



Anthropometric Dimensions of Lor Students for the Ergonomic Design of Khorramabad School Equipment, Iran (2018)

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Citation: Rashidi R. Anthropometric Dimensions of Lor Students for the Ergonomic Design of Khorramabad School Equipment, Iran (2018). JOHE 2021; 10(2):67-74.

Article Info

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Article history

Received: May 2021

Accepted: Jul 2021

 10.52547/johe.10.2.67

Print ISSN: 2251-8096

Online ISSN: 2252-0902

Peer review under responsibility of Journal of Occupational Health and Epidemiology

Abstract

Background: Students' physical health, performance, and comfort can be improved by designing equipment according to the needs of their body dimensions. This study aimed to establish a comprehensive database of anthropometric dimensions of students in Khorramabad, Lorestan, Iran.

Materials and Methods: This descriptive study was conducted to estimate 22 anthropometric students' dimensions in a sample of 4872 randomly selected students who belonged to the Lor ethnic group. The anthropometric dimensions were measured by a digital caliper and a standardized anthropometric instrument. Data were analyzed using a t-test, and the results were reported in tabular form.

Results: The results showed that elementary school students' body dimensions were larger in girls, except for chest depth, abdominal depth, and buttock-knee length. Anthropometric estimates of middle school students indicated that most anthropometric dimensions of girls were larger than boys; for example, the average height in girls with 1531.87 ± 72.84 was greater than boys with 1528.16 ± 101.79 mm. Findings in high school students showed that most anthropometric parameters of boys were larger than girls. Also, the t-test showed a significant difference between the means of all measured parameters except the variable of buttock-knee length in male and female students ($P < 0.05$).

Conclusions: Given the anthropometric differences obtained in this study, it can be concluded that in designing school equipment, especially desks and chairs, it is necessary to pay special attention to age, gender, level of education, and ethnicity of students in particular.

Keywords: Anthropometry, Ergonomics, Student.

Introduction

Students' physical health, performance, and comfort can be improved by designing equipment according to the needs of the human body dimensions. Nowadays, backache has gained public attention as an important health problem among school children [1, 2, 3, 4]. In the US, about \$25 million is spent on treating students' nonspecific backaches caused by the non-appropriation of bodily dimensions to the chairs

and desks used in classrooms. The use of poorly designed furniture, especially desks and tables, that fails to account for the users' anthropometric characteristics has a negative influence on human health. Students' sitting posture is influenced not only by the activities performed in the classroom but also by their anthropometric measures and school furniture designs. Therefore, one of the most important concerns of ergonomists is to design and produce instruments that match people's bodily dimensions in order to decrease

the adverse effects, thus increasing work output and efficiency [5, 6, 7, 8].

According to official statistics, the student population in Iran amounts to 20 million, while it is estimated to be one billion globally. However, it seems that no serious and persistent attention has been paid to classrooms, whether nationally or globally, thus neglecting students' health. Various studies have shown that individuals' postures during childhood and adolescence deeply affect the way they sit and stand for a lifetime. Indeed, the longer these early postures are maintained, they are more difficult to be corrected later on [9, 10, 11]. Students spend a great deal of their time in classrooms in sitting positions. Static postures and sitting in a crooked manner for long periods can put great physical strains on muscles, tendons, and vertebrae in particular.

Anthropometric measures vary among nations and ethnic groups and change over time depending on variations in populations and environmental conditions [3, 6]. Hence, it has been recommended to use students' anthropometric data to design school supplies and equipment. In order to design the equipment for students (e.g., chairs and desks) according to technical and health principles, it is necessary to aid the designers by providing accurate data about the anthropometric dimensions of the students residing in different geographical regions [6, 7]. One of the most comprehensive anthropometric studies was conducted on students aging 11-13 years in the US in 1975, in which 87 bodily features and dimensions were measured, except for the popliteal height and the buttock-popliteal fossa length [12, 13]. In other countries in Europe and America, the necessary relevant standards have been prepared. Among the international standards approved by the World Health Organization (WHO), those provided by the US National Center for Health Statistics (NCHS) can be pointed out. This center has specified the standards of bodily dimensions for different age groups, which can be used in designing equipment [14, 15, 16]. In Iran, a survey was designed in 1977 to compare the height and weight of 3270 students aging 6-14 years in urban and rural areas of Shiraz. Another anthropometric study was carried out in Mazandaran province to measure 17 bodily parameters of 1758 students aged 6-11 years; further, the means and percentiles of the anthropometric dimensions of male and female students were compared. This research objective was to provide the necessary data for designing students' chairs and desks [17, 18]. In another anthropometric survey on children less than 10 years old in Qazvin city, the height and weight of

boys and girls were less than the global averages reported by WHO [19]. In another study performed on students in Kashan, emphasis was put on reliance on the necessary standards obtained from domestic anthropometric data rather than foreign standards [20].

