

Women at work: An ergonomics perspective

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■ **ABSTRACT** : A woman is the nucleus around whom the family, the society and the whole community moves. Women now have multiple roles, being responsible not only for food production and processing but also domestic chores, income generation and care of dependants. Presently, they constitute one-third of the agricultural labour force and about 48 per cent of self-employed farmers. Furthermore, management and involvement of Indian women in farming enterprise has been on rise in recent years especially in better endowed rural regions (Praveena *et al.*, 2005). Women have to do jobs that are time and labour intensive. Women spend long hours with much labour in respective operations resulting in fatigue and drudgery. With scant availability of labour-saving technologies and poor working conditions, all these responsibilities significantly limit the time, which women can spend on productive activities. Therefore, the life of women is full of drudgery at every stage. Ergonomics matters particularly to women because they experience a high number of the musculo skeletal disorders (MSDs) and other health problems due to work that are the most severe and the most costly. This review summarizes the work drudgery in various aspects in which women are involved including the household work, farm and allied activities. The major concerns, risks and injuries to which women are exposed and possible strategies for the efficiency and improved health of women while at work.

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India is passing through a major socio-demographic, epidemiological, technological and media transition. The political, economic and social changes have altered the roles that women play. Women now have multiple roles; being responsible not only for food production and processing but also domestic chores, income generation and care of dependants. Due to the dual responsibility at home as well as at work places outside the home, there is a greater pressure for productivity enhancement, quality work and profitability. It is estimated that on an average, the Indian woman, especially in the poverty group spends above five hours per day more than the Indian man in work, including the visible burden of family. Their long periods of often repetitive work can be a source of fatigue and poor occupational health. Further, discrimination, low skills and family care obligations often mean that women's time commands a low return compared with that of men (Lewenhak, 1992).

The plight of poor rural women is rather worse. Every

dawn brings with it a long search of fuel fodder and water. It does not matter if the women are old, young or pregnant, crucial household needs have to be met after weary day. Among its principal causes in rural areas are poor working conditions, poor design of new technology and inadequate safety precautions. Women's physiological characteristics and reproductive requirements make them especially vulnerable to work-related illhealth. The energy spent on work, comprising of housework, livestock, farm work and self-employment increased significantly during the peak season. It is also estimated that on an average, the Indian woman, especially in the poverty group spends above five hours per day more than the Indian man in work, including the visible burden of family. Presently, they constitute one-third of the agricultural labour force and about 48 per cent of self employed farmers. Furthermore, management and involvement of Indian women in farming enterprise has been on rise recent years especially in better endowed rural regions (Praveena *et al.*, 2005).

Srivastava (1985) stated that all women irrespective of land status of family, provide 14 to 18 hours of productive physical labour in different chores. The energy used to carry water in rural areas may consume one third of a woman's daily calorific intake. For pregnant women and mothers of young children, this health impact is more severe, work-related oxygen and calorie consumption can affect the growth of the foetus and the quality of breast milk may be impaired. There is also the risk of miscarriage in the early stages of pregnancy from intra-abdominal pressure and sacroiliac joint strain brought on by carrying heavy loads. Women spend long hours with much labour in respective operations resulting in fatigue and drudgery. Therefore, the life of women is full of drudgery at every stage. The analysis emphasizes that there is a need to develop low cost technologies for the critical field problems of repetitive and forceful tasks such as weeding, harvesting, lifting and carrying heavy loads and so on. There is an urgent need to train women about using women friendly agriculture and household technologies and operating improved tools and equipment.

The household work :

Women work more at home as well as at the work place, to take care of the families particularly men and children (Capoor, 2000). The dual role of women as 'income earner' and 'family caretaker' has recently emerged as an important determinant of women's own nutrition. An important part of a women's status is her material fulfillment that depends on her own income, family income and her control over the income. Additional female earnings may increase total family income but may not necessarily increase women's access to such income and as a result, it may not be a sufficient force for improvement in her own status (Food and Nutrition Bulletin, 2006).

