COMPARATIVE STUDY OF MOPPING FLOOR IN SQUATTING AND STANDING POSTURE OF SELECTED WOMEN

By

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B.Sc. (Hons.) Home Science

DISSERTATION

Submitted to

Vasantrao Naik Marathwada Krishi Vidyapeeth,

Parbhani

In Partial Fulfilment of the Requirement

For the Degree of

Master of Science

In

HOME SCIENCE

(Family Resource Management)

DEPARTMENT OF FAMILY RESOURCE MANAGEMENT

COLLEGE OF HOME SCIENCE

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2015

CANDIDATE'S DECLARATION

I hereby, declare that the dissertation

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any other university or institute

Place: PARBHANI
Date : 30 / 05 / 2015

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CERTIFICATE – I

This is to certify that **Miss. SAVANT DEEPIKA RAMRAO** has satisfactorily prosecuted her course of research for period not less than two semesters and that the dissertation entitled **"Comparative Study of Mopping Floor in Squatting and Standing Posture of Selected Women"** submitted by her is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination.

I also certify that the dissertation or part thereof has not been previously submitted by her for the award of a degree to any other University.

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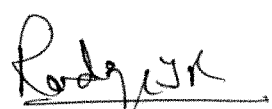

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CERTIFICATE – II

This is to certify that the dissertation entitled " **Comparative Study of Mopping Floor in Squatting and Standing Posture of Selected Women** " submitted by **Miss. SAVANT DEEPIKA RAMRAO** to the Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani in partial fulfillment of the requirement for the degree of **MASTER OF SCIENCE (Home Science)** in the subject of "**Family Resource Management**" has been approved by the students advisory committee after oral examination in collaboration with external examiner.

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Acknowledgement

Emotions cannot be adequately expressed by the words. My acknowledgements are much than what I am expressing. Here I take this opportunity to look back on the path traversed during the course of endeavour and to remember the guiding forces behind the task with a sense of gratitude.

I Respectfully acknowledge my gratitude to ***Prof. Vishala Patnam,*** *Associate Dean and Principal, College of Home Science, V.N.M.K.V., Parbhani for extending necessary facilities for completion of this research work.*

I wish to evince my grateful thanks to Dr. H.L. Sarambekar, Head, of Department of Family Resource Management, College of Home science, V.N.M.K.V., Parbhani.

I express my heart-felt deepest sense of gratitude and indebtedness to my dynamic, dedicated, kind hearted, versatile personality and enthusiastic research guide ***Dr. J. R. Rodge,*** *Assistant professor Dept. of Family Resource Management for her valuable guidance, through approach to research,, sustained interest and constant encouragement till the final shaping of present investigation*

I have immense pleasure in expressing my whole hearted sense of appreciation for members of advisory committee, ***Dr. M.S. Kulkarni, Associate Professor*** *Department of Family Resource Management,* ***Dr. J.V. Ekale, Associate professor*** *Department of Extension Education, who gave me contemplative suggestions during the research work.*

I express my deepest gratitude to my beloved grandparent's shree H.D. Savant and mrs A.H. Savant, uncle shree Rajesh H. Savant for their moral support, constant encouragement cooperation and blessings.

My thanks are due to my friends and seniors for their cooperation during my work.

Last but not least I acknowledge the subjects involved in study without whose help I could not have completed my research work.

I thank one and all who have directly or indirectly helped for completion of this research work.

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Date: 30/05 / 2015

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CHAPTER I

INTRODUCTION

The house is a physical setting for family living. The job of homemaking includes a core of activities essential for our existence. Women of India from time immemorial have been bearing this responsibility in a family. It starts from fetching of water, cleaning of house, washing of clothes, dishwashing and child care to various operations among different household chores. Cleaning of house is an integral part of our family living which is carried out daily and regularly. Proper cleaning and up keeping is important to its appearance, efficiency and livability.

It is believed that where cleanliness is maintained, there purity, health and goodness prevail. Cleanliness of house includes sweeping, washing and mopping of the floor, dusting of surfaces, removal of cobwebs and tidying up objects etc. To whatever region a family may belong it is a common practice to complete cleaning of the house on every festival day.

Peet et al. (1970) expressed that apart from health point of view, a neat and clean house adds beauty to a house. The first step for decorating the house is to clean the house and its surroundings.

Cleaning is an important activity in day-to-day domestic as well as professional lives. It has positive effect on the productivity and quality of work as well as ergonomic and safety work sites (Saari 1987).

Cleaning can be described as removal of undesired dirt, dust marks, stains and other extraneous materials from locations where they serve no useful purpose. A clean environment at workplaces enhances the feeling of wellbeing and it may be conducive to higher productivity, quality of work and job

satisfaction. An unclean environment can lead to occupational accidents, and there is also a risk of exposure to biological irritants, which may contribute to the start of allergic reactions and respiratory ailments. Cleaning should be good and effective in order to create a hygienic work environment. Cleaning consists of different types of tasks such as dusting, mopping, sweeping, swabbing, vacuuming and buffing. Cleaning also consists of handling garbage bags and lifting and moving furniture (Johansson and Ljunggren, 1989).

Many of cleaning tasks involve heavy manual work and are physically demanding. There is a high cardiovascular and musculoskeletal load in many cleaning tasks (Hagner and Hagberg, 1989; Kruger et al., 1997; Kumar et al., 2005). Many aspects of work and environment are not conducive to good health. Therefore, these factors increase the risk of occupational diseases (i.e., musculoskeletal disorders). Among these factors are poor working postures e.g. reaching and stooping, lack of task variation, poor ergonomic work and workplace, poor design of cleaning tools and the task including work organization such as long working hours, low salaries and uncomfortable working times.

Cleaning requires both dynamic and static muscular work, which is usually done with the use of various types or pieces of manual tool. It is considered a physically demanding job, resulting in high cardiovascular load; high frequency of awkward postures; and as such rated as a strenuous job. (Kumar et al., 2005).

Among all cleaning activities carried out at domestic level maintenance of floor is one of the hardest tasks because always some dirt is brought from outside and more is produced from food spillage, lint, hair or fur and dust. Mopping of the floors consists of cleaning dust and dirt from the floor surface using a wet absorbent material carrying a bucketful of water to rinse the soiled duster.

Although there are various tools available mopping of the floor is carried out in traditional method by majority of women with the help of wet rag. The women move back on their hunches as they mop the area. It was revealed as one of the most strenuous cleaning activity and demands much energy and time.(Varghese et al.1989, Sujatha et al.,1999).

Though it is a small activity it cannot be ignored as it is performed daily and regularly. The traditional postures adopted by women form a combination of static and dynamic muscular efforts, which causes tiredness and exhaustion and may increase the heart rate out of proportion that may lead to irreparable damage to the body. The posture the body takes up depends upon dimensions of the tool. Hence, care should be taken by the women to improve her working methods and tools. Knowledge of correct postures, adequate working heights and right method of work performance can help in reducing the physiological cost of the work and muscular fatigue to the minimum. Therefore, adoption of ergonomically designed drudgery reduction technology is the need of the hour.

Mopping floor is one of the leading causes of injuries among workers. It requires heavy lifting, downward pressure and repetitive motion, all of which can cause muscular strain to the lower back, hands, wrists and arms. Injuries are exacerbated in individuals who do not have access to ergonomic mops.

Awkward postures may lead to high demands of energy expenditure and develop high work stress on cleaners which can lead to musculoskeletal disorders, such as upper limb disorders and less job satisfaction which can affect the productivity and quality of the work. (Saari 1987).

Although a lot of improvements and modernization has been introduced in domestic operations there is a need of increased awareness for more incorporation. The improved mops with long handle have been designed with mechanized squeezing system to carry out the mopping activity in a standing posture with less bending at back. The main objective is to improve efficiency,

productivity and increased satisfaction of the worker without jeopardizing his/her health.

Homemakers work often demands more time and energy resources. There is certain job like mopping floor in which squatting, bending and standing postures predominate which is not a natural and balanced posture. The working methods can result in fatigue; drudgery and the resulting strain not only impair health but also affect the quality of work and performance. The measurement of physiological parameters such as heart rate, energy expenditure, postural deviation and perceived exertion which helps to assess workers inputs is of great importance for making work safe, productive and healthy. Keeping this observation in mind a physiological study has been attempted among the women to study the comparison of mopping operations in both squatting and standing postures.

The specific ob jectives of the study are

1. To assess the physiological cost while mopping the floor in squatting and standing posture of selected women.
2. To determine the postural deviation of selected women while mopping the floor in squatting and standing posture.
3. To assess the exertion perceived by selected women while mopping the floor in squatting and standing posture.

REVIEW of LITERATURE

CHAPTER II

REVIEW OF LITERATURE

The women in Indian households carry out most of the household activities manually. The method of performance of the various tasks did not change from centuries. The workers body constitutes her most important item of household equipment using oxygen and food as fuel to provide energy to working muscles and skeletal system. Household activities involve moderate to heavy physiological cost of work. Besides poor design of workplaces, poor postures and traditional equipment increase the drudgery of various household operations which results in rise of heart rate above the acceptable limits, exhaustion, fatigue and serves musculo skeletal aches and pains in the body. These on the long run leads to various occupational health and safety problems.

Hence to safeguard the health of women and to improve the productivity there is continuing research in the field of ergonomics by various investigators, scientists and institutes to find improved working heights, modified tools, equipment and methods of work to reduce the drudgery prone tasks under acceptable limits of physiological parameters. The present study had been taken up to serve the similar purpose.

The chapter highlights the literature available on the selected aspects of research. A review of literature gives an idea about work done previously by various research workers and provides insight into the methodology and findings of the other workers. Since the available literature on the topic of research is very scanty, literature related to this activities are considered.

The literature reviewed is presented under the following heads.

2.1 Anthropometric data of women.

2.2 Heart rate of the women while performing selected household activities.

2.3 Energy expenditure of the women while performing selected household activity.

2.4 Postural deviation of the women while performing selected household activities.

2.5 Perceived exerertion of the women while performing the selected household activities.

2.6 Musculoskeletal disorders while performing the selected household activities.

2.1 Anthropometric data of women

The science dealing specifically with the measurements of the human body to determine difference in individuals, group etc. are termed anthropometry. It is the systematic measurements of human body with the view to determine its average dimensions for creating the ergonomic design of workplaces and helps to enhance the work productivity and reduced physiological stress on the body. Anthropometric data can be used to optimize the dimensions workplaces, equipments and furniture to "fit the task to men" be it industrial and commercial or household hence this applies to any task work (Kuriyan, 2004). A study on workplace design or setting up a workstation would be inappropriate / incomplete if anthropometry of the workers is not considered. Studies related to anthropometry measurements are cited below.

Marras and Kin (1993) conducted an anthropometric study on 388 male industrial workers. The results showed that mean stature height recorded was 174 cm, mean shoulder height recorded was 144.3 cm, upper arm length 35.9 cm and lower arm length was recorded 47.2 cm.

Sengupta and Das (2000) studied maximum reach envelop for the seating and standing male and female for industrial workstation design. Maximum reach envelopes for the 5th, 50th and 95th percentile reach lengths of males and females in seating and standing work positions were determined. The maximum reach envelop for the standing position was significantly ($p<0.05$) larger than the corresponding measure in the seating position for both

the males and females. The average reach length of the female was 13.5 % smaller than that for the corresponding male.

Anthropometric data of enderly women for suggesting dimensions of furniture and work places was studied by Bakshi *et al* (2007). Total 150 elderly respondents were randomly selected for four areas of Ludhiana city in Punjab. Findings revealed that horizontal forward reach of respondents varied from 51 - 75 cm. Side reach of respondents varied from 54 - 78 cm and the normal reach of respondents varied from 60 - 115 cm.

Jinky and Prado (2007) conducted a study on anthropometric measurements among 1805 Filipino workers in 31 manufacturing industries. The results showed that the mean values for standing height, shoulder height, hand length, elbow height, waist height and span were 153.9 $\pm$ 28.28 cm, 143.05 $\pm$ 6.15 cm, 127.21 $\pm$ 8.80 cm, 96.28 $\pm$ 7.39 cm, 95.41 $\pm$ 6.09 cm and 153.18 $\pm$ 8.53 cm respectively.

Jakhar *et al* (2008) conducted an anthropometric study on total 103 respondents in the age group of 21 to 32 years. Results showed that mean stature of male was recorded in the range of 161-186.2 cm, mean left foot length recorded was 25.4 cm in the range of 22.6-28.4 cm and mean right foot length recorded was 25.4 cm in the range of 22.7-28.3 cm.

Agrawal *et al* (2010) conducted a study on anthropometric measurements among 1701 agricultural workers (944 male and 757 female) from Madhya Pradesh. The selected workers were witin the age group of 18-60 years with average age as 29.8 years for male and 33.7 for female. Mean stature height of male was recorded as 1649 mm, elbow height was recorded 1550 mm, span was recorded 1707 mm and grip diameter (inside) was recorded 51 mm.

Chandfra et al (2011) conducted an anthropometric study on 878 male industrial workers from Haryana State. The results showed that mean hand length of industrial workers recorded was 185.7 mm in the range of 170 - 202

mm and mean palm length recorded was as 105.5 mm in the range of 94 - 118 mm.

Selected anthropometric measurements of 475 male students within the age range of 18 - 25 years in Iran were reported by Jalil et al (2011). Mean values for stature, standing shoulder height, abdominal depth, arm length height and forearm length of male students were 1741.8 mm, 1446.5 mm, 218.5 mm, 372.5 mm and 471.7 mm respectively.

Milanovic *et al* (2011) conducted a study to determine the basic anthropometric characteristics and body composition of elderly individuals between 60 and 80 years of age. Results showed that body weight decreased among elderly man and women after the age of 60.

Chawla et al (2013) reported selected anthropometric measurements of 150 healthy males from North Indian Punjab population within the age range of 18-25 years. Mean value recorded for height were 1773.2 mm in the range of 1640 – 1695 mm mean hand breadth (right hand) was 83.687 mm and mean hand breadth (left hand) was 83.593 mm in the range of 98-70 mm.

Davoudiantalab et al (2013) conducted a study to evaluate 400 Iranian male worker in the age group of 25 – 55 year at Iran Khodro Automobile Factory. Results showed that the average height of the Iranian worker was recorded 173.73 ± 6.84 cm, standing shoulder height was recorded 145.30 ± 6.53 cm, standing elbow height was recorded 110.21 ± 5.36 cm, overhead reach 194.74 ± 8.65 cm and forward reach 69.64 ± 3.53 cm. In comparison to Indian and Philippine workers, Iranian workers are 100% and 83% taller respectively. This data can be useful for designing workplace space (e. g. height), work levels (e.g. elbow height) and peripheral equipment size, such as chair (e.g. the width of hips and height of thighs).

Singh *et al* (2013) conducted an anthropometric study on 150 agricultural farm women in the age group of 33-60 years from North Gujarat. A set of 20 body dimensions, which were found to be applicable in the design of

various agricultural equipments. Results showed that mean stature height was recorded 1506.4 mm, Eye height was recorded 1382.2 mm, Vertical reach was recorded 1869.2 mm, Elbow height was recorded 89.8 mm, it can concluded that anthropometric data is much needed to design tools and equipment. The data can be used to design area specific tools and equipment for the target group, which would be fit for them. This can reduce the occupational health problems and injuries. Further , analysis of body composition of the women would be helpful to know their physical fitness as well as their nutritional health.

Vipen *et al* (2013) conducted a study on 10 subjects amongst them 5 were males and 5 were females from River State who were matched on some variables such as age, weight and height. Findings indicated that the percent body fat in females is higher than that of males with lower mass. Also , the results can help to identify individuals with growth disorders, as well as assess the nutritional status of the healthy and unhealthy subjects.

2.2 Heart rate of the women while performing selected household activities

Heart rate is defined as number of ventricular beats per minute. It is a sensitive and fine discriminating measure for evaluating strain in muscular work. For comparing two work methods or an improved version of any machine with the original one, heart rate may be taken as a reliable index. The magnitude of the change in heart rate is dependent on the ability of the person to withstand the amount of stress produced by the physical or psychological aspects of the environment. Thus heart rate has been referred to as the primary indicator of the strain or the physiological reaction of a specific person to the stress of the environment. It is most useful criteria for ergonomical analysis. The studies related to it are cited here under.

Hanson and Maggio (1963) concluded that there was a large increase in heart rate when static component was added. This could be due to nervous regulation of heart rate indicated by unknown stimulus.

Some of the earlier workers stated that emotions increased the heart rate at rest and in light exercise but had little influence on maximal heart rate. Other researchers further mentioned that preliminary increase in heart rate usually showed a tendency to level off after few seconds. It was emphasized that stretching of muscles caused vaso constriction in muscles which resulted in the resistance to the blood flow and increased the systolic pressure. The pooling of blood in any part caused vasodilation in muscles and thus increased the diastolic pressure (Guyton, 1963; Morehouse et al., 1963 and Briuha, 1967).

Some researchers compared the relationship between heart rate and body temperature during muscular exercise in hot environment. They found that on an average when the body temperature increased by $1^{o}c$, the heart rate increased by 32.2 beats per minute. The effect of sex on heart rate using light work bicycle ergonometer concluded that men's heart rate was lower than women's during work, although their recovery patterns were almost similar (Brouha 1967, Jones and Reeves, 1968 and Pirnay et al. 1969).

Kilbom and Astrand (1969) stated that scrubbing of floors in kneeling position with brush and floor cloth the pulse rate varied from 98-117 beats per minute. When cleaning in a standing position using a long handled scrubber and cloth, the pulse rate reached 107-135 beats per minute.

Astrand and Rodahl (1970) reported that the heart rate differed significantly among many of the postures. The return of the venous blood to heart was reduced in a bending posture consequently, the cardiac output rate decreased and there was an increase in the heart rate. The highest mean heart rate was when the subjects squatted on the ground may be due to the greater degree of body bend as compared to other postures where the body bend was lesser.

Hanson and Jones (1970) found that the heart rate differed significantly among many body postures but not between the conditions of the task.

Charti (1971) studied the working heights of cooking units and revealed that there was increase in heart beats and blood pressure when the heights of cooking units were uncomfortable. More physical fatigue developed due to higher energy cost on the uncomfortable heights. She recommended 81cms as the best cooking height for an average Indian homemaker to work comfortably.

Dhesi and Firebaugh (1972) found that angle of knee and ankle has the highest relation to heart rate.

Dhesi and Chahal (1975) observed the effects of stages of chapathi making and angles of body bend on heart rate during sitting and standing postures. They found that heart rate was maximum during rolling stage of chapathi making both in sitting and standing postures and increase in heart rate was more in sitting position than in standing position.

According to Saha et al. (1979) the acceptable workload for an average young Indian worker is about 35 per cent of VO2 max. Therefore, about 0.7 lit min (0.51/ min for female workers) oxygen uptake can be taken as the upper limit of workload for daylong work. The corresponding heart rate at this workload would be about 110 beats/ min for male workers and 105 beats/min for female workers.

Mehta (1982) concluded that mopping the floor at standing posture was less tiring than at squatting posture. The per cent increase in heart rate was 19.69 to 49.23 to that of rest for standing and squatting body postures respectively. The pulmonary ventilation rate was also observed to be higher at squatting as compared to standing posture. The heart rate also showed similar results as that of pulmonary ventilation rate.

Oberoi and Miglani (1987) measured cardiovascular responses while washing clothes manually and by machine. The highest mean systolic pressure during manual washing was found when subjects were squatting on the ground and the lowest mean systolic pressure while standing at sink level. The highest mean diastolic pressure during manual washing was also found when subjects

were squatting on the ground and the lowest mean diastolic pressure was found while sitting on 13cm wooden seat stool (pihri) and the lowest mean heart rate was found while sitting on a 61.5 cm stool (patra).

Varghese et al. (1989) showed that peak heart rate of floor care activities of sweeping and mopping using common brooms and mops in squatting position was 139 and 135 bpm respectively and it was reported to be most strenuous by the home makers. A broom and a mop with convenient handle was physically acceptable, recording a mean heart rate of 116 and 114 bpm respectively.

Hagner and Hagberg (1989) evaluated two floor-mopping work methods in 11 healthy female cleaners by rating the perceived exertion. There was less perceived exertion and local muscle loading during work when the 'push' method was used than the 'figure-of-eight' method. The 'push' method nevertheless still implied a level of static loading that may be harmful during long term work. The methods did not differ regarding measured heart rate and oxygen consumption. However, for two cleaners the 'figure-of-eight' method and for three cleaners the 'push' method implied a work load corresponding to more than 40 % of their normal oxygen uptake.

Boki (2000) studied the physiological stress of farm women while performing selected household activities and the findings revealed that the heart rate for collection of fire wood (117.1 bpm), fetching of water (115.1 bpm) and washing of clothes (114.3 bpm) was significantly higher than that of preparation of food (104.7 bpm) and washing vessels (108.0 bpm).

Saraswathy Eswaran et al (2000) while studying improved implements for women agricultural workers observed that heart rate while cooking , washing clothes, water collection , household maintenance , firewood collection and child care were 96, 99, 112, 110, 120 and 80 bpm respectively.

Ghosh et al. (2001) conducted a study on physiological cost of four different kitchen operations on individual workers and the findings revealed

that heart rate for mixing atta for chapathi (118.0 bpm) and making chapathi (110.0 bpm) was significantly higher than that of frying batata wada (97.0 bpm) and baking chapathi (93.0 bpm).

Dhule (2001) while carrying out ergonomical analysis of sweeping and washing the floor with selected types of broom, reported that heart rate while washing the floor with coconut broom (124.96 bpm) was significantly higher than sweeping the floor with grass broom (110.2), palm broom (117.0 bpm) and nylon broom (104.43 bpm).

Sogaard et al. (1996) evaluated cardiovascular and muscle load levels during floor cleaning while studying work load during floor cleaning and the effect of cleaning methods and work technique. A group of 12 experienced female cleaners participated in the study reported that 6 subjects used a mopping method and 6 a traditional scrub and cloth method. The results revealed a high cardiovascular load corresponding on average to 53 percent of the individual maximal oxygen uptake. The time spent in extreme forward back flexion was shorter for the mopping group. Both groups exhibited high static, median and peak shoulder muscle load levels of 10 percent, 25 percent and 54 percent maximal voluntary contraction, respectively. At the same time, however, the mopping group tended to have a higher shoulder load than the group using the scrub and cloth method. Furthermore, electromyographic signs of fatigue in the trapezius muscle indicated a more stereotype activation of the shoulder muscles during mopping than during scrubbing. Based on these results, it was concluded that mopping cannot be recommended as less strenuous than scrubbing.

It is crystal clear from the studies reviewed above that, the working heart rate varied for each activity and also differed with different working heights/postures taken up by the women for the same activity. The improved tools, equipment and work places have been revealed to significantly reduce the working heart rate to the acceptable limits, there by increasing the working capacity, productivity and health of the homemaker.