At present, few countries have domestic anthropometric databases; thus, other countries have to use their data in case of need, which is scientifically unacceptable. The current study aims to develop a comprehensive database of the anthropometric dimensions of students from the Lor ethnic group residing in Khorramabad. Comparison of the anthropometric measures of different student populations could help design chairs, desks, and other school supplies.

Materials and Methods

This is a descriptive study conducted on Lor students in Khorramabad in primary, middle, and high schools in the public or non-profit sectors in 2018.

Given the standard variance and the coefficient of variation in similar populations, the appropriate sample size for each class, education level, and sex was determined. In the following formula, the values of z , δ , and d were equal to 1.96, 150, and 6, respectively. As a result, the sample size was estimated at 2401 people based on the variable of students' height with a standard deviation of 150 according to the formula below [21].

$$N = \frac{z^2 \times \sigma^2}{d^2} = 2401$$

Given the design effect, the estimated sample size was multiplied by two ($n=4802$). Yet, the total sample size was increased to 4872 students with equal numbers of male and female students. Inclusion criteria included all Lor students of different educational levels living in Khorramabad, and exclusion criteria included non-Lor students and those with physical development disorders. Cluster sampling was used in the study; accordingly, each of the three training areas of Khorramabad city was considered as a cluster, and all schools in each cluster were included in the study. Samples were selected randomly from male and female students by a proportional allocation. The following anthropometric parameters were recorded: age (years), weight (kg), stature, standing eye height, shoulder height, standing elbow height, chest depth, abdominal depth, arm length, forearm length, maximum forearm-forearm breadth, elbow-elbow breadth, shoulder breadth, hip breadth, thigh thickness, the thickness of both thighs measured together, sitting height, sitting eye

height, sitting elbow height, popliteal height, knee height, buttock-popliteal length, and buttock-knee length. The anthropometric dimensions were measured (in millimeters) by male and female assistants using a digital caliper and a standardized anthropometric instrument designed by Lahmi et al. [21]. Additionally, the students were weighed by Samsung digital scales with an accuracy of ± 5 grams. The accuracy and reliability of the utilized devices were assessed prior to the measurements. It should be noted that all students were wearing light clothes and were barefoot during the measurements. Besides, the data recorded for each student was the mean of three trials.

Ethics approval was obtained from the officials of Khorramabad University of Medical Sciences and Education. After entering the data into the computer, a t-test was used to compare the variables by gender at a significant level ($P < 0.005$). Given that percentiles express the real concept of dimensional scattering within the design range, in order to use the data in the design of different percentile equipment, anthropometric dimensions of students were determined. Finally, the results were expressed in a table as averages and standard deviations.

Results

This cross-sectional study was performed on 4872 male and female students to determine the anthropometric measurements of Lor students in Khorramabad. The average weight and height of male students were 43.05 kg with a maximum of 114kg and minimum 15 kg and 1499.43 mm height with a maximum 1900 and minimum 1020 mm. The average weight and height of female students were 41.75 kg with a maximum of 97 and a minimum of 14 kg and 1458 mm height with a maximum of 1760 and a minimum of 1020 mm, respectively. Standard deviation and statistical percentages were calculated as 5% to 99%.

Table 1 provides the comparison of the mean of anthropometric variables in male and female students. As can be seen, there is a significant difference between the mean of all measured parameters except the variable of buttock-popliteal length in male and female students.

The results also show that the average anthropometric dimensions of the chest depth and abdominal depth in female students are larger than boys; these dimensions in girls were 176.89 and 172.19 mm compared to boys with 170.93 and 158.99 mm, respectively.

