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Anthropometric Measurement-Related Musculoskeletal Complaints in Office Workers

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Abstract

One of the factors blamed for the musculo-skeletal problems seen in office workers is incompatibility between staff anthropometric measurements and the working environment. This study was intended to evaluate musculo-skeletal complaints in individuals whose measurement values deviated very slightly from average.

The height, arm, forearm, hand length and sitting height values of 172 office workers were measured. Separate mean and standard deviation values were determined for men and women. Subjects with mean ± 1 SD measurements and subjects with values outside these measurements were then compared in terms of complaints in the previous 12 months using the Nordic Musculoskeletal Questionnaire.

Individuals with sitting height, arm length, forearm length and hand length measurements exceeding mean ± 1 SD exhibited more frequent symptoms in various regions of the body.

We think that working environments being adaptable to employees' body measurements will lead to fewer complaints arising in office workers' musculo-skeletal systems.

Keywords: Office workers, anthropometric measurement, musculoskeletal complaints

1. Introduction

Scientists, and particularly anatomists and anthropologists, have defined a great many points on the human body and performed measurements with them for a range of purposes (Bogin and Varela-Silva 2010, Küchmeister et al. 2009). Thanks to such measurements, people's surroundings and the objects and equipment they use can be designed in such a way as to improveing quality of life and working efficiency (Babalık 2005, Durant et al. 2006, Güler 2004, Office Ergonomics Workbook 1998, Bolstad et al. 2001).

If the working environment is unsuited to the human body, this gives rise to various health problems in specific regions of the body due to factors such as the performance of essential and repeated actions, the use of badly designed equipment and poor posture. Problems such as muscle strain, tendinitis, tenosynovitis, cervical and lumbar spinal disk herniation, osteoarthritis and nerve entrapment syndromes have generally been reported (Özcan 2011). Ergonomic incompatibility is reported to be responsible for nearly half the problems emerging as a result of abnormal posture and repetitive strain injury (Smith and Bayeth 2003, Andersen et al., 2007, Eltayeb et al., 2009, Cho CY et al., 2012, Madeleine P et al., 2013, Kaliniene G et al., 2016, Çelik S et al., 2018). Musculoskeletal system symptoms developing in the neck, shoulder and back regions and caused by ergonomic incompatibility have been reported to be correlated with invariable risk factors such as genetic predisposition, body structure, structural spinal deformities and gender, and with variable risk factors such as posture, length of time spent working and the working environment (van Niekerk et al. 2012).

Factors such as posture, movements and structure and location of equipment used during work that lead to musculoskeletal system problems caused by ergonomic incompatibility have been investigated by many researchers, but there has been little emphasis on workers' anthropometric measurements (Özcan 2011, Eltayeb et al. 2009, Kryger et al. 2003, Lassen et al. 2004, Sillanpää et al. 2003, Matsudaira et al. 2011, Kaliniene G et al. 2013).

Although body structure and measurements are invariable factors, health problems caused by ergonomic incompatibility can still be eliminated if the working environment is adapted to the individual's body measurements. Standards for the manufacture of equipment such as tables and chairs in the working environment, of great importance in terms of ergonomic incompatibility, are calculated according to average anatomical measurements (Babalık 2005, Durant et al. 2006, Güler 2004). When these standards are being determined, individuals with body measurements values in the top or bottom 5% are generally ignored (Openshaw and Taylor 2006, Hedge 2012, Ciccarelli M et al. 2014). As a result, ergonomic incompatibility is only considered in terms of those with end-of-spectrum values. However, ergonomic incompatibility can appear not only in individuals with measurements in the top or bottom 5% according to normal distribution, but also those with only a slight deviation from average. This study was intended to determine how the musculoskeletal systems of office workers in a health institution whose anatomical measurements exhibited slight deviation from average values might be affected.

2. Method

One hundred seventy-two office employees (107 female and 65 male) out of 177 desk workers at the Karadeniz Technical University Farabi Hospital, aged between 20 and 56 and who agreed to participate, were included. The requisite permission was obtained from the Hospital Chief Physician's Office, and approval was secured from the local ethical committee. Participants completing the informed consent form were administered the Nordic Musculoskeletal Questionnaire, and various body measurements that might have effects on individuals in a sitting position were taken in order to determine probable causes of symptoms that might arise.

2.1. Anatomical measurements:

The following measurements were taken using a non-elastic tape measure (Figure 1)

1 – Height: Distance from the floor to the highest point on the body with the subject in a standing position

2 –Sitting height: Distance between the seat and the highest point of the spine with the subject sitting upright on a stool

3 – Arm length: Distance between the wall and tip of the middle finger with the subject standing upright, back against the wall, and with both arms fully extended to the front

4 – Forearm length: Distance between the wall and tip of the middle finger with the subject standing upright, elbow leaning against the wall and both forearms extended to the front

5 – Hand length: Distance from the radiocarpal joint (wrist joint) to the tip of the middle finger.