2.3 Energy expenditure of the women while performing selected household activities.

The workers body constitutes her most important item of household equipment. The entire body involved in the work is the focus in work study for the homemaker. The efficiency of human machine is only 25 per cent measurement of energy consumption (oxygen consumption) is essentially an absolute measurement. Energy consumption and cardiac capacity sets limit to the performance of physical work and these two functions are used to assess the degree of severity of physical work. A relation between the amount of work performed, muscular activity, blood pressure, grip fatigue and energy metabolism with respect to heart rate / ECG has been recognized long ago. The work done earlier in this respect has been reported here.

The energy cost of bed making at different heights by employing the different techniques revealed that the amount of energy decreased at the height of the bed increased up to a desirable extent. It was also revealed that during any physical activity there was an increase in the systolic pressure where as diastolic pressure increased only in case of strenuous activities (Singer, 1960; Best and Taylor, 1961).

Koshy (1964) reported that energy consumption when washing the floor was maximum and was minimum while sweeping the floor depending upon the type of floor.

Nirmala (1965) studied the time and energy expenditure of ironing a sari at different working heights. At the commercial ironing board the oxygen consumption was less than at the study table. At floor level less oxygen was consumed per minute during sitting and ironing than during kneeling and ironing.

Richardson (1966) while studying the energy expenditure of women for cleaning carpets with three types of vacuum cleaners namely upright, canister and tank at different speeds found that the mean energy expenditure was 100.2

cal/hr, 110.7 cal/hr and 106.7 cal/hr respectively. Based on energy expenditure and level of cleaning of floor upright cleaner was selected as best vacuum cleaner.

Steidl and Bratton (1968) while studying energy cost of selected activities class -ified mopping as moderate activity, involving energy expenditure of 2-3 cal per min.

Jain *et al* (1975) calculated the human energy expenditure while brooming with brooms of different kinds and postures. The findings showed that bamboo stick jharu required more energy 169.4 kgm/min, fur jharu required slightly less energy 165.9 kgm/min and for brush it was only 142.4 kgm/min. The results of energy requirements for brooming in different postures showed that sitting cum bending posture required maximum energy 171.4 kgm/min followed by brooming in standing cum bending posture 162.0 kgm/min. Energy expenditure was lowest in erect standing posture (142.4 kgm/min).

Jain *et al* (1975) studied the energy expenditure of the girls while sweeping floors in different body postures. It was found from the study that brooming with 122 cm long fur jharu in erect posture was least tiring for the body as compared to 97 cm and 70 cm long fur jharu and bamboo stick jharu respectively. Among the three postures is erect standing, standing cum bending and sitting cum bending, erect standing postures took the minimum energy and sitting cum bending the maximum energy.

Raj Gopal and Ray (1977) conducted a study on Indian adolescents to assess the energy cost of some selected activities like sweeping the floor, mopping the floor, cleaning the table cover, walking with a load of 10 kg etc. The energy cost of selected activities was reading 1.2 cal min, writing 1.3 cal per min, sweeping of the floor 2.4 cal per min, mopping of the floor 2.7 cal per min, etc. The study further revealed that energy cost increased with increased in body surface area for heavy activities but not for light activities.

Vasanthi (1981) found that mopping with a cloth mop was tiring and energy consuming activity. While mopping with long stick mop was less tiring and did not consume much energy.

Dhillon (1982) Conducted a comparative study of physiological cost in different postures of dish washing and results indicated that the maximum expenditure was observed at squatting on ground position (2.2 kcal/m^2/min) and minimum at sink level (1.34 kcal/m^2/min).

Mehata (1982) found mean values of energy expenditure during rest, mopping at standing and squatting postures as 0.46, 1.38 and 2.74kcal/m^2/min. It was revealed that the per cent increase in energy expenditure over rest at squatting postures was 495.65 and 200.00 at the standing posture.

Kaur (1985) while assessing ergonomics of washing the floor with brooms of different length, it was concluded that energy expenditure and pulmonary ventilation rate of the subjects for varied heights were minimum, when floor was washed with 90 cm long broom used in squatting posture as compared to 50 cm or shorter broom length used in squatting cum bending postures.

Varghese *et al* (1989) showed that care of floor activities i.e. brooming and mopping using common brooms and mops in squatting posture was most strenuous recording the peak energy expenditure of 2.95 kcal and 3.55 kcal per min, while a broom and mop with a convenient handle was physiologically acceptable recording a mean energy expenditure of 2.37 kcal and 2.00 kcal per minute respectively.

Parvathi et al (1993) found that energy expenditure for the household activities such as meal preparation, house keeping, cleaning utensils, washing clothes, grinding masala and fetching water were 901.6, 43.3, 282.6, 248.4, 192.8 and 296.1 kcal per day respectively. The average energy spent by the rural women for meal preparation and washing clothes was 5.6 kcal per minute

and for other activities it was lower. Meal preparation and washing clothes were more fatiguing operation for rural women than other household chores.

Vaeghese and Surabathula (1994) reported that while mopping by using ordinary cloth mop the energy expenditure was higher and lowest when long handled mop was used. They also indicated that body weight and age had an effect on energy expenditure for floor care activities. As the body weight and age of the subjects increased the energy expenditure also increased . While body height did not make significant difference in the energy expenditure.

Boki (2000) reported significantly higher energy expenditure of 9.9, 9.5 and 9.4 kj/min while collecting firewood, fetching water and washing clothes respectively where as preparation of food and washing of vessels recorded a significantly lower energy expenditure of 7.7 and 8.5 kj/min respectively.

Saraswathy Eswaran *et al* (2000) reported energy expenditure of 1.81, 1.91, 2.39, 1.98, 2.86 and 4.19 kcal/min while cooking, washing the clothes, water collection, household maintenance, firewood collection and child care respectively.

Sujatha *et al* (2000) while studying energy cost of activities of women of different occupations from the poor socio economic group in India, reported that the women spent 5.73, 7.28, 9.16, 10.12, 11.29 and 11.88 kj/min or the activities like cooking, scouring vessels, arranging vessels and folding beds, sweeping, washing clothes, water fetching and mopping respectively. Mopping was revealed as the most heaviest activity. They also reported that among the selected occupational groups of women homemakers spent less energy in terms of kg/min. when compared with beedi makers and tailors in most of the instances though the difference were not significant.

Dhule (2001) while studying the ergonomical analysis of sweeping and washing the floor with selected types of broom found that sweeping with grass, nylon, palm and washing with coconut brooms incurred energy expenditures of 8.79 kj/min, 7.88 kj/min, 9.89 kj/min and 11.11 kj/min respectively.

Dandotikar (2002) ergonomically analyzed selected types of mops for mopping the floor It was noticed that energy expenditure of mopping the floor with cloth mop was higher while mopping of the floor with sponge mop required significantly lesser energy expenditure. The average and Peak energy spent by women while mopping the floor with cloth mop was 2.27 and 2.56 times more than resting energy expenditure. In case of wick and felt mop it was 1.85 and 2.0 times and 1.84 and 1.9 times more than resting energy expenditure respectively. Mopping of the floor with sponge mop recorded least working and peak energy expenditure which was 1.76 and 1.88 times more than resting energy expenditure. The peak energy expenditure while mopping with a cloth mop was slightly above the acceptable limits.

Richardson *et al* (1985) reported that household work now a days has become very strenuous and consumes 2700 k. cals. to 2800 k. cals. of energy in every day and can be compared with any hard occupation outside the home in terms of energy costs and time utilization. However the use of efficient equipment in the the home not only conserves the time and energy in performing housework but also improves the quality of product makes the task pleasant and its ownership enhances the prestige of household.

Grandjean (1973) indicated that the energy requirement for household activities was as high as 2600 to 2700 kcals. It was also reported that energy costs of household work can rise up to 3.0-4.0 k. cals/sq.m/min if wrong posture is adopted for long time during work. On the other hand, a good working posture reduces the energy costs of work and fatigue to the minimum.

Marut and Hedge (1999) conducted a ergonomic survey of 314 male and female regarding household tasks and products. The study revealed that scrubbing and mopping were the most tiring aspect of selected house work followed by vacuuming. With respect to gender it was found that mopping floors, scrubbing, tidying up and vacuuming are most tiring tasks for the women (304) compared to men (78).

Sujatha et al. (2000) while studying energy cost of activities of women of different occupations from the poor socio economic group in India, reported that the women spent 5.73, 7.28, 9.16, 9.16, 10.12, 11.29 and 11.88 kj/min for the activities like cooking, scouring vessels, arranging vessels and folding beds, sweeping, washing clothes, water fetching, and mopping respectively. Mopping was revealed as the most heaviest activity. They also reported that among the selected occupational groups of women homemakers spent less energy in terms of kg/min. when compared with bakery makers and tailors in most of the instances though the differences were not significant.

An experimental study was conducted by Sandhu P. (2003) on 24 female to test the efficiency of selected kitchen gadgets and ergonomic principles for reducing energy costs of selected household work. The results of the study revealed that using right body posture in doing household work also saved considerable amount of human energy. 73.55 percent of energy was saved while washing dishes standing at 82 cms high sink, followed by brooming with long handled broom (90 cms) in erect posture (54 percent) and mopping with long handled mopper in standing position (50 percent).

Kumar (2006) conducted a study on ergonomic evaluation and design of tools in cleaning occupation results indicated that the cleaning job consists of high cardiovascular, muscular, and postural load. Using a participatory ergonomic approach and user- centered design, cleaning problems can be identified comprehensively and can be solved ergonomically, and cleaning tools can be redesigned considering ergonomic aspects by involving the end user. The strategy of participatory ergonomics in cleaning activities can significantly reduce work injuries, absenteeism, and compensation costs while at the same time lead to high quality of work and greater job satisfaction among the workforce.

Kumar (2014) ergonomically assessed two different cleaning tools while cleaning floor revealed that cleaning is an important activity in a day-to-day life as well as professional lives. It has positive effects on the productivity and

quality of work. In this study, the cleaning process was studied and analyzed with special reference to cleaning tools. A group of 4 cleaners participated in this study. Heart rate, rating of perceived exertion and postural analysis were obtained during floor cleaning. The results revealed that there was less perceived exertion during cleaning task when the "adjustable long handle cleaning tool'' was used than that of the "traditional broom''. In terms of heart rate cleaning with the long handle tool (mean 86 bpm, SD ± 8.32) produced significantly less ($p< 0.05$) heart rate at work compared to the traditional broom (mean 102, SD ± 8.01). Using adjustable long handle tool postural angle of the trunk and spinal forces on the lower back was also found significantly less ($p < 0.05$) than that of traditional broom. Based on these results, it was concluded that the long handle cleaning tool could be recommended as less strenuous than the traditional cleaning broom. It is also clear from the studies that age, body weight, posture, etc. had impact on the energy spent on various activities.

2. 4 Postural deviation of the women while performing selected household activities.

A good working posture is one, which can sustain minimum of static muscular effect and in which it is possible to perform the given task more effectively and with least muscular discomfort. The term posture is defined as orientation of body segments in the space. This orientation is possible only because of the related muscular effort. The basic framework of our body is the skeleton on which muscles are attached. By contracting the muscle we therefore manipulate our body segments resulting changes in posture. Our main purpose is to assess the work posture and see that during work whole body center of gravity remains as close as possible to that of normal standing erect position. The studies pertaining to it are reviewed here under.

Bala (1980) calculated the physiological cost of chapathi making in sitting and standing postures and revealed that rolling stage of chapathi making was more strenuous as compared to other operations of chapathi making and had maximum effect on heart rate. The energy expenditure for kneading the

dough and chapathi making was found to be more, when done in squatting position than in standing position.

Vos (1973) found that at low movement frequencies the squatting posture is preferable. Heart rate and energy expenditure were slightly higher than that when sitting, but performance and also the gradient of the heart rate were slightly more favourable. A remarkable increase in workload was observed in the bending posture only when the working level was lower than the level of the feet. If work had to be carried out on the ground itself squatting appeared to be most favourable posture.

Jindal (1974) studied the physiological costs while ironing during sitting and standing positions. The maximum amount of energy was required in the sitting position followed by ironing at the 69 cm height and then ironing at 82cm height.

Dhesi and Chahal (1975) observed the effects of stages of chapathi making and angles of body bend on heart rate during sitting and standing postures they found that increase in heart was more in sitting position than in standing position.

Corett and Bishop (1976) recorded that standing and sitting position without lumber support gave rise to pain in the feet and lumber region. Sitting without support of back lead to pain in erect or spinal muscles. Sitting without good footrest of the correct height gave rose to pain in the knee, legs and lumber region.

Jyoti (1980) studied the physiological cost of chapathi making in squatting and standing positions and analysed that energy expenditure was more for kneading the dough and chapathi making in squatting position than in standing position.

Dhillon (1982) while studying the physiological cost of dishwashing in different postures and concluded that among the various body positions,

dishwashing while standing at sink level was least fatiguing followed by sitting on patra and stool. However squatting on the ground was found to be tiresome as compared to other body postures.

Mehta (1982) while studying the mean values of energy expenditure during rest, mopping at standing and mopping at squatting postures found that mopping the floor in squatting posture demands more energy intake than at the standing posture.

Sidhu (1985) compared the time consumed and distance traveled with postural variation for cooking in existing and improved kitchens of rural homes. She found that the reduction in sitting and bending postures while working in the improved standing level kitchen was 1.5 times (58.7 per cent) and 4.0 times (36 per cent) respectively. While bending and standing postures were reduced by 5.0 times (41.5 per cent) and 1.6 times (98.0 per cent) while working in the improved sitting level kitchens.

Sandhu *et al* (1991) conducted an ergonomic study on muscular fatigue and found that the lowest arm muscular strength was needed while sitting on pihri and highest while grinding spices in squatting posture. Mean muscular fatigue (hand grip and arms) while sitting on pihri and standing at sink level was most significantly different from the muscular fatigue experienced while sitting on patra and squatting on the floor during dry grinding.

Single and Srinivasan (1991) while conducting a study in Hisar district with a sample of 120 rural women found that the commonly adopted posture for selected domestic tasks was squatting, sitting on the ground and bending posture. Among the selected activities dishwashing, washing of clothes and plastering were done in squatting posture. Cooking was done while sitting on the ground and sweeping the floor in a bending posture by majority of the respondents.

Puri (1992) analysed that grinding of masala while sitting on pihri among various selected body postures was least fatiguing and required

minimum energy and minimum stress on other physiological conditions of the body such as heart rate, blood pressure, pulse rate, respiration frequency, pulmonary ventilation rate, muscular fatigue and grip fatigue during the activity followed by sitting on patra and standing at counter level.

Saha (1995) while studying the incidence of musculo skeletal problems among female workers while performing household tasks, found that incidence of back pain at cervical and lumber point was 20 to 50 and 30 to 70 per cent respectively.

Gupta (1996) found that strain during mopping of the floor depends upon the posture adopted by the women during work. The improved mop operated in standing posture was least strenuous than ordinary mop and sponge mop used in squatting posture and standing cum bending posture respectively.

Murali *et al* (1999) reported that the tasks of cleaning namely dusting and mopping were done in sitting posture while bending posture was used for sweeping the house by most of the farmwomen.

Badve (1999) reported that mopping the floor and sweeping were performed in bending and squatting posture by majority of the farmwomen.

Dhule (2001) reported that all the selected women were sweeping and washing the floor in a bending posture. The shorter the length of the handle the more was the deviation of the body from normal position to perform the selected activity.

Dandotikar (2002) in the context of postural alignment of women while mopping the floor with selected types of mop. It was observed that the angle of deviation at cervical and lumbar region ranged from 0° to 8° and 0° to 16° respectively. The angle of deviation at cervical and lumbar point was more while mopping the floor (in a squatting posture) with cloth mop. On the other hand less deviation at lumbar point of the body was noticed while mopping the floor (in a standing posture) in case of improved mops.

Jennifer Desa, et al. (2003) conducted a case study on " Are Microfiber Mops Beneficial for Hospitals''. One worker was videotaped while performing both conventional loop mopping and microfiber mopping. One cycle of the job analyzed, focusing on forceful exertions, awkward postures, localized contact stresses, vibration, working ambient temperatures, repetition or prolonged activities. These components are all risk factors for musculoskeletal injuries. The analysis revealed similar unfavorable postures in both mopping methods, the microfiber mopping system significantly reduced the frequency and severity of the risk factors. The postures of concern include: trunk in forward flexion, rotation, flexion at knees, hips and trunk, upper extremity flexion, supination, pronation and neck flexion and extension. Based on these limited observations, the microfiber mopping system is expected to be more comfortable and result in fewer musculoskeletal injuries.

Kumar (2008) evaluated muscular activity of Professional cleaners while mopping on two different types of floor. It was found that in cleaning occupations, about 80% of all cleaning tasks are done by manual cleaning tools, and about 30% - 35% of working time is spent on mopping floors. The cleaners performed the mopping task for both polished and non- polished floors at their normal working rate. The results show no significant difference ($p < 0.05$) in muscular activity while mopping on the polished floor compared to the non-polished floor; however, the cleaners rated the polished floor more comfortable to mop.

Anneli Pekkarinen (2009) studied development in professional cleaning work brings challenges to ergonomics to evaluate the physical stress factors in cleaning work and their relationship with musculoskeletal disorders. The sample was collected in three regional studies carried out in northern Finland during a ten-year period. The results showed that cleaning is moderately heavy work containing continuous moving and repetitive movement of the upper extremities mainly when mopping. The cleaners themselves estimated that these two stress factors caused the greatest physical

stress in their work. In the ten-year period the statistical test showed no significant reduction in the amount of repetitive movements. Instead, the working postures had improved. Bent, twisted and awkward working postures, and working with hands over shoulder level, had decreased significantly ($p<0.001$).

Cleaning is done mostly with the hands and the body, and cleaners are able to plan their own work to some extent. This enables them to influence the physical workload and musculoskeletal disorders. Cleaning techniques, tools, and machines have recently undergone major improvements, which has resulted in training needs for cleaners. Good results were achieved in adopting ergonomic ways of working after a training intervention. The conclusion is that professional cleaners would greatly benefit from relevant training in ergonomics and working techniques.

2.5 Perceived exertion of the women while performing the selected household activities.

One of the criterion for evaluating the strain and fatigue during any physical activity can be based on an individual's sensation of perception following an activity. This can be designated as perceived exertion. It was experimentally demonstrated that there was a positive correlation between physiological reaction and perceived exertion. Perceived exertion is considered to be an important measure of individual strain as a complement to physiological variables. The relevant studies are cited here.

Hogen and Fieshman (1979) studied the relationship between ratings of perceived physical effort required in human task performance and found a strong relationship between the performances of effort and actual efforts in task performance.

Vasanthi (1981) during her study on sweeping and mopping with selected tools revealed that subjects I (students) got fatigued sooner while mopping the floor with cloth mop for 2 min 48 sec. and long handled mop for 3

min 56 sec. respectively. While subjects II (workers) could mop for a longer period of 6 min 18 sec. and 7 min. 10 sec. with ordinary cloth mop and long stick mop respectively. Mopping with cloth mop and long stick mop was identified as very tiring and less tiring activity respectively.

Rao (1987) studied the perceived exertion of selected household activities of rural housewives and the results showed that the perceived exertion of sweeping and cleaning as somewhat hard to hard task.

Hagner and Hagberg (1989) during their study on floor mopping work methods and measurement of load reported that the cleaners rated figure of eight method as more strenuous than push method and more strenuous than the estimated oxygen consumption indicated. The 'figure of eight' method was assessed as corresponding to 'some what hard' and 'push' method as 'very light' according to Borg RPE scale. However the measured heart rate did not differ between the floor mopping methods.

Varghese *et al* (1989) categorized dusting as light, sweeping as fairly light and mopping the floor as heavy activity in terms of heart rate and energy expenditure. They also reported that perceived exertion of floor care activities was positively correlated with heart rate of the subject.

Ningarwal (1992) while administering the developed scale for measuring perceived exertion of homemakers found that higher exertion was perceived for washing of clothes, tiding and dusting and ironing where as cleaning of grains and vegetables, sweeping, rolling and roasting chapathies were perceived as easy and least tiring tasks by the homemakers.

Verghese *et al* (1994) categorized the work load for different household activities by Indian women and the findings showed that sweeping, kneading dough, grinding masala and washing clothes were categorized moderately heavy activities while mopping the floor, carrying and storing water graded as heavy activities.

Mehata *et al* (1995) studied the perceived exertion of rural respondents while performing selected household activities and reported that dishwashing, grinding masala and kneading dough were perceived as moderately heavy activities while frying and cooking vegetables were evaluated as lightest activities by rural women.

Asma et al. (1996) reported that sweeping, rolling and roasting chapathi , cleaning of grains and vegetables were scored least mean scores of 20.3, 20.6 and 42.27 for perceived exertion respectively by the urban homemakers.

Murali et al. (1999) reported that all the three tasks of cleaning house namely dusting, sweeping and mopping were felt as easy and very easy task by most of the farm women.

Satpute (1999) assessed perceived exertion of rural women in home , farm and allied operations and findings indicated that bringing firewood (4.3) , mopping plastering (4.1) and making of cow dung cake (4.2) were perceived as very heavy by most of the rural women while washing vessels, washing clothes, cleaning vessels were perceived as heavy tasks.

Badve (1999) conducted an inventory analysis of working pattern of farmwomen and the findings indicated that mopping floor, sweeping and dusting were expressed as difficult and very difficult task by majority of the rural women.

Boki (2000) indicated that fetching of water (4.6) and collection of firewood (4.6) were scored high for perceived exertion by selected farmwomen while preparation of food rated (1.98) for perceived exertion. She also stated that perceived exertion for selected household activities was correlated with the heart rate.

Dhule (2001) while carrying out ergonomical analysis of sweeping and washing the floor with selected types of mop revealed that washing the floor with coconut broom (4.55) and sweeping the floor with palm broom (3.45)

were reported heavy and exerting tasks while sweeping with nylon (1.9) and grass broom (2.4) were light and less exerting tasks.

The studies reviewed above under this head clearly indicate that the perceived exertion of workers varied with different types of activities performed. The women differ in their perceptions of exertion while performing various household activities. Some of the activities proved to be more exerting than other activities.

2.6 Musculoskeletal disorders while performing the selected household activities.

Work related musculoskeletal disorders are common health problems throughout world and a major cause of disability in the workplace. Awkward working posture is a main risk factor for developing work related musculoskeletal disorder. Assessment of exposure level to work related musculoskeletal disorders risk can be an appropriate base for planning and implementing interventional ergonomic programme in the workplace. It has been widly accepted that awkward and constrained posture results in musculoskeletal stress on different body region and major factor in the development of musculoskeletal disorders. The studies related to musculoskeletal disorders are cited here.

