Determination of the Static Anthropometric Characteristics of Iranian Microscope Users Via Regression Model

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Abstract

Background: Anthropometry is a branch of Ergonomics that considers the measurement and description of the human body dimensions. Accordingly, equipment, environments, and workstations should be designed using user-centered design processes. Anthropometric dimensions differ considerably across gender, race, ethnicity and age, taking into account ergonomic and anthropometric principles. The aim of this study was to determine anthropometric characteristics of microscope users and provide a regression model for anthropometric dimensions.
Methods: In this cross-sectional study, anthropometric dimensions (18 dimensions) of the microscope users (N=174; 78 males and 96 females) in Shiraz were measured. Instruments included a Studio meter, 2 type calipers, adjustable seats, a 40-cm ruler, a tape measure, and scales. The study data were analyzed using SPSS, version 20.
Results: The means of male and female microscope users' age were 31.64±8.86 and 35±10.9 years, respectively and their height were 161.03±6.87cm and 174.81±5.45cm, respectively. The results showed that sitting and standing eye height and sitting horizontal range of accessibility had a significant correlation with stature.
Conclusion: The established anthropometric database can be used as a source for designing workstations for working with microscopes in this group of users. The regression analysis showed that three dimensions, i.e. standing eye height, sitting eye height, and horizontal range of accessibility sitting had a significant correlation with stature. Therefore, given one's stature, these dimensions can be obtained with less measurement.

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Introduction

Anthropometry is a branch of Ergonomics that considers the measurement and description of the human body dimensions. Anthropometric considerations in tools design will result in the improvement of performance and efficiency along with safety and comfort as well as prevention of work-related injuries or accidents. Anthropometric dimensions differ considerably across gender, race, ethnicity and age.[1] Equipment, environments, and workstations should be designed using user-centered design processes, taking ergonomic and anthropometric principles into account.[2] Tools and equipment are considered appropriate only when people are able to use them easily. This is consistent with the basic principle of ergonomics, fitting work with humans.[3] Designing equipment and workstations regardless of anthropometric data can have undesirable consequences such as musculoskeletal disorders, and health problems.[4-6] Since the design is done based on specific data including anthropometric data for humans, the data must be fully adapted to the characteristics of the target population.[7] One way to facilitate anthropometry is to determine the correlation between anthropometric dimensions, in which, by measuring a limited number of physical dimensions of the target group, other dimensions can be estimated with acceptable accuracy. Numerous studies are conducted to show the anthropometric factors and regression between different dimensions of human body. However, a few of them examined the association of the ratio of standing eye height to sitting eye height, standing eye height to sitting horizontal accessibility and also sitting eye height to sitting horizontal accessibility. For example, Akhlaghi et al. showed the association of stature from the upper limb anthropometry with hand dimension.[8] Accordingly, a significant and direct association between hand lengths, hand breadth, foot length and foot breadth with stature in Krishan et al.'s study.[9] In another study conducted by Krishan et al., various dimensions of the upper and lower limbs were found to be highly correlated with stature.[10]

Additionally, it is well known that the accurate investigation of stature helps to establish an individual's identity in medicolegal investigations involving skeletal remains. The anatomical and mathematical methods are the two main techniques for the estimation of living stature.[11] The anatomical method involves the direct reconstruction of the stature by measuring and adding together the lengths or heights of all the skeletal elements from the skull to the foot and figuring a correction factor for soft tissues.[12] Accordingly, based on the report published by Pelin, no strong association was found between craniofacial dimensions and body height.[12] Stature may be estimated by means of various anthropometric measurements of the skeleton.[13-16] Such estimation is based on the relationship between skeletal elements and stature. It is an established fact that stature bears a direct relationship to the length of various bones, and linear regression equations are derived to estimate the stature from the length of a bone. As a rule of thumb, the larger the skeletal element is, the taller the individual is. This suggests that, theoretically, the length of any bone of an individual reflects that individual's stature.

