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Hand anthropometry: Musculoskeletal symptoms among women workers performing packing activities in pharmaceutical industry

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Abstract
Anthropometry is the science of studying the difference in body size and proportions by measuring various body characteristics including height, weight, physical range of mobility, and body dimensions. In pharmaceutical industry mostly men are engaged for working with machines and equipments, whereas women are engaged for sedentary and repetitive manual work. In the industry though the process of manufacturing is mechanized, the process of packing is still undertaken manually by women often. The women workers are involved in packing carry out the work in sitting down posture with fairly long hours of static work. Work related musculoskeletal disorders arise from ordinary arm and hand movements such as bending, straightening, gripping, holding, twisting, clenching and reaching. These common movements are not particularly harmful in the ordinary activities of daily life, but they are hazardous in work situations of continual repetition, often in a forceful manner with lack of time for recovery between them. A study was carried out to know the relationship between anthropometry and occurrence of musculoskeletal symptoms among women working in packing units of pharmaceutical industry. The results showed that the span length, forward grip reach and sitting height of the respondents was inversely proportional to musculoskeletal symptoms whereas shoulder breadth, shoulder elbow length and hand length of the respondents was found to be having no influence.

Keywords: Anthropometry, Musculoskeletal symptoms, Packing, Pharmaceutical industry

Introduction
The pharmaceutical industry is one of the major industries of Telangana employing huge number of women in packing activities. The packing activities being static and repetitive work may give rise to fixed or constrained body positions, continued repetition of movements and concentrated force on hand or wrist without sufficient recovery between the movements. As a result of a combination of these movements work related musculoskeletal disorders are common among women involved in packing activities in pharmaceutical industry. The impact of musculoskeletal disorders on working life is huge. Musculoskeletal disorders can interfere with activities at work and can lead to reduced productivity, sickness, absence and chronic occupational disability. Musculoskeletal impairments impact significantly on the population, the health care utilization and the cost for society. Unlike other occupational health hazards, musculoskeletal symptoms are recognized slowly. When the subjects continue to work with symptoms they develop musculoskeletal disorders.
Anthropometry is the science of studying the difference in body size and proportions by measuring various body characteristics including height, weight, physical range of mobility, and body dimensions. Comparatively prevalence of musculoskeletal symptoms among workers in industries of organized sector especially in women was found less explored. The role of individual anthropometry in developing musculoskeletal symptoms was found unexplored much in industrial sector. In the interest of majority of women involved in repetitive tasks, unnoticed and suffering from acute repetitive strain injuries, it was felt essential to investigate about the present study.

Materials and methods
The study was conducted in Hyderabad as it is pharmaceutical hub emerged as a major drug manufacturing city with presence in the global market. It is the largest exporter of bulk drugs and pharmaceuticals. The list of registered pharmaceutical industries in the city of Hyderabad was collected from commissioner of Industries. Based on the manufacturing capacity and turn over the industries were divided into large, medium and small units. Nine pharmaceutical industries that were willing to participate in the study were chosen for the investigation. The women who were involved in the packing activities in pharmaceutical industries for a period

of minimum three years and aged above 30 years was the criteria adopted to select the sample for the study as the age is one of the factors that can cause musculoskeletal disorders among working population (Okunribido and Wynn, 2010) [5]. Physiological and biological changes related to ageing may cause degenerative changes in the muscles, tendons, ligaments and joints which may contribute to the pathogenesis of musculoskeletal symtpoms (Cassou *et al*., 2002) [3]. The women satisfying the criteria and willing to participate in the study in each industry ranged from 35-45. The total population of the study consisted of 360 women from the nine selected industries. From the total study population 75 percent i.e. 270 women were chosen at random to form the sample for the present investigation.

The anthropometric parameters identified as variables in the study are taken by adopting the methodology suggested by Hertzberg, 1968 [4]. Weight was measured in Kilograms by using digital weighing machine and the other parameters viz. height, shoulder breadth deltoid, shoulder elbow length, upper limb length, hand length, span, forward grip reach and sitting height were measured in centimetres using anthropometric height measurement rod and tape. The musculoskeletal symptoms include pain, stiffness, swelling, spasms, cramps, numbness, tingling sensation, tiredness, soreness and weakness (Browne *et al*., 1984) [2]. A scale was constructed to measure the prevalence of the musculoskeletal symptoms. The data was analyzed by computing frequencies, percentages and means. Correlations were calculated to test the association between the musculoskeletal symptoms and anthropometric parameters of the study. Analysis of variance was computed for musculoskeletal symptoms and anthropometric variables.