Sogaard *et al* (1996) reported that the risk factors involved in the physical work of professional cleaning are static muscular load and repetitive movements of the arms and hands with a high output of force. Cleaning requires both dynamic and static muscular work, which is usually done with the use of various types or pieces of manual tool.

Grozdanovic (2002) had conducted the study on human activity and musculoskeletal injuries and disorders. The findings of the study revealed that there is recent rise in work related health problems such as cumulative trauma disorders of the upper extremity & lower back.

Krause et al (2005) studied physical workload, work intensification and prevalence of pain in low wage workers. A sample of nine hundred forty-one male unionised hotel room cleaners was selected for the study. Results showed that after 1 month prevalence of severe bodily pain was 47% in general, 43% experienced pain for neck, 59% experienced pain for upper back and 63%experienced pain for low back.

According to Kumar *et al* (2005) MSD risk factor is considered a physically demanding job, resulting in high cardiovascular load, high frequency of awkward postures and as such rated as a strenuous job.

Metgud *et al* (2008) carried out an ergonomic study in a woolen textile factory for identification of health related problems. The study was conducted in Belgaum district, Karnataka state. Total 100 women in the age range between 30 to 45 years were randomly selected. Study revealed that postural pain in low back was 47% while pain neck was 19%. It was also noticed that 91% of the women suffered from at least one work related musculoskeletal pain in relation to length of occupational exposure.

Anneli Pekkarinen (2009) studied development in professional cleaning work brings challenges to ergonomics to evaluate the physical stress factors in cleaning work and their relationship with musculoskeletal disorders. The cleaners also reported that there had been significant reduction in manual lifting and carrying during the years ($p<0.05$). No statistical difference was found in the stress caused by heavy physical work. The results also revealed that musculoskeletal disorders are common among professional cleaners. Particularly, pain in the neck and shoulder area clearly increased with age.

Chandra and Parvez (2012) conducted a study on 110 workers. (55 men and 55 women) age ranging between 30-35 years in garment manufacturing unit were selected. Results showed that the long working hours directly affected on the workers health such as the male workers experienced pain in shoulder (45.5%), neck (21.8%), back (29.9%), wrist (1.8%), hand (5.4%), leg

(9.1%), thigh (10.9%), knee (7.3%), ankle (1.8%), head (21.8%) and feet (1.8%).

Pande *et al* (2012) studied upper extremity musculoskeletal disorders in hospital seventy-six laundry workers. The signs and symptoms of upper limb musculoskeletal disorders were assessed. Results showed that (32%) of laundry workers experienced neck, shoulder and wrist problems due to repetitive body movements.

Materials and Method

CHAPTER III

MATERIALS AND METHOD

The main purpose of the study was to assess and compare the physiological cost while mopping the floor in squatting and standing posture of selected women, determine the postural deviation of selected women and to assess exertion perceived by selected women while mopping the floor in squatting and standing posture. Keeping these objectives in view the study was designed as follows.

3.1 Locale of the study

3.2 Selection of sample

3.3 Selection of mops for assessment of physiological cost

3.4 Characteristics of long handle mop

3.5 Tools and Techniques of data collection

3.6 Selection of area of floor for conducting the experiment

3.7 Assessment of rate of perceived exertion

3.8 Physical fitness of respondents

3.9 Assessment of Physiological cost of work

3.10 Statistical analysis

3.1 Locale of the study:

The study was conducted in Parbhani city of Marathwada region in Maharashtra state. Women participated in mopping activity will be coming from the different localities of the Parbhani city.

3.2 Selection of sample:

A sample for any study represents population and the specific group of study to draw general inference. Purposive random sampling was followed to select thirty women involved in mopping activity. The selected subjects was grouped between the

age ranges from 25-35 years. The selected subjects were healthy and without any physical deformities and illness.

3.3 Selection of mops for the assessment of physiological cost.:

For assessment of physiological cost in squatting posture traditional cloth mop was selected and for standing posture long handle mop with basket was used, as this type of mop is newly introduced in the market. A Basket having pedal at the base and revolving squeezer inside the basket. Mop have round base having wicks and handle to hold.

3.4 Characteristics of long handle mop :

Table.1. Physical characteristics of selected mop

Sr.No.	Characteristics of mop	Basket mop
1	Height of handle (cm)	117
2	Circumference of handle mop (cm)	20
3	Circumference of handle	10.3
4	Material used for handle	Iron and plastic
5	Absorbent material used	Cotton ropes
6	Squeezing mechanism	√
7	Height of basket	31
8	Width of basket	42
9	Dry weight of handle mop (gms)	620
10	Wet weight of handle mop (gm)	896
11	Source	Local market
12	Cost (Rs)	1700

3.5 Tools and Techniques of data collection: The study was carried out in two phases: i.e. Survey and Experiment.

1) Survey:

The study was comprise of survey and prepared questionnaire to find out detailed information of the women and collected information through personal interview method.

Plate no. 1 Basket mop

A) Preparing questionnaire and Pretesting questionnaire:

The questionnaire was prepared to collect the general information about the specific objectives. Recording sheet for noting down the selected physiological variables like heart rate, blood pressure and body temperature was prepared.

2) Experiment:

The experiment was consisting of anthropometric measurement, Physical fitness, physiological cost, and rate of perceived exertion of the selected women.

A) Anthropometric measurements of selected women in squatting and standing position

Anthropometry is the study of the range of human physical dimensions, such as size (e.g., height), breadth (e.g., shoulder width) and distance between anatomical points (e.g., upper arm length).

Measurement of selected women in standing position

3.5.1 Stature - Measurements of body from top of the head to floor when standing in erect stretched posture.

3.5.2 Normal standing height - The vertical distance from the floor to top of the head, standing in normal relaxed erect posture.

3.5.3 Eye height – The vertical distance from the floor to inner corner of the eye when the subject stands erect and look ahead.

3.5.4 Full hand length - Distance between shoulder point and tip of middle finger.

3.5.5 Palm length – Distance between tip of middle finger and palm

3.5.6 Hand Grip Dynamometer- A hand grip dynamometer was used to measure the hand grip strength of right hand of selected women.

3.5.7 Elbow height- The vertical distance from the floor to the depression formed at elbow where the forearm meets the upper arm.

3.5.8 Lower position arm reach length - Standing in erect posture, low level horizontal comfortable arm reach.

3.5.9 Lower position arm reach height - Standing in erect posture, lower level vertical comfortable arm reach.

Measurement of selected women in squatting position

3.5.9 Normal squatting height – The vertical distance from the sitting surface to the top of the head when the subject sit erect, looking straight ahead.

3.5.10 Squatting arm reach length at lower position- Sitting in erect posture, comfortable lower position arm reach length from spine.

3.5.11 Maximum arm reach forward - Sitting in erect squatting posture, comfortable lower position arm reach length from spine.

3.5.12 Squatting side arm reach right hand – Squatting in erect posture, comfortable arm reach side was from spine center (right hand).

3.5.13 Knee to knee distance – Maximum horizontal distance across the lateral surface of the knees in relaxed squatting posture.

Equipment to be used for collecting data: Various types of equipment was used in this study.

1) Weighing machine :

A portable weighing machine was used for measuring the weight of the workers. It was calibrated in kilo grams. Every reading was taken up after adjusting the scale to zero for accuracy of result.

2) Anthropometer:

Anthropometer was used for measuring heights of the respondents. Anthropometer is a precision in instruments consisting vertical graduated rod made up

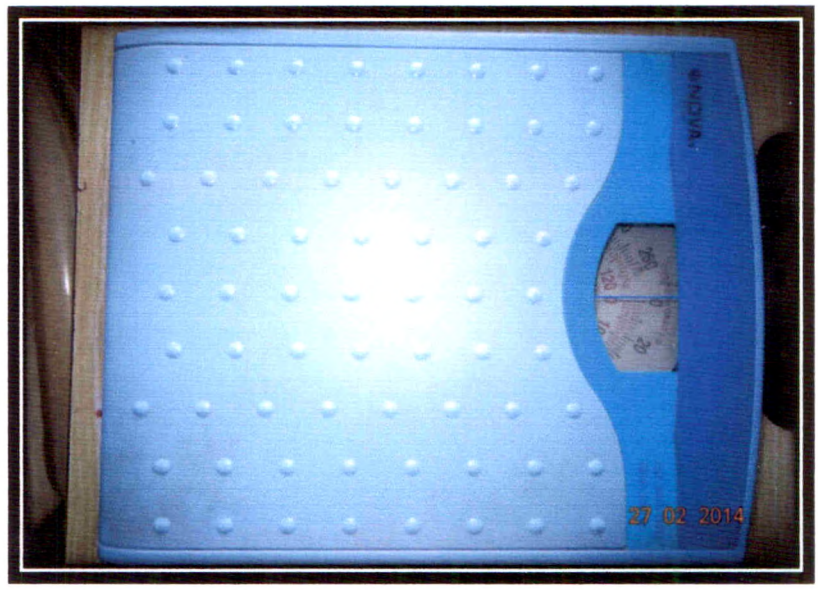


Plate No. 2 Weighing balance

Plate no. 3 Anthropometer

of 4 connecting sections tubular metal that are engraved in mm intervals. The model was capable of measuring stature and other heights from the floor up to 210 cm when completely assembled.

3) Measuring tape:

A narrow metal measuring tape marked in feet, inches and centimeters was used for taking the various maximum and minimum reach measurements in vertical and horizontal plane and flexible measuring tape was used for body circumferences of the respondent.

4) Polar sports tester heart rate monitor

Heart rate is in numbers of ventricular beats per minute for measuring the heart rate the polar sport tester heart rate monitor was used. Heart rate was recorded while performing activity of mopping. The polar transmitter of the instrument will be attached to chest of the subject. The belt length was adjusted as per the measurements of subject so that the fit is snug but not too tight. The heart rate was recorded with the help of watch tied around the wrist of the subject. Then the resting heart rate was recorded in the sitting position without doing any work. Working heart rate was recorded for 15 minute while performing activity of mopping. Average peak heart rate (bm^{-1}) was noted down during performance of task. Then after completion of the activity recovery heart rate was recorded after every minute till a period of normal heart rate.

5) Grip dynamo meter:

Dynamometer is the device for measuring the force of muscle contraction; for example, hand grip dynamometer measures power grip strength.

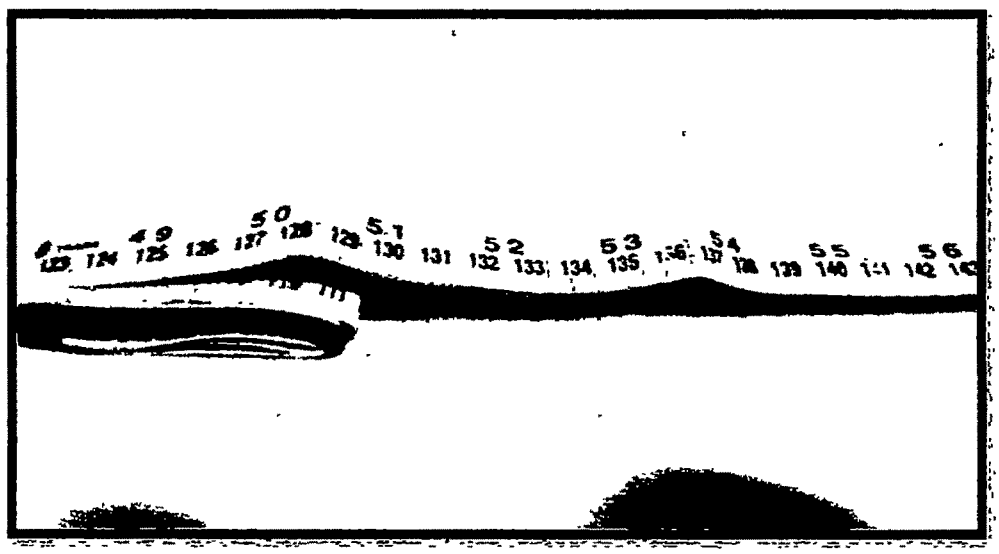


Plate no. 4 Flexible measuring tape

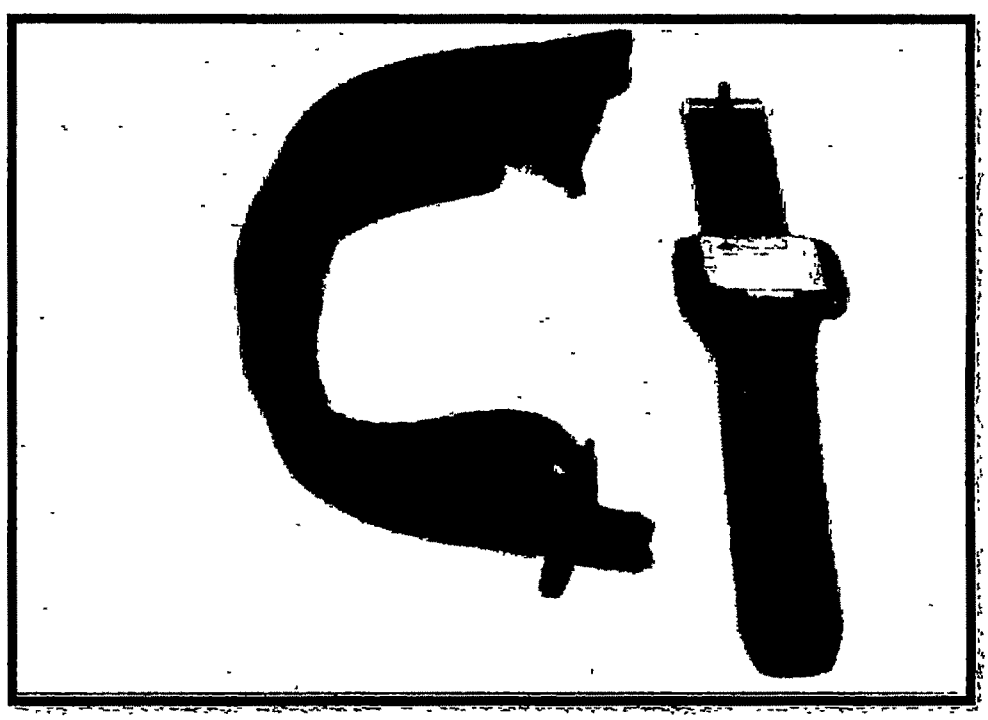


Plate no. 5 Heart rate monitor

6) Goniometer:

Goniometer is the device that measures the angle and range of angular movement between two body segments connected by a joint. Goniometer was used for measuring the postural angle at lumbar, cervical and elbow region. Postural analysis of the respondents at lumbar region, cervical region and elbow region was carried out by calculating angle of deviation while performing mopping activity.

7) Body type of respondents

For determining the body type of the respondents body mass index method was used. Body mass index was derived by measuring body weight and height of the subjects. The following formula was used to assess BMI of selected respondents.

$$\text{BMI (kg / m}^2\text{)} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

On the basis of assessed BMI score, body types was categorized as per classification given by Garrow (1981).

Respondents was categorized as per the body type:

Body type	BMI
Ectomorph	<20
Mesomorph	20-25
Endomorph	>25

3.6 Selection of area of floor for conducting the experiment:

Similar type of polished mosaic tiled flooring, covering a fixed area of 10 x 12 feet was selected to carry out the experiment in the residences for mopping the floor in squatting & standing posture.

Plate No. 6 Hand Grip Dynamometer

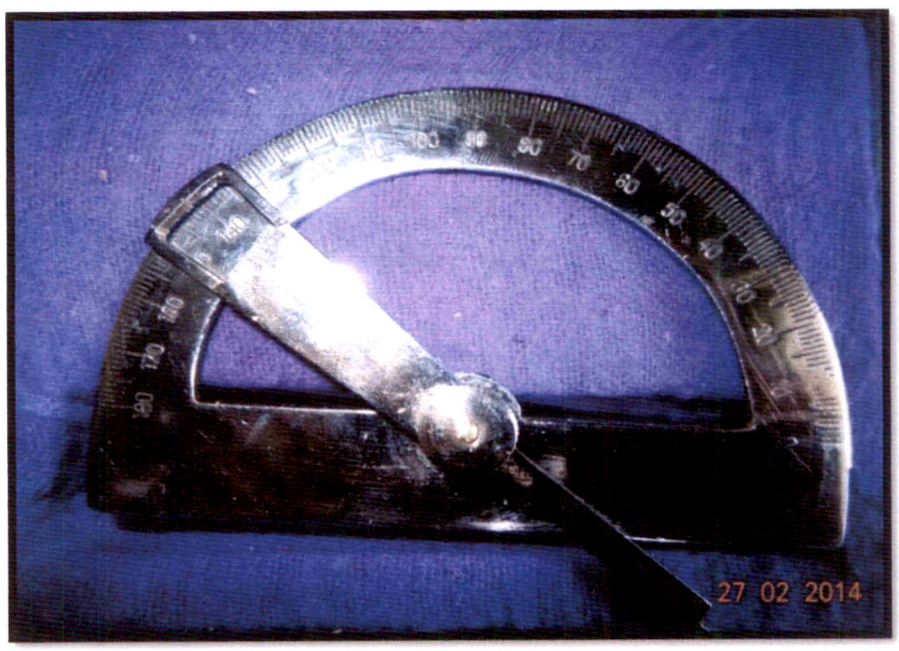


Plate no. 7 Goniometer

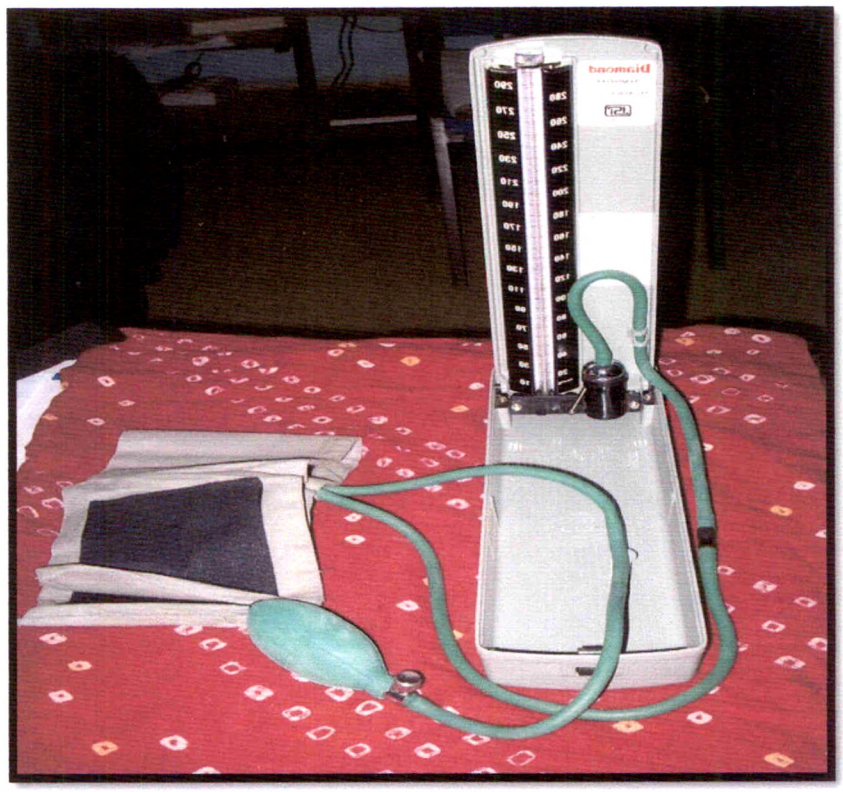


Plate No. 8 Blood Pressure Apparatus

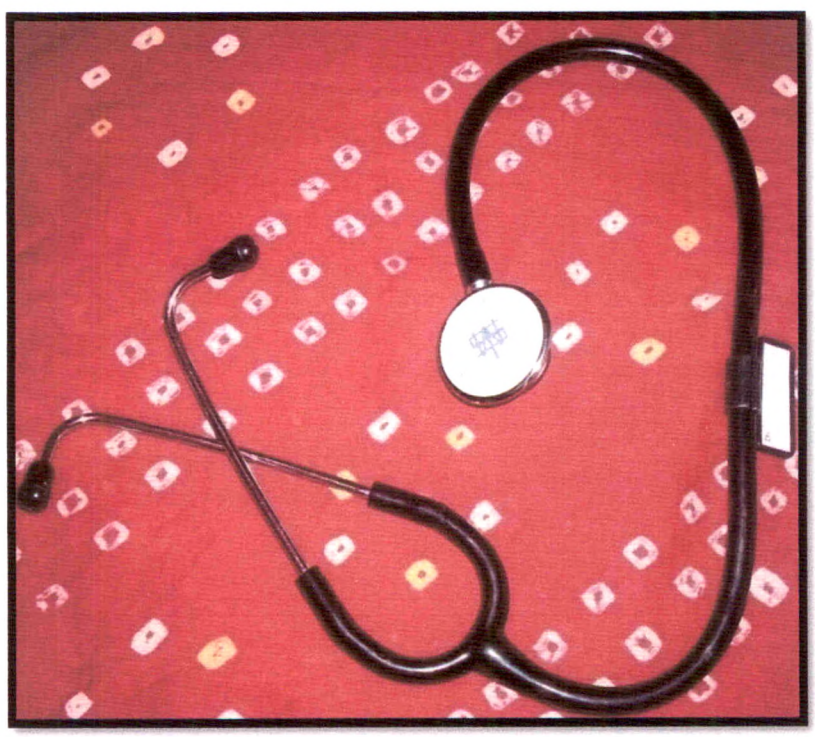


Plate No. 9 Stethoscope

3.7 Assessment of rate of perceived exertion:

Rate of perceived exertion of the selected subject was calculated with the help of perceived exertion five point scale. Scale developed by Varghese et al (1994) was used in the present study.

The scale is mentioned below:

Sr. No	Perceived exertion	RPE
1	Very light	1
2	Light	2
3	Moderately light	3
4	Heavy	4
5	Very heavy	5

3.8 Physical fitness of respondents

Aerobic fitness

Aerobic fitness serves as a measure of stamina and all round physical condition and measured in terms of VO_2 max. It was used to evaluate the physical condition of individuals. Based on VO_2 max one can rate the ability of heart rate and lungs to supply the body with oxygen. Aerobic capacity of the subjects was determined with the help of equation derived by Varghese et al (1994) which is given below. The formula is based on the relationship between age and body weight as they have great influence on VO_2 max.

Vo_2 max (L /min) = 0.023 X Body weight (kg) – 0.034 X Age (yrs.) +1.652

$$\textbf{Vo}_2\textbf{max (ml/ kg/min)} = \frac{VO_2 \text{ max (lit/min)}}{\text{Body weight (kg)}} \times 1000$$

Based on the assessment of VO_2 max the physical fitness level of selected respondents was categorized (Varghese et al 1994)

Classification of vo_2max

Vo_2 max (ml /kg/min)	Health status
Up to 15	Poor
16-25	Low average
26-30	High average
31-40	Good
41-45	Very good
Beyond 45	Excellent

3.9 Assessment of physiological cost of work:

A) Assessment of energy expenditure

The energy expenditure was calculated from the heart rate response of the subjects using following formula (Varghese et al 1994).

