

*Full Length Research Paper*

# **A review of ergonomically designed work seats; the situation of small-scale garment producers in Ghana**

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Accepted 04 October, 2013

**The knowledge of the role of seats and posture in everyday occupations has generated attention lately. Research has consistently found that the physical characteristics of the job of the machinist in garment production are an important risk factor for muscle pain and injury. The risks have often been linked to conditions such as chairs and awkward postures. Working chairs that are too high or too low result in awkward bodily positions that may cause pain and injuries that may reduce production rates and quality. This paper contrasts evidence on biomechanics of sitting posture and anthropometric measurements for seated workers from western sources with recent empirical evidence in Ghana so as to highlight any differences in ergonomic practices with respect to work seats. Findings from recent empirical study in Ghana revealed that the height and depth of seats of dressmakers and tailors did not meet standards as recommended in the literature. Seats were non-adjustable, had no backrest and seat pads. Our review thereby sheds new light on the effects of difficult practices on dressmakers/ tailors vocation. It is therefore suggested that trade organizations assist garment producers to improve work seats.**

**Key words:** Seats attributes, garment manufacturing, ergonomics, Ghana, small scale.

## **INTRODUCTION**

A chair is a critical piece of equipment for the machinist who works in a seated position. In a sitting position the weight of the body is transferred to a supporting area, mainly by the ischial tuberosities of the pelvis and their surrounding tissues provides stability required in the tasks that involve high visual and motor control (CU Ergo 2012). The job of garment production requires speed, accuracy, vision and long periods of work in a seated position. Empirical evidence suggests that workers in garment factories suffer from work-related musculoskeletal disorders due to poor ergonomic practices (Chavalitatsakulchai and Shahnava, 1993; Hague et al., 2001). Prolonged sitting itself causes health problems. For example, abdominal muscles slacken and curve the spine and also the function of some internal organs are impaired (Beach et al., 2005). As far back as

1982, Osborne (1982) cited Pottier et al., (1969) to have reported that prolonged sitting for more than 60 minutes produces swelling in the lower leg of all sitters as a result of an increase in hydrostatic pressure in the veins and the compression of the thighs causing an obstruction in the return of blood flow. For a work seat, stability, adequate support of the lumbar area and distribution of the body weight over the seat pan are important considerations. Anthropometric dimensions of the worker, the sitting height, height of the working surface and the arm reach are important considerations for any work station (Figure 1). People come in different sizes, shapes and strengths. There is no such thing as "one size fits all". For example dimensions for normal and extended reaching areas accessible to the worker in a seated position for an object are 40 and 60cm respectively (Ortiz, 1991; Hiba, 1998). Longer reaches requires additional time and effort from the worker. The dimensions of the sewing table that should be considered are height, size, shape, tilt and leg room (Gunning et al., 2001). Bridger (2003) argued that muscular fatigue and

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spinal deformation reduce comfort and increase the stress of the operators and will in turn reduce performance. In this review article, we present both theoretical and empirical literature on recommended heights, depth and width of the work seats and seating posture.

## REVIEW METHODOLOGY

Ergonomics is an old issue and there are many studies available therefore very old and current literature from both print and the internet were used for this review. A systematic narrative review of extant literature was performed using keywords such as ergonomics, Ghana, ergonomic designs of seats, ergonomics, garment production, and apprenticeship. The main search engines used were Google scholar and University of Ghana Online Catalogue. The search produced only one study on seats in garment industry in Ghana: Vandyck and Fianu (2012). The results of this systematic search showed that there is dearth of literature on ergonomic quality of seat used by garment producers in Ghana. This was therefore the main study used in this review. However, other relevant literature were reviewed and were drawn from codes of practice on ergonomics, workers' education manuals, ILO reports, newsletters, technical publications and guides, journals and books.

## THEORETICAL LITERATURE

### Seats and Seating Posture

Different seating positions have effects on the body's structure. The knowledge of relationship between seats, awkward postures and musculoskeletal disorders go back many years. A good seat is one that helps the individual to stabilize his body joints so that comfortable posture is maintained (Bridger 2003; Kelly et al., 2013). Many years ago Grandjean et al., (1973) estimated that 50 percent of adults suffer backaches during, at least, one period of their lives. This is due to pathological degeneration of the discs, which lie between the bony vertebrae and act as an elastic cushion to give the spinal column its flexibility. Improper postures, they mentioned, wear out the disc. He cited Yamaguchi and Umezawa (1970) to have studied the effect of various seat inclinations on the spine. They found that with a horizontal seat surface, a backrest angle of 125° is required to get a low tension in the spine. Osborne (1982) reported Kengan and Radke (1964) to have used X-ray to study the shape of the spine during different posture and suggested that the normal relaxed spinal shape is produced when a person is lying comfortably on his side with the thigh and legs moderately flexed. They pointed out that the sitting posture which produces the nearest