2.2. Nordic Questionnaire:

This was developed for use in ergonomic studies and enquires into musculoskeletal system complaints in various parts of the body (Barros and Alexandre 2003, Baron et al. 1996, Crawford 2007).

The questionnaire contains four questions enquiring into the presence of complaints in the neck, shoulders, back, elbows, wrist/hands, lower back, hip/thigh and ankles/feet. The questions put for each region are as follows:

1. Have you experienced any problems such as pain, discomfort or numbness over the last 12 months?
2. In the last 12 months, have you been prevented from performing any normal activities because of this problem? (work, housework, hobbies, etc.)
3. Have you been seen by a physician because of a problem in the last 12 months?
4. Have you experienced a problem in any of the specified regions in the last 7 days?

Since all the chairs used by the participants during the course of the study were movable and with adjustable heights, no measurements were performed for the lower extremity, and symptoms in the region were not enquired into. Only answers to the first question for each region in the Nordic Questionnaire were used, the answers to the 2nd, 3rd and 4th questions being excluded from analysis.

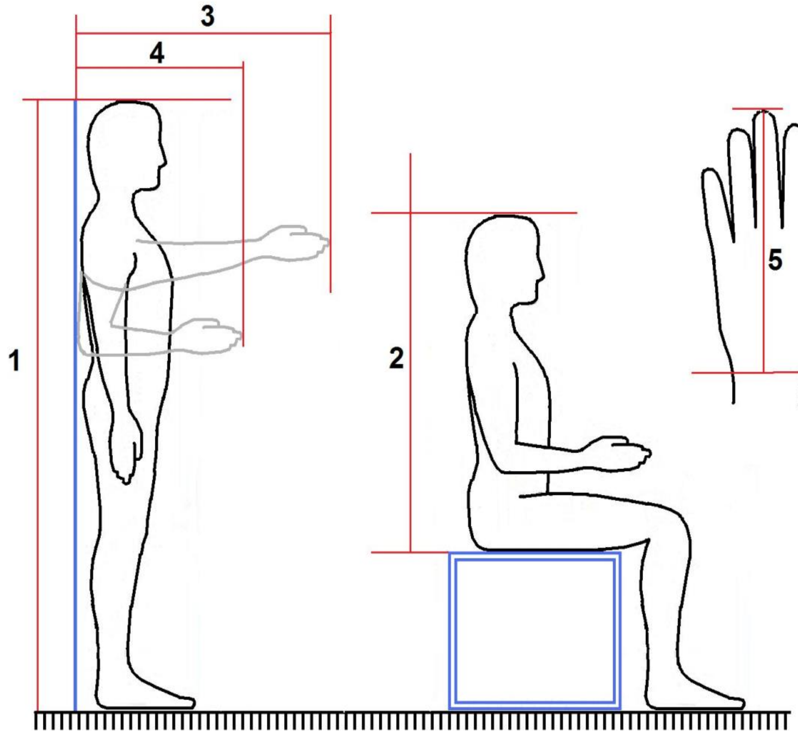

Figure 1. Measurements performed

2.3. Data Analysis:

Individuals whose mean anatomic measurements, obtained separately for men and women, were within mean (±1) standard deviation were classified as Group I and the other subjects as Group II (Figure 2).
Mean and standard deviation values for the anthropometric measurement values from men and women are shown in Table 1.
Groups were calculated separately on the basis of the means and standard deviations for men and women in Table 1; these were then combined and the two study groups established.
Neck, shoulder, back, elbow, wrist/hand and lower back regions exhibiting symptoms were compared between the groups.
Data analysis was performed using SPSS. Descriptive data compared are presented as numbers (%). The chi-square test was used in the comparison of pain, discomfort and numbness problems in the neck, shoulder, back, elbow, wrist/hand and lower back regions of the individuals in groups I and II.