Energy expenditure ($Kj.m^{-1}$) = 0.159 x heart rate ($b.m^{-1}$)-8.72

B) Measurement of total cardiac cost of work

The total cardiac cost of work was calculated from the heart rate response of subjects using formula given by Varghese et al (1994)..

1) Total cardiac cost of work (TCCW) = Cardiac Cost of Work (CCW) + Cardiac Cost of Recovery (CCR) X Duration

Where,

Cardiac Cost of Work = (Average Working Heart Rate - Average Resting Heart Rate) X Duration of work

Cardiac Cost of Recovery = (Average Recovery Heart Rate - Average Resting Heart Rate) X Duration of work

C) Assessments of physiological cost of work

The physiological cost of work was calculated from the heart rate response of subjects using formula given by Varghese et al (1994).

$$\text{Physiological Cost of Work (PCW)} = \frac{\text{Total Cardiac Cost of Work (TCCW)}}{\text{Total Time of Work (min)}}$$

3.10 Statistical analysis

After collection of data the collected information was carefully edited, tabulated and processed. The tabulated data was subjected to following statistical analysis.

3.10.1 Frequency and Percentage

Frequency was noted down to find out the number of women mopping the floor in specific group with respect to demographic variables and the percentage was used for making simple influences, percentages was calculated by using the following formula

$$P(\%) = \frac{n}{N} \times 100$$

Where,

n= Frequency of particular cell

N= Total number of respondents of that particular cell

P = percentage

3.10.2 Mean

Mean was defined as any figure that conveys the characteristics of any group to the maximum extent. The mean of static and dynamic anthropometry and physiological parameters was calculated by using formula.

$$\text{Mean} = \frac{\text{Responses}}{\text{Total number of responses}} \times 100$$

3.10.3 Standard deviation

Standard deviation is the most important absolute measures of dispersion to estimate the amount of variability of the distribution. Standard deviation was calculated for anthropometry, physiological parameters and difficulty perception by using the formula.

$$\sigma = \sqrt{\frac{1}{n} \Sigma (x_1 - \bar{x})^2}$$

Where,

$\overline{X}$ is mean

n is sample size

σ is standard deviation

3.10.4 't' test

't' test was used for assessing the differences in variables related to ergonomic assessment of mopping activity in traditional and selected mop. Following formula was used to assess 't' value (Sharma 2005).

$$\text{'t'} = \frac{M_1 - M_2}{\sqrt{\frac{(SD_1)^2 + (SD_2)^2}{n}}}$$

Where,

M_1 = Mean value of existing method

M_2 = Mean value of improved method

SD_1= Standard deviation of existing method

SD_2 = Standard deviation of improved method

n = Sample size

3.10.5 Correlation coefficient

Correlation coefficient describes the degree of correlation between two variables. The independent variables in the study was age, BMI (Body Mass Index), body weight, anthropometry, VO_2 max. The dependent variables was physiological cost of work, RPE (Rate Perceived Exertion).

Correlation coefficient was assessed by using following formula (Sharma 2005).

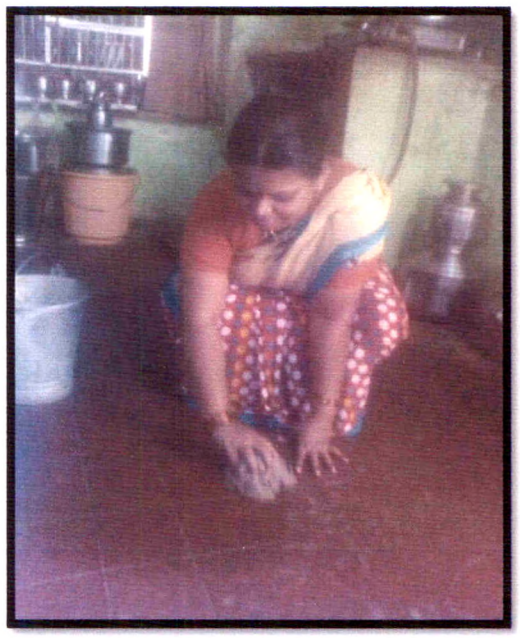
$$r(x, y) = \frac{\text{Covariance } (x, y)}{\sqrt{\text{Variance } (x).\ \text{Variance } (y)}}$$

Where,

r= correlation coefficient

x=dependent variable $(x-\bar{x})$

y= independent variable $(y-\bar{y})$



Women while mopping floor in squatting posture (Cloth mop)

Women while mopping floor in standing posture (Basket mop)

Plate no. 10 Mopping floor in squatting and standing posture of selected women

Resting heart rate

Working heart rate

Plate no. 11 Recording heart rate of selected women

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The present study entitled "comparative study of mopping floor in squatting and standing posture of selected women" was undertaken to assess the physiological cost of women while mopping the floor in squatting and standing posture with selected types of mop. The physiological variables selected for the study were body temperature, blood pressure, heart rate, energy expenditure, postural alignment and exertion perceived by the women while performing the mopping activity. The data thus collected was compiled, tabulated, analyzed statistically, and the findings are discussed under the following headings.

4.1 General information of selected women

4.2 Anthropometric measurements of selected women in squatting and standing posture

4.3 Physical fitness of selected women

4.4 General information regarding mopping floor

4.5 Physiological cost of mopping floor

4.6 Perceived exertion experienced by selected women while mopping floor in squatting and standing posture

4.7 Angle of postural deviation at cervical, lumbar and elbow joint of the selected women was measured while mopping the floor in squatting and standing posture

4.8 Pain experienced by selected women due to mopping floor in squatting and standing posture

4.9 Statistical implications

4.1 General information of selected women

The data on personal information of selected women like age, family income, size and type of the family, education, occupation, weight and height is given in the table no. 1 and depicted in figure 1.

It is evident from the table that majority 53.3 per cent of the women were in the age group of 31-35 years while 46.6 per cent of the women were in the age group of 25-30 years. With reference to the family type it was found that 66.6 per cent of the women belonged to nuclear family while only 33.3 per cent of the women were from joint family. Regarding the family size it was found that 53.3 per cent of the women were having 2-4 members in the family while 33.3 per cent and 13.3 per cent of the women were having 5-6 and above 6 members in the family respectively.

Regarding monthly income of the family it was observed that 86.6 per cent income of women was ranging between Rs. 10000-15000 /- . While 10 and 3.3 per cent of selected women were in the income group ranging between Rs. 15000-20000 /- and Rs. 20000 /- and above respectively. Majority 43.3 per cent of selected women were secondary school educated followed by high school (30%) and college educated (26.6%). Majority of the women were engaged in household activities (70%) while 30 per cent women were engaged in small scale enterprises.

Further perusal of the table regarding body weight shows that 46.6 per cent and 53.3 per cent of the women were having body weight ranging between 40-50 kg and 51-60 kg respectively. In the context of body height majority of the women

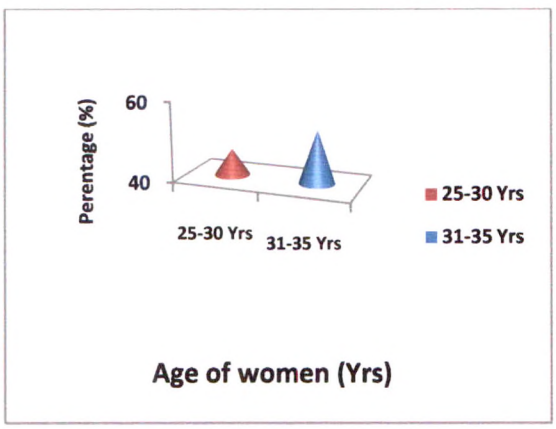
were in the height range of 146-155 cm (56.6%) followed by 135-145 cm (23.3%) and 156-165 cm (20%) respectively.

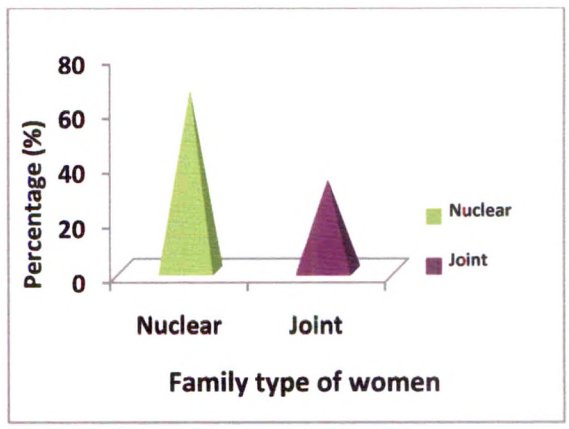
On the whole it was seen that majority of women were in the age group 31-35 years, belonging to nuclear families with 2-4 family members and earning monthly income Rs. 10000 – 15000/-, having body weight ranging between 51-60 kg and range of body height 146-155 cm .

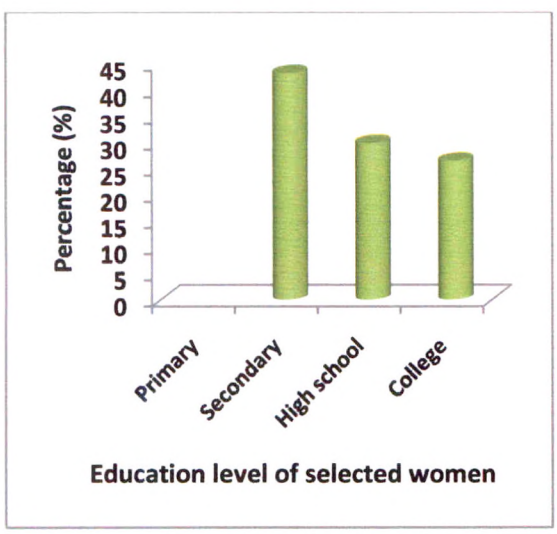
Table 1. General information of selected women

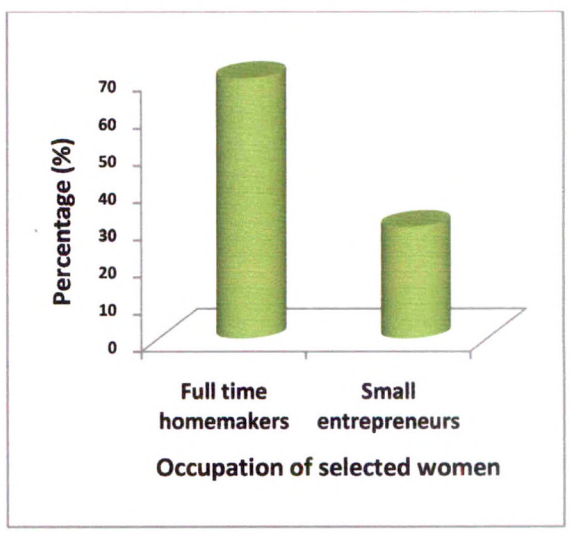
Characteristics	Number and percentage
Age (years)	
25 – 30	14 (46.6)
31-35	16 (53.3)
Family type	
Nuclear	20 (66.6)
Joint	10 (33.3)
Family size	
2-4	16 (53.3)
5-6	10 (33.3)
Above 6	4 (13.3)
Monthly family income (Rs)	
10000 - 15000	26 (86.6)
15000- 20000	03 (10)
20000& above	01(3.3)
Education	
Primary	Nil
Secondary	13 (43.3)
High school	09 (30)
College	08 (26.6)
Occupation	
Full time homemakers	21 (70)
Small entrepreneurs	09 (30)
Weight (Kg)	
40-50	14 (46.66)
51-60	16 (53.33)
Height(cm)	
135-145	07(23.33)
146-155	17(56.66)
156-165	6 (20)

Figures in parenthesis indicate percentages









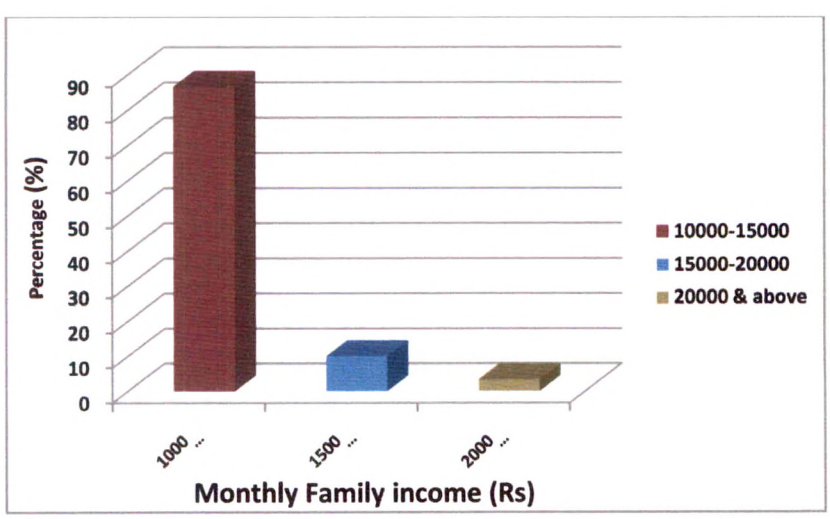
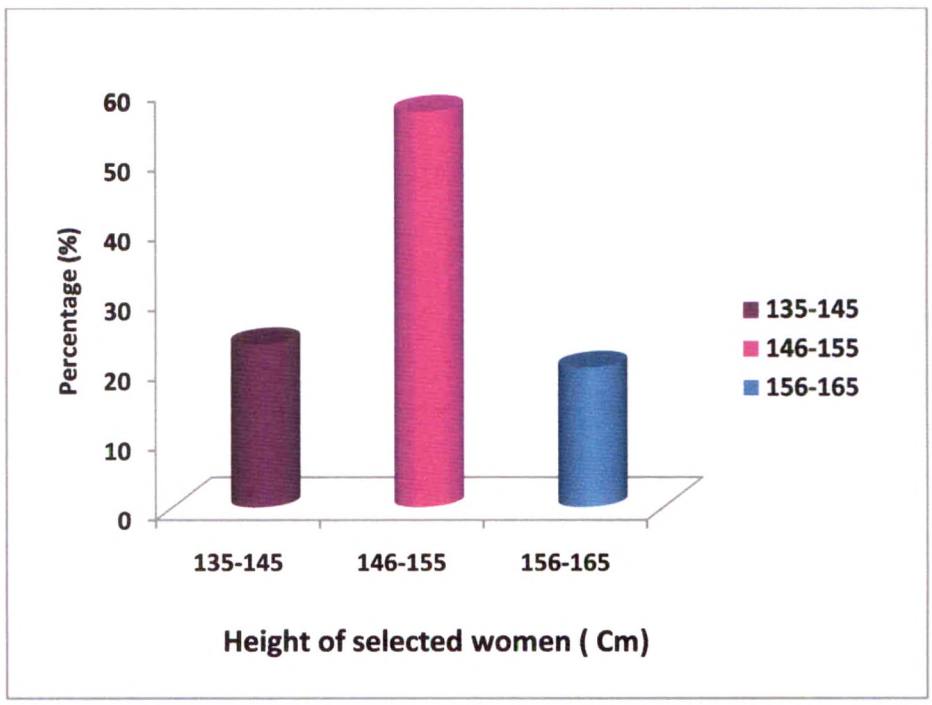


Fig.1.General information of selected women



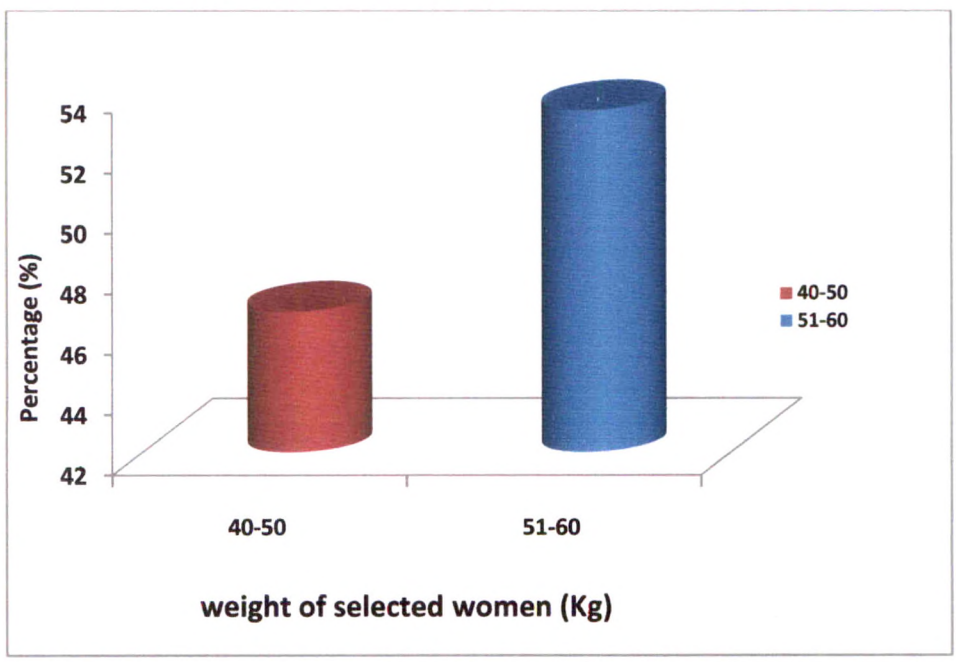


Fig.1. General information of selected women

4.1.1. Body temperature of selected women before and after mopping floor

Body temperature of selected women was recorded before and after mopping floor and is shown in table. Mean body temperature of the selected women before mopping the floor in squatting posture was 97.44 ^{0}F ranged from 97.2 to 98.8 ^{0}F and after mopping floor was 98.07 ^{0}F ranged between 97.4 to 98.2 ^{0}F. The mean body temperature before mopping floor in standing posture was 98.11 ^{0}F ranged between 97.4 to 99.4 and after mopping floor was 98.47 ^{0}F ranged between 97.6 to 98.8 ^{0}F.

Statistically results revealed highly significant difference (t=7**) between body temperature before and after mopping the floor in squatting posture. A significant difference was also found for the body temperature before and after mopping the floor in standing posture (t = 3.6**).

On the whole it can be concluded that difference between mean body temperature before and after mopping floor in squatting posture was more and the difference is statistically significant.

Table 2 Body temperature of selected women before and after mopping floor

Posture	Body temperature (^{0} F)				
	Range (^{0}F)	Before	Range (^{0}F)	After	't' Value
Squatting (Cloth mop)	97.2 – 98.8	97.44 ± 0.33	97.4 – 98.2	98.07 ± 0.44	7**
Standing (Basket mop)	97.4 – 99.4	98.11 ± 0.47	97.6 – 98.8	98.47 ± 0.41	3.6**

** : Highly significant at 1 % level

4.1.2. Blood pressure of selected women before and after mopping floor

Blood pressure of selected women before and after mopping floor in squatting and standing posture is reported in table 3. It is evident from the table that the mean systolic pressure recorded before mopping floor in squatting posture was 116.26 mm/Hg ranging from 110 to 126 mm/Hg and after mopping mean systolic pressure was 118.8 mm/Hg ranging from 110 to 128 mm/Hg. The mean diastolic value before mopping the floor in squatting posture was 77.2 mm/Hg ranging from 70 to 90 mm/Hg with mean diastolic pressure after mopping floor was 78.26 ranging from 72 to 90 mm/Hg.

It was observed that mean systolic pressure recorded before mopping floor in standing posture was 115.8 mm/Hg ranging from 110 to 122 mm/Hg with mean systolic pressure after mopping floor was 116.8 mm/Hg ranging from 110 to 124 mm/Hg. The diastolic pressure before mopping the floor in standing posture was

75.86 mm/Hg ranging from 70 to 80 mm/Hg with mean diastolic pressure after mopping was 78.26 mm/Hg ranging from 70 to 90 mm/Hg.

Slight rise in systolic pressure was found while mopping the floor in squatting posture. However 't' value was significantly correlated for systolic pressure while mopping floor in squatting posture (t=2.51*). The results are inline with the results of Best and Taylor (1961) showed same results as any physical activity there was an increase in the systolic pressure. However significant increase in systolic blood pressure was noted while mopping floor in squatting posture.

On the whole it can be concluded that systolic pressure before and after mopping floor in squatting posture was more as compared to standing posture. However 't' value showed significant difference for rise in systolic pressure while mopping floor in squatting posture.

Table 3 Blood pressure of selected women before and after mopping floor.

Posture / Mop	Blood pressure									
	Systolic					Diastolic				
	Range	Before	Range	After	't' Value	Range	Before	Range	After	't' Value
Squatting (Cloth mop)	110-126	116.26±4.89	110-128	118.8±4.62	2.51*	70-90	77.2±5.16	72-90	78.26±4.71	0.94^{NS}
Standing (Basket mop)	110-122	115.8±4.21	110-124	116.8±4.35	0.90^{NS}	70-80	75.86±5.63	70-90	78.26±5.13	1.73^{NS}

* : significant at 5 % level NS : Not significant

4.2. Anthropometric measurements of selected women in standing and squatting position

Anthropometric measurements of selected women in standing and squatting position is presented in table 4 and illustrated in fig 2. It is clear from the table that mean stature of women was 150.36 cm ranging from 143 to 165 cm. Mean normal standing height of women was recorded as 147.2 cm in the range from 135 to 159.2 cm. The mean elbow height was recorded as 97.7 cm ranging between 91 to 109 cm. The mean palm length and hand length were 17.1 and 69.1 cm and ranged between 15.5 to 19 cm and 61 to77 cm respectively. The grip strength was 18.66 kg ranged between 13 to 26 kg.

The mean arm reach height at lower position was 78.3 cm ranged between 59 to 93 cm. The mean arm reach length at lower position was 66.1 cm ranged between 58 to 85 cm .

It is clear from the table that mean normal squatting height of women was 93.3 cm in the range of 80 to 101 cm, knee to knee distance was 31.9 cm with range from 20 to 40 cm and maximum arm reach forward was 72.3 cm within the range of 61 to 90 cm. The mean squatting side arm reach of right hand was 70.4 cm and lower position arm length was 67.13 cm ranged between 62 to 90 cm and 59 to 86 cm respectively.

