Review of Literature
CHAPTER 2
REVIEW OF LITERATURE

The literature pertaining to the study on “Physical Stress, Productivity and Perceived Exertion of Women in Charkha Spinning” is presented in this chapter. The first section presents the literature on the evolution of charkhas and employment generation. The subsequent section covers the work measurement techniques applicable to the present study and the last section deals with the occupational health problems of women.

2.1 Evolution of Charkha Spinning

Spinning, according to the McGraw Hill Encyclopedia of Science and Technology (1982), is the making of yarn either from fibre or from a spinning solution. In the drawing out of the yarn, twisting and winding of either natural or synthetic fibres into a continuous thread or yarn, several operations, collectively called spinning, are performed. During spinning, the fibre is twisted to the required number of turns per inch, forming a yarn.

Early spinning was carried out by twisting the fibres by hand. It must have been an extremely slow process until the invention of the spindle, around 1000 BC. Rough wool or cotton was wrapped on a stick called a distaff and some of the fibres were pulled away and attached to a small spindle which was
twirled in the hand, so that it pulled and twisted the fibres to form a continuous thread. This tool was called ‘Takli’

The production of yarn on Tahir was around one hank per eight hours. Though it was not economical to spin on Takli, it was considered a prestigious work in India during the pre-independence period. It was a past time productive occupation for men, women and children to stand self supported in textile manufacture. Further, the quality of yarn was poor and unacceptable to the weaver, although the cotton used was costly and of a high quality (Meetei, 1991).

Later, a large wheel mounted on a stand, was used to turn the spindle. This was called the spinning wheel and was used for centuries (Encyclopedia of Science, 1980). In India, the spinning wheel was rediscovered by Gandhiji in 1908 as an indispensable tool for winning Swaraj by reviving the entire economic, social and cultural life of the villages. In the year 1920, Bamboo Charkha was introduced as part of the Khadi programme and the wheel found an honoured place in the national flag. Thus it became a symbol and an instrument in the non-violent light, for freedom. Revival of hand spinning and hand weaving was advocated as the only ready means of alleviating India’s wretchedness and misery (Arunachalarn, 1974).
Yeravada Charkha, which Gandhiji devised after experimentation while in Yeravada jail (near Poona) is an improvement over the original charkha. The introduction of the speed wheel considerably increased the spindle efficiency. However, Gandhiji was not satisfied with it. A prize of a lakh of rupees was announced in May 1929 for the invention of a spinning wheel which could be repaired, maintained and handled conveniently by village folk, spin 2000 rounds per hour and yet would not cost more than Rs. 150/-. Several attempts were made, incorporating gratifying improvements in various directions, but none satisfied all the tests (Arunachalam, 1974). The Kissan Charkha was the next model that evolved but even this did not satisfy the commercial requirements.

The most important milestone in the khadi industry was the invention of the four spindle Ambar Charkha in 1955. By spinning on this charkha for eight hours one could earn three rupees and if the family members also spun in turn they could earn still more from a charkha (Taori, 1995). During the post-independence era, the rural artisans were encouraged to go in for these charkhas at highly subsidised prices and liberal loans were provided to enable them to shift to the new charkhas (Maliajan, 2001).

The Khadi and Village Industry Technologies: Machinery and Equipment Division (1994), through continuous research and development, put forth numerous modifications in this charkha in order to suit different types of cotton,
silk, woollen and muslin yams with different counts. Four spindle—two for one twisting machine, six spindle high speed charkha, high speed New Model Charkha (NMC), six spindle charkha for coarse spinning, 12-spindle pedal operated charkha, 10-spindle charkha, eight-spindle charkha, pot charkha, slub spinning charkha, high tech charkha, and, fancy doubler siro spinning ambar charkha were the new models of Ambar Charkhas.

Thus it is evident from the literature reviewed that there has been a steady shift from Takli to Kissan Charkha to Ambar Charkha over the years. The number of spindles in the popular ambar charkha ranged from four to twelve. The productivity claim with increase in the number of spindles in the charkha could not, however, be ascertained from the available literature.

2.2 Employment in Khadi Industry

Khadi now stands out as one of the popular village industries providing employment to the rural poor. As a result of the ever-growing population, the employment situation in the country has deteriorated and the backlog of unemployed has increased. Khadi offers a solution to these problems. Khadi production has become either a part time or whole time occupation in deprived regions like hill areas as well as arid and drought-prone districts. Fine quality khadi of 100 and 120 counts has a growing market and coloured khadi is
becoming popular as it is used to make fashion garments (Zaidi and Fatima, 1999).

Khadi is one of the promising rural industries. There are more than 3,000 institutions all over India which are involved in the Khadi and Village Industry network, providing employment to about, live million people. Out of this, nearly 1.5 million are specifically engaged in the various operations connected with the production of cotton, silk and woollen khadi (Watts, 1993). According to the excerpts from a report (Srivasthava, 2000) there is no risk involved in using the charkha but the repeated motion of winding the charkha causes exertion and pain in the hands and shoulder. Continued sitting on the ground causes hack pain and stitches in the ribs.