1. Lack of match between equipment and working environments on the one hand and anthropometric characteristics of individual users on the other can lead to discomfort, pain and disorders in the neck and shoulder,[17] arm, hand and wrist,[18] and back.[17]

2. Health problems and musculoskeletal disorders are the most important consequences of the mismatch between anthropometric dimensions and the mentioned products;[17,19-21] these problems can be reduced using anthropometric data in the design process.

3. Physical design and layout of laboratories can have a significant impact on performance, health, safety, product quality, and production efficiency.[22] Anthropometric data have been reported in several Asian Pacific populations, such as those in China, Japan and Korea,[23] the Philippines,[24] Turkey,[25] Malaysia,[26] and Iran.[27] However, the application of anthropometry to the design of microscope workstation has not been implemented in practice in Iran due to the lack of a proper anthropometric database.

4. Given that microscope is one of the essential and widely used tools needed for work in the laboratory and also the load imposed on the musculoskeletal system when working with microscope, ergonomically designed workstations for microscope use is of critical importance. Since no study has been done in the country in this field, this study aimed to evaluate anthropometric dimensions of microscope users, establish an anthropometric database, and provide a corresponding regression model.

Materials and Methods

5. This cross-sectional study was carried out in 2015 on 174 microscope users including pathologists, cytologists and laboratory sciences experts at teaching hospitals in Shiraz city. To determine the sample size of the study, a pilot study was carried out on 60 microscope users (30 females and 30 males) who were selected by simple random sampling from among 90 users. The results of this pilot study were used to estimate the sample size. 18 anthropometric characteristics were measured based on Pheasant's criteria (Figure 1).[28]

During the study, all the subjects did not wear shoes, but they were dressed. Measuring instruments included Studiometer (two perpendicular panes with precision of 1mm), 2 types of calipers, adjustable seats, a 40cm ruler, tape measure, and scales (with precision of 0.1 kg) (Figure 2).

6. Direct or physical method was used to measure the dimensions in this study. The mentioned devices were used to measure the dimensions and other body sizes of the microscope users. Measurements were performed during the morning shift. In this study, to reduce the measurement error, microscope users' dimensions were measured by a single individual (the researcher). Participants consisted of individuals who had used microscope for over 20 years.

7. Analysis of the study data was performed using SPSS, version 20. In order to evaluate the normality, Kolmogorov-Smirnov test was used and the significance level of 0.05 was considered. Student's t-test was used to compare the means of quantitative data and linear regression model was used to evaluate the correlation between the measured dimensions.