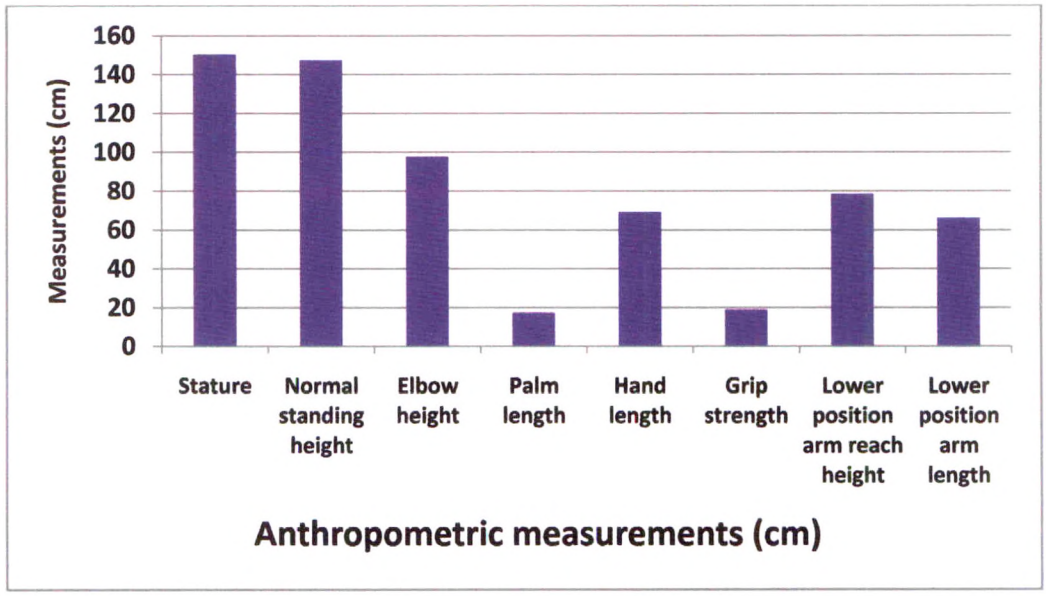
Thus it can be concluded that the mean stature of women was 150.3 cm followed by normal standing height and elbow height were 147.2 cm and 97.7 cm respectively. The mean palm and hand length were 17.17 cm and 69.13 cm respectively and the mean grip strength was 18.66 kg. The mean lower position arm reach height and arm length were 78.36 cm and 66.13 cm respectively.

The mean normal squatting height of selected women was 93.3 cm, knee to knee distance 31.9 cm, and maximum arm reach forward length 72.3 cm, and

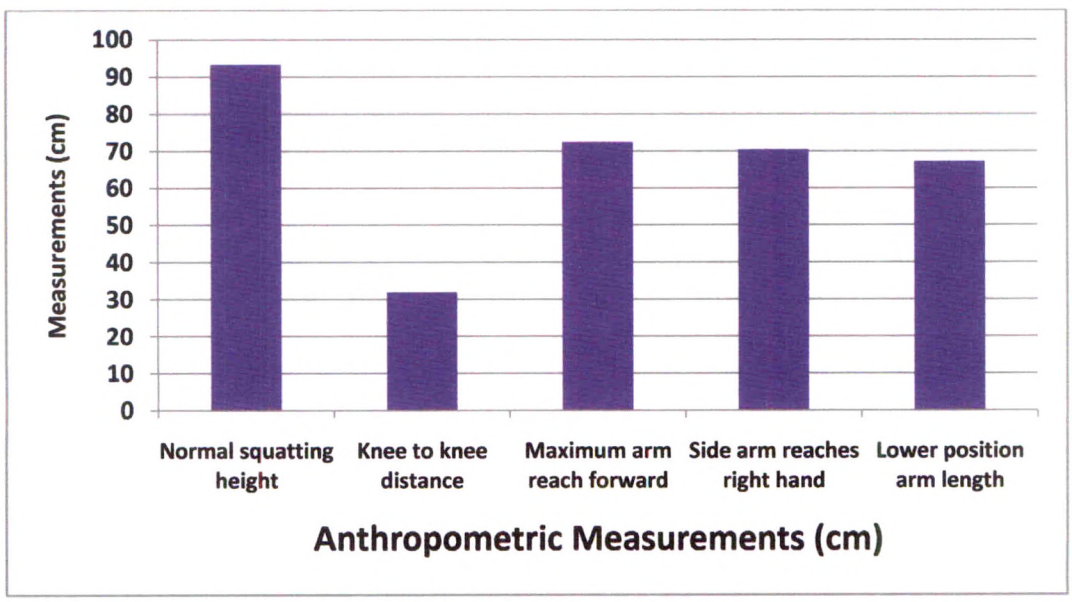
squatting side arm reach right hand was 70.4 cm. Squatting lower position arm length was 67.13 cm.

Table 4 Anthropometric measurements of selected women in standing and squatting position

Anthropometric variables	Measurements (centimeters)		
	Minimum	Maximum	Mean ± SD
Standing Anthropometric Measurements			
Stature	143	165	150.36± 6.80
Normal standing height	135	159.2	147.26± 7.22
Elbow height	91	109	97.7± 5.08
Palm length	15.5	19	17.17± 0.93
Hand length	61	77	69.13± 5.79
Grip strength	13 (kg)	26 (kg)	18.66± 3.46
Lower position arm reach height	59	93	78.36±10.71
Lower position arm length	58	85	66.13±5.95
Squatting Anthropometric Measurements			
Normal squatting height	80	101	93.3± 5.120
Knee to knee distance	20	40	31.96 ± 5.93
Maximum arm reach forward	61	90	72.3± 5.99
Side arm reaches right hand	62	90	70.4±6.15
Lower position arm length	59	86	67.13± 6.76



Anthropometric measurements of selected women in standing position



Anthropometric measurements of selected women in squatting position

Fig. 2. Anthropometric measurements of selected women in standing and squatting position

4.3 Physical fitness of selected women

Based on the age and body weight of women, VO_2 max of the selected women was calculated. Physical fitness of the selected women is indicated in table 5 and illustrated in fig 3. It is clear from the table that vast majority of the women (80%) had good physical fitness in the range of 31-40 ml/min, while 10 per cent of the women were having high average fitness with VO_2 max ranging from 26-30 ml/min followed by very good (6.6%) and excellent (3.3%) physical fitness in the range of VO_2 max 41-45 ml/min and more than 45 ml/min respectively.

From the above findings it can be inferred that the women selected for study were having good and high average physical fitness.

Table 5 Physical fitness of selected women

Classification of physical fitness Vo_2 max (ml/ min)	**Frequency and percentage of women N = 30**
< - 15 Poor	Nil
16-25 Low average	Nil
26-30 High average	03 (10)
31-40 Good	24 (80)
41-45 Very good	02 (6.6)
>- 45 Excellent	01 (3.3)

Figures in the parenthesis indicate percentage.

4.3.1 Body somato types of selected women

Body somato types of selected women is indicated in table 6 and fig.4. Body somato types revealed that majority of the women were in mesomorph body type category (63.3) followed by endomorph category 20 per cent. Whereas 16.6 per cent of women were in ectomorph body type category.

It can be concluded that majority of selected women were in mesomorrph in body type.

Table 6 Body somato types of selected women

Body Somato types	Frequency and percentages N = 30
Ectomorph (< 20)	05(16.6)
Mesomorph(20- 25)	19 (63.3)
Endomorph (>25)	06 (20)

4.4. General information regarding mopping floor of selected women

Information on no. of rooms in the home, time spent, help taken and time of mopping is presented in table 7. It is evident from the table that majority of the women (60%) had 3 to 4 rooms in the home followed by 33.3 percent women had 1 to 2 rooms and 6.6 per cent of women had more than 5 rooms in their houses. Majority of the women (73.33%) mopped 2 rooms daily followed by 1 room (23.33%) and 3 rooms (3.33%) daily.

Majority (86.66%) of women spent 15 min. on mopping floor followed by half an hr (13.33%). Majority 86.66 per cent of the selected women mop the floor

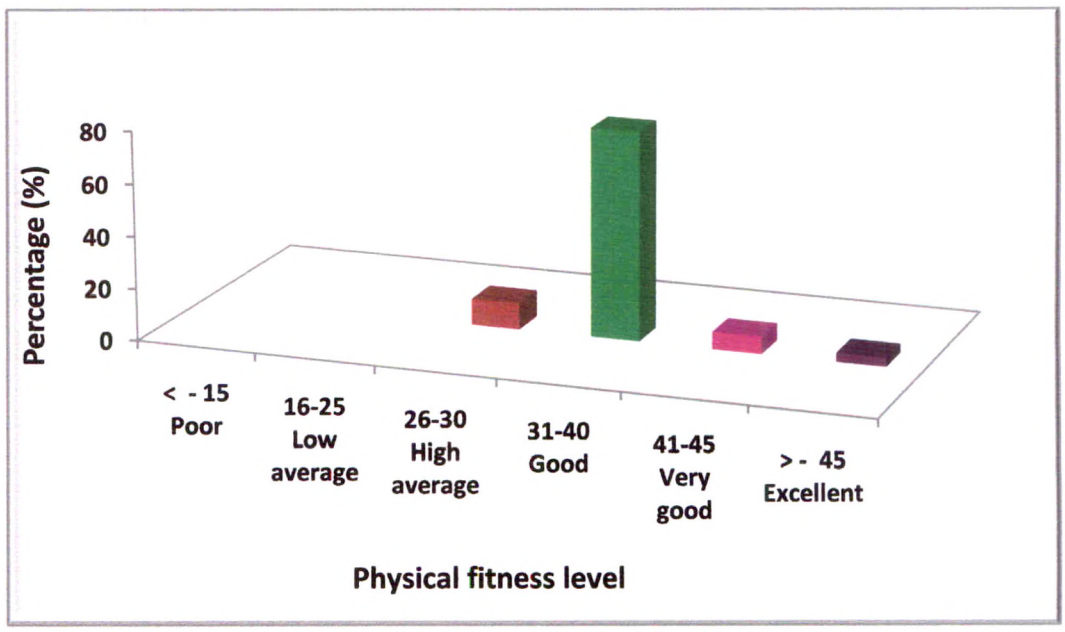


Fig. 3. Physical fitness of selected women

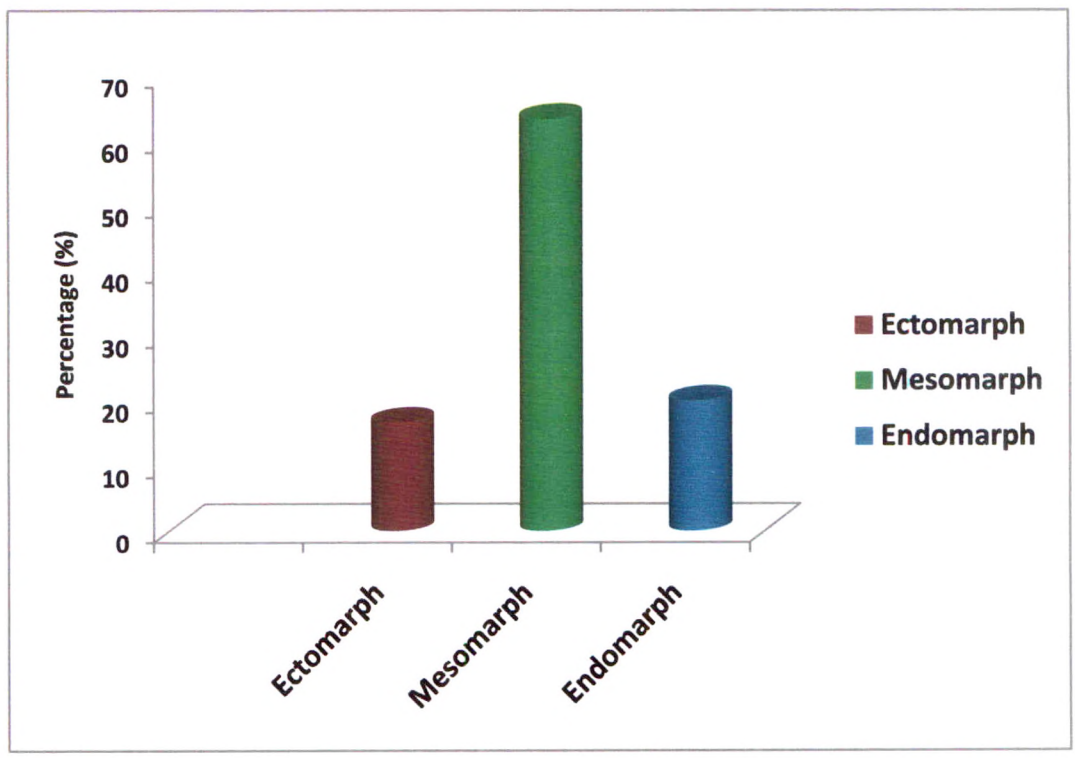


Fig. 4. Body somato types of selected women

personally, none of the women took no paid help, while 13.33 per cent women took help of family members. Percentage of mopping the floor in the morning and afternoon was at par i.e. forty per cent. While very few percentage of women (twenty per cent) mopped floor in the evening time.

Therefore it can be concluded that majority of the women had 3 to 4 rooms in their house, mopped 2 rooms and spent 15 min. daily on mopping floor. Majority 86.66 per cent of women personally mop the floor preferably in the morning or afternoon.

Table 7 General information regarding mopping floor of selected women

Attributes	Frequency N = 30	Percentage
No. of rooms in the home		
1-2	10	33.3
3-4	18	60
5 & above	02	6.6
No. of rooms mopped daily		
1	07	23.33
2	22	73.33
3	01	3.33
4& above	Nil	Nil
Time spent for mopping the floor (min./hrs)		
15 min.	26	86.66
1/2 hr	04	13.33
45min.	Nil	Nil
1hr.	Nil	Nil
More than 1 hr	Nil	Nil
Who does the mopping activity		
personally	26	86.66
Paid help	Nil	Nil
Family members help	04	13.33
Time of mopping the floor		
morning	12	40
Afternoon	12	40
Evening	06	20

4.4.1. Types of marketed mops used by selected women

Type of marketed mops used by selected women for mopping floor is presented in table 8 and illustrated in fig. 5. It is evident from the table that majority of the women used wick mop for mopping the floor (63.33 %) followed by basket mop (23.33%), minimum number of women used felt mop (13.33%) and none of the women used sponge mop and cloth mop for mopping the floor. It can be concluded that majority of women were used wick mop for mopping the floor.

Table 8 Types of marketed mops used by selected women

Type of mops	Frequency N = 30	Percentage
Felt mop	04	13.33
Wick mop	19	63.33
Sponge mop	Nil	Nil
Basket mop	07	23.33
Cloth mop	Nil	Nil

4.4.2 Reasons for using long handle marketed mops by selected women for mopping the floor in standing posture

Table 9 and fig. 6 indicate the reasons for using long handle mops for mopping floor in standing posture. It is clear from the table that majority of women 73 per cent used the mops as they were easy to handle, 66 per cent women expressed that more area can be cleaned and less energy is required for mopping,

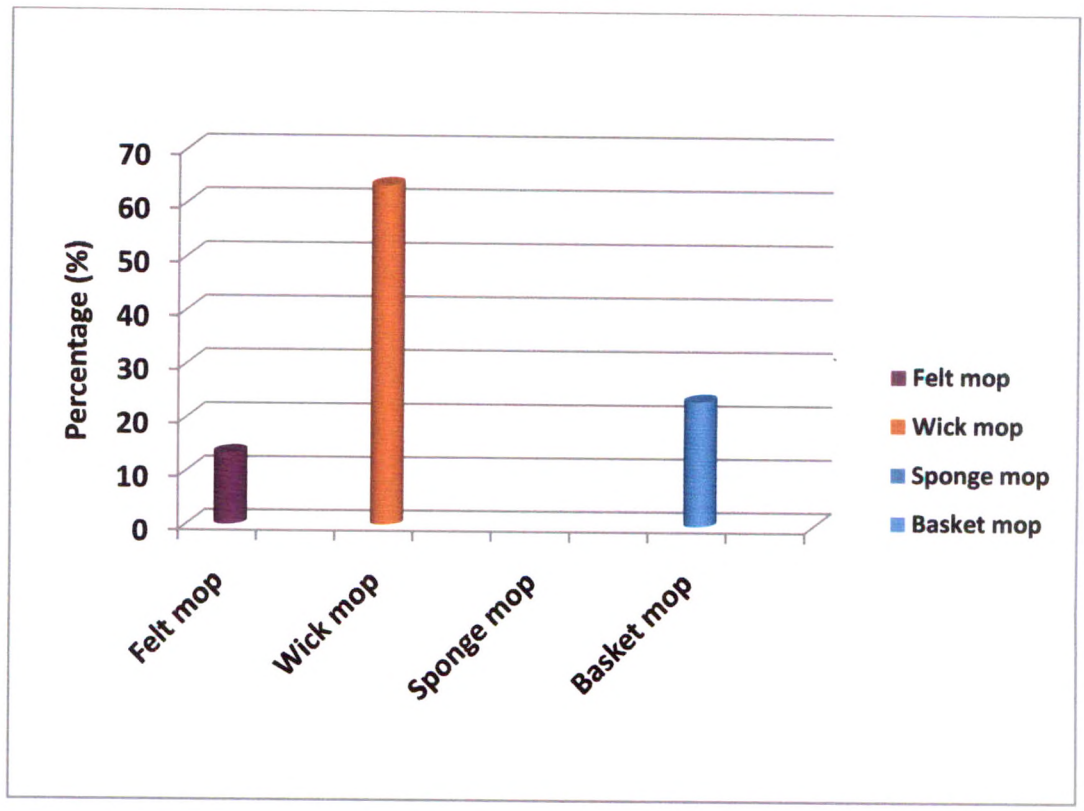


Fig. 5. Types of marketed mops used by selected women

it also requires less time as expressed by 60 per cent women. The other reasons given were easy availability and less cost.

It can be said that the mops were used by selected women because of easy in handling, requires less energy and ease of handling.

Table 9 Reasons for using long handle marketed mops by selected women for mopping the floor in standing posture

Reasons	Frequency N = 30	Percentage
Less cost	10	33.33
Easy to handle	22	73.33
Easily available	15	50
More area can be cleaned	20	66.66
Requires less time	18	60
Requires less energy	20	66.66

4.5. Physiological cost of mopping floor

Physiological cost of mopping floor in squatting and standing posture was carried out and the results are shown in the table 10 and illustrated in fig 7. It is apparent from the table that average working heart rate while mopping floor in squatting posture noted was 106 b.m.$^{-1}$, average resting heart rate was recorded as 83 b.m^{-1}, average recovery heart rate observed that was 91 b.m^{-1} and average peak heart rate recorded during mopping was 115 b.m^{-1}. Cardiac cost of recovery was noted to be 31 b.m^{-1} , cardiac cost of work noted was 354 b.m^{-1}, physiological cost of work 25 b.m^{-1} and total cardiac cost of work was 385 b.m^{-1}. Average working energy expenditure, average resting energy expenditure, average peak energy expenditure and average rate of perceived exertion observed were 8.16 kj.m^{-1}, 4.41 kj.m^{-1} , 9.61 kj.m^{-1}, and 3.06 respectively.

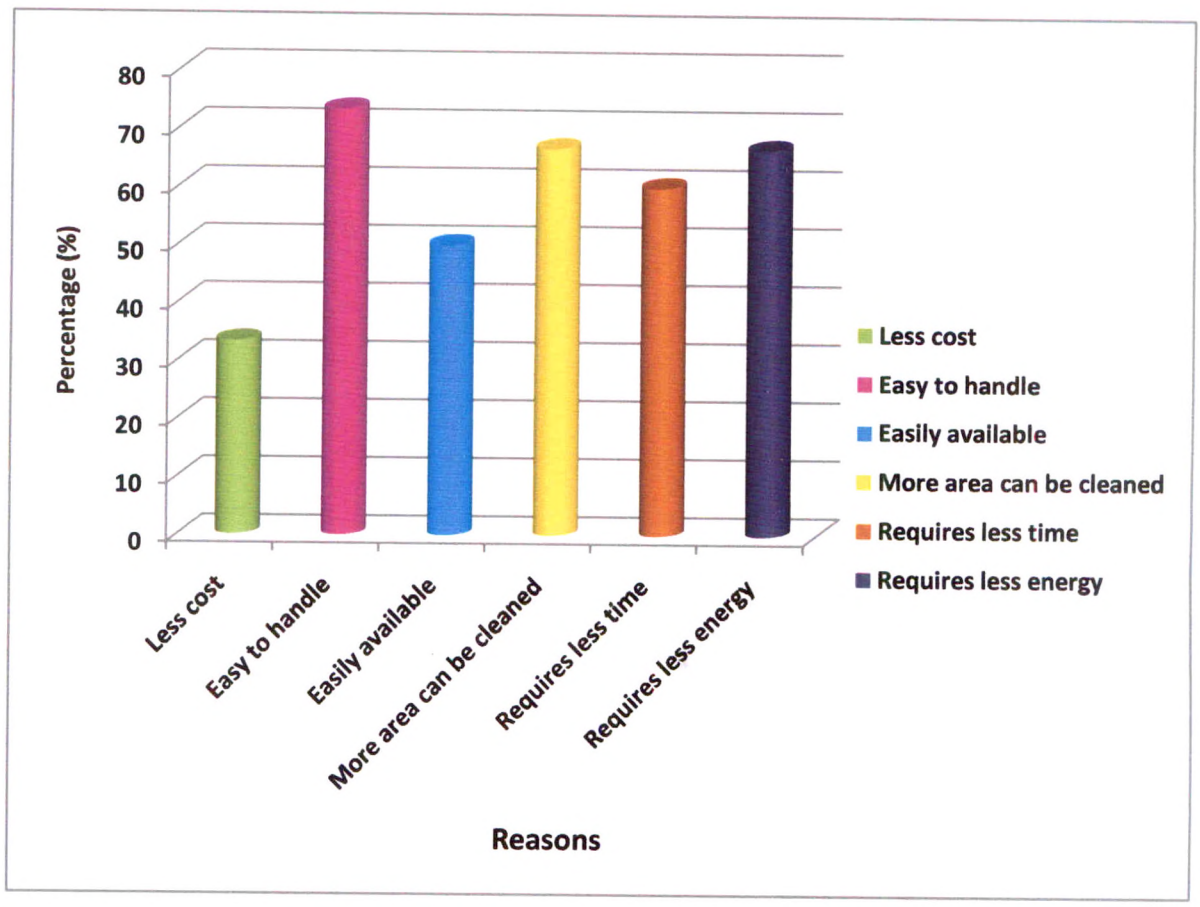


Fig. 6. Reasons for using long handle marketed mops by selected women for mopping the floor in squatting and standing posture

Average working heart rate while mopping floor in standing posture noted was 104 b.m.$^{-1}$ as against the average resting heart rate 83 b.m^{-1}. Average recovery heart rate following mopping was 90 b.m$^{-1.}$ Cardiac cost of recovery was 30 b.m^{-1} , cardiac cost of work noted was 319 b.m^{-1}, while physiological cost of work 23 b.m^{-1} and total cardiac cost of work was 349 b.m^{-1}. Average working energy expenditure, average resting energy expenditure, average peak energy expenditure and average rate of perceived exertion were 7.79 kj.m^{-1}, 4.41 kj.m^{-1} , 9.18 kj.m^{-1}, and 2.43 kj.m^{-1} respectively.