2.3 Work Measurement Techniques

Several sophisticated procedures are employed in industries for measuring the physical and physiological cost of a task. They include oxygen consumption, motion study or method study and time study. All these are normally conducted in laboratory situations. In the field situations, simpler techniques or methods are used. These techniques are reviewed in this section for identifying the methods that can be used for the present study.
2.3.1 Measurement of Physical Stress

Until the middle of the twentieth century, work physiologists mainly concentrated on oxygen consumption or energy expenditure to evaluate the occupational workload of workers. This method involves complicated and time-consuming procedures.

Another method widely used for assessing the physiological cost of work is the heart rate measurement. Several researchers (Asmussen and Ilemingsen 1958; Okasujadnja, 1997; Reddy, 1907; Yoopat and Glinsukon, 1997,) have used this technique. It has been reported (Varghese et al., 2000) as a simple, easy to measure and, at the same time, a reliable parameter of the physiological workload. Unlike oxygen consumption or energy expenditure, it takes care of environmental factors such as heat, humidity, ventilation etc. and other variables like abnormal working posture. It has been well established that heart rate and energy expenditure bear a linear relationship which can be made use of for estimating the occupational workload from the heart rate responses.

The physiological cost of physical work results from the activities of the muscles of arms, legs, back and other parts of the body (Shan, 1992). The degree of physical stress depends on the number of muscles involved and on the extent to which they are under static load. As shown in figure I, the rise in heart rate with increasing workload becomes steeper with rise in ambient
temperature, the proportion of static effort to dynamic effort, and, involvement of smaller number of muscles. At the higher level of stress, the heart rate goes on increasing as long as the stress lasts, whereas, at the lower level, it levels off at a 'plateau' or steady state (Grandjean, 1985).

Figure-1 Increase in heart rate associated with various types of stress

"During physical activity there is an increase in blood circulation, which increases the rate of transportation of oxygen, carbon dioxide and the

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metabolites formed during muscular contraction. The increase in rate of blood flow is met through a combination of two factors: an increase in pulse rate and an increase in the blood volume output from the heart per beat (stroke volume)” (Steidl and Bratton, 1968).

An estimate of blood flow during work can be made by measuring the heart rate (Rodgers, 1986). According to Nag (1996), the heart rate variability is often a useful measure in setting RA (rest allowance) in both physical and non-physical work.

The heart rate reflects an individual's capacity for the work being done. A person’s maximum heart rate is defined as the point when increasing workload no longer increases the heart rate. This value declines with age, falling roughly one beat per year (Rodgers, 1986).

The heart rate of the subject while performing a task is referred to as working pulse. Resting pulse rate is the average pulse rate before work. The resting pulse rate is a simple and accurate gauge of cardiovascular fitness. As the fitness level of a person increases, the resting pulse rate will become slower, stronger and more regular. If the resting pulse is found to be over 100 beats a minute, a doctor is to be consulted. Binney (1 987) suggests that the pulse can be taken at the wrist i.e., at the base of the thumb (radial pulse) or by feeling the artery in the neck located below the ear and toward the jawbone (carotid pulse).
Work pulse is the difference between the resting pulse rate and the working pulse rate (Dalela, 1983). A one-minute heart rate of 150 beats per minutes for instance, may be less satisfactory than a five-minute heart rate of 130 beats per minute. Further, a one-minute heart rate of 180 beats per minute for a person over 40 years of age would be undesirable because it could represent the maximum level of work for the heart (Rodgers, 1986). The heart rate of a person doing a job can be measured continuously or discontinuously. The former involves investment in telemetry or tape-recording equipment, but the latter can be done by a trained observer taking the worker’s pulse rate at the wrist using only a watch that registers seconds.

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<td>96+</td>
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<td>99+</td>
<td>103+</td>
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During exercise the heart rate increases linearly with the amount of oxygen consumed. On cessation of the exercise the pulse rate returns to normal in one to four minutes for a person who is well. However, the more severe the exercise and the less physically ill the individual, the greater the length of time that is taken for the pulse rate to return to normal (Steidl and Bratton, 1968). The pulse rate taken during recovery from a work period results in a loss of important information about peals, loads, duration of elevated heart rate, and pattern of recovery from heavier efforts. Monitoring an activity by heart rate is desirable because of its suitability to field situation and limited cost (McArdle et al., 1991).

S2.3.1.1 Studies imsed on Steail rate

Okasujadnja (1997), in her study titled “Work Posture of Female Load carriers in Denpasar Market,” adopted heart rate measurement. Measurement and registration were clone tor the working altitude while the workers were lifting, delivering and bringing down the load. Heart rates were measured during the work, the break, and the recover\(\) phase using ten-pulse method. The physical characteristics of the subjects, such as age, body weight and height were recorded. Working hours, humidity, wet and dry temperatures, room lighting slope of the stairs and also the height and width of the stairs were measured and analysed to study the stress involved in the work.
Reddy (1997) used heart rate measurement to study the physical cost of the tasks most fatiguing to women in sericulture. The physical cost of work was assessed from the pulse rate of the subjects at rest, while working and during recovery. The time taken by the subjects for coming back to 110 percent of the normal resting pulse after the exertion level was recorded by feeling the carotid pulse. Resting and working pulse were taken for 30 and 10 beats respectively. After the cessation of work, the recovery pulse rate was recorded every minute till the pulse rate came down to 110 percent of the resting pulse. The incremental cardiac cost was estimated for different tasks to make a valid assessment of the physiological cost of the tasks performed as the tasks were of short duration with heavy load lifting.