Table 1. Mean \pm SD, min, and max of the anthropometric dimensions in the two genders (in millimeters)

Statistical index variables	Male students				Female students				T-test results
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Weight (kg)	43.05	16.69	15	114	41.75	14.81	14	97	0.004
Stature	1499.43	189.86	1020	1900	1458	154.29	1020	1760	0.001
Standing eye height	1384.72	192.62	880	1790	1337.19	156.22	760	1650	0.001
Shoulder height	1233.13	175.85	640	1600	1197.08	142.58	640	1480	0.001
Standing elbow height	933.70	132.21	590	1220	883.93	106.32	600	1180	0.001
Chest depth	170.93	28.19	90	290	176.89	31.94	80	318	0.001
Abdominal depth	158.99	30.17	80	370	172.19	33.49	60	398	0.001
Arm length	304.92	45.69	130	490	298.33	40.80	116	458	0.001
Forearm length	395.01	58.67	230	530	378.65	50.35	148	557	0.001
Maximum forearm-forearm breadth	359.07	50.49	200	570	315.06	41	116	540	0.001
Elbow-elbow breadth	347.15	50.78	220	540	343.90	46.32	188	550	0.001
Shoulder breadth	340.02	51.98	190	540	330.16	44.34	110	580	0.001
Hip breadth	284.09	47.57	100	450	276.11	44.09	140	467	0.001
Thigh thickness	107.13	26.56	37	310	75.01	21.75	22	203	0.001
The thickness of both thighs measured together	194.57	40.21	97	360	185.05	40.14	94	396	0.001
Sitting height	786.95	95.79	480	1000	753.93	82.66	440	920	0.001
Sitting eye height	674.99	95.60	390	890	633.37	78.70	340	860	0.001
Sitting elbow height	209.50	35.32	80	460	177.51	30.90	90	320	0.001
Popliteal height	384.33	53.04	230	530	353.78	31.77	210	580	0.001
Knee height	462.05	64.54	240	620	428.12	47.03	245	598	0.001
Buttock-popliteal length	380.90	59.61	190	570	382.89	58.55	220	576	0.2
Buttock-knee length	478.74	72.60	280	650	487.67	68.22	252	670	0.001

Table 2 presents the different percentiles of anthropometric dimensions of male and female students. Percentiles are very important statistical indicators in developing tools and equipment and are widely used in design engineering. As can be

seen, in the 95th percentile, as one of the most important percentiles in equipment design, all dimensions, except chest depth and abdominal depth, in male students have larger values than females.

Table 2. Percentile values of different anthropometric dimensions of students in the two genders (in millimeters)

Percentiles variables	Male students						Female students					
	1 st	5 th	10 th	50 th	95 th	99 th	1 st	5 th	10 th	50 th	95 th	99 th
Weight (kg)	17	20	22	41	72	85	17.68	20	23	42	66	77.32
Height	1130	1190	1230	1490	1770	1836	1110	1180	1220	1500	1660	1700
Standing eye height	1000	1070	1120	1370	1660	1720	980	1050	1100	1380	1540	1580
Standing shoulder height	890	940	990	1230	1480	1540	880	940	980	1240	1380	1420
Standing elbow height	660	710	750	940	1120	1170	640	690	720	910	1020	1070
Chest depth	120	130	140	170	220	240	114.68	130	139	175	230	257
Abdominal depth	110	120	130	150	220	250	105.68	124	133	170	230	270.32
Arm length	210	230	240	300	370	390	200	230	243	305	354	380
Forearm length	280	300	310	400	480	500	260	293	310	390	447	32.466
Maximum forearm-forearm breadth	244.4	280	300	360	440	480	228.67	250.40	264	314	380	420
Elbow-elbow breadth	250	270	280	340	430	490	250	272	386	340	424	468
Shoulder breadth	240	260	270	340	420	450	236	256	270	337	396	420
Hip breadth	190	210	220	280	360	390	187.68	205	217	279	350	380
Thigh thickness	55	70	80	100	150	180	35	43	48	74	110	136.33
The thickness of both thighs measured together	120	140	150	190	270	310	114	130	140	180	260	305.96
Sitting height	570	630	660	790	940	970	550	610	630	770	860	890
Sitting eye height	460	510	550	670	820	850	450	490	520	650	740	770
Sitting elbow height	120	150	170	210	270	290	100	130	140	180	230	250
Popliteal height	270	300	310	390	460	480	280	310	320	350	410	440
Knee height	323.2	350	370	470	550	570	316	345	360	438	60.496	520
Buttock-popliteal length	250	280	300	380	470	500	259.68	283	300	390	469	500
Buttock-knee length	320	350	380	480	580	600	335.68	364	386	507	580	602.32