On the basis of above observation it can be said that the physiological cost of mopping the floor in squatting posture was definitely more when compared with standing posture. Since mopping in squatting posture definitely requires more energy than standing posture.

Table 10 Physiological cost of mopping floor

Physiological parameters	Squatting posture	Standing posture
Average working heart rate (b.m^{-1})	106 ± 4.11	104 ± 4
Average resting heart rate (b.m^{-1})	83 ± 4.14	83 ± 4.14
Average recovery heart rate (b.m^{-1})	91 ± 7	90 ± 5.16
Average peak heart rate (b.m^{-1})	115 ± 3.43	113 ± 4.22
Cardiac cost of recovery (b.m^{-1})	31 ± 19	30 ± 22
Cardiac Cost of Work (b.m^{-1})	354 ± 65	319 ± 78.18
Physiological cost of work (b.m^{-1})	25 ± 4.16	23 ± 5.32
Total cardiac cost of work (beats)	385 ± 61	349 ± 80
Average Working energy expenditure (kj.m^{-1})	8.16 ± 0.65	7.79 ±0.59
Average resting energy expenditure (kj.m^{-1})	4.41 ± 0.65	4.41 ± 0.65
Average peak energy expenditure (kj.m^{-1})	9.61 ± 0.54	9.18 ± 0.67
Average RPE	3.06 ± 0.58	2.43 ± 0.50

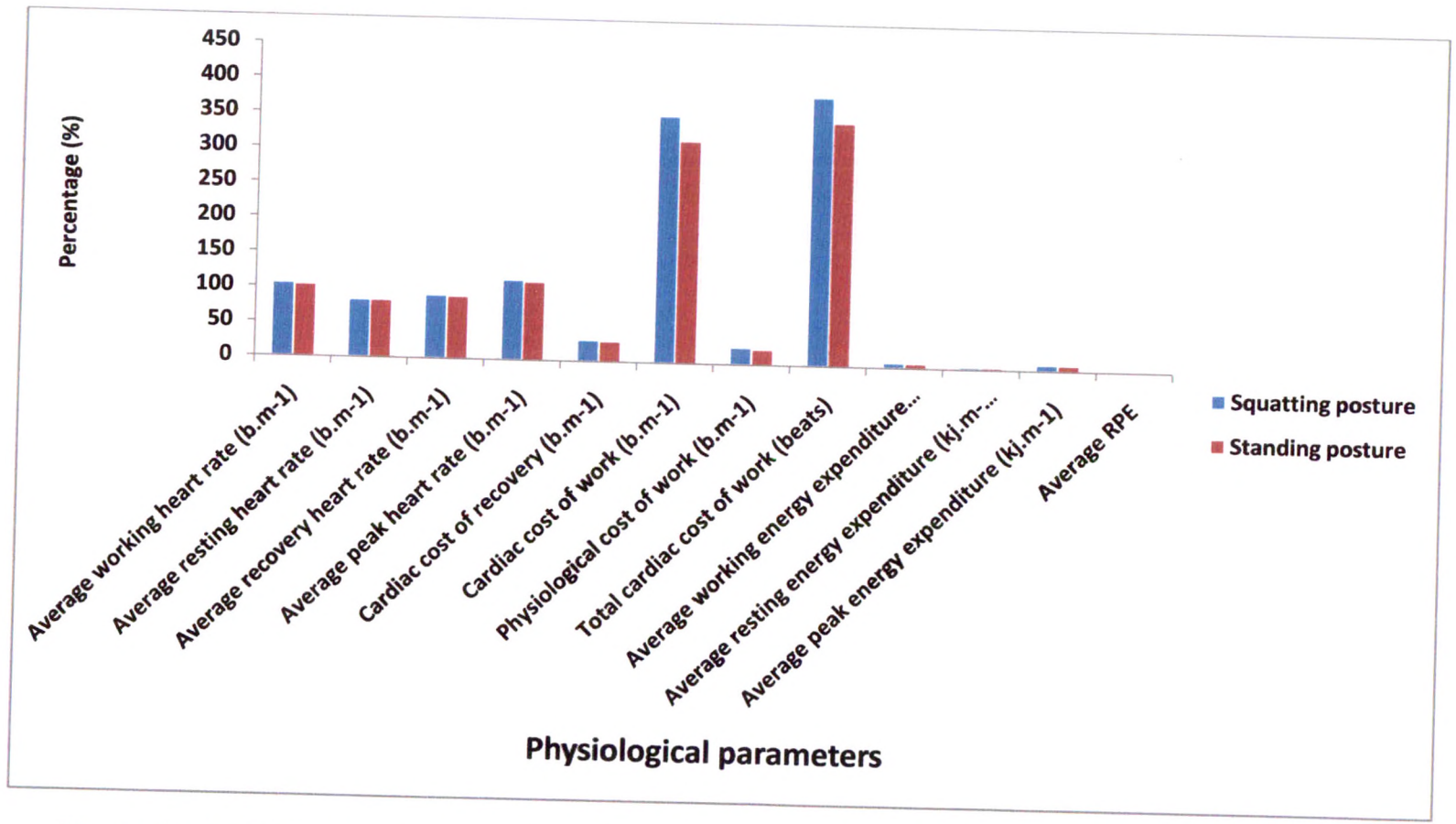


Fig. 7. Physiological cost of mopping floor in squatting and standing posture of selected women

4.6 Perceived exertion experienced by selected women while mopping floor in squatting and standing posture

Posture related drudgery experienced by selected women while mopping floor is shown in table 11 and displayed in fig 8. It is revealed from table that mopping floor in squatting posture was felt moderately heavy by 66.66 per cent women followed by 20 per cent heavy and 13.33 per cent light. None of the response of women was felt mopping floor in squatting posture as very light and very heavy.

Mopping the floor in standing posture was felt light by 56.66 per cent women, followed by 43.33 per cent felt moderately heavy. Whereas none of the women was felt mopping floor in standing posture as very light, heavy, and very heavy.

Statistically there was a significant difference observed between mopping floor in squatting and standing posture. The results are in line with the results of Dandotikar (2002) for more perceived exertion while mopping the floor with cloth mop (Squatting posture).

On the whole it was observed from table that mopping floor in squatting posture was perceived as moderately heavy task by majority of women while mopping floor in standing posture was perceived light task by maximum per cent of women.

It was observed that mopping floor in squatting posture was perceived as moderately heavy by majority of selected women. Statistically significant difference was observed.

Table 11 Perceived exertion experienced by selected women while mopping floor in squatting and standing posture

Posture / Mop	Percentage and frequency of women					Mean	't' Value
	Very light 1	Light 2	Moderately heavy 3	Heavy 4	Very heavy 5		
Squatting (Cloth mop)	Nil	4 (13.33)	20(66.66)	06 (20)	Nil	3.06 ±0.58	6.3 **
Standing (Basket mop)	Nil	17 (56.66)	13 (43.33)	Nil	Nil	2.43± 0.50	

Figures in parentheses indicate percentage

4.7 Angle of postural deviation at cervical, lumbar and elbow joint of the selected women was measured while mopping the floor in squatting and standing posture

Angle of postural deviation at cervical, lumbar and elbow joint of the selected women was measured while mopping the floor in squatting and standing posture. Angle of postural deviation of body of the women while mopping the floor in squatting and standing posture is shown in table 12 and displayed in fig 9.

It is evident from the table that at cervical joint, the mean angle of postural deviation of women while mopping in squatting posture was 8.76° ranged from 6^0-15^0. While it was minimum for mopping floor in standing posture i.e 3.63° ranged from 2^0- 5^0 .

At lumbar joint the mean angle of postural deviation of women while mopping in squatting posture was 12.33^0 ranged from 8 to 20^0. The mean angle of postural deviation of women at lumbar joint while mopping in standing posture

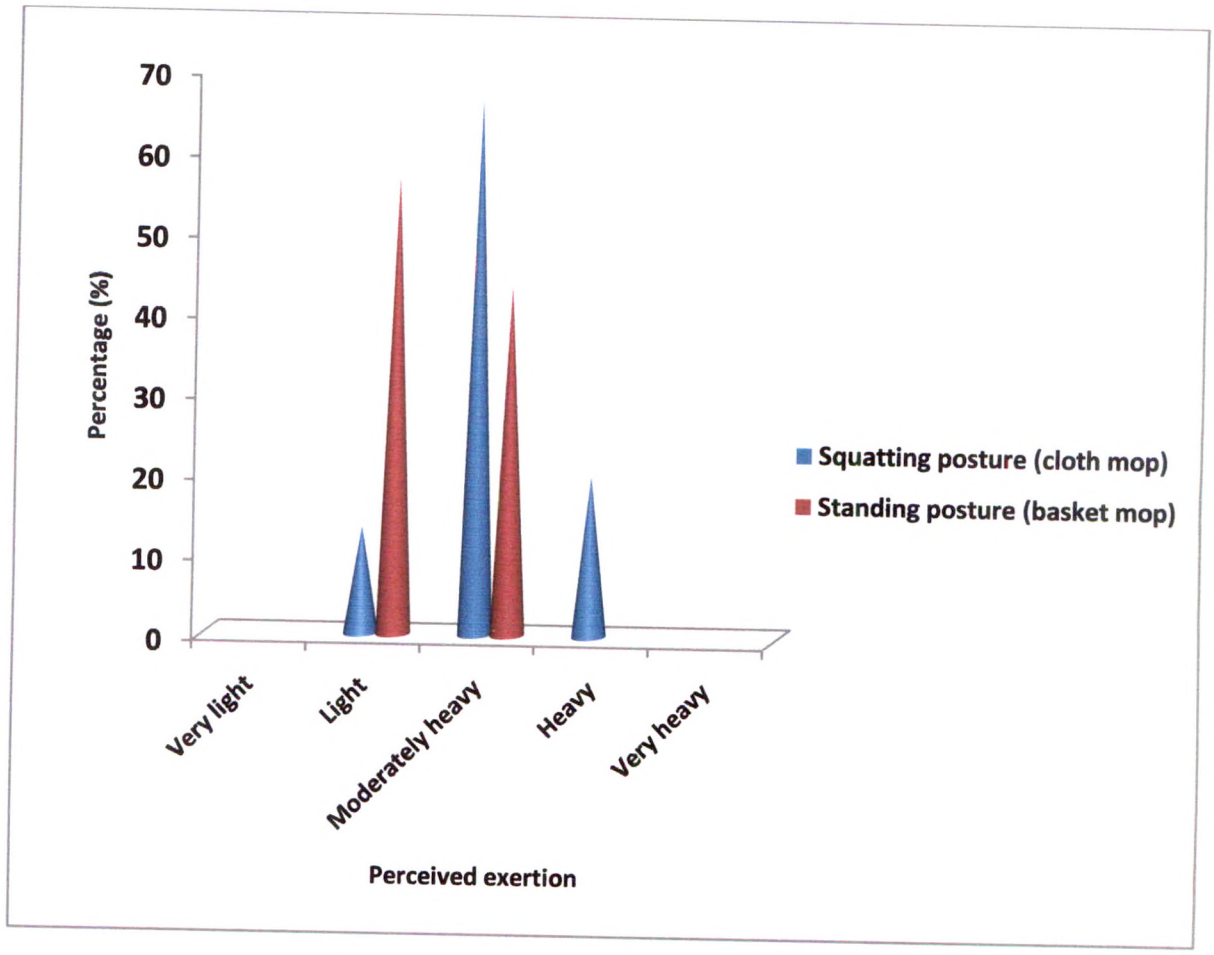


Fig. 8. Perceived exertion experienced by selected women while mopping floor in squatting and standing posture

was 3.83^0 ranged from 2 to 6^0 which was minimum as compared to squatting posture.

In case of elbow joint the mean angle of postural deviation was 7.56^0 ranged between 5 to 10^0 while mopping floor in squatting posture. The mean angle of postural deviation of women at elbow joint while mopping floor in standing posture was 4.5^0 ranged from 3 to 7^0.

Calculation of 't' values showed a highly significant difference between angle of postural deviation at cervical, lumbar and elbow joint while mopping floor in squatting and standing posture.

On the whole it can be said that the body was deviating more at cervical, lumbar and elbow joint while mopping in squatting posture which may be because in squatting posture women had to bend at cervical, lumbar and elbow joint. Statistically 't' values showed a significant difference between angle of deviation at cervical, lumbar and elbow joint while mopping in squatting and standing posture. Mopping in squatting posture was more exerting as it recorded a greater deviation of body from the normal position which disturbs blood circulation to the muscles resulting in musculo skeletal problems in women in the long run.

Table 12. Angle of postural deviation at cervical, lumbar and elbow joint of the selected women was measured while mopping the floor in squatting and standing posture

Posture / Mop	Postural deviation($<^0$) at cervical joint			Postural deviation ($<^0$) at lumbar joint			Postural deviation ($<^0$) at elbow joint		
	Range	Average	't' value	Range	Average	't' value	Range	Average	't' value
Squatting (Cloth mop)	6 – 15	8.76 ± 2.84	9.5 **	8 – 20	12.33 ±3.46	13.07**	5 – 10	7.56 ± 1.65	9**
Standing (Basket mop)	2 – 5	3.63 ± 1.03		2 – 6	3.83 ± 1.08		3 – 7	4.5 ± 1.008	

** : Highly significant at 1 % level

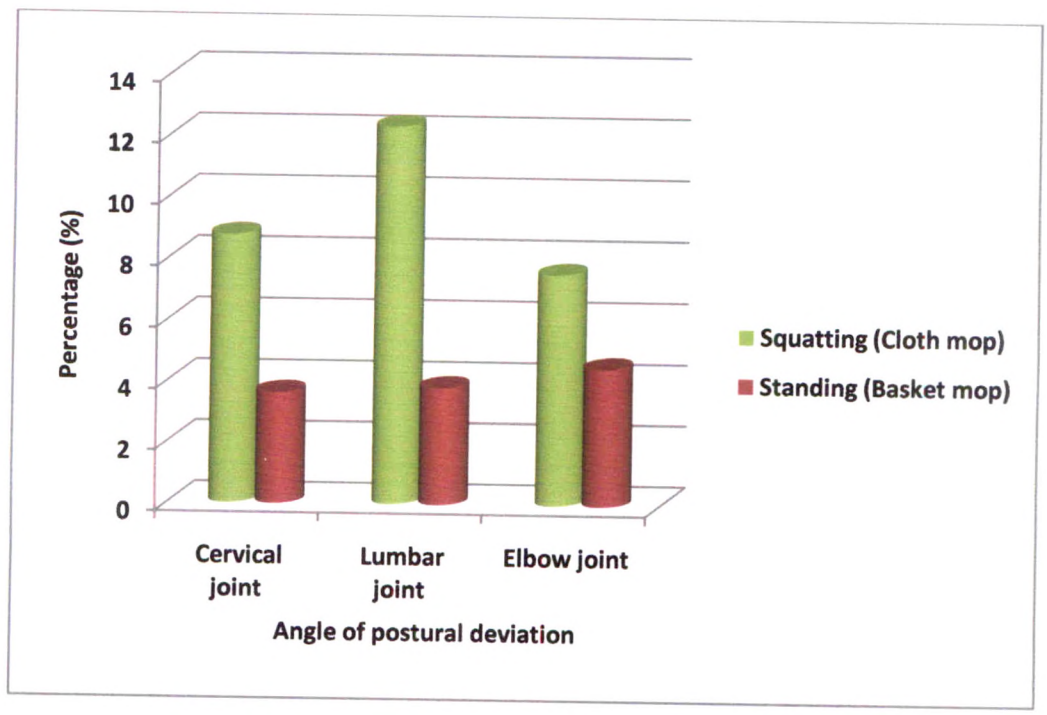


Fig. 9 Angle of postural deviation at cervical, lumbar and elbow joint of the selected women was measured while mopping the floor in squatting and standing posture

4.8. Pain experienced by selected women due to mopping floor in squatting and standing posture

Pain experienced by selected women due to mopping floor in squatting and standing posture is presented in table 13 and illustrated in fig 10. It is cognizant from the table that the mopping floor was not painful for majority of selected women 33.33 and 50 per cent in squatting and standing posture, while pain in wrist while mopping was reported by 13.33 and 10 per cent women. Similarly pain in knee joint was reported by 23.33 and 6.66 per cent women followed by pain in neck 10 and 6.66 per cent and pain in lower back was 20 and 13 per cent. Pain in leg was experienced by 20 per cent women while mopping in standing posture. However the pain reported by the selected women due to handling of mop and improper use of posture.

On the whole it can be conclude that mopping activity was not painful for selected women in squatting and standing posture. Majority of the selected women having pain in knee joint followed by pain in lower back while mopping in squatting posture

Table 13 Pain experienced by selected women due to mopping floor in squatting and standing posture

Pain	Frequency and Percentage	
	Squatting (Cloth mop)	Standing (Basket mop)
No pain	10 (33.33)	15 (50)
Pain in wrist	04 (13.33)	03 (10)
Pain in the knee joint	07 (23.33)	02 (6.66)
Pain in neck	03 (10)	02 (6.66)
Pain in lower back	06 (20)	02 (6.66)
Pain in leg	Nil	06 (20)

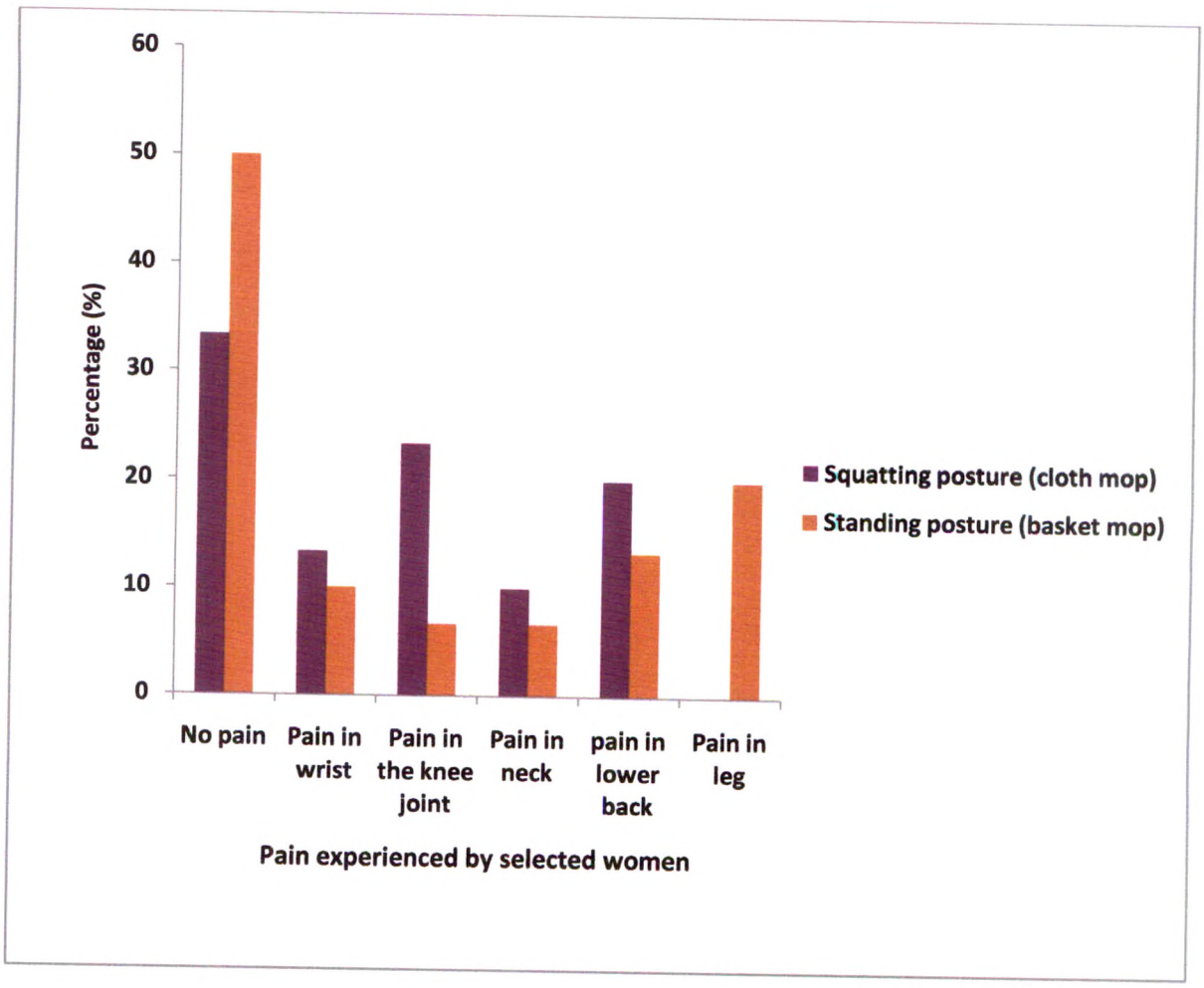


Fig. 10. Pain experienced by selected women due to mopping the floor in squatting and standing posture

4.8.1 Reasons expressed by selected women for pain due to mopping the floor in squatting and standing posture

Reasons expressed by selected women for pain due to mopping the floor in squatting and standing posture are presented in table 14. It is clear from the table that reasons expressed by selected women for pain due to mopping the floor in squatting posture was repetitive squatting posture experienced (pain in lower back) 20 per cent, repetitive lifting of bucket and squeezing of mop (pain in wrist) 13.33 per cent, repetitive standing & bending experienced (pain in knee) 23.33 per cent, repetitive bending in neck experienced (pain in neck) 10 per cent and 33.33 per cent women did not experienced pain due to mopping so that reasons were not expressed.

The reasons expressed by selected women for pain due to mopping the floor in standing posture was repetitive lifting and holding of mop handle and basket experienced (pain in lower back) 6.66 per cent, frequently lifting and handling rod of the mop & basket (pain in wrist) 10 per cent, repetitive movements of leg experienced (pain in leg) 20 per cent, repetitive movements of knee for squeezing the mop (pain in knee) 6.66 per cent, repetitive movements of neck experienced pain in neck 6.66 per cent and 43.33 per cent women did not experienced any pain due to mopping so that reasons were not expressed.

On the whole it can be concluded that reasons expressed by selected women regarding pain due to mopping floor in squatting posture were repetitive standing and bending (pain in knee joint), repetitive squatting posture (pain in lower back) and repetitive lifting of bucket and squeezing of mop (pain in wrist). While mopping in standing posture the reasons expressed by selected women were repetitive movements of leg (pain in leg) and frequently lifting and handling rod of the mop & basket (pain in wrist).