Yoopat and Glinsukon (1997) used the cardiovascular load as the basic criterion for the assessment of physical workload (static and dynamic). A standardized test on ergobike in an air-conditioned environment was carried out by them during which oxygen uptake and heart rate were measured at the established protocol (pedalling at 50 rounds/minute).

Asmussen and Hemmingsen (1958) made an attempt to correlate physiological strain with subjective estimate of fatigue and found a good positive correlation. This finding led them to believe that the psychological
method for determining fatigue criteria, while simultaneously measuring heart rate, could be used to determine occupational workload.

Thus the physical stress of an individual can be assessed by using heart rate measurement with or without recovery pulse rate, depending upon the nature of the work. Many researchers have studied the relationship between heart rate and perceived exertion in standard laboratory protocols (Chow and Wilmore, 1984; Brick and Brick, 1987; Ljungren and Hassmen, 1991; Dunbar 1992; O’Neill et al., 1992; Robertson et al., 1992; Yamaji et al., 1992). Yet little information exists on the validity of this relationship for predicting the intensity of occupational or leisure tasks.

2.3.2 Postural Stress

23.2.1 Posture

Posture is the position of a person’s body and the way he/she sits or stands. Kumar (1999) defines posture as “the configuration of the body’s head, trunk and limbs in space.” Poor posture during work results in permanent changes in spine, position of joints, ligaments and muscles.

The bad working posture adopted by people during different occupational activities exerts many adverse effects on their health. One of the common and frequently occurring illnesses resulting from sustained abnormal posture over a period of time is musculoskeletal problems, such as low back pain, pain in the
neck-shoulder-arm region, pain in joints, bones and muscles. If the problems are not taken care of, they may result in irreparable damage to muscle tissues, eventually leading to incapacitation and lowered efficiency and productivity (Varghese et al., 2000).

Other occupational risk factors include frequency or repetitiveness of movement, task duration and so on (Kilbom, 1994; Winkel and Mathiassen, 1994). Poor posture results in fatigue. It is, therefore, important that the worker should be able to maintain an erect and comfortable body position while working (Moorthy, 1990).

Poor working postures constitute one of the main risk factors for musculoskeletal disorders, ranging from minor back problems to severe handicapping (Aaras et al., 1988). The effects of poor working postures will continue unless proactive steps are taken to evaluate and reduce the problem. More suitable working postures may have a positive effect on workers’ musculoskeletal systems, and may allow for more effective control of work performance and reduction in the number of occupational accidents. With defective posture even normal persons without primary anatomical or physiological defects also develop degenerative tissue changes and functional defects of the musculoskeletal system (Chaffin, 1974; Magora, 1970; Van Wely,
1970) due to the stress induced by long enforced postures, maldistribution of tissue pressure and prolonged static loading on the muscles.

A sitting posture causes the abdominal muscles to slacken, incites pain in the spine and impairs the functions of some internal organs, especially those of digestion and respiration. The person who allows his/her shoulders to drop while sitting will be crowding the organs within his chest, particularly his lungs (Shryock and Mervyn, 1985). When portions of the lungs are not allowed freedom of movement, the blood in these parts tends to stagnate. This results in improper gas exchange between air and blood. Fixed posture of seated work affects circulation in the legs, causing oedema (Winkel, 1986).

Static Workload and Posture

Long continued and excessive static workload leads to deterioration of joints, ligaments and tendons. During static muscle work, tissue pressure increases in the muscle and the blood supply begins to fall at a contraction level of 15-20 percent of total muscle force (Aaras, 1996). The troubles that may be expected to follow from certain forms of static load are presented in Table 2.02.
Table 2.02

Static Load and Bodily Pains

<table>
<thead>
<tr>
<th>Work Posture</th>
<th>Sites of pain/consequences</th>
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<tr>
<td>Standing in one place</td>
<td>Feet and legs, possibly varicose veins</td>
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<tr>
<td>Sitting erect without back support</td>
<td>Extensor muscles of the back</td>
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<tr>
<td>Seat too high</td>
<td>Knee, calf of leg, foot</td>
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<tr>
<td>Seat too low</td>
<td>Shoulders and neck</td>
</tr>
<tr>
<td>Trunk curved forward, when sitting or standing</td>
<td>Lumbar region, deterioration of inter vertebral discs</td>
</tr>
<tr>
<td>Arm outstretched, sideways, forwards or upwards</td>
<td>Shoulders and upper arm; possibly periarthritis of shoulders</td>
</tr>
<tr>
<td>Head excessively inclined backwards or forwards</td>
<td>Neck; deterioration of inter vertebral discs</td>
</tr>
<tr>
<td>Unnatural, grasp of hand grip or tools</td>
<td>Forearm; possibly inflammation of tendons</td>
</tr>
</tbody>
</table>

Increased static loads while working lead to increase in inflammation of the joints, inflammation of the attachment points of tendons and symptoms of chronic degeneration of the joints, in the form of arthritis, and disc trouble. The pains do not disappear when the work stops, but continue even afterwards (Bharadwaj, 1994).