According to an estimate, energy spent on domestic work by a homemaker is in the range of 2,600 to 2,700 kilo calories per day (Grandjean, 1973) which is comparable to the energy spent on moderately hard occupations outside home. A homemaker spends about 11.56 hours in the household activities out of which about 6-7 hours of working time are spent in cooking only (Kaur, 1991). The energy expenditure during cooking activities performed by women ranged from 7.0 to 10 kJ/min, TCCW between 200.81 to 364.30 beats, and PCW 12.82 to 26.26 beats/min (Bhatt *et al.*, 2011). Rural women perform wide range of activities like fetching water for household use which physiological stress is involved during pumping water and while carrying the vessel filled with water back to home (Oberoi and Verma, 2001). During these activities, stress is found beyond the acceptable limits of the women resulting in low work output along with deterioration of her health.

Women often work in awkward postures for long

duration as some of the jobs (like rolling chapatties) consist of repetitive work in single position. They seldom realize the cost of energy and other physiological costs incurred due to wrong posture. Poor posture increases the physiological cost of work and energy expenditure. The static muscular efforts and incorrect posture if sustained for a long period of time can give rise to various types of health and musculoskeletal problems (Saha, 1999). If the body fails to maintain the equilibrium while doing work, it adds to the human energy cost and physiological dynamics such as energy expansion, physiological cost of work, muscular effort etc. It may also lead to major risk like cervical and back disorders because of poor postures and eye strain due to extended concentration. Awkward positions force the muscles to work harder and stress ligaments. Wear and tear of muscles, tissues and ligaments can harm the neck, shoulders, arms, legs, wrists, and back. Grandjean and Burant (1962) indicated that the forward trunk bend give rise to pain in lumbar region as well as in erector spinal muscles. Such postures also cause pain in knees due to disturbed blood circulation.

Women at farm and allied activities :

In India, women constitute about 45 per cent agriculture work force. In addition to their daily household activities, they contribute 50–75 per cent of the total labour required for various production and post-production agricultural operations in the developing countries. She does the most tedious and back-breaking tasks in agriculture, animal husbandry and homes. The nature and extent of women's involvement in agriculture varies greatly from region to region, even within the region. Also their involvement varies widely among different ecological subzones, farming system, castes, classes etc. but regardless of these variations, there is hardly any activity in agricultural production in which women are not actively involved. It causes lot of drudgery to them and thus low-productivity. But the agricultural roles and needs of women are rarely captured in official reports. They also play a significant and crucial role in allied fields too including livestock production, horticulture, postharvest operations etc. Women take up small ventures to generate additional family income. Therefore, the role of women in agriculture and allied occupations need proper recognition.

Women have to do jobs that are time and labour intensive such as sowing, transplanting, weeding, interculture, harvesting, threshing, and post-harvest operations like, shelling, cleaning, grading and processing. In activities like fodder collection, average heart rate of women workers goes up to 111.6 bpm and energy expenditure shows a gradual increase from 5.4 kJ/min to 11.7 KJ/min. For complete cycle of fodder collection TCCW and PCW are found as 7213.8 beats and 40.0 bpm (Gandhi *et al.*, 2001). A study was conducted by Sinwal (2010) on a sample of 30 agricultural

workers (15 male and 15 female) engaged in agricultural tasks for determining physiological workload before and after self-designed technology (Single wheel hand truck and Double wheel hand truck) intervention. It was concluded that Double wheel hand truck and Single wheel hand truck were better option for carrying loads than the traditional method of carrying load and also that DWHT was better than SWHT. In activities like milking of animals, farmwomen adopt standing, sitting and squatting posture. Very severe pain is reported in thumb/finger and forearm by almost all the women, moderate pain in shoulder joints, upper leg/thigh and ankles/feet during such activity. Similarly in activity of weeding when done manually, a combination of bending and squatting postures was required. The angle of lumbo-sacral region is found 3 degree to 4 degree as compared to normal curve (Singh *et al.*, 2001).

Ergonomic injuries and work related health hazards :

The burden of work and work-related health problems has profound effects on productivity and on economic and social well-being of women. There is little recognition of their significant role and contribution to the socio-economic development of a nation. The entrenched social and religious norms that define women's role as secondary and subordinate keep women vulnerable and dependent. Many of the health problems and ergonomic injuries faced by people, and especially by farm women, remain unrecognised and undiagnosed. Even participatory types of appraisal rarely go into the necessary levels of detail, and many people accept occupational health problems as part of life and find it difficult to see them objectively.