Results and discussion

The musculoskeletal symptoms experienced by women involved in packing activities in nine anatomical body regions such as neck, shoulder, elbows, wrists/hands, upper back, low back, hips/thighs, knees, ankles/feet were measured with the help of musculoskeletal symptom assessment scale developed for the present investigation. In the present investigation the nine anatomical body regions were grouped into five body regions such as neck, shoulder, upper limb (upper arm, elbow, fore arm, wrist, hand and fingers), back (upper back and low back) and lower limb (thigh, knee, leg, ankle, feet and toes) regions (Winwood and Smith, 1985) [8].

Anthropometric measurement is the science of measurement and the art of application that establishes the physical geometry, mass properties and strength capabilities of human body (Pardo-Lu, 2004) [6]. The mismatch between anthropometric dimensions and equipment or furniture may cause health problems in human body as musculoskeletal disorders (Bendix, 1987) [1]. The height, length and breadth of work station, shoulder height and arm length of the person were factors leading to musculoskeletal disorders (Somasundaram and Srinivasan, 2010) [7]. In the present investigation the anthropometric measurements that are relevant to packing activities viz. height, weight, shoulder breadth deltoid, shoulder elbow length, upper limb length, hand length, span, forward grip reach and sitting height were selected as variables. The relationship between these selected individual anthropometric measurements and prevalence of work related musculoskeletal symptoms was explored.

a) Height

Height is the stature of the body measured when standing in normal relaxed erect posture (Hertzberg, 1968) [4] (Fig 1). The height of 71.1 per cent of the respondents ranged between 148 to 158cm. The mean height estimated was 152.71cm with standard deviation 5.50. The height of the respondents showed significant negative correlation with musculoskeletal symptoms in neck (r=-0.13), shoulder (r=-0.16), upper limb (r=-0.18), back (r=-0.15) and over all body symptoms (r=-0.16). The computed F values revealed significant difference at 0.05 level between respondent's height and neck, over all body symptoms. The F values showed significant difference at 0.01 level between height and musculoskeletal symptoms in shoulder and upper limb.According to the present investigation as height increased the musculoskeletal symptoms in the women engaged in packing activities of pharmaceutical industries decreased. Height was found to be inversely proportional to perceived level of musculoskeletal symptoms. Similar findings were observed in a study conducted by Morken *et al.* (2000) where they found short stature as a risk factor for developing musculoskeletal symptoms.

Fig1: Height

b) Weight

Heaviness of the body measured while a person is in standing posture with minimal movement with hands by their side. The weight of the person is heaviness of the body measured while a person is in standing posture (Hertzberg, 1968) [4] (Fig 2). The weight of 70.74 per cent of the respondents ranged between 45 to 61kg. The mean weight estimated was 52.46 with standard deviation 8.27. The weight of the respondents showed significant positive correlation with musculoskeletal symptoms in neck (r=0.13), shoulder (r=0.16), upper limb (r=0.17) and over all body symptoms(r=0.14). The computed F values revealed significant difference at 0.05 level between weight and musculoskeletal symptoms in neck and shoulder. According to the present investigation as weight increased the musculoskeletal symptoms in the women engaged in packing activities of pharmaceutical industries increased. Weight was found to be directly proportional to perceived level of musculoskeletal symptoms. Similar finding was reported by Morken *et al.* (2000). According to their study over weight was found to be one of the risk factors for developing musculoskeletal symptoms in most of the areas of the body.