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Postural Studies and Their Major Findings

Studies by Nachemson and Elfstrom (1970) and Andersson and Ortengren (1974) on measuring the pressure inside an intervertebral disc during a variety of bodily postures and sitting positions found that body posture had a profound effect on disc pressure. Increased internal pressure on disc means that it is being overloaded and will wear out more quickly. Nachemson (1974) found that the pressure on the disc amounted to about 1.5 times the vertical force exerted upon it by the overlying vertebrae.

Adams and Hutton (1983) showed that a fully flexed spine is much weaker than a spine in an upright posture. Recent studies have shown that a flexed spine may be as much as 40% weaker than what it is during an upright posture.

It has been found that, when a person moves from a standing posture (180° trunk-thigh angle) to a normal sitting posture (90° trunk - thigh angle), the pelvis rotates backwards 28 degrees to 40 degrees. The rotation of the pelvis, leading to the flattening of the lumbar spine, has been found to be approximately 25 degrees to 38-degrees (Mandal, 1985).

Effect of Posture on Physiological Cost of Work

A good working posture reduces the physiological cost of work and the fatigue to the minimum, whereas static muscular effort and incorrect posture, if
sustained for long periods of time, can give rise to various types of musculoskeletal problems. Varghese et al. (2000), in a study on Kitchen activities, found out that the sitting work posture usually adopted by women in rural areas is, physiologically speaking, more economical in energy cost and less tiring. So a combination of sitting and standing postures has been suggested for some of the activities like chopping, kneading dough, grinding (manual), rolling chappaties, cleaning rice and dhal etc. Studies on certain household activities like food preparation, washing clothes and ironing reveal that the physiological cost of the activities changes as the posture changes.

According to Chaturvedi and Varghese (1994), repetitive operations like packaging cause physiological problems like fatigue (91.3 percent), back pain (86.95 percent), and shoulder pain (30.43 percent). The study observed a high percentage of musculoskeletal problems among the subjects irrespective of age and sex.

Repetitive trauma has been increasingly recognized as the cause of a variety of musculoskeletal and neurologic disorders in women (Ryan and Bampton, 1988). In industry, tasks like assembly work, heavy weight carrying and lifting work etc. are particularly associated with musculoskeletal problems. Furthermore, workers doing repetitive work are often paid by a piece-rate
system that often results in a fast work pace which increases the risk of developing adverse symptoms.

Many researchers have linked musculoskeletal discomfort with exposure time to work involving repetitive movements and the differences in workload on individual body segments (Jonsson and Ydreborg, 1985; Hayashi et al., 1984; Maeda et al., 1980). The main symptom of MSD (Musculo Skeletal Disorder) is pain and a correlation between posture and signs or symptoms of such disorders have often been demonstrated (Westgaard and Aaras, 1985; Rjetle et al., 1981).

Studies reveal that there is a high incidence of MSD among women involved in repetitive tasks (Samioleva, 1971). Many musculoskeletal problems (e.g. cumulative trauma disorders) are thus caused, precipitated or aggravated by a number of occupational activities including repetitive motions, forceful exertions and awkward postures. Work-related musculoskeletal disorders have been found to be associated with numerous occupational "risk factors", including physical workload factors such as force, posture, movement and vibration (Gerr et al., 1991; Burdorf, 1992; Kilbom, 1994), psychosocial stressors (Bongers et al., 1993; Bernard et al., 1994; Eklund, 1996) and individual factors (Armstrong et al., 1993). The level of exposure to physical
workload can be normally assessed with respect to intensity (or magnitude), repetitiveness and duration.

*Low Back Pain*

Low back pain is another common problem observed among the working population (Rowe, 1971). The symptoms and impairment are generally slow at the onset. In most cases, low back pain is recurrent but self-limiting (Brown, 1973).

Low back pain can be classified as primary and secondary (Wyke, 1976). Primary back pain arises directly from the tissues of the back which experience neurological, mechanical or biochemical irritation because of fatigue, postural stress, injury or local pathological change such as degeneration of joints. Secondary back pain is caused by a lesion which affects the nerve supply to the tissues of the back.

All these structures the lumbar discs, the posterior ligaments and the (lumbar) spinal nerves teem with pain sensitive nerve endings which are distorted when overstretched or traumatized. These may all be the sources of low back pain (Desai, 1993). Plante et al (1997) report, that up to 80 percent of adults eventually experience back pain at some time during their life and four to five percent of the population have an acute low back pain episode every year.
LBD (Low Back Disorder) typically begins at a relatively young age with the highest frequency of symptoms occurring between 35 and 55, while lost workdays typically increase with increasing age (Andersson, 1997). Gender also appears to be an interactive factor in determining who experiences LBD. The risk for men peaks at 40 years of age, whereas the greatest prevalence and incidence for women occurs between 50 and 60. The flattening of the lumbar curvature produces stress on the lumbar discs, posterior ligaments and spinal nerves. However, with the advancement of age, the intervertebral disc loses its elasticity and becomes harder and harder (Mandal, 1985). Low back disorder is associated with high costs to industry and the individual, and can negatively influence the quality of life for the workers.

