth

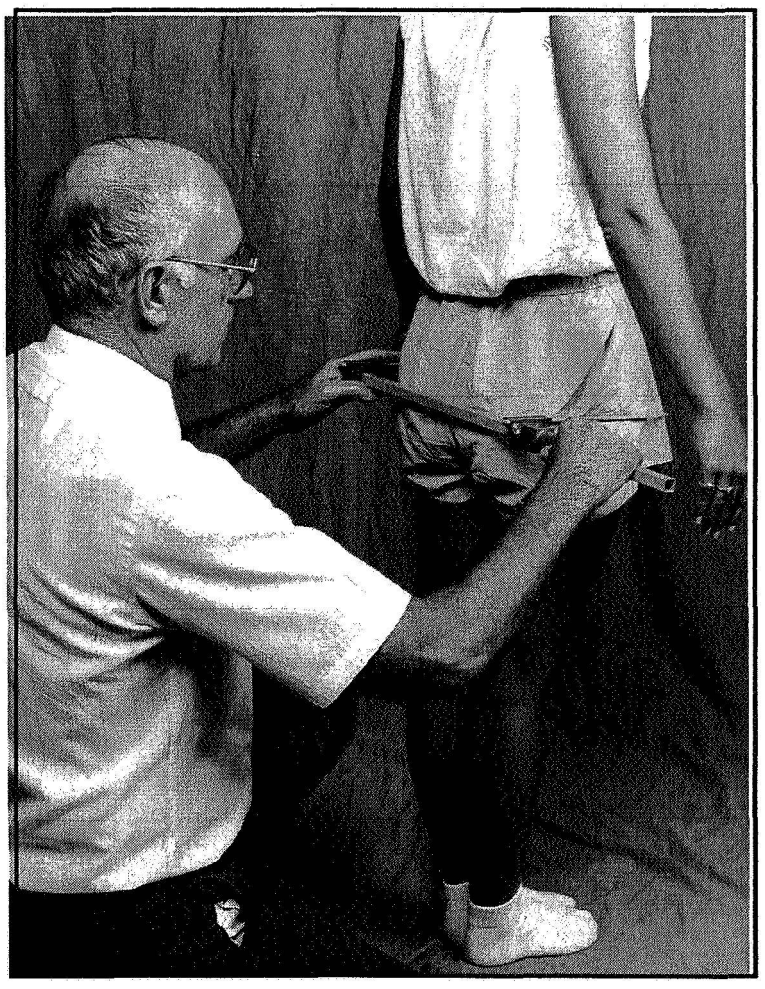

Figure 15. Measurement of the Subject's Hip Breadth

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	May 1993	Reference Publication--1985 to 1991

4. TITLE AND SUBTITLE
Anthropometric Survey of the Astronaut Applicants and Astronauts From 1985 to 1991

5. FUNDING NUMBERS

6. AUTHOR(S)
* Sudhakar L. Rajulu
Glenn K. Klute

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
* Lockheed Engineering & Sciences Company
Houston, Texas

Lyndon B. Johnson Space Center
Houston, Texas

8. PERFORMING ORGANIZATION REPORT NUMBER
S-718

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
National Aeronautics and Space Administration
Washington, D.C. 20546

10. SPONSORING / MONITORING AGENCY REPORT NUMBER
RP 1304

11. SUPPLEMENTARY NOTES
Technical Monitor--Glenn K. Klute

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Available from the NASA Center for Aerospace Information
800 Elkridge Landing Road
Linthicum Heights, MD 21090 (301) 621-0390

Unclassified/Unlimited Star Category 54

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The Anthropometry and Biomechanics Laboratory at the Johnson Space Center has been collecting anthropometric data from astronaut applicants since 1977. These anthropometric data include various body measurements. As of January 1992, anthropometric measurements had been taken from 473 applicants. Based on the position they applied for, these applicants were classified as either mission specialists, payload specialists, pilots, or observers. The main objective of this report was to document the variations among these applicants and tabulate the percentile data for each anthropometric dimension. The percentile and the descriptive statistics data were tabulated and graphed for the whole astronaut candidate population; for the male and female groups; for each subject classification such as pilot, mission specialist, and payload specialist; and finally, for those who were selected as astronauts.

14. SUBJECT TERMS
Anthropometry, Body Measurement, Body Size, Human Factors Engineering

15. NUMBER OF PAGES
70 + 15 pg. Appendix

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

END DATE AUG 5, 1993