Table 3 shows the anthropometric dimensions of male and female students at different levels of education. As can be seen, the average growth of anthropometric dimensions in girls often occurs in middle school, while it occurs in high school in

males. Further, the average weight and height in middle school girls are 45.93 kg and 1531.87 mm, respectively, while in boys, the values are 44.06 kg and 1528.16 mm, respectively, which are lower than the anthropometric measurements of girls

Table 3. Anthropometric estimation of body dimensions among male and female students in different education levels

Statistical index variable	Primary school				Junior high school				High school				
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	
Weight (kg)	Male	29.76	9.53	15	71	44.06	12.54	22	92	58.88	11.59	30	114
	Female	29.08	8.94	14	73	45.93	11.13	23	94	54.52	9.49	36	97
Height	Male	1321.73	107.99	1020	1660	1528.16	101.79	1270	1810	1699.31	75.42	1380	1900
	Female	1308.09	109.33	1020	1660	1531.87	72.84	1310	1720	1590.26	54.78	1310	1760
Standing eye height	Male	1204.35	108.81	880	1540	1413.85	102.05	1150	1700	1587.66	78.41	1150	1790
	Female	1186.20	113.48	760	1550	1411.92	71.38	1200	1610	1470.17	55.85	1130	1650
Standing shoulder height	Male	1069.51	104.87	640	1400	1261.64	93.91	1030	1520	1415.82	70.22	1020	1600
	Female	1060.67	105.69	640	1390	1264.40	65.95	1030	1420	1318.9	51.33	1150	1480
Standing elbow height	Male	811.42	83.12	590	1100	956.18	70.36	790	1160	1069.26	51.22	890	1220
	Female	785.80	82.66	600	1070	929.53	52.84	720	1070	972.65	43.62	820	1180
Chest depth	Male	152.22	20.98	90	230	171.84	23.53	120	290	193.57	21.70	140	270
	Female	154.47	22.31	80	250	189.50	28.60	105	312	195.45	27.11	108	318
Abdominal depth	Male	147.98	26.36	80	260	159.44	31.24	110	300	172.46	28.45	110	370
	Female	154.71	27.83	60	297	186.04	34.03	102	355	183.54	29.51	100	398

Arm length	Male	266.53	32.11	140	380	309.38	28.34	130	400	349.42	23.10	280	490
	Female	265.50	32.16	130	380	317.05	26.72	119	458	325.31	28.96	116	430
Forearm length	Male	342.72	36.47	230	450	401.10	34.46	270	510	455.63	25.51	320	530
	Female	334.01	38.19	148	452	406.73	31.84	151	557	413.30	27.29	289	486
Maximum forearm-forearm breadth	Male	328.99	42.85	200	470	356.89	37.47	260	480	398.25	40.43	290	570
	Female	288.42	32.30	207	420	337.54	39.74	116	501	331.29	31.86	158	540
Elbow-elbow breadth	Male	324.73	46	220	500	342.66	47.05	230	540	378.53	42.65	270	540
	Female	315.25	39.68	188	462	361.98	42.97	262	511	366.12	36.31	260	550
Shoulder breadth	Male	300.61	36.06	190	450	336.93	33.82	240	440	391.46	32.05	240	540
	Female	295.10	35.37	110	420	348.46	35.11	139	580	360.31	26.79	247	478
Hip breadth	Male	249.32	36.77	100	400	287.34	35.91	200	410	325.02	30.73	120	450
	Female	242.21	33.52	140	390	294.40	35.71	199	467	304.80	31.10	174	430
Thigh thickness	Male	91.97	20.87	37	170	107.20	23.19	50	190	125.99	22.99	80	310
	Female	65.42	20.74	22	170	85.60	21.66	30	203	78.93	17.67	36	141
The thickness of both thighs measured together	Male	170.65	30.66	97	290	195.95	36.51	110	350	223.42	33.77	140	360
	Female	167.67	35.49	94	358	197.19	41.48	100	396	197.61	36.32	113	384
Sitting height	Male	702.79	72.59	480	910	798.43	52.13	580	970	883.19	48.62	720	1000
	Female	680.67	64.20	440	890	785.22	52.51	580	900	822.31	34.70	670	920
Sitting eye height	Male	590.60	60.37	390	800	683.87	52.50	450	860	773.38	46.22	610	890
	Female	563.85	61.52	340	750	666.76	45.23	510	780	659.39	40.46	340	860
Sitting elbow height	Male	185.05	29.92	80	250	211.25	19.78	140	270	238.69	26.99	160	460
	Female	162.14	28.09	90	250	180.32	24.84	120	260	194.76	28.73	110	320
Popliteal height	Male	337.11	35.95	250	480	396.56	31.56	230	530	433.98	26.63	330	530
	Female	334.68	29.82	210	580	363.84	30.92	320	460	370.15	19.89	310	470
Knee height	Male	402.59	43.14	240	530	478.11	35.28	360	580	524.13	27.71	410	620
	Female	390.97	41.90	280	540	452.97	31.83	317	598	455.82	27.01	245	556
Buttock-popliteal height	Male	331.73	45.74	190	530	389.54	34.19	280	510	435.65	32.96	340	570
	Female	331.22	42.49	220	507	411.75	37.85	285	576	425.83	34.10	300	559
Buttock-knee height	Male	413.36	49.18	280	570	491.95	39.24	350	610	550.31	32.17	420	650
	Female	426.16	74.52	260	593	524.23	40.92	252	670	537.10	32.71	305	645