An ergonomic injury is one that occurs as a direct or indirect consequence of the nature and demands of the person's working task, rather than as a result of some hazard to which the person is exposed, during the course of his or her work, but which is not intrinsically part of the working task itself (Pheasant, 1986). In other words, ergonomic injuries result from a mismatch between the demands of the working task and the capacity of the working person to meet those demands; generally when the former exceeds the latter and the person is placed in a situation of overload. While at work, women are exposed to many of the ergonomic injuries including (for example) lifting and handling injuries work-related upper limb disorders, musculoskeletal pain and dysfunction resulting from unsatisfactory working posture, etc.

Work-related musculoskeletal disorders :

Work-related musculoskeletal disorders (WMSDs) have become a major problem in many industrialized country including India. These disorders have caused a considerable human suffering and are also economically very costly, because of reduced working capacity and lessened

production. High incidence rate for WMSDs of the upper extremities have been reported for workers in office work, manufacturing and agriculture which include numerous material handling occupation in various factories.

There are numerous types of work-related musculoskeletal disorders that are reported among women. These include disorders of the back and neck, nerve entrapment syndromes, musculoskeletal disorders such as tenosynovitis, tendinitis, peritendinitis, epicondylitis and nonspecific muscle and forearm tenderness (National Institute for Occupational Safety and Health, 1997). The majority of the farm women reported musculoskeletal problems is non-specific and lacks a well-defined clinical diagnosis (National Research Council and Institute of Medicine, 2001). The prevalence of specific disorders and syndromes are not precisely known since many of these disorders have been difficult to classify in epidemiologic studies (NIOSH, 1997). This may be due to inconsistent case definitions and that many musculoskeletal disorders are difficult to ascertain using conventional medical diagnostic tools. Although quantitative laboratory tests such as nerve conduction studies are available for nerve entrapment syndromes, it is difficult to objectively measure the presence or severity of disease and functional deficits in muscular or tendon disorders.

Work-related musculoskeletal disorders are so common among experiences among women farmers and farm workers that many perceive them as no more than normal and inevitable consequences of farm labour. However, even when limited to the poor sources of data currently available on the extent of these injuries in agricultural workplaces, there is reason for new, high priority concern. Jyotsna *et al.* (2005) stated that during wheat harvesting activity from morning till evening, women usually adapts squatting posture and they continue to work in this posture for long duration without adapting any other posture due to which they reported severe pain in lower back and knees. Musculoskeletal injuries and diseases likely affect the production agriculture workforce more frequently during their working years than any other safety and health problem. Disability due to musculoskeletal injuries and diseases incurred during their working years affect the production agriculture workforce more frequently and more severely than any other safety and health problem during the remainder of their working years and, for many, for the balance of their lives.

Manual materials handling :

The women are frequently get involved in manual materials handling tasks while at household, farm or other workplaces. In rural areas, loads weighing over 100 kg might be carried several miles on a daily basis. The women and children have to fetch water and fuel wood from a distance. The modes of load carrying include carrying on the head, on the hips, on the back and on the shoulder (yoke), with

substantial risk of musculoskeletal strains, including spinal injuries). In general, the optimization of loads that may be lifted or carried would help in minimizing the potential risks. Comparing different modes of load carrying, Sen and Nag (1975) suggested that load carrying using transverse yoke was relatively less strenuous than the head pack and frontal yoke. Sandhu *et al.*, (2005) studied physical assessment of Punjabi women for safe manual handling of domestic, agricultural and allied tasks. They found that remarkable differences in physical assessment with age. VO₂ max capacity was minimum in category of 40 years of women. Females in the age category of 20 years expanded minimum time to recover from physical exertion. VO₂ max capacity was maximum in the case of group of 15 years age women. Women of 35-45 years weighing between 52-75 kg, having physiological parameters within permissible limits and average fitness level can lift weight safely 12±2 kg while standing. If she has to work in sitting posture then she can lift upto 3±0.75 kg safely without exposing herself to any health hazard.

Nutritional inadequacy :

Nutritional inadequacy impairs the ability of people to perform biologically (diminishing strength and endurance) and this in turn affects working capacity. Many of the rural poor women are engaged in moderate or heavy physical work so that the negative impact of poor nutrition on performance is particularly acute for them. Sets out the links between improved nutrition, greater productivity and higher earnings. Whether and how far improved nutrition will translate into increased earnings depends on social and institutional, as well as nutritional and economic factors, and will be highly context-specific.