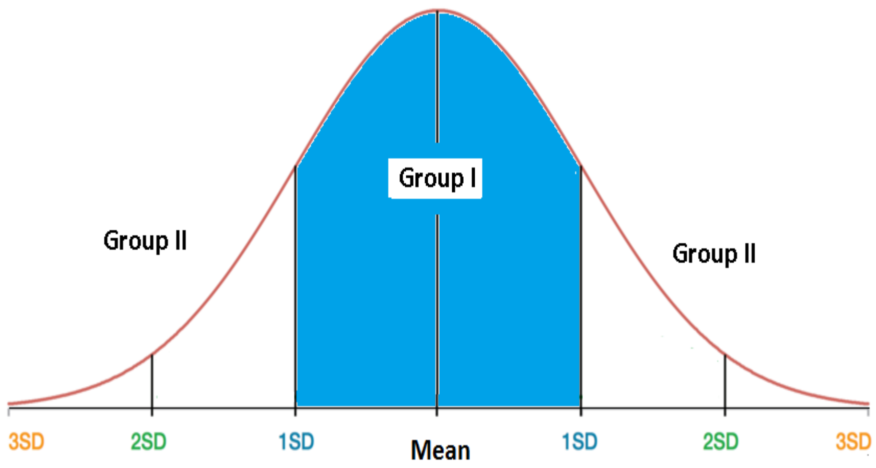

Figure 2. Classification of individuals based on measurement values

Table 1: Means and standard deviations of anthropometric measurements in men and women

	Female Mean ± SD	Male Mean ± SD
Height	158.19 ± 6.46	172.79 ± 6.30
Sitting height	59.19 ± 2.78	63.88 ± 2.68
Arm length	75.48 ± 3.81	83.78 ± 3.52
Forearm length	43.35 ± 2.02	47.90 ± 1.84
Hand length	17.13 ± 1.12	18.89 ± 0.99

3. Results

One hundred seven (62.2%) of the participants were women and 65 (37.8%) men. Mean age was 34.2±9.3 years (min:20–max:56), mean length of employment 12.4±8.5 years (min:1-max:33), and mean length of time in current post during the research 7.9±7.0 years (min:1–max:28). Seventy-eight (45.2%) staff were secretaries and 94 (54.7%) were office personnel in clerical positions.

Distribution of anthropometric measurements obtained in groups I and II and a comparison of symptoms in the different regions obtained using the Nordic Questionnaire are given below (Table 2). Comparison was based on complaints over the previous 12 months.

On the basis of the comparisons performed:

In terms of sitting height, individuals in Group II had more symptoms in the shoulder, back and wrist/hand regions (P:0.002, P:0.007 and P:0.033, respectively).

In terms of arm length, the individuals in Group II had more symptoms in the back region (P:0.029),

In terms of forearm length, the individuals in Group II had more symptoms in the shoulder, back and wrist/hand regions (P:0.034, P:0.048 and P:0.003, respectively),

In terms of hand length, individuals in Group II had more symptoms in the shoulder, back and wrist/hand regions (P:0.008, P:0.002 and P:0.005).

Table 2: Comparison of symptoms over the previous 12 months based on the Nordic Questionnaire in groups I and II

Measurement			Neck (n=95)	Shoulders (n=67)	Back (n=79)	Elbows (n=19)	Hand/wrist (n=42)	Lower back (n=92)
			Symptom Region					
Height	Group I	**n**	68	46	56	14	31	56
	(n=115)	**%**	55.7	40.0	48.7	12.2	27.0	48.7
	Group II	**n**	31	21	23	5	11	36
	(n=57)	**%**	54.4	36.8	40.4	8.8	19.3	63.2
	P		0.875	0.815	0.384	0.681	0.362	0.104
Sitting height	Group I	**n**	21	8	12	4	5	21
	(n=44)	**%**	47.7	18.2	27.3	9.1	11.4	47.7
	Group II	**n**	74	59	67	15	37	71
	(n=128)	**%**	57.8	46.1	52.3	11.7	28.9	55.5
	P		0.325	**0.002**	**0.007**	0.784	**0.033**	0.476
Arm length	Group I	**n**	69	46	56	13	29	56
	(n=118)	**%**	58.5	39.0	47.5	11.0	24.6	47.5
	Group II	**n**	26	21	23	6	13	36
	(n=54)	**%**	48.1	38.9	42.6	11.1	24.1	66.7
	P		0.206	1.000	0.668	1.000	1.000	**0.029**
Forearm length	Group I	**n**	20	9	12	5	2	20
	(n=39)	**%**	51.3	23.1	30.8	12.8	5.1	51.3
	Group II	**n**	75	58	67	14	40	72
	(n=133)	**%**	56.4	43.6	50.4	10.5	30.1	54.1
	P		0.703	**0.034**	**0.048**	0.911	**0.003**	0.895
Hand length	Group I	**n**	26	12	14	5	5	23
	(n=52)	**%**	50.0	23.1	26.9	9.6	9.6	44.2
	Group II	**n**	69	55	65	14	37	69
	(n=120)	**%**	57.5	45.8	54.2	11.7	30.8	57.5
	P		0.364	**0.008**	**0.002**	0.897	**0.005**	0.151

4. Discussion

Offices are one of the most common working environments. The presence of large numbers of office workers has encouraged research into the establishment of suitable environments for them. Stress factors such as positions and movements impacting on posture, microtraumas established by repetitive movements, disproportionate or inappropriate use of certain regions of the body and burdens and stresses imposed on those regions as a result of badly designed workplaces inevitably lead to health problems, particularly involving the musculo-skeletal system. Vernaza et al. (2005) revealed that working postures in the professional environment represent a major risk for musculo-skeletal lesions. Ramadan et al.'s (2006) results point to the same conclusion.