Table 4 provides the different percentiles of anthropometric dimensions for students in both middle and high school. Due to the difference in the anthropometric dimensions of male and female

students (Table 3), which often occurs in middle and high school, it is important for design engineers to know the percentiles of these two degrees.

Table 4. Percentile values of anthropometric dimensions among students in different education levels

Variables	Percentiles	Elementary school					Junior high school					High school				
		5 th	10 th	50 th	90 th	99 th	5 th	10 th	50 th	90 th	99 th	5 th	10 th	50 th	90 th	99 th
Weight (kg)	Male	18	20	28	43	60	29	30	42	62	83.89	42	45	57.5	73	93.83
	Female	19	20	27	41	59.73	30	33	44	60	85.69	41	43	54	67	81.88
Height	Male	1150	1180	1320	1460	1570	1380	1401	1520	1670	1780	1560	1600	1710	1780	1858.30
	Female	1130	1170	1300	1460	1580	1400	1430	1540	1620	1690	1510	1520	1590	1660	1710
Standing eye height	Male	1030	1060	1200	1340	1450	1265.5	1290	1410	1559	1660	1448.50	1490	1595	1680	1750
	Female	1000	1040	1180	1340	1450	1290	1320	1420	1500	1570	1390	1400	1470	1540	1600
Standing shoulder height	Male	900	930	1070	1200	1298.4	1120	1140	1250	1390	1488.90	1290	1330	1420	1490	1578.30
	Female	900	930	1060	1200	1310	1150	1180	1270	1340	1400	1240	1260	1320	1380	1440
Standing elbow height	Male	680	700	810	910	1010	850	870	950	1050	1120	980	1010	1070	1130	1190
	Female	660	680	780	900	980	840	860	930	1000	1050	910	920	970	1030	1088.80
Chest depth	Male	120	130	150	180	220	140	150	170	200	248.90	160	170	190	220	250
	Female	120	129	150	185	210.73	150	156	187	224.9	274.69	152.60	165	193	232	261.76
Abdominal depth	Male	120	120	140	180	248.4	120	130	150	200	278.90	140	150	170	200	260
	Female	116	123	150	190	239.73	141	150	190	230	306.90	140	150	180	219	267.76
Arm length	Male	220	230	260	300	358.4	270	280	310	350	388.90	310	320	350	370	418.30
	Female	218.35	228	263	307	358.38	278	284	319	347	384.38	285	298	326	355	407.76
Forearm length	Male	290	300	340	390	428.4	350	360	400	450	480	420	430	460	480	510
	Female	273.70	290	334	385	420	352.55	370	410	440	472.69	367	380	415	446	472.88
Maximum forearm-forearm breadth	Male	260	270	330	380	440	300	310	350	410	450	340	350	400	450	500
	Female	240	250	286	330	373.2	283	292	332	390	456.90	280	292	330	370	406.76