Table 14. Reasons expressed by selected women for pain due to mopping the floor in squatting and standing posture

Reasons (Squatting posture)	Frequency and Percentage of women	Reasons (Standing posture)	Frequency and Percentage of women
Repetitive squatting posture experienced pain in lower back	06 (20)	pain in lower back	02 (6.66)
Repetitive Lifting of bucket and squeezing of mop experienced pain in wrist	04 (13.33)	Frequently lifting and handling rod of the mop & basket experienced pain in wrist	03 (10)
Repetitive movements of leg experienced pain in leg	Nil	Repetitive movements of leg experienced pain in leg	06 (20)
Repetitive standing and bending experienced pain in knee	07 (23.33)	Repetitive movements of knee for squeezing of mop experienced pain in knee	02 (6.66)
Repetitive bending neck experienced pain in neck	03 (10)	Repetitive movements of neck experienced pain in neck	02 (6.66)
Experienced no pain	10 (33.33)	Experienced no pain	15 (50)

4.9 Statistical implications

4.9.1 Comparison between physiological cost of mopping floor in squatting and standing posture of selected women

Assessment of physiological cost of mopping floor in squatting and standing posture was carried out and the results are shown in the table 15. It is apparent from the table that physiological parameters of selected women such as average working heart rate (104 $b.m^{-1}$), average recovery heart rate (90 $b.m^{-1}$), average peak heart rate (113 $b.m^{-1}$), cardiac cost of recovery (30), cardiac cost of work (319),

physiological cost of work (23 $b.m^{-1}$), and total cardiac cost of work (349 beats), average working energy expenditure (7.79 $kj.m^{-1}$), average peak energy expenditure (9.18 $kj.m^{-1}$), average RPE (2.4) were less in mopping the floor in standing posture as compared to the mopping in squatting posture. Whereas average resting heart rate (83 $b.m^{-1}$) and average resting energy expenditure (4.41$kj.m^{-1}$) were same in both mopping the floor in squatting and standing posture.

Statistical analysis with 't' test manifested significant reduction in average peak heart rate (t= 2.04*), average working energy expenditure (t= 2.64*), average peak energy expenditure (t= 3.07**) and average RPE (t= 6.3**) of women when mopping the floor in squatting and standing posture.

On the whole it can be concluded that the physiological cost of mopping the floor in squatting posture was more as compared to standing posture. Statistically 't'value revealed the significant results, which indicated that average working heart rate, average peak heart rate, average working energy expenditure, average RPE and average peak energy expenditure was reduced significantly when mopping the floor was carried out in standing posture.

Table 15 Comparison between Physiological cost of mopping floor in squatting and standing posture of selected women

Physiological parameters	Squatting posture	Standing posture	Reduction/ Increase	't' values
Average working heart rate ($b.m^{-1}$)	106 ± 4.11	104 ± 4	2 (1.8)	2 NS
Average resting heart rate ($b.m^{-1}$)	83±4.14	83±4.14	0	0
Average recovery heart rate ($b.m^{-1}$)	91±7	90± 5.16	1(1.1)	0.6
Average peak heart rate ($b.m^{-1}$)	115 ±3.43	113 ±4.22	2 (1.7)	2.04*
Cardiac cost of recovery ($b.m^{-1}$)	31±19	30±22	1(3.2)	0.18
Cardiac cost of work ($b.m^{-1}$)	354±65	319±78.18	35(9.8)	1.88
Physiological cost of work ($b.m^{-1}$)	25 ±4.16	23±5.32	2 (8)	1.62
Total cardiac cost of work (beats)	385 ±61	349 ±80	36 (9.3)	1.96
Average working energy expenditure ($kj.m^{-1}$)	8.16±0.65	7.79±0.59	0.37(4.5)	2.64*
Average resting energy expenditure ($kj.m^{-1}$)	4.41± 0.65	4.41± 0.65	0 (0)	0
Average peak energy expenditure ($kj.m^{-1}$)	9.61± 0.54	9.18± 0.67	0.43(4.4)	3.07**
Average RPE	3.06 ± 0.58	2.43± 0.50	-0.63(20.58)	6.3**

NS : Non significant ***: Significant at 5% level** **** : Highly significant at 1 % level**

4.9.2. Correlation of age of women with selected variables of physiological cost while mopping the floor in squatting and standing posture.

Correlation of age of women with selected variables of physiological cost while mopping the floor in squatting and standing posture is presented in table 16. Statistically the correlation between age of women and physiological cost of work, total cardiac cost of work, average working energy expenditure, average resting energy expenditure, average peak energy expenditure and average RPE was non significant while mopping floor in squatting and standing posture.

Table 16 Correlation of age of women with selected variables of physiological cost while mopping the floor in squatting and standing posture

Physiological parameters / Age	Type of posture	
	Squatting (Cloth mop) 'r' Value	Standing (Basket mop) 'r' Value
Physiological cost of work ($b.m^{-1}$)	0.13^{NS}	-0.06^{NS}
Total cardiac cost of work (beats)	0.10^{NS}	-0.07^{NS}
Average working energy expenditure ($kj.m^{-1}$)	0.18^{NS}	0.03^{NS}
Average resting energy expenditure ($kj.m^{-1}$)	0.07^{NS}	0.07^{NS}
Average peak energy expenditure ($kj.m^{-1}$)	-0.081^{NS}	-0.10^{NS}
Average RPE	0.14^{NS}	0.0005^{NS}

NS : Non significant

4.9.3 Correlation of weight of women with selected variables of physiological cost while mopping the floor in squatting and standing posture

Correlation of weight of women with selected variables of physiological cost while mopping floor in squatting and standing posture is indicated in table 17. Statistical analysis with correlation coefficient revealed a significant correlation between body weight of women and average peak energy expenditure while mopping in squatting posture (r = 0.44*) and while mopping in standing posture (r = 0.35*).

Statistically the correlation between body weight of women and physiological cost of work, total cardiac cost of work, average working energy expenditure, average resting energy expenditure and average RPE of women while mopping floor in squatting and standing posture was non significant.

On the whole it can be concluded that correlation coefficient revealed a significant correlation between body weight of women and average peak energy expenditure while mopping in squatting and standing posture.

Table 17 Correlation of weight of women with selected variables of physiological cost while mopping floor in squatting and standing posture

Physiological parameters / Weight	Type of posture	
	Squatting (Cloth mop) 'r' Value	Standing (Basket mop) 'r' Value
Physiological cost of work ($b.m^{-1}$)	-0.19^{NS}	-0.028^{NS}
Total cardiac cost of work (beats)	-0.21^{NS}	-0.02^{NS}
Average working energy expenditure ($kj.m^{-1}$)	0.038^{NS}	0.28^{NS}
Average resting energy expenditure ($kj.m^{-1}$)	0.31^{NS}	0.31^{NS}
Average peak energy expenditure ($kj.m^{-1}$)	0.44*	0.35*
Average RPE	0.05^{NS}	0.21^{NS}

NS : Non significant ***: Significant at 5 % level**

4.9.4 Correlation of height of women with selected variables of physiological cost while mopping the floor in squatting and standing posture

Correlation of height of women with selected variables of physiological cost while mopping the floor in squatting and standing posture is reported in table 18. Computation of correlation coefficient recorded a significant correlation between body height of women and selected variables such as physiological cost of work (0.41*), total cardiac cost of work (0.41*) and average peak energy expenditure while mopping floor in standing posture (0.38) .Which shows that as the height of

women increases the physiological parameters such as physiological cost of work, total cardiac cost of work and average peak energy expenditure also increases while mopping the floor in standing posture.

Statistically the correlation between height of women and physiological cost of work (except standing posture), total cardiac cost of work, average working energy expenditure, average resting energy expenditure, average peak energy expenditure and average RPE was non significant.

On the whole it can be concluded that physiological parameters such as physiological cost of work, total cardiac cost of work and average peak energy expenditure significantly correlated with height of the women while mopping the floor in standing posture.

Table 18 Correlation of height of women with selected variables of physiological cost while mopping the floor in squatting and standing posture

Physiological parameters / Height	Type of posture	
	Squatting (Cloth mop) 'r' Value	Standing (Basket mop) 'r' Value
Physiological cost of work ($b.m^{-1}$)	0.25^{NS}	0.41*
Total cardiac cost of work (beats)	0.24^{NS}	0.41*
Average working energy expenditure ($kj.m^{-1}$)	-0.17^{NS}	0.10^{NS}
Average resting energy expenditure ($kj.m^{-1}$)	-0.31^{NS}	-0.31^{NS}
Average peak energy expenditure ($kj.m^{-1}$)	0.19^{NS}	0.38*
Average RPE	0.12^{NS}	0.13^{NS}

NS : Non significant ***: Significant at 5 % level**

4.9.5 Correlation of age, weight and height of women with postural deviation while mopping the floor in squatting and standing posture

Table 19 indicate correlation of age, weight and height of women with postural deviation while mopping the floor in squatting and standing posture.

Age :-

It is evident from the table that the mean age of the I group (25 – 30 yrs) was 27.07 yrs and mean age of II group (31 – 35 yrs) was 34 yrs. Correlation coefficient test revealed that I age group (25 – 30 yrs) of the selected women was highly significantly correlated with angle of postural deviation at cervical joint (0.53**) while mopping in standing posture and also showed a significant correlation with angle of postural deviation at elbow joint (0.38*) while mopping floor in squatting posture.

A non significant correlation was revealed with the I age group (25 – 30 yrs) with cervical joint (in case of squatting posture), lumbar joint in both the postures and elbow joint (in case of standing posture). With regard to the II age group (31 – 35 yrs) non significant correlation was observed with cervical, lumbar and elbow joint in squatting and standing posture while mopping floor.

Weight :-

The mean weight of the I group (40 – 50 kg) was 48.07 kg and mean weight of the II group (51 – 60 kg) was 55 kg. Weight of selected women was correlated with postural deviation while mopping the floor in squatting and standing posture. There was a negative highly significant correlation between I group of weight (40 – 50 kg) with mopping floor in standing posture (- 0.52**). It was found that as the weight of women increases their angle of deviation at cervical joint decreases while mopping floor in standing position.

Statistically the correlation between weight of women in the I group (40-50 kg) with cervical joint (in case of squatting posture), lumbar and elbow joint while mopping in squatting and standing posture was non significant. It was also found that weight of the women in the II group (51 – 60 kg) showed non significant correlation with cervical, lumbar and elbow joint while mopping floor in squatting and standing posture.

Height :-

The mean height of the I group (135 – 145 cm), II group (146 – 155 cm) and III group (156 – 165 cm) were 142.28 cm, 149.82 cm and 161.33 cm respectively. It is clearly seen from the table that women in I group of height (135-145 cm) showed negative highly significant correlation with angle of postural deviation at cervical (-0.65**) and lumbar joint (-0.55**) while mopping in squatting posture. The women in the II group of height (146-155 cm) showed negatively significant correlation with angle of postural deviation at cervical joint (- 0.42*) while mopping in squatting posture. It was found that as the height of women increases their angle of deviation at cervical joint and lumbar joint decreases while mopping floor in squatting posture.

While women in the II group of height (156 – 165 cm) showed highly significant correlation with angle of postural deviation at cervical joint (0.54**), and significant correlation with lumbar joint (0.42*) while mopping in squatting posture. A negatively highly significant correlation was observed with angle of postural deviation at cervical joint (- 0.58**), and negative significant correlation at lumbar joint (- 0.36*) while mopping in standing posture. Indicated that as the height of selected women increased the angle of deviation at cervical and lumbar joint decreased.

Statistically non significant correlation was observed between height of the women in I group (135 – 145 cm) with angle of postural deviation at cervical joint and lumbar joint (in case of standing posture) and elbow joint (both squatting and standing posture). In case II group of height (146 – 155 cm) showed non significant

correlation with cervical joint in case of standing posture, lumbar and elbow joint while mopping in squatting and standing posture. Women in the III group (156 – 165 cm) showed non significant correlation with angle of deviation at elbow joint while mopping in squatting and standing posture.

On the whole it can be concluded that statistically age of women in I group (25 – 30 yrs.) was highly significant with angle of postural deviation at cervical joint (0.53**) while mopping in standing posture and significantly correlated with angle of postural deviation at elbow joint (0.38*).

Second group of weight (40 – 50 kg) of women was negatively highly significant with angle of deviation at cervical joint (- 0.52**) while mopping in standing posture.

Negatively highly significant correlation was found in I group of height (135 – 145 cm) of women and angle of postural deviation at cervical and lumbar joint (- 0.65** and – 0.55**) while mopping in squatting posture. For II group (146 - 155 cm) of height negative significant correlation was observed with cervical joint (- 0.42*). Women in the III group (156 – 165 cm) of height showed highly significant correlation with cervical joint (0.54**) and significant correlation with lumbar joint (0.42*) while mopping in squatting and standing posture. Women in the III group (156 – 165 cm) of height showed negatively highly significant correlation with angle of postural deviation at cervical joint (- 0.58**) while mopping in squatting posture and significant correlation with angle of postural deviation at lumbar joint (0.42*) while mopping in standing posture.

Table 19 Correlation of age, weight and height, of women with postural deviation while mopping the floor in squatting and standing posture

Personal Variables	Mean	Postural deviation (< ^{0}) at cervical joint		Postural deviation (< ^{0}) at Lumbar joint		Postural deviation (< ^{0}) at Elbow joint	
		Squatting 'r' Value	Standing 'r' Value	Squatting 'r' Value	Standing 'r' Value	Squatting 'r' Value	Standing 'r' Value
Age							
25 - 30	27.07 ± 2.20	0.08 ^{NS}	0.53**	-0.06 ^{NS}	0.08 ^{NS}	0.38*	0.26 ^{NS}
31 - 35	34 ± 1.50	0.12 ^{NS}	0.128 ^{NS}	-0.07 ^{NS}	-0.27 ^{NS}	0.32 ^{NS}	-0.11 ^{NS}
Weight							
40 - 50	48.07 ± 2.94	0.25 ^{NS}	-0.52**	0.16 ^{NS}	-0.19^{NS}	-0.25^{NS}	-0.18 ^{NS}
51 – 60	55 ± 2.96	0.13 ^{NS}	0.06 ^{NS}	-0.28 ^{NS}	0.26 ^{NS}	0.33 ^{NS}	0.16 ^{NS}
Height							
135 - 145	142.28 ± 1.97	-0.65**	-0.33 ^{NS}	-0.55**	0.27 ^{NS}	0.07 ^{NS}	0.18 ^{NS}
146 - 155	149.82 ± 2.69	- 0.42*	-0.02 ^{NS}	0.32 ^{NS}	-0.03 ^{NS}	-0.30 ^{NS}	-0.24 ^{NS}
156 – 165	161.33 ± 1.96	0.54**	-0.58**	0.42*	-0.36*	-0.20 ^{NS}	-0.31 ^{NS}

NS : Non significant , *: Significant at 5 % level; ** : Highly significant at 1 % level

4.9.6 Correlation of age, weight and height, of women with perceived exertion while mopping the floor in squatting and standing posture

Correlation of age, weight, height, of women with perceived exertion while mopping floor in squatting and standing posture is shown in table no.20 . Correlation coefficient test revealed that independent variables such as age, weight and height of women and perceived exertion while mopping floor in squatting and standing posture was non significant.

Table 20 Correlation of age, weight and height, of women with perceived exertion while mopping the floor in squatting and standing posture

Personal Variables and Posture	Perceived exertion	
	Squatting 'r' Value	Standing 'r' Value
Age		
25 – 30	0.14^{NS}	0.005^{NS}
31 - 35	-0.06^{NS}	0.08^{NS}
Weight		
40 – 50	0.05^{NS}	0.21^{NS}
51 - 60	0.13^{NS}	0.26^{NS}
Height		
135 – 145	0.12^{NS}	0.13^{NS}
146 – 155	0.07^{NS}	0.18^{NS}
156 – 165	-0.20^{NS}	-0.31 NS

NS : Non significant

4.9.7 Correlation of perceived exertion with selected parameters of physiological cost while mopping floor in squatting and standing posture

Correlation of perceived exertion with selected parameters of physiological cost while mopping floor in squatting and standing posture is presented in table 21. The mean physiological cost of work was 25 $b.m^{-1}$, mean total cardiac cost of work was 385 beats, mean average working energy expenditure was 8.16 $kj.m^{1}$, mean average resting energy expenditure was 4.41 $kj.m^{1}$ and mean average peak energy expenditure was 9.61 $kj.m^{1}$. Statistical analysis of correlation coefficient revealed a highly significant correlation of perceived exertion with physiological cost of work (0.479**), total cardiac cost of work (0.456**) and average working energy expenditure (0.470**) while mopping floor in squatting posture. Significant correlation of perceived exertion was seen with average peak energy expenditure (0.375*) while mopping floor in squatting posture. Which indicates that as the physiological cost of work increases the rate of perceived exertion also increases while mopping floor in squatting posture.

The mean physiological cost of work was 23, mean total cardiac cost of work was 349, mean average working energy expenditure was 7.79, mean average resting energy expenditure was 4.41 and mean average peak energy expenditure was 9.18. Perceived exertion showed highly significant correlation with physiological cost of work (0.546**), total cardiac cost of work (0.545**) and average working energy expenditure (0.856**) while mopping floor in standing posture. There was a significant correlation between perceived exertion with average peak energy expenditure (0.430*). Which indicates that as the physiological cost of work increases the rate of perceived exertion also increases

while mopping floor in standing posture. However non significant correlation of perceived exertion was found with average resting heart rate.

This findings are similar with the results of Kumar (2014) stating that there was less perceived exertion observed during cleaning floor when the long handle cleaning tool was used than that of the "traditional broom" by professional cleaners.

On the whole it can be concluded that perceived exertion showed highly significant correlation with physiological cost of work, total cardiac cost of work and average working energy expenditure while mopping floor in squatting and standing posture. Perceived exertion showed significant correlation with average peak energy expenditure while mopping floor in squatting and standing posture.

Table 21 Correlation of perceived exertion with selected parameters of physiological cost while mopping floor in squatting and standing posture

Physiological parameters	Type of posture			
	Squatting (Cloth mop)	Squatting (Cloth mop)	Standing (Basket mop)	Standing (Basket mop)
Perceived exertion	Mean	'r' Value	Mean	'r' Value
1. Physiological cost of work ($b.m^{-1}$)	25±4.16	0.479**	23±5.32	0.546**
2. Total cardiac cost of work (beats)	385±61	0.456**	349±80	0.545**
3. Average working energy expenditure ($kj.m^{1}$)	8.16±0.65	0.470**	7.79±0.59	0.856**
4. Average resting energy expenditure ($kj.m^{-1}$)	4.41±0.65	0.064^{NS}	4.41± 0.65	-0.025^{NS}
5. Average peak energy expenditure ($kj.m^{-1}$)	9.61±0.54	0.375*	9.18±0.67	0.430*

NS : Non significant , **: Higly significant at 1 % level , *: Significant at 5 % level

SUMMARY AND CONCLUSIONS

CHAPTER V

SUMMARY AND CONCULSSIONS

The present study entitled "Comparative study of mopping floor in squatting and standing posture of selected women" was planned with main objective of assessing physiological cost of mopping floor. This investigation consisted survey and experiment which was conducted in the different localities of the Parbhani city among thirty selected women between the age of 25 - 35 yrs were selected randomly for the study. The questionnaire was used to collect information on family background, drudgery and pain experienced by selected women while mopping floor in squatting and standing posture. The data with respect to anthropometry, body temperature, blood pressure, heart rate (resting and recovery), energy expenditure and postural deviation of selected women were recorded in the observation schedule.

Salient findings of the study are briefed below:

Majority of the women were in the age group 31-35 years belonging to nuclear families with 2-4 family members and earning monthly income Rs. 10000 – 15000/-, having body weight ranging between 51-60 kg with range of body height 146-155 cm. The difference between mean body temperature before and after mopping floor in squatting posture was more and the difference is statistically significant. Blood pressure of selected women before and after mopping floor in squatting and standing posture was calculated. Slight rise in systolic pressure was found while mopping the floor in squatting posture. However 't' value was significant for systolic pressure while mopping floor in squatting posture.

The mean stature of women was 150.3 cm followed by normal standing height and elbow height were 147.2 cm and 97.7 cm respectively. The mean

palm and hand length were 17.17 cm and 69.13 cm respectively and the mean grip strength was 18.66 . The mean lower position arm reach height and arm length were 78.36 cm and 66.13 cm respectively.

The mean normal squatting height of selected women was 93.3 cm, knee to knee distance 31.9 cm, and maximum arm reach forward length 72.3 cm, and squatting side arm reach right hand was 70.4 cm. Squatting lower position arm length was 67.13.

The women selected for study were having good and high average physical fitness. Majority of selected women were in mesomorphs in body type.

Majority of the women had 3 to 4 rooms in their house, daily mopped 2 rooms and spent 15 min. on mopping floor. Majority 86.66 per cent of women personally mopped the floor preferably in the morning or afternoon .

Majority of women used wick mop for mopping the floor and reasons expressed for using the mop were easy in handling, requires less energy and ease of handling.

The physiological cost of mopping the floor in squatting posture was more as compared to standing posture.

Mopping floor in squatting posture was perceived as moderately heavy task by majority of women while mopping floor in standing posture was perceived light task by maximum per cent of women. Statistically significant difference was observed.

The body was deviating more at cervical, lumbar and elbow joint while mopping in squatting posture which is because in squatting posture women had to bend at cervical, lumbar and elbow joint which showed a significant difference.

Mopping activity was not painful for selected women in squatting and standing posture. Majority of the selected women were having pain in knee joint followed by pain in lower back while mopping in squatting posture. Majority of selected women did not experienced pain due to mopping floor followed pain in knee joint, pain in lower back and pain in wrist while mopping floor in squatting posture. While majority of selected women did not experience pain due to mopping floor followed pain in leg and pain in wrist while mopping floor in standing posture.

The physiological cost of mopping the floor in squatting posture was more as compared standing posture. Average working heart rate, average peak heart rate, average working energy expenditure, average RPE and average peak energy expenditure reduced significantly when mopping the floor in standing posture.

Statistically the correlation between age of women and physiological cost of work, total cardiac cost of work, average working energy expenditure, average resting energy expenditure, average peak energy expenditure and average RPE was non significant while mopping floor in squatting and standing posture.

Correlation coefficient revealed a significant correlation between body weight of women and average peak energy expenditure while mopping in squatting and standing posture.

Physiological parameters such as physiological cost of work, total cardiac cost of work and average peak energy expenditure significantly correlated with height of the women while mopping the floor in standing posture.

Statistically age of women in I group (25 – 30 yrs) was highly significant with angle of postural deviation at cervical joint while mopping in standing posture and significantly correlated with angle of postural deviation at elbow joint.

Second group of weight (40 – 50 kg) revealed negative correlation with angle of deviation at cervical joint while mopping in standing posture.

Negative highly significant correlation was found in I group of height (135 – 145 cm) of women and angle of postural deviation at cervical and lumbar joint while mopping in squatting posture.