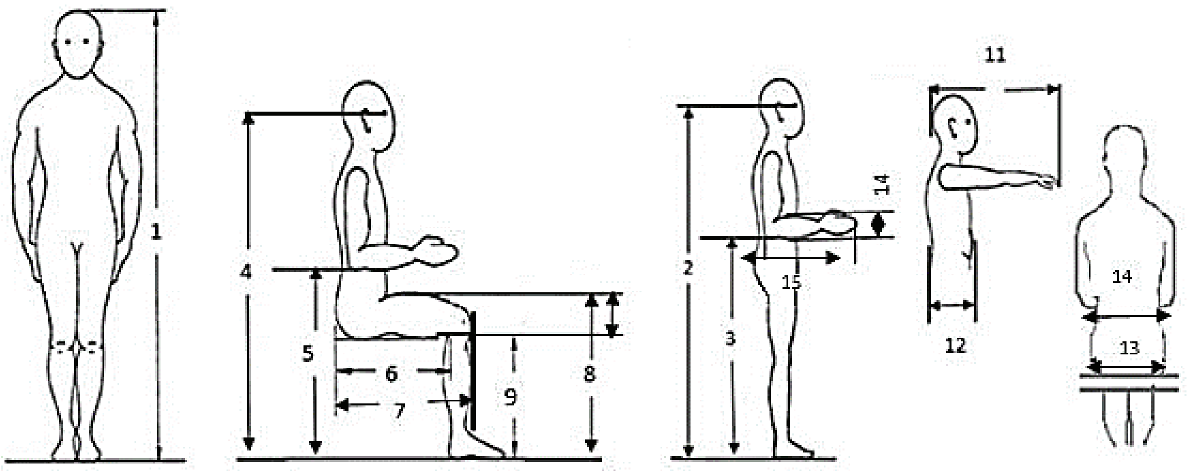

Figure 1: Representation of anthropometric measurements: (1) stature; (2) standing eye height; (3) standing elbow height; (4) sitting eye height; (5) sitting elbow height; (6) buttock-popliteal length; (7) buttock-knee length; (8) knee height; (9) popliteal height; (10) Sitting rest thigh depth; (11) Horizontal range of accessibility sitting; (12) Abdominal depth; (13) Breadth buttock; (14) Forearms depth; (15) Forearm length.

Figure 2: Technicians measuring the participants' body dimensions

8. Stratified univariate analysis based on the stature was also conducted in both males and females separately.

Results

9. Subjects consisted of 174 people, including 78 men (44.8%) and 96 women (55.2%). Their mean age was 33.14 years and their mean body mass index (BMI) was 4.59±22.14 kg/m2.

10 Mean, SD, and Percentile of 5, 50 and 95 microscope users' anthropometric dimensions by gender are presented in Table 1.

11. Linear regression models derived for reconstruction of stature in males and females are presented in Table 2.

Regression results for the measured dimensions are shown in Table 2. The univariate regression model showed that standing eye height ($\beta=0.91$, $P<0.001$) sitting eye height ($\beta=1.17$, $P<0.001$), sitting horizontal range of accessibility ($\beta=1.36$, $P<0.001$), the ratio of standing eye height to sitting eye height ($\beta=4.89$, $P>0.001$) and the ratio of standing eye height to sitting horizontal accessibility ($\beta=1.96$, $P=0.005$) were directly and significantly correlated with stature. However, an inverse association was found between the ratio of sitting eye height to sitting horizontal accessibility ($\beta=-2.02$, $P=0.004$) and stature. Additionally, a direct and significant association was found between the hip breadths sitting ($\beta=1.40$, $P>0.001$), buttock kneel length ($\beta=1.37$, $P>0.001$), knee height ($\beta=1.60$, $P>0.001$), popliteal height ($\beta=1.73$, $P>0.001$), forearm depth ($\beta=2.31$, $P=0.001$) and head length ($\beta=1.48$, $P>0.001$) with stature. The results of stratified analysis are also shown in Table 2.

Discussion

12. This study provides a comprehensive anthropometric database for Iranian microscope users. The results showed the differences between the two gender groups as well as differences in the dimensions of different target groups. In addition, the data obtained from this study can be used to design the equipment used by Iranian

Table 1: Anthropometric measures of the body dimensions of the subjects (cm)