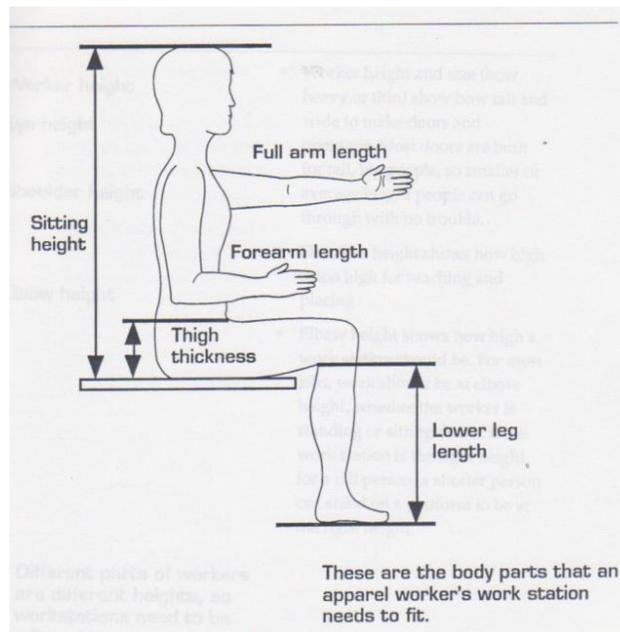
approximation to the 'normal' lumber shape is the one in which the trunk-thigh angle is about 115 degrees and the lumber position of the spine is supported. A "sitting up straight", that is, 90 degree backrest angle position produces a great deal of spinal distortion. Osborne (1982) noted that a forward-seated posture causes the normally forwards-bent lumber area to straighten and eventually, bend backwards. This affects the angles of the thoracic and cervical areas causing a hunchback posture which when maintained for long periods increases the load on the musculature supporting the head and produces fatigue in the neck and back. Grandjean (1973) therefore suggested that seats should be designed so that in both forward and backward postures, they provide support to the upper edge of the pelvis.

The relative comfort and functional utility of chairs and seats are a consequence of the chair's physical design in relationship to the physical structure and biomechanics of the human body. Seats should have back support and should provide for correct curvature of the lumber or low back area in order to keep the spinal column in a state of balance. It should be so designed that the weight of the body is distributed throughout the buttock region by proper contouring of the seat pan in combination with other features of the seat such as seat height, seat angle and seat back (Gunning et al 2001). Recent work supports the view that a forward hunchback posture cause pain in the upper back and shoulder regions but the pain ceased as soon as a backrest was provided (CUErgo 2012; Kroemer 2009; Dul and Weerdmeester 2008). Features of a "good chair" listed by Gunning et al. (2001) included; seats with firm cushioning on the backrest and seat pan; seats with adjustable height and tilt; seat with adjustable backrest both in height and from front to back; and seat pan which is large enough to support the operator but small enough so that the backrest can be used.

Else (1998) wrote that if the number of hours spent sitting in a chair add up to over 8hours, then the chairs adjustment, support and comfort are very important for good health and comfort. She said that it is, therefore, desirable to have a seat with an adjustable lumber support that can move up and down and in and out. Similarly, Ergonomic Report (1993), Hiba (1998) and Ortiz et al. (1991) stressed the need to provide an ergonomically designed seat that is adjustable, has a backrest and has a large padded seat pan for machine operators (as shown in figure 2b). Agan and Luchsinger (1965) suggested an adjustable backrest not lower than 6inches (16cm) above the seat to support the lower spine.

Osborne (1982) cautioned that for a working chair, it should be positioned for easy access to the worker's work area in front of him as backward tilting seat would cause a worker to bend forward and would curve his spine unnecessarily. He reported Mandal (1976) to have taken this point further to argue that since most work is

**Figure 1.** Body parts that a work station needs to fit.



Source; Ortiz et al. (1991).

carried out in a forward bent posture, a forward- sloping seat is most appropriate.

Else (1998) and Ortiz et al (1991) pointed out that a lightly padded back and seat cushions and a chair on rollers to move easily from sewing machine, to the serger and cutting board without stressing the back were necessary. However, Dees (1998) warned that a chair with rollers might be a health hazard as it may roll too freely on a highly waxed surface or threads from shag carpet could be caught in the wheel of rollers. This could cause accidents making it necessary to re-consider chairs with rollers through research. Ortiz et al (1991) suggested that the texture of seat material may be rough textured to help keep workers from accidentally sliding in the chair.