Equipment used in workplaces is generally designed to match the anatomical features of 90% of society, the remaining 10% being ignored. People representing ±1 standard deviation and representing 68% of the total were included in Group I in this study. Our results show a significant rise in symptoms without departing far from mean values. The level of musculo-skeletal symptoms in the office workers in our study was quite high (65.7%). In their study of office workers, Vernaza et al. (2005) reported that 50%

of subjects complained of pain somewhere in the body. Andersen et al. (2007) reported that only 7.7% of participants described no pain anywhere in the body.

Matsudaira et al. (2011) enquired into workforce losses over the previous year and reported levels of 3% in nurses and 4% in sales staff compared to 11% among office workers. Research has reported levels of symptoms involving the neck and upper extremities in staff using computers of up to 75% (Özcan 2011). In our study of office workers, since all the chairs used in the working environment were mobile and adjustable in height, only measurements for the upper extremity were taken, while symptoms in the lower extremities were not investigated. One finding supporting the accuracy of this method is that we identified no correlation between height and symptoms in the upper extremity and lower back region.

Ergonomic factors in the working environment involving the upper extremity include desk dimensions, the arrangement of the computer on the desk and surrounding units and the sizes of the equipment used. Complaints naturally develop in environments where these factors are not suitable. There are several studies on the subject in the literature. In Dane et al.'s (2002) study, ergonomic evaluation forms involving keyboard, mouse, monitor and other office equipment, paper trays, chairs, the working area, surroundings and carrying activities were completed. The data obtained were then compared with upper extremity symptoms. Significant correlations were determined between the ergonomic factors investigated and upper extremity symptoms.

No significant difference was determined in our study in the neck region and elbows between individuals with normal or abnormal measurements. We ascribed this to the partial establishment of a suitable environment with the use of height-adjustable seats. Since neck symptoms are thought to be caused more by repetitive head movements, different measurement values in the upper extremity may be expected to have less effect in the development of symptoms. Height, which might have given rise to complaints, was eliminated as a factor through the use of height-adjustable chairs. Values related to sitting height, another potential agent, were not statistically significant, although they do exhibit greater neck region symptoms in the non-normal group. Korhonen et al. (2003) observed that a poor physical working environment and bad keyboard location increase the risk of neck pain.

The absence of any difference between the groups in terms of elbow-related symptoms may be ascribed to the arm/forearm angle being capable of adjustment to a level that will not cause symptoms as seating is adjusted to a suitable height. The closest values between the groups were obtained in terms of elbow symptoms.

More symptoms were identified in the shoulder, back and wrist/hand regions in individuals with abnormal sitting height and abnormal forearm and hand length values. The first agent that comes to mind here is unsuitable desk depth and the location of the objects on it. In terms of the use of equipment on the desk, chairs being adjustable in height mean that seating is not of great importance in the development of symptoms in the shoulder and back, and particularly the wrist/hand region. The height of the chair being adjustable does not affect the depth of the desk. In subjects with non-normal back height and forearm and hand lengths, the appearance of symptoms in these regions is inevitable due to a significant range of wrist angles occurring during work. Continued extension/contraction movements indirectly lead to the appearance of symptoms in the back and shoulders. The size and shape of objects on the desk is as important as their location. Various studies have been performed regarding the size of objects used and the duration of that use. Lassen et al. (2004) investigated the correlation between mouse use and hand/wrist pain and obtained significant results. Kryger et al. (2003) determined that excessive mouse use and a small keyboard were the main risk factors for forearm pain. In contrast, Sillanpää et al. (2003) determined no significant relation between duration of computer or mouse use and pain in any region of the upper extremity.

Longer or shorter than normal forearm dimension was identified as the most significant factor leading to symptoms in the lower back. This was thought to be due to forearm dimension causing changes in the upright seated posture.

Our findings show that compatibility between body measurements and the working environment is of great importance in terms of personnel health. It is clear that health problems that may arise in the world of work can be prevented with the adjustment of the working environment to suit the individual and by the equipment used being located most appropriately, even if the sizes of equipment involved are standard. The use of mobile and height-adjustable chairs has been seen to prevent many symptoms, in both this and other studies. Similarly, personnel health complaints and resulting workforce losses can be prevented by the desk layout being sufficiently flexible as to permit adjustment according to the needs of the individual using it.

In conclusion, incompatibilities between office workers' anatomical measurements and their working environment affect the development of symptoms. A working environment adaptable to office worker's anatomies should be provided.

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