Female workers' physical performance is on average lower than men's because of differences in factors such as muscle strength, cardiovascular function and aerobic work capacity. For these reasons, heavy physical labour such as lifting and carrying, poor working postures, and fast pace of work exposure make women more vulnerable than men to musculo skeletal problems. Because of their higher proportion of fat, women are more likely to be affected by chemicals such as pesticides and fertilisers which are absorbed through the skin, by inhalation and by ingestion. Further, overexertion and fatigue from working long hours can contribute to prolapsed of the uterus and result in spontaneous abortions.

Ergonomics and work comfort :

Use of ergonomic science in disposing of the day to day work load of housewife has been found important these days because there is an increased demand on the available resources of women who perform dual type of work both inside and outside the home. She requires a lot of energy and time to complete work inside and outside the home with satisfaction

and desired standards. According to Rodger and Cavanagh (1962) ergonomics attempts to 'fit' the job to man (FJM) rather than to 'fit' the man to the job (FMJ). To obtain maximum efficiency in work with least cost to the body there should be an ideal relationship between work, worker and work place (Steidl and Bratton, 1968).

Design features of kitchen workstation :

Ergonomically sound kitchen layout saves 43 per cent of cooking time, 84 per cent distance travelled and 65 per cent of postural change, therefore, reduces the women drudgery. We should place frequently used items at the place of first use. Store items within the women's comfortable reach. Store items, which are easy to see, reach, grasp and replace. Give sufficient clearance for grasping and replacing item. Place heavy items on the lower shelves. Store items one row deep and one layer deep. Items of same dimensions are to be stacked.

The physical amenities and designing of house are not always planned as per her needs of health, security and workplace comfort (Sumangala, 1995). So, poor designing of houses especially the kitchen directly affects the health of the inmates and especially the homemaker and other members of the family. Verghese *et al.* (1985) in an ergonomic study on workload on some household activities, have shown that by adjusting the heights of the kitchen platform according to the individual's convenience and comfort, the physiological workload could be reduced considerably, *i.e.* 12 to 21 per cent in selected meal preparation tasks, at the same time saving a total time of cooking by 20 per cent. Researches have proved that any work station design or work environment that helps to perform the work with minimum energy and put minimum stress on cardio vascular system and muscular system is the best design of work (Varghese *et al.*, 1995). So, the kitchen workstation should be adequately designed and properly arranged in order to reduce the physical, physiological and temporal costs of the homemaker.

As stated by Chakrabarti and Sen (1997) the workstation must be ergonomically designed in accordance with human functions, such as: postural control and distribution of the body weight, visibility ranges for display and control areas, optimal positioning of the hands and foot control, and user's behavioral pattern in performing the tasks. The fundamental goal of the ergonomic design is to adopt the work process, tool or equipment and the working environment to fit the needs, size and capabilities of the worker to enable the worker to work comfortably, safely and ultimately increase productivity (Boerding, 1997). The kitchen surfaces should not be too low or too high. When these are too low the worker has to stand in a stooped posture and when the working heights are too high, arms and shoulders must be raised to adjust to the higher surface.

Wrongly designed systems induce improper postures leading to operational uneasiness. Design of systems without due considerations to body's dimensional requirements for intended users cause operational uneasiness, musculo-skeletal and sometimes physiological disorders. Oberoi *et al.* (2004) emphasized that kitchen designs based on the anthropometric and reach measurements of the women were important for effective reduction of the ergonomic cost of kitchen work. They further highlighted that ergonomic cost of work in the ergonomically sound kitchen could be reduced up to 47-50 per cent and with the organized layout of the kitchen the ergonomic cost of work could further be reduced by 7-22 per cent.

ISO 8995 (1989) revealed that a well-lighted place means a better quality of work done in less time, with less strain on the eyes and expending less mental and physical energy. In other words the quality of work done depends upon the amount of light entering in the place. Many working interiors are dim at illuminances that are lower than 200 lx. This was the reason that 200 lx was recommended as the minimum illuminance for workplace where work is to be executed for long periods.

Proper work environment :

Conducive environment is crucial to anyone in performing day to day routine activities especially for the homemaker or the worker involved in different activities. Being the most important room in a house, environment of the kitchen should be highly conducive when performing daily kitchen activities. On the contrary, bad environment can harm our health. The environmental parameters play a big role in the working efficiency of the workers. If in a workplace the environmental parameters go below or beyond the optimum level then naturally it will cause discomfort for the workers (Agarwal and Sharma, 2001).