Kroemer (2009) reported that the subjects he studied preferred backrest shapes that follow the curvature of the rear side of the human body; concave at the bottom and convex at the top. Backrest should be prominent in the lumbar region to reduce stress on the spinal column while the seat pan should be padded and be in a form to distribute the body weight pressure from the ischial tuberosities (as shown in figure 2b).

Ortiz et al. (1991), Hiba (1998) and Bridger (2003) noted that when chairs and work tables cannot be adjusted to fit the worker, they are forced to use movements or positions that may make them uncomfortable or cause aches and pains. For good posture most jobs should be at elbow height, whether the worker is standing or sitting. Elbow height shows how high a work station is (HESIS 2012). A manual by

SMEDA-JICA (2012) stressed that for seated and standing work, the height of the workstation should allow workers to function with elbows at 90 degrees. If the workstation is too low, the worker is forced to bend at the waist to reach the work being done. This puts stress on the lower back. If the station is too high, the worker is forced to lift their shoulders or move their elbows away from the body to reach their work. This puts increased stress on the shoulders which may lead to injury. The workstation and chair should be positioned so that the worker's knees, hips, and elbows are at 90 degrees, which will reduce stress on the body. There should also be enough room to allow the worker to change their sitting position throughout the day.

## **DIMENSIONS OF ERGONOMICALLY DESIGNED SEATS FOR SEATED WORK: HEIGHT, DEPTH, AND WIDTH**

### **Seat Height**

Osborne (1982), McCormick and Sanders (1982) and Bex (1971) stated that to avoid discomfort, the height of a seat should allow the placement of feet on the floor and should be such as to avoid excessive pressure on the thigh. The front edge of a seat should therefore be a bit lower than the distance from the floor to the thigh when seated. This is termed popliteal height. In this regard, McCormick and Sanders (1982) reported Tichaner (1978) to have recommended that the front edge should be at

**Figure 2a.** Position that may cause pain. **Figure 2b.** Position that may be comfortable.



Source; HESIS (2012).

least 5cm (2 inches) below the popliteal crease (the crease at the back of the hollow of the knee). McCormick and Sanders (1982) suggested the provision of adjustable seat height of between 38cm to 48cm to accommodate persons of various heights. Grandjean *et al.* (1973) also suggested the provision of an adjustable seat and gave a work chair height of 43 to 50cm. Hiba (1998) suggested an adjustable seat height of between 34cm and 45cm. A more recent study by Parimalam *et al.* noted that a high stool (mean height 59.5 cm) forced garment workers to bend their trunk and head toward the table to have a clear view of their sewing, resulting in complaints of pain in the lower back, mid back, shoulders and the neck.

### Seat Depth and Width

With regard to seat depth and width, McCormick and Sander (1982) stressed that while the depth and width of seats depended on the purpose of the seat (whether multipurpose, typing or lounge chair, among others) the depth set should be suitable for small persons and the width suitable for large persons. Osborne (1982) added that seat width needs to accommodate the largest person using the hip width dimension and the depth of the seat should ensure that the sitters find support in the lumbar area from the backrest. He suggested a seat width of 35 to 40cm for a work chair. While Agan and Luchsinger (1965) mentioned a width of 42 to 44cm and a depth of 33 to 37cm, Grandjean *et al.* (1973) however, recommended that a multipurpose chair's depth should not exceed 43 cm and a width of not less than 40 cm. Kroemer (2009) suggested a seat depth of between 38-42cm and a width of at least 45cm. Provided the seat height is adequate and the feet are able to be placed on the floor, compression fatigue in the thighs is unlikely to

be induced. McCormick and Sanders (1982), Osborne (1982), Yu and Keyserling (1989) and Ortiz *et al.* (1991) indicated that seat depths that were not able to provide clearance for the calf of the leg and did not minimize the thigh pressure.

### CURRENT EVIDENCE ON ATTRIBUTES OF GARMENT PRODUCERS' WORK SEATS IN GHANA

A study by Vandyck and Fianu (2012) showed that the measurement of the seats they studied did not meet the recommendations in the literature as espoused by McCormick and Sanders, (1982), Osborne (1982), Kanawaty, (1992), Hiba (1998) and Kroemer (2009). Table I shows the percentage distribution of the seat dimensions of workplace chairs surveyed.