No	Parameter	Male (N=78) Mean					Female (N=96) Mean				
				Percentiles					Percentiles		
			Std. Deviation	5	50	95		Std. Deviation	5	50	95
1	Stature	174.81	5.45	166.00	174.00	185.52	161.03	6.87	148.85	161.00	172.15
2	Eye Height Standing	163.12	6.11	152.00	163.00	174.05	148.42	6.79	137.00	148.00	162.00
3	Elbow Height Standing	109.32	5.76	101.00	108.00	117.52	99.59	10.47	92.85	100.00	109.00
4	Eye Height Sitting Rest	119.11	4.85	111.95	119.00	127.00	112.40	4.88	103.85	112.00	120.00
5	Elbow Height Sitting	69.64	5.82	63.00	69.00	77.05	66.91	6.53	60.00	66.00	73.00
6	Horizontal Range of Accessibility Sitting	84.03	3.82	77.95	84.00	91.52	77.53	4.42	70.00	78.00	84.15
7	Depth Thigh Sitting Rest	15.87	2.07	13.00	15.50	19.02	14.48	1.81	12.00	14.00	18.07
8	Buttock-Knee Length	59.74	3.63	53.00	60.00	64.00	55.74	3.33	50.00	56.00	61.15
9	Buttock-Popliteal Length	47.43	2.78	42.47	48.00	52.00	44.54	2.80	39.85	45.00	49.15
10	Knee Height Sitting Rest	54.02	2.97	49.00	54.00	58.00	49.46	3.63	42.00	49.75	56.00
11	Popliteal Height Sitting Rest	40.37	2.59	35.95	41.00	45.00	36.92	3.45	30.00	37.00	42.00
12	Depth Abdominal	23.86	3.36	17.97	24.00	29.57	21.12	3.61	16.42	20.50	26.63
13	Head Circumference	58.21	1.57	55.50	58.00	61.00	57.30	2.05	54.00	57.00	61.00
14	Depth Forearms	7.10	.94	5.50	7.00	8.50	6.24	.95	4.92	6.00	8.00
15	Elbow to the tip of the middle finger	47.63	4.66	41.90	48.00	58.00	42.97	3.53	38.00	43.00	49.07
16	Waist Circumference	17.62	1.14	16.00	18.00	19.52	15.59	.89	14.50	15.50	17.00
17	Elbow to Elbow Length	40.45	3.91	33.97	40.50	45.57	36.46	3.94	30.92	36.00	43.57
18	Breadth Buttock	37.31	2.56	33.47	37.25	41.02	36.95	2.86	32.50	36.75	42.00

Table 2: Linear regression models derived for reconstruction of stature in males and females

Variable	Males (n=78)	P value	Females (96)	P value	Total	P value
Eye Height Standing	42.26+0.81(SEH)	>0.001	31.44+0.92	0.001>	25.56+0.91(SEH)	>0.001
Eye Height Sitting Rest	100.32+0.62 (SEH)	>0.001	64.66+0.85 (SEH)	0.001>	31.88+1.17 (SEH)	>0.001
Horizontal Range of Accessibility Sitting	108.59+0.78 (SHA)	>0.001	86.33+ 0.96 (SHA)	0.001>	57.75+1.36 (SHA)	>0.001
Standing eye height/ Sitting eye height	173.98+1.75 (SEH/SEH)	0.01	162.15+2.92 (SEH/SEH)	0.001>	167.20+4.89 (SEH/SEH)	>0.001
Eye Height Standing / Horizontal Range of Accessibility Sitting	174.57+ 1.49 (SEH/SHA)	0.04	161.12+ 0.77 (SEH/SHA)	0.23	167.20+1.96 (SEH/SHA)	0.005
Eye Height Sitting Rest / Horizontal Range of Accessibility Sitting	174.75+(-0.26) (SEH/SHA)	0.70	161.20+(-0.97) (SEH/SHA)	0.14	167.20+(-2.02) (SEH/SHA)	0.004
Elbow Height Standing	122.61+0.47 (EH)	>0.001	143.70 +0.174 (EH)	0.009	113.52+0.51(EH)	>0.001
Elbow Height Sitting	161.28+0.18 (SEH)	0.08	141.05+0.29 (SHE)	0.005	134.85+0.47(SHE)	>0.001
Depth Thigh Sitting Rest	169.48+0.33 (HBS)	0.26	156.81+0.29 (HBS)	0.45	145.97+1.40(HBS)	>0.001
Buttock kneel Length	161.26+0.22 (BKL)	0.18	98.14+1.12 (BKL)	0.001>	88.13+1.37 (BKL)	>0.001
Knee Height Sitting Rest	115.21+1.10 (KH)	>0.001	118.67+0.85 (KH)	0.001>	84.73+1.60 (KH)	>0.001
Popliteal Height Sitting Rest	128.45+1.14 (PH)	>0.001	124.99+0.97(PH)	0.001>	100.58+1.73(PH)	>0.001
Depth Abdominal	181.17+(-0.97) (AD)	0.15	158.65+0.11(AD)	0.001>	153.15+0.62 (AD)	0.001
Head Circumference	133.26+0.71(HL)	0.07	124.38+0.63(HL)	0.06	81.32+1.48 (HL)	>0.001
Depth Forearms	175.63+(-0.11) (FD)	0.86	166.03+(-0.80) (FD)	0.27	151.85+2.31(FD)	0.001
Elbow to the tip of the middle finger	156.81+0.37 (FL)	0.004	123.74+0.86 (FL)	0.001>	114.65+1.16(FL)	>0.001
Waist Circumference	174.76+0.002 (WL)	0.99	144.01+1.09 (WL)	0.16	107.14+3.63(WL)	>0.001
Elbow to Elbow Length	174.27+0.01 (EL)	0.93	153.07+0.21 (EL)	0.22	136.22+0.80(EL)	>0.001