One of the characteristic peculiarities of the spinal column is the existence of the so-called four physiological curvatures situated in the sagittal plane: (i) cervical lordosis, formed by all the cervical and upper thoracic vertebrae; with maximum convexity occurring at the level of the fifth and the sixth cervical vertebrae; (ii) thoracic kyphosis; with maximum concavity occurring at the level of the sixth and the seventh thoracic vertebrae; (iii) lumbar lordosis, formed by the last thoracic and all the lumbar vertebrae; with maximum convexity occurring at the level of the body of the fourth lumbar vertebra; and, (iv) sacrocccygeal kyphosis (Yumashev and Fairman, 1976).
Most studies have indicated that isometric strength, by itself, is not related to risk of LBD. However, when matched to the job requirements, strength is an indicator of risk (Chaffin and Park, 1973). In addition, endurance strength appears to be related to symptoms of LBD. One study explored patient handling skill and found an association with risk (Videman et al., 1989).

Magnusson (1997), in his study, found out that the stress of a posture was minimum at the neutral position of the joint and it increased with departure from neutrality. His study proved that uncomfortable posture led to low back pain in many cases.

*Disc Trouble*

For reasons that are still unknown, intervertebral discs may degenerate and lose their strength: they become flattened, and, in advanced cases, the viscous fluid may even the squeezed out (Adams and Hutton, 1983). This impairs the working of the vertebral column, and allows tissues and nerves to be strained and pinched, leading to various diseases of the pelvis, lumbago, and even to paralysis of the legs (Grandjean, 1985).

According to Kramer (1973), disc troubles are the cause of 20 percent of absenteeism and 50 percent of premature retirement among the workforce. Disc trouble and the associated infirmities of the back and legs are essentially a human problem, and one that concerns industrial man. Back troubles are painful
and reduce the workers’ mobility and vitality. An intervertebral disc is a sort of cushion which separates two vertebrae and the discs collectively give flexibility to the spine. An intervertebral disc consists of a viscous fluid enclosed in a tough, fibrous ring, which encircles the disc.

The chronic loading, either due to increased compressive force or asymmetrical force on the lumbar discs, may gradually distort, traumatize and prolapse the lamellae of the posterior annulus fibrosus (Adams and Hutton, 1982). Finally, this increases tension on the lumbar spinal nerve due to substantial increase of tension in the spinal canal. The tension may lead to tensile ischemia and hamper nutrition supply to the nerves, resulting in neurological dysfunction (Parke and Watanabe, 1985).

Disc Trouble and Posture

There is an obvious relation between human body posture and the risk of damage to the intervertebral discs. Any great increase in intradiscal pressure must be considered an unnecessary load and strain on the spinal discs, with possible consequences of developing pathological and degenerative changes such as loss of mechanical resistance and flattening of the disc (Nag, 1996). Table 2.03 shows the percentage of disc pressure at various postures.
While sitting, the following changes occur: (i) the thigh is used as a lever; (ii) the upper edge of the pelvis is rotated backwards; (iii) the sacrum turns upright; and, (iv) the vertebral column changes over from a lordosis to either a straight or a kyphotic shape. The backward rotation of the pelvis puts the spine into a state of kyphosis at this point, which, in turn, increases the pressure within the discs.

23.2.2 Methods used for Assessment of Postural Stress

The standard methods for obtaining information on work related musculoskeletal disorders at the ‘meso’ level (i.e., active occupational health surveillance) are questionnaire, worker interview, observation and physical examination (Sluiter et al., 2001; Fredrikson et al., 2001). Rating of body

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discomfort using body discomfort scale with body map is another commonly adopted method widely used even in advanced studies to measure postural stress.

Corlett and Bishop (1976) developed a Body Discomfort Mapping Method for identifying the sites and intensities of pain (body discomfort), using a five point scale, a body map and associated procedures. In use, the words describing the parts represented by each division of the figure are omitted. The divisions are made according to the situation under study. The numbers are for convenient reference by the person being questioned, and a range of maps with the areas differently numbered protects against the possibility of the memory of the number biasing subsequent trials. In use, the body map is employed together with a five or seven point scale with the extremes ‘anchored’ by the terms ‘no discomfort’ and ‘extreme discomfort’. When the general rating has been obtained, the worker is shown the body map and is asked to indicate the part or parts of the body which are at the moment most uncomfortable. After this, the worker is asked to point out which parts are the next most uncomfortable and so on until no more parts are reported. The method is usually adopted for short duration work.