Elbow-elbow breadth	Male	260	270	320	380	468.4	280	290	340	410	490	320	330	370	430	500
	Female	260	270	310	370	430	299.55	313	356.50	420.90	489.69	316	325	364	410	469.52
Shoulder breadth	Male	250	260	300	350	400	280	290	330	380	420	340	350	390	430	480
	Female	245	254	290	342.3	399.2	298	309	345.50	390	437.14	315	330	360	390	418
Hip breadth	Male	200	210	240	300	350	240	250	280	330	388.90	280	290	325	360	408.30
	Female	195	201.4	240	284.3	340.92	244	250	290	340	393.45	250	269	303	349	389.28
Thigh thickness	Male	60	70	90	120	150	80	80	100	140	178.90	100	100	120	150	200
	Female	38	43	60	96	120	55	60	84	110	151.38	50	57	78	100	130
The thickness of both thighs measured together	Male	130	140	164	210	270	140	160	190	240	308.90	180	187	220	270	328.30
	Female	120	130	160	212	283.2	144.55	152	190	259.90	310.69	144.60	156	192	245	314.40
Sitting height	Male	600	620	700	780	850	720	730	800	860	940	800	820	890	950	980
	Female	580	600	680	760	847	690	720	790	850	880	770	780	820	870	900
Sitting eye height	Male	490	510	590	670	738	610	620	680	750	828.90	690	717	780	830	870
	Female	460	490	560	650	710	580	610	670	720	770	630	650	700	740	800
Sitting elbow height	Male	130	150	190	220	248	180	190	210	240	260	200	200	240	270	300
	Female	110	120	160	200	237	140	150	180	220	240	150	160	190	230	260
Popliteal height	Male	280	300	340	380	440	350	360	400	440	480	390	400	430	470	500
	Female	300	310	330	370	430	340	340	350	410	450	350	350	360	400	438.80
Knee height	Male	340	350	400	460	518	420	430	480	520	560	480	490	520	560	590
	Female	330	340	385	450	507	404	415	450	490	543	415	425	456	490	519.52
Buttock-popliteal length	Male	260	270	330	390	450	330	350	390	440	470	380	390	435	480	518.30
	Female	270	280	330	387	457.7	350	367	410.5	457.90	506.83	370	383	428	468.80	504.88
Buttock-knee length	Male	340	350	410	480	540	430	440	490	540	580	498.50	510	550	590	628.30
	Female	350	360	420	500	555.8	459	479	528.8	571.80	616.83	485	500	537	577.80	613

Discussion

In a community-based descriptive study, 4872 male and female students of Lor ethnicity in Khorramabad who met the necessary criteria for inclusion were studied to determine 22 anthropometric dimensions used in designing equipment needed by students in schools. In order to use this anthropometric data in designing school equipment, in addition to the mean and standard deviation of each anthropometric dimension of students, the maximum and minimum dimensions were determined. Also, different statistical percentiles, including 5, 50, 95, and 99 percentiles widely applied by design engineers in designing tools and equipment used by students, were calculated for different anthropometric dimensions. Comparison of the measured anthropometric dimensions among elementary school students indicated that the anthropometric dimensions of male students were greater than those of females, except for chest depth, abdominal depth, and buttock-knee length. For instance, the means of standing height and sitting height were 1321.73 and 702.79 mm, respectively, among the male students. These measures were respectively obtained as 1308.09 and 680.67 mm among female students. Additionally, the minimum and maximum height were 1020 and 1660 mm, respectively, for male and female students. The results showed no significant differences between male and female students with regard to the estimated percentiles of anthropometric

dimensions. In other words, the obtained sizes were quite close in almost all calculated percentiles. Moreover, the anthropometric dimensions of the elementary school students in Lorestan province were compared to the data obtained in similar studies in Ilam and Mazandaran provinces. The results showed that the bodily dimensions of male and female students residing in Khorramabad were greater than those of the students residing in Ilam and Mazandaran. Therefore, it can be concluded that anthropometric dimensions in different Iranian ethnicities are different. Nonetheless, the anthropometric estimations obtained in this study are almost equal to those published by WHO [18, 19, 20].