Fig 2: Weight

c) Shoulder breadth deltoid

Shoulder breadth deltoid is the maximum horizontal breadth across the shoulders between protrusions of deltoid muscles measured in sitting posture (Hertzberg, 1968) [4] (Fig 3). The shoulder breadth of 71.11 per cent of the respondents ranged from 35 to 40cm. The mean shoulder breadth estimated was 36.84 with standard deviation 2.82. Shoulder breadth of the respondents showed no correlation with musculoskeletal symptoms in neck, shoulder, upper limb, back and lower limb. The computed F values revealed no significant difference between shoulder breadth and musculoskeletal symptoms in neck, shoulder, upper limb, back, lower limb and over all musculoskeletal symptoms. The shoulder breadth of the individual had not contributed towards the development of musculoskeletal symptoms.

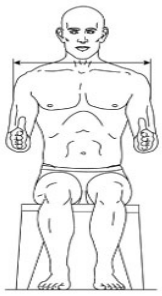

Fig 3: Shoulder breadth deltoid

d) Shoulder elbow length

Shoulder elbow length is the distance from the acromion to underside of the elbow in a standard sitting position (Hertzberg, 1968) [4] (Fig 4). The shoulder elbow length of the 69.26 per cent of the respondents varied from 26 to 30cm. The mean shoulder elbow length of the women involved in packing activities in pharmaceutical industry was 27.88cm. The product moment correlation computed between musculoskeletal symptoms in neck, shoulder, upper limb, back, lower limb and shoulder elbow length of the respondents revealed no significant correlation. The computed F values revealed no significant mean difference between shoulder elbow length and musculoskeletal symptoms in neck, shoulder, upper limb, back, lower limb and over all body symptoms. The shoulder elbow length of an individual was found to have no influence on respondents' perceived level of musculoskeletal symptoms.

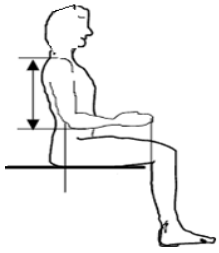

Fig 4: Shoulder elbow length

e) Upper limb length

Upper limb length is the distance from the acromion to the fingertip with the elbow and wrist straight extended (Hertzberg, 1968) [4] (Fig 5). The upper limb length of the majority of the respondents (72.22%) of the study ranged from 60 to 71 cm. The mean upper limb length of the women involved in packing activities in pharmaceutical industry was 64.93cm. The upper limb length of the respondents showed significant negative correlation with musculoskeletal symptoms in shoulder (r=-0.12), upper limb(r=-0.13). The computed F values revealed significant mean difference between upper limb length and musculoskeletal symptoms in shoulder and upper limb. According to the present investigation as upper limb length increased the musculoskeletal symptoms in the women engaged in packing activities of pharmaceutical industries decreased. Upper limb length was found to be inversely proportional to perceived level of musculoskeletal symptoms in shoulder and upper limb.

Fig 5: Upper limb length

f) Hand length

Hand length is the distance from the crease of the wrist to the tip of the middle finger with the hand held straight and stiff (Hertzberg, 1968) [4] (Fig 6). The hand length of maximum respondents (91.48%) ranged from 16 to 18cm. The mean hand length of the women involved in packing activities in pharmaceutical industry was 17.07cm. Hand length of the respondents showed significant negative correlation with musculoskeletal symptoms in shoulder (r=-0.14), upper limb (r=-0.15), back (r=-0.16) and over all body symptoms (r=-0.14). The computed F values revealed no significant mean difference between hand length and musculoskeletal symptoms in neck, shoulder, upper limb, back and lower limb. According to the present investigation hand length of the subject was found to be having no influence on their perception of symptoms like pain, stiffness, swelling, burning, spasms, cramps, soreness, heaviness, numbness, tingling sensations in various musculoskeletal regions of the body.

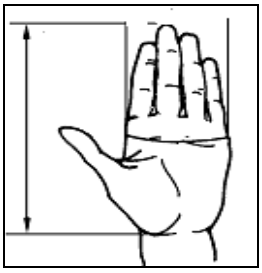

Fig 6: Hand length

g) Span length

Span length is the maximum horizontal distance between the fingertips when both the arms are stretched out sideways (Hertzberg, 1968) [4] (Fig 7). The span length of the 66.67 per cent of the respondents ranged from 149 to 160cm. The mean span length estimated was 153.87 with standard deviation of 6.27. The mean span length of the women involved in packing activities in pharmaceutical industry was 153.87cm. Span length of the respondents showed significant negative correlation with musculoskeletal symptoms in neck (r=-0.15), shoulder (r=-0.18), upper limb(r=-0.18), back (r=-0.12) and over all body symptoms (r=-0.16). The computed F values revealed significant mean difference between span length and musculoskeletal symptoms in shoulder and upper limb.