Each level of discomfort is weighed according to its intensity level, counting from the no discomfort level as zero. The lowest reported discomfort
level is scored one, the next two and so on up to the highest. As discomfort increases, so does the weighted value. The weights for each body part group are added together and divided by the number of parts in the group, if necessary and then plotted. The body discomfort scale gives an overall assessment of the working discomfort and the body map helps in identifying the parts experiencing noticeable discomfort (Corlett, 1981).

Corlett’s method (Body Discomfort Mapping Method) is still the method of choice in evaluating postural stress from the subjective point of view, especially in developing countries, where testing needs to be kept simple and cost effective. Recent users of this method include Lorti et al. (1995), Lee and Chung (1999), Mrunalini (2001) and Sita (2002). Boehm et al. (1992) used a seven point scale to clarify variables influencing behaviour in a pilot study of seat belt users. Kubo et al. (2001) also used a seven point scale to measure the intensity of physical, mental and nervous symptoms. Sita (2002) used a seven point scale for assessing the postural discomfort of women working in the cashew industry.

Body posture can be measured manually with hand held devices like the goniometer or inclinometer (Loeb, 1967) and the jlexi curve (Burton, 1986) or with electric equipment. In the case of the inclinometer, when the device is attached to the body segment, the angular measure of the body section is
directly indicated by the device. With the flexicurve, the angular measure of the body section is measured by tracing the body line on a paper. The apparent advantages of these techniques are that they are inexpensive and easy to use, and the body posture, its regional flexibility and curved shape can be described in detail. Researchers like Pathak (1995) and Sita (2002) used flexicurve for assessing the postural stress.

Pathak (1995), in her study on assembly workers, used a flexicurve to identify the type of posture adopted by the workers while at work. In this study the subjects were first made to sit erect and the shape of their backbone was traced with the help of a flexicurve. They were then allowed to work and then the different postures adopted by them at work were traced with the flexicurve. After the shapes were transferred to paper, the different angles were drawn and measured at the neck, the upper lumbar and the lower lumbar regions.

2.3.2.3 Other methods of studying Postural Stress

In an ergonomic survey (Chavalitsakulchaisakulchai and Shahnavaz, 1993) conducted in Thailand, postural study was carried out using interviews based on Standardized Nordiac Questionnaires. The musculoskeletal disorders of 1,000 female workers in five different industries, viz. garment, fertilizer, pharmaceutical, textile and cigarette, were evaluated using a checklist used in an ILO (International Labour Organisation) study for examining ergonomic
problems. Nag et al. (1986) used the EMG (Electro Myo Graphic) analysis for studying the sitting working postures adopted by working women in developing countries. They compared seven sitting working postures with relaxed standing position.

Biomechanical modelling is a widely used tool for quantifying the spinal loading associated with activities like lifting, carrying, pushing and pulling. Numerous biomechanical models have been developed to estimate mechanical load parameters on the basis of various input parameters, e.g. kinematic data, external forces, anthropometric measurements, anatomical data on muscles, ligaments and vertebrae, myoelectrical activity and intra-abdominal pressure (Chaffin, 1988).

2.3.2.4 Studies on Postural Stress

About 50 percent of the female workers in the five industries surveyed by Chavlitsakulchai and Shahnavaz (1993), namely garment, fertilizer, pharmaceutical, textile and cigarette industries, experienced a high rate of musculoskeletal discomfts in their lower backs. The garment workers had musculoskeletal pains in their shoulders, lower back and hips/thighs while the textile workers had pain in their upper back, lower back, hips/thighs, and knees.

To a large extent, postural configurations are determined by the position of the vertebral column, where there is a fine interplay of the muscles of the
vertebrae (Steindler, 1955). The anterior muscles run obliquely and contract to axially rotate and flex the spine. The posterior muscles in the back contract to extend the spine, while the lateral muscles run obliquely and contract to axially rotate and bend the spine laterally. By the motions of the spine, the tensile forces are applied to the annulus fibrosus of the vertebral discs. Accordingly, the lowest disc pressure and the least cumulative muscular load have been taken as indications of a most desirable postural position (Davies and Troup, 1964).

Nachemson (1974) found that the pressure on the disc amounted to about 1.5 times the vertical force exerted upon it by the overlying vertebrae. Women who roll beedis or weave carpets or are involved in other strenuous work and are working in the same posture for hours suffer from lower and upper back pain, spondelyitis. Their spinal columns are bent from constant stooping (Bhardwaj, 2001).

In most of the factory sewing rooms, the machine operators sit on a hard stool with little adjustability and no lumbar support. This causes the torso to be bent slightly forward, which reduces the lordosis of the spine and creates pressure on the discs and the muscles of the spine.

Lack of height adjustment forces the operator to sit too low in relation to the work, which concentrates pressure on the buttocks. The use of these kinds of stools could lead to MSDs like low back pain (Devadas, 2001).
A study by Swaminathan (1997) shows a high rate of child mortality due to excessive strain, backache and pain, ocular deficiency, as well as spondylitis as common with workers engaged in the handloom sector, especially in chikan work, embroidery, lace making and zari work, due to bent posture while sitting and tuberculosis as a result of dingy congested living and working conditions. Respiratory problems are also noticed in 50 percent of the women in this occupation. The annual report of the National Institute of Occupational Health (1989-90) reveals that the health hazards of women in sewing work are backache (66 percent), pain in lower limbs (65 percent), head ache (54 percent) and lacrimation (40 percent).