The best design of work environment is one, which keeps the body of the worker in the natural alignment, by putting minimum stress on cardiovascular, muscular and respiratory system. It can be used to specify the physical dimensions of workplace, equipment and furniture to "Fit the task to the man" (Grandjean, 1980) and to ensure the physical mismatches between the dimensions of equipment, workspace and the corresponding user dimensions are avoided. According to Pheasant (1991), travelling or reaching farther than the maximum work area permitted by limitations of the human body is found to affect one's efficiency and ultimately one's health. All household activities should be performed in the right posture initiated by less bending of the back since it puts less strain on muscle and ligament of backbone and reduces the work cost (Oberoi *et al.*, 1987).

Drudgery reducing technologies :

Agricultural equipment is usually designed to match the

physical requirements and capacities of men. Women, by implication, may have greater difficulty in operating it, and their risk of injury is enhanced. '565 million poor rural women in the developing world are not a burden but rather a tremendous and vitally important force against hunger and poverty. If they have the rights tools, they can plant the seeds for a brighter future' (Rahman, 1993).

From an occupational point of view, the cervical spine, head and shoulders, elbow and wrist joint can be considered to be interrelated as far as the problem of efficiency, design and comfort are considered. Women have, however, lagged behind in use of improved crop production and processing tools and machinery. The physical stress associated with farm work can be minimized or in some tasks entirely prevented with appropriate ergonomic interventions. To empower, women need to be provided with women friendly agricultural tools and equipment, and opportunities for gainful engagement throughout the year to supplement their income with reduced drudgery - agro-processing related activities have proved to be of significance through our interventions. Now, a number of gender neutral and simple devices/equipment for crop production and processing have been developed. The uses of these tool/ implements reduce the work efforts and increase the work efficiency with minimum of body stress. These tools are cost effective, easy to use and maintain and also these are women - friendly. The women worker can easily use these tool/implements and reduce the drudgery in work. Their adoption by women will not only help improving agricultural production but will also elevate the status of women through better jobs and greater role in the economy of the family. An example is using a ratchet with a longer handle, which will increase the amount of leverage and reduce force. Some of the technologies like ergonomic sickles, revolving stools etc. have been developed and tested by the scientists working in the field of ergonomics, the use of these can be helpful to reduce women drudgery and increase work output.

The tools and equipment should be based on various ergonomic considerations. Women have different ergonomical characteristics than a man. There is a need to design women friendly tools and equipment as women can comfortably operate these tools and equipment. It will reduce musculoskeletal disorders and increase the efficiency and thereby productivity of the worker. Women have anatomical and physiological differences that may place them at risk for farm injuries (Engberg 1993). Females are, on average, shorter than men and have more adipose tissue. Females also have narrower shoulders, wider hips and proportionally have shorter legs and arms than their male counterparts (Mackay and Bishop, 1984). On an average upper body strength lower body strength is 5 per cent - 30 per cent less in females (Falkel *et al.*, 1986). The higher prevalence of shoulder-neck disorders among women in industry has been associated with weaker muscle strength in the upper body (Kilbom and Broberg 1988).

However, other literature reports that both strength and endurance were similar for men and women when body composition and size were controlled (Falkel *et al.*, 1985; Hosler and Morrow 1982). Whole body vibration affects women more than men because of anatomic and physiologic characteristics. Circulatory changes in the pelvic organs were found in a study of female tractor drivers; vascular tone decreased and venous stasis occurred at times, depending on the intensity and duration of the vibration (Engberg, 1993).

Conclusion :

The identification of ergonomics injuries, occupational health hazards and further the development of systems to evaluate, intervene, resulting in the minimization of health hazards is quite crucial for safety and efficiency of women at household, farm and during allied activities. Technologies ergonomically designed which are labour saving, drudgery reducing, income generating and productivity increasing should be given wide publicity and their use encouraged through pragmatic extension. Also proper training needs to be imparted to farm women in the operation of identified tools and equipment. All successful efforts on technology generation and dissemination experimented at the micro level should be translated into technology policies and programmes at the macro level by planners, policy makers and government machinery, so that they do not remain sporadic, isolated efforts and later discarded. At a specific level measures can usefully be taken to improve the design of equipment and machinery used by women in household, farming and in related activities. This should be done with regard to improving efficiency and improving health and safety.

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