The findings of this study regarding the anthropometric estimations of junior high school students in Khorramabad indicated the mean values for bodily dimensions, such as weight, height, standing shoulder height, chest depth, abdominal depth, arm length, forearm length, elbow-elbow breadth, shoulder breadth, hip breadth, the thickness of both thighs measured together, buttock-popliteal length, and buttock-knee length, to be greater among female students compared to male students. This might be attributed to the earlier pubescence among female students and must be taken into account in designing school desks and chairs [9, 10]. According to various percentiles of the anthropometric dimensions of male and female students at the junior high school level, variables

such as weight, height, standing eye height, arm length, forearm length, and standing shoulder height were greater among female students compared to male students up to the 50th percentile, while the same variables were greater among male students at the 90th and 99th percentiles. Moreover, the anthropometric estimations of standing elbow height, maximum forearm-forearm breadth, sitting height, sitting eye height, sitting elbow height, popliteal height, and knee height were greater among male students compared with female ones. A remarkable point concerning the anthropometric percentiles of students at the junior high school level was that hip breadth, buttock-popliteal length, and buttock-knee length, mostly used in designing chair seats, were greater among female students in various percentiles. Further, the mean height was higher among female students compared to males at the junior high school level (1531.87 mm), unlike the elementary school level (1528.16 mm). As mentioned above, this can be explained by earlier pubescence among female students. Comparing the measured anthropometric dimensions of male and female students at the junior high school level in Khorramabad with other similar studies revealed noticeable differences. Accordingly, the mean height of Lor females at this age range was greater than that of females from Hong Kong (1508) but lower compared to English females (1555) [18].

The present study also showed all measured anthropometric parameters to be greater in male students, except for chest depth and abdominal depth. Accordingly, the mean height was 1699.31 mm (± 75.42) among male students and 1590.26 (± 54.78) among female ones. Further comparison at the high school level showed that, except for chest depth and abdominal depth being a little greater in size among female students, all other anthropometric dimensions were greater among male students. This difference might be due to musculoskeletal growth among male students in this age range. The anthropometric measurements obtained among high school students in the present study were different from those in similar studies performed on the same age range participants. Accordingly, the mean height of male and female high school students in Khorramabad was greater in those from Hong Kong but lower in those from the UK [18].

In one study, anthropometric indices of height, weight, seating height, seating depth, and seating width of 300 girls and boys aged 18-25 years in southern Thailand were examined by Klamklay et al. (2008). The results indicated a significant difference in the weight, structure, and body

dimensions of the subjects, which should be considered for the design of school chairs [22].

Another study showed that the proportion of the furniture dimensions in the schools to the anthropometric dimensions of the students was not optimal. Therefore, it is necessary to consider anthropometric differences in designing a suitable chair for students [23].

The available studies are applicable according to their methodologies, i.e., applying their results to the general Iranian population would have some limitations. Therefore, it is necessary to be up-to-date with the existing anthropometric tables to produce a comprehensive table for Iranian anthropometric dimensions [24].

One of the limitations of this study is its large volume of samples, thus coordinating with schools in the study community and transporting the measuring instruments and equipment.

Since the design starts and ends with humans, an appropriate comprehensive database of human anthropometric dimensions is recommended to be created for the relevant designing activities. These results may help design school furniture for Lor students. This study can be conducted in other Iranian ethnic and age groups to achieve a complete bank of anthropometric dimensions required by designers of various equipment.

Conclusion

This study shows that the anthropometric dimensions of female students in middle school are often larger than male students; also, in high school, boys have larger anthropometric dimensions. It is necessary to pay special attention to students' age and education level in designing school supplies, particularly desks and chairs. Also, the designs should be targeted at specific populations, given the considerable differences between male and female students' body dimensions. Since racial differences are an important factor, designers need to pay attention to anthropometric differences among various ethnic groups.

Acknowledgement

The authors would like to express their gratitude to the individuals and organizations that cooperated in this study, especially Lorestan University of Medical Sciences.

Conflict of interest: None declared.