A study of women in the agarbathi industry (Kakoty, 1996) shows that all the women, irrespective of the category they belonged to, reported hand and shoulder pain arising out of rolling of the bathi. Leg pain was reported by one-fifth of the workers due to prolonged squatting on the floor and forty five percent of the workers complained of backache.

2.3.3 Perceived Exertion

Ryan and Smith (1954) stressed the importance of studying effort as a measure of the cost of work. Effort is “a characteristic of the working activity itself. It is also more fundamental in the sense that fatigue itself derives from effort, being the cumulative effect of the prolonged expenditure of effort.” They
said, “Effort refers primarily to the experience of the individual, a feeling of working hard or easily”.

2.3.3.1 Rating of Perceived Exertions

Borg (1973) proposed a rating scale, known as the RPE scale, based on perceived exertion of the individual correlated with physiological responses like energy expenditure and heart rate, which has now been accepted as a simple method for determining the occupational workload. At the initial stage, he proposed a 15-point scale which has since been modified to a 10-point scale. His original 15-point scale is an ordinal scale with equidistant intervals determined by verbal expressions that are designed to increase linearly with exercise intensity and heart rate.

Considering the inability of the general population to discriminately respond to the finer details of Borg’s long scale (1982) and the difficulty experienced in a study of home and farm activities (Rao, 1987), a modified five-point rating scale of perceived exertion has been constructed by Varghese et al., (1994). The scale is given below:

<table>
<thead>
<tr>
<th>Scale</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very light</td>
<td>1</td>
</tr>
<tr>
<td>Light</td>
<td>2</td>
</tr>
<tr>
<td>Moderately heavy</td>
<td>3</td>
</tr>
<tr>
<td>Heavy</td>
<td>4</td>
</tr>
<tr>
<td>Very heavy</td>
<td>5</td>
</tr>
</tbody>
</table>
2.33.2 Studies on Perceived Exertion

The RPE scale has been applied in various settings, including clinical exercise tests, cardiac rehabilitation, adult fitness programmes, and ergonomics work studies (Noble, 1982). The RPE scale requires minimal instrumentation. It is easily learned, does not interrupt activity and can be generalized over a range of activities (Robertson et al., 1990; Dunbar, 1992). With increasing workloads, perception of effort has demonstrated a linear relationship with many physiological variables related to exercise intensity, including heart rate, oxygen uptake, ventilation and lactate accumulation (Helzler et al., 1991; Watt and Grove, 1993). Some have suggested that the RPE scale can predict energy consumption as well as or better than heart rate (Ljungren and Johansson, 1988), while others have warned that the RPE scale is only reliable for well-defined activity conditions (Sniutok et al., 1980).

2.3.4 Productivity

The ILO defines productivity as “the ratio between the volume of output as measured by production indices and the corresponding volume of labour input as measured by employment indices.” This definition is widely accepted because of two reasons. First, the labour time is more readily measurable than other input factors and it is a universal element common to all plants, processes and industries. The second reason responsible for the popularity of this
definition rests in widespread interest in labour saving because such saving can affect costs, prices, profits and even the level of living (Singh and Sadhu, 1988).

Productivity is the relationship between physical output and one or more of the associated physical inputs used in the production process. Broadly conceived, productivity is a systems concept: it can apply to various entities, ranging from an individual or machine to a company, industry, or national economy. Productivity refers to the relative efficiency or effectiveness with which resources are used in the production of goods or the delivery of services. When the same quantity of input yields more or better goods or services in one time period than in another, or when the same quantity of output is produced with less input, we say that productivity is higher, or has increased.

The best known concept............labour productivity -traces the change in quantity of output per unit of work input. So, it can be used to compare output per hour in one period with that of an earlier period characterized by a different scale of output or method of production (Heyel, 1982).

2.3.4.1 Productivity in relation to Cardiac Cost

Productivity is total production divided by cardiac cost. Increased productivity provides the means for an improved quality of life.

Increased productivity means accomplishing more with less, or doing a more effective job with the same skills and resources. If we desire more
personal benefits from productive activities, then we should seek to make the activity more productive.

2.4 Working Environments

The National Perspective Plan for Women (1988) has recommended the provision of a safe workplace and safety equipment (including personal protective equipment) for women for ensuring safety and health at work and work site (Monappa and Saiyadain, 1996). A bad working environment is one that is too noisy, warm and crowded. Constant loud noise may cause heart complaints, stomach upsets, ulcers, nervous troubles and behaviour changes (Selvarani, 1992). Women working indoors have problems of a different kind related to poor environment—lack of light, space and ventilation, causing poor vision, eye strain and headaches (Sudhir, 1992).