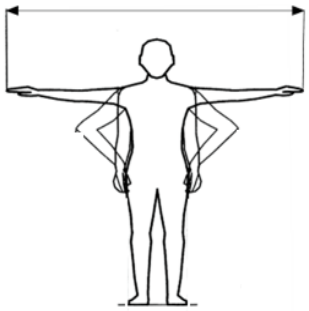

Fig 7: Span length

h) Forward grip reach

Forward grip reach is the distance from the back of the shoulder blades to the knuckle of the hand (Hertzberg, 1968) [4] (Fig 8). The forward grip reach of the majority of the respondents (71.85%) ranged from 61 to 70cm. Forward grip reach of the respondents showed significant negative correlation with musculoskeletal symptoms in upper limb (r=-0.14) and back (r=-0.12). The computed F values showed significant mean difference between forward grip reach and musculoskeletal symptoms in upper limb.

According to the present investigation as forward grip reach increased the musculoskeletal symptoms in the women engaged in packing activities of pharmaceutical industries decreased. If the length of forward grip reach is more the respondents were comfortable in grasping the things and gripping activities so that they were not suffering much with musculoskeletal symptoms where as the respondents with low lengths were not comfortable in easy reach contributing to musculoskeletal symptoms.

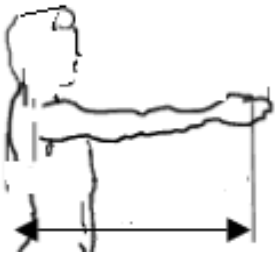

Fig 8: Forward grip reach

i) Sitting height

It is the vertical distance from the sitting surface to the vertex i.e. crown of the head (Hertzberg, 1968) [4] (Fig 9). The sitting height of the majority of the respondents (73.33 %) varied from 68-80 cm. The mean sitting height estimated was 73.46 with standard deviation of 6.43. Sitting height of the respondents showed significant negative correlation with musculoskeletal symptoms in neck(r=-0.12), shoulder (r=-0.15), upper limb (r=-0.16), back (r=-0.14) and over all body symptoms (r=-0.15). The computed F values revealed significant mean difference between sitting height and musculoskeletal symptoms in shoulder, upper limb and over all body symptoms.

According to the present investigation as sitting height increased the musculoskeletal symptoms in the women engaged in packing activities of pharmaceutical industry decreased (Fig 10). Sitting height was found to be inversely proportional to perceived level of musculoskeletal symptoms. In the present investigation when sitting height of the respondents is more they were comfortable in handling the things without bending and twisting. They were able to hold proper posture which might have lead to feeling of less musculoskeletal symptoms. When the sitting height is less they need to bend and twist the body for carrying out the packing activities, which might have resulting in feeling of musculoskeletal symptoms.

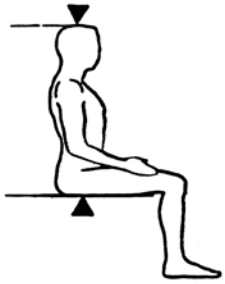

Fig 9: Sitting height

Fig 10: Women performing packing activities in pharmaceutical industry

Conclusion

The mean anthropometric measurements of the sample of the present investigation were found to be in line with the 50th percentile Indian women. In the present research an attempt was made to find out the interrelationship between musculoskeletal symptoms and anthropometric parameters of the respondents. The height, upper limb length, span length, forward grip reach and sitting height of the respondents

showed significant negative correlation with musculoskeletal symptoms whereas the weight of the respondents showed significant positive correlation. The shoulder breadth, shoulder elbow length and hand length of the respondents was found to be having no influence on musculoskeletal symptoms. Hence for reducing and controlling these musculoskeletal symptoms proper work station designing to be done and some interventions like rest breaks, safe work postures, job rotation, regular exercise and yoga are suggested.

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