References

1. Dhara PC, Khaspuri G, Sau SK. Complaints arising from a mismatch between school furniture and anthropometric measurements of rural secondary school children during classwork. *Environ Health Prev Med* 2009; 14(1):36-45.
2. Tunay M, Melemez K. An analysis of biomechanical and anthropometric parameters on classroom furniture design. *Afr J Biotechnol* 2008; 7(8):1081-6.
3. Jones GT, Watson KD, Silman AJ, Symmons DP, Macfarlane GJ. Predictors of low back pain in British schoolchildren: a population-based prospective cohort study. *Pediatrics* 2003; 111(4 pt 1):822-8.
4. Jeffries LJ, Milanese SF, Grimmer-Sommers KA. Epidemiology of adolescent spinal pain: a systematic overview of the research literature. *Spine (Phila Pa 1976)* 2007; 32(23):2630-7.
5. Hoy D, Bain C, Williams G, March L, Brooks P, Blyth F, et al. A systematic review of the global prevalence of low back pain. *Arthritis Rheum* 2012; 64(6):2028-37.
6. Milanese S, Grimmer K. School furniture and the user population: an anthropometric perspective. *Ergonomics* 2004; 47(4):416-26.
7. Limon S, Valinsky L, Ben-Shalom Y. Children at risk: risk factors for low back pain in the elementary school environment. *Spine (Phila Pa 1976)* 2004; 29(6):697-702.
8. Masiero S, Carraro E, Celia A, Sarto D, Ermani M. Prevalence of nonspecific low back pain in schoolchildren aged between 13 and 15 years. *Acta Paediatr* 2008; 97(2):212-6.
9. Preedy VR. *Handbook of Anthropometry: Physical Measures of Human form in Health and Disease*. 1st ed. New York, United States: Springer-Verlag; 2012.
10. Arefi MF, Pouya AB, Poursadeqiyani M. Investigating the match between anthropometric measures and the classroom furniture dimensions in Iranian students with health approach: A systematic review. *J Educ Health Promot* 2021; 10:38.
11. Pheasant S, Haslegrave CM. *Bodyspace: Anthropometry, Ergonomics, and the Design of Work*. 3rd ed. Milton Park, Abingdon, United Kingdom: Taylor & Francis; 2005.
12. Olsen TL, Anderson RL, Dearwater SR, Kriska AM, Cauley JA, Aaron DJ, et al. The epidemiology of low back pain in an adolescent population. *Am J Public Health* 1992; 82(4):606-8.
13. Manouchehri H, Moradpour P, Mououdi MA, Aga-Rafiei E. Designing Ergonomic Furniture Based on Students Anthropometry Attributes; College of Agriculture and Natural Resources, University of Tehran. *Iran J Ergon* 2020; 8(3):70-84
14. de Onis M, Onyango AW, Borghi E, Garza C, Yang H, WHO Multicentre Growth Reference Study Group. Comparison of the World Health Organization (WHO) Child Growth Standards and the National Center for Health Statistics/WHO international growth reference: implications for child health programmes. *Public Health Nutr* 2006; 9(7):942-7.
15. McDowell MA, Fryar CD, Ogden CL, Flegal KM. Anthropometric reference data for children and adults: United States, 2003–2006. *Natl Health Stat Report* 2008; (10):1-48.
16. Salvarzi E, Choobineh A, Jahangiri M, Keshavarzi S. Facial anthropometric measurements in Iranian male workers using Digimizer version 4.1.1.0 image analysis software: a pilot study. *Int J Occup Saf Ergon* 2018; 24(4):570-6.
17. Ramin Sabet M, Sadeghi F, Safari M. *Anthropometry and indices of Iranian workers body size to design a workstations*. 1st ed. Tehran: Asar Sobhan; 2013.
18. Falahati, M, Zokaei M, Sadeghi Naeini H, Moradi G. Determination of Variables and Static Anthropometric Indicators for Classroom Chair Design. *Iran Occup Health J* 2013; 10(2):99.
19. Motiei Langrudi SH. A survey of height and weight of children younger than 10 living in Qazvin city. *J Inflamm Dis* 1997; 1(2):39-46.
20. Ershadi A. Height & weight of 6 years old pupils Kashan. *J Inflamm Dis* 1998; 2(2):58-64.
21. Taifa IW, Desai DA. Anthropometric measurements for ergonomic design of students' furniture in India. *Eng Sci Technol Int J* 2016; 20(1):232-9.
22. Klamklay J, Sungkhapong A, Yodpijit N, Patterson PE. Anthropometry of the southern Thai population. *Int J Ind Ergon* 2008; 38(1):111-8.
23. Seyedi F, Dalfardi M, Eftekhavaghefi SH. Assessment of Accommodation of Anthropometric Dimensions with Classroom Furniture: Systematic Review Article. *J Jiroft Univ Med Sci* 2020; 6(2):222-33.
24. Kazemhaghighi M, Saremi M. The situation of anthropometric databank in Iran: a review study. *Iran Occup Health J* 2017; 14(4):102-95.