2.4.1 Environment and Occupational Strain

A job in which a person must lift cases in a hot environment can be improved either by reducing the lifting requirements or by cooling the environment. If the lifting task is relatively heavy and difficult in any environment, simply reducing the heat level may not be the most effective intervention. Reducing the workload by redesigning the handling task could result in increased productivity and permit the hotter environment to be more
easily tolerated, especially if the heat is only a factor in the summer months (Rodgers, 1986).

The advantages of an unfixed workplace may include opportunity to vary the place of work in order to facilitate improved working conditions (light, temperature, ventilation) to add variety, to facilitate doing tasks concurrently, or to permit an increase in companionship (Steidl and Bratton, 1968). The object of considering the requirements of the task in designing the workplace is to determine the conditions that will expedite the activity. The availability of needed space, items and facilities makes it possible for the worker to do the work without diverting much attention to the situation itself (Steidl and Bratton, 1968).

Other stressful aspects of industrial settings are low salaries, long working hours, dangerous working conditions, difficulties in accomplishment of job, interpersonal problems, insufficient training, improper induction programme, lack of education and training opportunities, low status of job, over-riding authority, restricted autonomy, inadequate supervising support, insufficient resources and legislative regulations (Rao, 1993). In some industries, the method of offering systematic ways of relaxation and rest through techniques like yoga, fitness exercises, etc. is adopted. Though this seems costly, it will prove to be cost effective in the long run. Such orientation
programmes will always focus on the dynamics of stress and effective coping strategies (Rao, 1993). The specific effects of stress, which results from the different facets of the status of women, have not been investigated. Information is wanting on the effects of stress and fatigue on women’s health, and yet both are closely associated with the changing social and economic conditions of women (WHO, 1980).

2.5 Occupational Health Problems

Occupational health is the promotion and maintenance of the highest degree of physical, mental and social well being of workers in all occupations, protecting workers from risks resulting from adverse factors in the working conditions and placing maintenance of workers in an occupational environment adopted to their physiological and psychological equipment (Dave, 1997). While occupational diseases stand at one end of the spectrum of work relatedness where the relationship to specific causative factors at work has been fully established and can be identified, measured and controlled, at the other end, there are diseases which have weak, inconsistent and unclear relationship to working conditions, and, in the middle of the spectrum, there is a possible causal relationship but the strength and magnitude of it may vary (WHO, 1985).
2.5.1 Occupational Health Problems of Workers in Textile Units

Work in textile units, like any other prolonged and monotonous activity, can pose stress and allied problems. Dust, heat and noise are the worst occupational hazards in the textile mills. The high dust level gives rise to respiratory problems and diseases. Another serious health hazard is thermal stress. In textile mills a rather high level of humidity is required and the increase has to be artificially induced at times. Moreover, in an environment of high humidity, the sweat on the human body cannot evaporate and the metabolic heat accumulates. Heavy machines in constant motion also contribute to the existing atmospheric heat. In Maharashtra, mass thermal stress among the textile workers has been reported from many mills (Dogra, 1985).

Byssinosis, a disabling lung disease, is caused by inhaling cotton Hags for several years and is characterised by tightness in the chest and breathlessness. A study of byssinosis conducted by three textile mills and the Central Labour Institute in Mumbai found that byssinosis was noticed in seven percent of those working up to five years and in 18 percent of those with longer service (Dogra, 1985).

In Coimbatore District, in a village called Kuruchi, women spinning on Ambar charkhas were paid 40 paise per hank of yarn and could produce only 20 hanks daily, i.e., they could earn only Rs.8 daily. The workers complained of
headaches from the constant clacking of the charkhas (Report of the National Commission on Self-employed Women and Women in the Informal Sector, 1988).

According to Banerjee (1994), the characteristic features of women’s work in the cotton textile industry are: repetitive and unskilled nature of the work, high degree of casualisation, unpredictability, long hours of work and low pay, and physically taxing and monotonous nature of the work. The nimble fingers of the women are used to perform the repetitive time consuming tasks conscientiously.

In the industrially developing countries, due to lack of strict adherence to work environment standards and legislation, the bulk of the workforce is subjected to various work hazards (both physical and toxic chemical environment) (Nag, 1996). In mass production industries as well as traditional village and cottage industries, women are engaged in repetitive tasks with high postural load due to constraints of work method and working conditions. Evidences suggest that the stress of repetitive work has a cumulative effect on the pathogenesis of diverse health problems, including reproductive health hazards.

Parameswari (1999), in her study of the profile of women in Khadi Spinning Units, Dindigul District, Tamil Nadu, found that the workers
experienced severe pain in the shoulders and hands. The other difficulties faced by the women spinners at the workplace are poor ventilation, excessive heat, wheezing problem, eyestrain, excessive noise from the machine, leg pain and low wages. Notwithstanding the problems, no one is willing to quit the job. In the prevailing conditions of severe unemployment and poverty they are compelled to accept whatever meager payment is given and submit to the inhuman working conditions provided (Lalitha, 2000).

Conclusion

The review presents the background of charkha spinning and the methodological aspects of work study. Further, the literature revealed scarcity of studies on the effort in charkha spinning and the relative advantages of use of different models of charkhas for spinning.