#### Seat Height

Only 37 seats fell within the suggested 38–50cm range for heights suitable for work (Table 1). Fifty seven seats were higher than the recommended height; 6 had seats lower than the recommended height and none of the seat could be adjusted for height. From observation, 48 seats were so high that they would not allow adequate knee room under machinists' tables for seated work or let them place their feet on the floor (Vandyck and Fianu, 2012).

#### Seat Depth

Thirty-seven seat depths were within the recommended range of 30–40cm for work (Table 1). Fifty-two and 11 seats respectively had less than, and more than, the recommended depth range (Vandyck and Fianu, 2012).

**Table 1.** Percentage distribution of seat dimensions used.

Seat Height (cm)	%	Seat Width (cm)	%	Seat Depth (cm)	%
< 38	6	< 40	13	<33	52
38 - 50*	37	40 - 45*	51	33 - 40*	37
> 50	57	> 45	36	>40	11
<b>Totals</b>	<b>100</b>		<b>100</b>		<b>100</b>

\*Recommended measurements **Source:** Vandyck and Fianu (2012: pg 488).

### Seat Width

As shown in Table 1, 51 seats had widths that ranged between 40- 45cm and therefore fell within the recommended range. Thirty-six seats had widths that were larger than the upper limit of 45cm. While more than 80 seats were broad enough for sitting comfortably, thirteen seats had smaller widths which could cause discomfort in the thigh region of users because they were narrow (Vandyck and Fianu, 2012).

### DISCUSSIONS

A seat might be “inefficient” to the degree to which it interferes with the primary activity for which the seat was required. The assessment of “comfort” needs, sometimes, to give way to a consideration of operators’ “efficiency” since it is unlikely that one can exit without the other. Bad seats results in awkward or bad postures. However, from 100 seats, used by dressmaker and tailors, sampled in Madina, Accra the seats were, found to be of different heights, widths and depths. No standard measurements existed in the local manufacturing environment and carpenters used their own discretion. Seats generally had no backrest, not adjustable or padded. Most seats were therefore actually unsuitable (Vandyck and Fianu 2012).

Seats that were too high were likely to cause pain in the knee, lower legs and neck while seats that were too low caused pain in the shoulders and neck. High seats that did not allow adequate knee room under their tables for seated work would cause a feeling of crowdedness and inability to move legs into a comfortable position. Seat heights that do not allow feet to be placed on the floor may cause excessive pressure on thighs where they

press against the chair, and also cause swelling of the feet as they hang in mid-air (Vandyck and Fianu 2012).

Sewing requires many jobs. For example, ironing, pressing, cutting out, stitching at different machines to mention a few. Posture of the trunk is strongly related to the manual aspects of the machining task and the head posture is related to viewing the fabric and the needle. Machining forces the body to be held in one position for long periods. One's position is determined by the ‘fit’ of his/her chair and foot control, your need to see the work, and your need to grasp or hold materials in place. If it is an uncomfortable position, pain and injury can result (HESIS, 2012). When a body is taken out of its normal alignment or a joint is moved towards the limits of its range of motion it creates unusual and uneven stress on the joints and surrounding soft tissues (Kroemer 2009). For example raising elbows away from the body hurts arms and shoulders; bending the back hurts the back, neck, and shoulders; sitting wrongly hurts back, neck, shoulders, and legs; and tilting the head hurts the neck (HESIS, 2012). Long work hours and few breaks mean less time for muscles and joint injuries to heal.

Ergonomic interventions including redesign and the proper adjustment of workstations, use of ergonomically designed seating, and training in low-risk methods and postures substantially reduce pain and injuries (Kelly et al., 1992; Kawakami and Kogi, 2005). While some solutions are simple others may be major. For example, there is the need to invest in equipment like chairs. Use adjustable, well-padded chairs. Immediately use of pillows and pads in chairs to improve the seat so that “it fits the worker”.

There is a need to match resources with appropriate knowledge through education, research and creative problem solving skills for sustained economic growth and improved living standards for machinist.

## CONCLUSION AND RECOMMENDATIONS

The authors review the literature about recommended heights, depth and width of work seats and seating posture and, then apply this knowledge to explore the results found by Vandyck and Fianu's (2012) study. The existence of a good seat for any type of work promotes efficiency of production and improves performance and well-being of the worker. Seats were non-adjustable, generally had no backrest and seat pads. The height and depth of seats did not meet standards recommended in the literature. Seminars or workshops should be organized by trade organizations for its members to discuss possible ergonomic changes in chair designs. Local carpenters could be identified and advised of suitable measurements for when they produce seats. There is little research currently available on the general health and work practices of dressmakers and tailors and future research be carried out to gather relevant data which will help improve the quality of life of dressmakers/tailors by reducing stressors in the work environment.

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