microscope users.

13. Results of regression analysis showed a strong correlation between standing eye height, sitting eye height, and sitting horizontal range of accessibility with stature. Therefore, these dimensions can be estimated according to their stature with less measurement. Although other dimensions were correlated, they did not show a high correlation coefficient.

14. Comparison of the findings of the present study with those of Abedini's study on a student population to measure their static anthropometric dimensions showed that standing and sitting eye height, standing and sitting elbow height, sitting horizontal range of accessibility and buttock

breadth in the present study were higher than those of Abedini's study. Buttock-knee length, buttock-popliteal length, knee height, popliteal height sitting rest, depth abdominal, thighs thickness sitting rest, and elbow-elbow length in the current study were lower than those of Abedini's study.[29]

15. In addition, comparison of the findings with those of Habibi's study on a student population to measure their static anthropometric dimensions showed that standing and sitting eye height, standing elbow height and popliteal height in the women in the current study were higher than those of Habibi's study. However, sitting elbow height, buttock- knee height sitting rest, thigh depth sitting rest, buttock-knee length, buttock-popliteal length, forearm length, and buttock breadth in the women in the current study were lower than those of Habibi's study. Standing and sitting eye height, standing elbow height, sitting knee height, popliteal height, buttock-knee length, and buttock-popliteal length in males in the current study were higher than those of Habibi's study. In addition, sitting elbow height, thigh depth sitting rest, forearm length and buttock breadth of in the males in the current study were lower than those in Habibi's study.[30]

16. Comparison of the results of the current study with those of Mououdi's study on men working in an assembly industry to design a saddle seat showed that most of the measured dimensions in this study were higher than those in Mououdi's study.[31] It can be concluded that anthropometric variables have been different in different populations and to design workstations and equipment for each population, anthropometry dimensions of that particular population should be measured.

17. The difference between the dimensions of the current study and those of other studies may be due to the differences in the measurement methods, and the age range of the subjects.

18. One of the purposes of this study was to investigate the correlation between different body dimensions of microscope users. In this case, the subject's stature is usually used as the reference based on which other dimensions are assessed.[7]

19. The findings of the study showed that three dimensions, i.e. standing eye height, sitting eye height, and sitting horizontal range of accessibility, had a significant correlation with stature. Therefore, given one's stature, these dimensions can be obtained with less measurement. Measuring these correlations can have many applications. For example, if such correlations are determined in a population, measuring a limited number of body sizes can be used to estimate other dimensions with acceptable accuracy. This can facilitate anthropometric data collection in the target population.

20. The findings of the study showed that anthropometric measurements in men were higher than those in women, except for the 95th percentile of the buttock breadth in women, which was higher than men. Given the dimensions obtained in this study, it seems that for appropriate design of equipment and instruments for microscope users, it would be better to use the fifth percentile of women for the range of accessibility and the ninety-fifth percentile dimensions of women for the extra space. This way, the equipment designed will be appropriate for a high percentage of microscope users. The results of the study indicated that for designing equipment, and workstations for each population, anthropometric dimensions of that particular population should be measured so that the designed workstations and equipment is proportional to the needs of the population and provides the opportunity for its maximum comfort, efficiency, and productivity.

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