Second group (146 – 155 cm) of height exhibited negative significant correlation was observed with cervical joint. Women in the III group (156 – 165 cm) of height showed highly significant correlation with cervical joint while mopping in squatting posture and significant correlation with lumbar joint while mopping in standing posture.

Age, weight and height of women and perceived exertion while mopping floor in squatting and standing posture was non significant.

Perceived exertion showed highly significant correlation with physiological cost of work, total cardiac cost of work & average working energy expenditure and significantly correlated with average peak heart while mopping floor in squatting posture.

Perceived exertion while mopping floor in standing posture showed highly significant correlation with physiological parameters such as physiological cost of work, total cardiac cost of work and average working energy expenditure and showed significant correlation with average peak energy expenditure while mopping floor in standing posture.

It can be concluded that blood pressure and body temperature of selected women recorded while mopping floor in standing posture (Basket mop) was less as compared to squatting posture (Cloth mop). There was a reduction in physiological cost while mopping floor in standing posture. Statistically 't' values showed a significant difference between Perceived exertion and postural deviation while mopping floor in standing posture. Hence standing posture (basket mop) for mopping floor was proved better from health point of women.

LITERATURE CITED

LITERATURE CITED

Agrawal, K.N., Tiwari, P.S., Gite, L.P., Pharade, S., Majumdar, J. and Bhushanababu, V. (2010). Anthropometry of agricultural workers of Madhya Pradesh. Journal of Agricultural Engineering, 48(4): 1-9.

Anneli Pekkarinen (2009). Development in professional cleaning work brings challenges to ergonomics. The Ergonomics Open Journal, 2 : 40 – 46.

Asma, K.; Murali, D.; Zend, J.P. and Kulkarni, M.S. (1996). Assessment of perceived exertion of women for selected household tasks. Journal of Maharashtra Agricultural University, 21 (2) : 107- 109.

Astrand, P.O. and Rodahl, M.D. (1970). Textbook of work physiology. Mc Graw Hill Book Company, New York, pp. 249-322.

Badve, G. P (1999). Inventory analysis of working patterns of rural women in home and farm activities. Unpublished M.Sc. Dissertation, Department of Home management, College of Home science, M.A.U., Parbhani.

Bakhshi, R., Sandhu, P., Sindhu, M. And Bhalla, M. (2007). Anthropometric data of elderly women of Punjab for suggesting dimensions of furniture and workplaces. J. Dairying Foods and Home Science, 26 (1): 33-41.

Bala, J.(1980). A comparative study of physiological cost of Chapathi making in squatting and standing positions. M.Sc. Thesis, Punjab Agricultural University, Ludhiana.

Boki. (2000). Physiological stress on farm women in the performing of household and farm activities. Unpublished M.sc. Thesis, Department of Home Management, College of Home Science, Marathwada Agricultural University, Parbhani.

Chandra, A., Chandra, P.and Deswal, S. (2011). Analysis of hand anthropometric dimensions of male industrial workers of Haryana State. International Journal of Engineering, 5(3): 242-256.

Chandra, N. and Parvez, R. (2012). A study on work releated musculoskeletal disorders among sewing machine operators in Garment Manufacturing unit. Cited in Humanizing work and work environment Ergo safety for all (2012). edited by Vinay , D., College of Home science GBPUA & T.

Charti, G. (1971). Working heights of cooking units. Unpublished M.Sc. Dissertation, University of Nagpur, Nagpur.

Chawala, R. M. (2013). The relationship between hand breadh and height in adult males of North Indian Punjabi Population. Journal of Evolution of Medical and Dental Sciences, 2(12): 1880-1887.

Corett, E. N. and Bishop, R. P. (1976). A technique for assessing postural discomfort. Ergonomics, **19**: 175-182.

Dandotikar, V. (2002). Ergonomical analysis of mopping the floor with selected types of mop. Unpublished M.Sc. Thesis, Department of Home Management, Marathwada Agricultural University, Parbhani.

Davoudiantalab, A., Meshkani M., Nourian, S. and Mofidi, A. (2013). Anthropometric Dimensions of Iranian Male Workers and Comparision with Three Asian Countries. International Journal of occupational Hygiene, 5: 166-171.

Dhesi, J. K. and Firebaugh, F. M. (1972). The effect of body positions on angles of body bend during chapathi making at the ground level kitchen. Indian journal of Home Science, Vol. **6**(1): 10-16.

Dhesi, J. K. and Chahal, H. K. (1975). Effects of stages of chapathi making and body bend on heart rate during sitting and standing postures. Indian J. Home sci., Vol. **9** : 7-13.

Dhillon, M. K. (1982). Comparative study of physiological cost in different postures of dishwashing. Ph.D. Thesis, Punjab Agricultural University, Ludhiyana.

Dhule, (2001). Ergonomical analysis of sweeping and washing the floor with selected types of brooms. Unpublished M.Sc. Thesis, Department of Home Management, Marathwada Agricultural University, Parbhani.

Garrow, G. H (1987) Oqetelets index as measure of fatness. International J. of obesity, 9 : 147-153.

Ghosh, P. C.; Marker, V. M.; Sathe Sharmila and Iqbal Rauf. (2001). Physiological cost of Indian kitchen operations in an industrial setup. Indian journal of occupational and environmental medicine, 5(1) : 13-15.

Grandjean, E. B. (1973). Ergonomics of the home. Taylor and Francis Ltd., London, pp. 139-170.

Grozdonovic, M. (2002). Human and musculoskeletal disorders. Medicine and Biology, 9 (2)Pp 150-156. Cited in Sawant, V. V. (2012). Ergonomic assessment of washing clothes. Unpublished M.Sc Dissertation Dept. of Home Management, College of Home Science M.A.U., Parbhani (MS)

Gupta, Alka. (1996). A study on sweeping and mopping operations. M.Sc. Thesis, Hissar Agricultural University, Haryana.

Guyton, A. C. (1963).Circulatory physiology: Cardiac output and its Regulation. W. B. saunders Philadelphia, pp. 312, 326-365..

Hagner, M. and Hagberg, M. (1989). Evaluation of two floor- mopping work methods by measurement of load. Ergonomics, **32** (4) : 401- 408.

Hanson, J. A. and Jones, P. P. (1970). Heart rate and small postural changes in man. Indian Journal of Home Science, Vol.**9** (24), 1-7.

Hanson, O. E. and Maggio, M. (1963). Static work and heart rate. International zeits. Fur Angrew J. Physiol., 18: 242-247.

Jain, S. P. and Dhesi, J. K. (1975). Energy expenditure while sweeping with different types of brooms held in different postures. Indian Journal of Home Science. Vol. **9** (2), 45-51.

Jakhar, K., Pal, V. and Paliwal, K. (2008). Estimation of height from measurements of foot length in Haryana Region. J Indian Acad. Forensic Med, 32(3): 0971-0973. Email: jjakhar2008@Yahoo.com.

Jalil, Houshang, Jafari, and Mostaghaci, (2011). An Assessment of the Anthropometric Data of Iranian University Students. International Journal of occupational Hygiene, 3: 85-89.

Jennifer Desa et al (2003). Case study : are microfiber mops beneficial for hospitals ? A project of the lowell center for sustainable production, University of Massachusetts Lowell. www.sustainablehospitals.org

Jinky, and Prado, (2007). Anthropometric measurements of filipino manufacturing workers. International Journal of Industrial Ergonomics, 37: 497-503. www.sciencedirect.com

Johansson, S. E., Ljunggren, G., (1989). Perceived exertion during a self-imposed pace of work for a group of cleaners, Applied Ergonomics, 20(4) : 307-312.

Jyoti. (1980). A comparative study of the physiological cost of chapathi making in squatting and standing positions. M.Sc. Thesis, Punjab Agricultural University, Ludhiana.

Kaur, J. (1985). An ergonomic study of mopping floor with brooms of different lengths. M.Sc. Thesis, Punjab Agricultural University, Ludhiana.

Kilbom, A..and Astrand, I. (1969). Pulse rates of female subjects during the performance of various household tasks. (Cited from Grandjean, E.B. 1973).

Koshy, M. M. (1964). Energy expenditure in cleaning of floors. M.Sc. Thesis, St. Taresa college, Ernakulum.

Krause, N., Scherzer, T. and Rugulies, R. (2005). Physical workload, work intensification, and prevalence of pain in low wage workers. American Journal of Industrial Medicine, DO I10.1002/ ajim. 20221 (www. interscience.wiley.com)

Kruger, D., Louhevaara, V., Nielsen, J., Schneider, T., (1997). Risk assessment and preventive strategies in cleaning work. Hamburg, Germany.

Kumar, S. and Narayan, Y. (2005) Cumulative spinal load among X-ray technologist: A field study of techniques, frame rate and prediction. International Journal of Industrial Ergobomics, 35: 889-903.)

Kumar, R. (2006). Ergonomic evaluation and design of tools in cleaning occupation. Doctoral Thesis, Division of industrial design, Department of human work sciences, Lulea University of technology, Lulea, Sweden.

Kumar, R. (2008). Evaluation of muscular activity while mopping on two different types of floor.www.arbetsliv.eu/nes2008/papers/1738.doc.

Kumar, R. (2014). Ergonomic assessment of two different cleaning tools while cleaning floor. www.pure.hu.se/portal/files/1905470/physio4.Pdf.

Kumar, S. And Narayan, Y. (2005). Cumulative spinal load among X- ray technologist: A field study of techniques, frame rate and prediction, International Journal of Industrial Ergobomics, 35: 889-903.

Marras, S. and Kim, Y. (1993). Anthropometry of Industrial Population. Ergonomic, 36(4):371-378.

Marut, M. and Hedge, A. (1999). Ergonomic survey of household tasks and products. Proceedings of the human factors and ergonomic society 43rd Annual meeting. 1, Pp. 506-510.

Mehta, A. (1982). A study on the physiological cost of mopping in different body postures. M.Sc. Thesis Punjab Agricultural University, Ludhiana.

Mehta, M. C.; Gandhi, S.; Gupta, M. And Sharma, D. N. (1995). Women's time and energy inputs in various kitchen activities. Kurukshetra, 3, pp. 34-38.

Metgut, D. C., Khatri, S., Mokhashi, M. G. and Saha, P. N. (2008). An ergonomic study of women workers in a woolen textile factory for

identification of health related problms. International Journal of Occupational and Environmental Medicine, 12(1): 14-19.

Milanovic, Z., Pantelic, S., Trajkovic, N, Spori G (2011). Basic anthropometric and body composition characteristics in an elderly population: a systematic review. Physical Education and sport, 9 (2): 173-182.

Murali, D. ; Kulkarni, M. S. and Badve, G. P.(1999). Impact of posture on the degree of difficulty experienced by farm women while performing various household activities. AGRESCO Report, M.A.U., Parbhani.

Nigarwal, A. G. (1992). A developing of scale for measuring perceived exertion of the home makers in selected household tasks. M.Sc. Dissertation, Department of Home Management, College of Home Science, M.A.U., Parbhani.

Nirmala, B. (1965). Time and energy cost of ironing sari, at different work heights. M.Sc. Thesis, Queen Mary's College, Madras.

Oberoi, K. And Miglani, S. S. (1987). A study on the cardiovascular responses during manual and machine washing of clothes. Indian J. Physiological Applied Sci., **41** : 141-146.

Oberoi, K. and Miglani, S. S. (1987). Ergonomics assessment of household activities. J. Maharashtra Agri. University.12 : 364- 366.

Pandy, L. (2012). upper extremity musculoskeletal disorders in hospital workers, J Hand Surg Am, 12(5&2): 858-862.

Parvathi, S. and Kumar V. J. F. (1996). Ergonomics of Selected Household Activities. Agricultural Engineering Today, 20 and 21(1 to 4) : 31-35.

Parvathi, S.; Vijayaraghavan, N. C. and Swaminathan, K. R. (1993). Energy expenditure for household activities, Energy Management, Oct- Dec., 1993, pp. 29-32.

Peet, L. J.; Pickett, M. S.; Arnold, M. C. and Wolf, L. M. (1970). Household equipment. John wiley and sons, Inc. New York, Pp. 389-415.

Puri, S. (1992). Physiological cost of grinding masala (wet.) in different body postures. M.Sc. Thesis, Punjab Agricultural University, Ludhiyana.

Raja Gopal, L. S. and Ray, S. (1977). Energy cost of selected activities. Indian J. Home Sci., Vol. **3** ; 62-67.

Rao. (1987). Physiological cost of perceived exertion for home and farm activities done by rural women. Unpublished Ph.D. Thesis, College of Home Science, SNDT women's University, Bombay.

Richardson, S., Phillips , J. A., Anolon, J. M., Iovingood, R. P., Pearson, J. M. and Sattmarch, M. (1985). Total and active time required to prepare convenience and home prepsred foods with an electric range and a microwave oven. Home Econ.,Res. J. 14: 21-28.

Saari, J. (1987). Management of housekeeping by feedback. Ergonomics 30. Pp: 313-317).

Saha, P. N.; Datta, S. R.; Banerjee, P. K. and Narayane, G. G.(1979). An acceptable workload for Indian workers. Ergonomics, **22**,1059-1071.

Saha, P. N. (1995). Workload and postural stress edit by training courses on ergonomics background material organized by postgraduate , Department of Family Resource Management, SNDT women's University, Santacruz, West Mumbai.

Sandhu,P.; Oberoi, K. And singal, S. (1991). An ergonomic study of muscular fatigue during grinding of spices in different postures. J. Res. Punjab agricultural University, Ludhiana. **28**:298-304.

Sandhu P. (2003). Reduction in energy costs of doing selected household work by using efficient gadgets and applying ergonomics in homes. J. Hum. Ecol., 14 (5) : 323 – 327.

Saraswathy Eswaran. et al. (2000). Improved implements for women Agricultural workers, Social welfare. 47 (2) : 17.

Satpute, S. T. (1999). Perceived exertion of women in home,farm and allied activities. Unpublished M.Sc. Dissertation. Department of Home Management. College of Home Science, M.A.U., Parbhani.

Sengupta, A. K. and Das, B. (2000). Maximum reach envelop for the seated and standing male and female for industrial workstation design. 43(9):1390-404.

Sharma, H. L. (2005) ''Basic statistical methods with applications'. Agro tech Publishing Academy, Udaipur, Pp143,262-62,267.

Sidhu, J. (1985). A comparative study of time consumption and distance travelled with postural variation for cooking in existing and improved kitchens of rural homes. M.Sc. Thesis, Punjab Agricultural University, Ludhiyana.

Singer, N. E. (1960). Energy expenditure and it's relationship to working heights, space and methods of work in the performance of a household tasks. Ph.D. Dissertation, Ohio state University, Wooster, Ohio, U.S.A.

Singh, P. S., Ahlawat, S., Pandya, S. and Prafull, B. (2013). Anthropometric Measurementsa and Body Composition Parameters of Farm Women in North Gujarat. J Ergonomics, 3(1): 2-4.

Sogaard, K., Fallentin, N. and Nielsen, J. (1996). Work load during floor cleaning. The effect of cleaning methods and work technique, Eur.J. appl. Physiol. Occup. Physiology, 73(1-2) :73- 81.

Steidl, R. E. and Bratton, E. C. (1968). Work in the home. John Wiley and Sons, New York, London Sydney, pp. 144.

Sujatha, T.; Veena Shatrugna.; Venkatramana, Y. and Nazeema Begum. (2000). Energy expenditure on household, childcare and occupational activities of women from urban poor households. British Journal of Nutrition, 83 : 497- 503.

Varghese, M. A., Atreya, N and Bhatnager, A. (1989). Studies on workload and perceived exertion in household work. Department of Family Resource Management. DRS. (UGC). Department of post graduate studies and research in Home Science , SNDT Women's University, Bombay.

Varghese, M. A., Saha P.N. and Atreya, N (1994). Ergonomic assessment of occupational work load and rest allowances for female agricultural labourers in Dharward, Karnataka, published in the proceedings of the conference on Humanizing Work and Work Environment, 9:11-14.

Vasanthi, N. (1981). A study on sweeping and mopping with selected tools and their effect on the worker. M.Sc. Thesis, Department of FRM, CHSc, ANGRAU, A.P.

Vipene, J. B., and Victor, O. A. (2013). Anthropometric study of Body Composition Variables in Selected Male and Female Athletes in Rivers State, Nigeria. Asian Journal of Social Sciences & Humanities, 2(4): 281-287.

Vos, H. W. (1973). Physical workload in different body postures while working near to or below ground level. Ergonomics, **16** : 817-829.

APPENDICES

APPENDICES - I

Questionnaire to elicit the information of selected women while performing the task of Mopping Floor

1) Date:

2) Name of the homemaker:

3) Address:

4) Age: ---------- year

5) Body Weight: -------- kg

6) Height: ------ cm

7) Type of Family: Nuclear/ Joint

8) Size of Family: ---------- Adult ------ Children------

9) Education of Homemaker:

1) Primary 2) Secondary 3) High school 4) College

10) Occupation of homemaker: ----------

11) Monthly income of family: ----------Rs

12) How many rooms do you have in your house?

1) 1-2 2) 3-4 3) 5 and above

13) How much time do you spend on performing activity of mopping floor in a day?

1) 15 min. 2) 1/2 hr 3) 45 min 4) 1hr 5) More than 1 hr.

14) Who does the mopping activity?

1) Personally 2) Paid help 3) Family members help

15) How many rooms do you mop daily?

1) 1 2) 2 3) 3 4) Four & above

16) At what time do you mop the floor ?

1) In the morning 2) Afternoon 3)Evening

17) Are you aware of different types of mops available in the market for mopping the floor ?

Yes / No

18) Which type of mop do you used for mopping ?

1)Felt mop 2) Wick mop 3)Sponge mop 4) Cloth mop 5) Any other please mention

Give reasons for using this type of mop

- Less cost
- Easy to handle
- Easily available
- More area can be cleaned
- Requires less time
- Requires less energy

19) Do you like the mopping activity? Yes / No

20) Express your feelings about mopping the floor ?

1) Easy 2) Very easy 3) Hard 4) Very hard 5) Difficult 6) very difficult

21) Which posture do you adopt while mopping?

1) Bending 2) Squatting 3) Standing 4) Combination of bending & squatting

22) Do you experience any while mopping floor ?

Pain	**Frequency and Percentage**	
	Squatting (Cloth mop)	**Standing (Basket mop)**
No pain		
Pain in wrist		
Pain in the knee joint		
Pain in neck		
Pain in lower back		
Pain in leg		

23) What are the reasons for pain experienced ?

Reasons (Squatting posture)	**Squatting posture**	**Reasons**	**Standing posture**
Repetitive squatting posture experienced pain in lower back		pain in lower back	
Repetitive Lifting of bucket and squeezing of mop experienced pain in wrist		Frequently lifting and handling rod of the mop & basket experienced pain in wrist	
Repetitive movements of leg experienced pain in leg		Repetitive movements of leg experienced pain in leg	
Repetitive standing and bending experienced pain in knee		Repetitive movements of knee for squeezing of mop experienced pain in knee	
Repetitive bending neck experienced pain in neck		Repetitive movements of neck experienced pain in neck	
Experienced no pain		Experienced no pain	

24) Which posture do you adopt while mopping?

2) Bending 2) Squatting 3) Standing 4) Combination of bending & squatting

25) Anthropometric measurements of women in squatting and standing position

Measurements (Standing)	**cm**
1.Stature	----------
2. Normal standing height	----------
3. Elbow height	----------
4. Palm length	----------
5. Hand length	----------
6. Grip strength	----------
7. Lower position arm reach height	----------
8. Lower position arm length	----------

Measurements (Squatting)	**cm**
1. Normal squatting height	----------
2. Knee to knee distance	----------
3. Maximum arm reach forward	----------
6.Squatting side arm reaches right hand	----------
5. Lower position arm length	----------

26)Physical fitness of selected women

1) BMI-- ----------kg/m2

2)VO2Max----------lit/min

APPENDICES – II

Recording sheet for experiment

1)Name of the women:

2) Address:

3) Age: ---------- year

4) Body Weight: ------- kg

5) Height: ------ cm

6) Physiological cost of the subject while performing the activity

Posture / Mop	Blood pressure (mm / Hg)		Body temperature (Degree Fahrenheit)	
	Before	After	Before	After
1. Squatting (Cloth mop)				
2. Standing(Basket mop)				

7) Perceived exertion experienced by the subject while performing the activity

Posture / Mop	Very light (1)	Light (2)	Moderately heavy (3)	Heavy (4)	Very heavy (5)
1. Squatting (Cloth mop) 2. Standing (Basket mop)					

8) Postural deviation of the subject while performing the activity.

Postural Angles	Natural	Working		Angle of deviation	
		Squatting (Cloth mop)	Standing (Basket mop)	Squatting (Cloth mop)	Standing (Basket mop)
Cervical					
Lumbar					
Elbow					

HEART RATE OBSERVATION SCHEDULE

Mopping floor (Squatting posture)

Sr. No.	Resting heart rate/min (5 min)										Average heart rate	RPE	Ti
	1	2	3	4	5	6	7	8	9	10			
R1													
R2													
R3													
Sr. No.	Working heart rate/min(15min)												
	1	2	3	4	5	6	7	8	9	10			
R1													
R2													
R3													
Sr. No.	Recovery heart rate/min												
	1	2	3	4	5	6	7	8	9	10			
R1													
R2													
R3													

Mopping floor (Standing posture)

Sr. No.	Resting heart rate/min (05 min)										Average heart rate	RPE	Time
	1	2	3	4	5	6	7	8	9	10			
R1													
R2													
R3													
Sr. No.	Working heart rate/min(15min)												
	1	2	3	4	5	6	7	8	9	10			
R1													
R2													
R3													
Sr. No.	Recovery heart rate/min												
	1	2	3	4	5	6	7	8	9	10			
R1													
R2													
R3													

APPENDICES - III

Individual values of systolic and diastolic blood pressure (mm/ hg) of women before mopping the floor with selected types of mop

Sr. No.	Cloth mop		Basket mop		Sr. No.	Cloth mop		Basket mop	
	Syst -olic	Diast -olic	Systo -lic	Diast -olic		Systoli -c	Diast -olic	Systo -lic	Diasto -lic
1	120	72	112	70	16	124	70	120	72
2	120	78	118	70	17	120	80	122	80
3	120	72	118	70	18	124	72	122	72
4	114	80	112	80	19	126	80	118	80
5	118	82	120	80	20	112	72	114	70
6	110	72	110	70	21	118	80	118	80
7	118	72	112	80	22	120	80	120	80
8	110	82	110	80	23	112	72	112	70
9	120	82	112	80	24	120	80	122	80
10	116	82	118	80	25	110	72	112	70
11	118	82	120	80	26	120	90	122	90
12	116	80	118	80	27	112	82	116	82
13	118	82	118	80	28	110	74	112	70
14	110	72	114	70	29	110	72	110	70
15	112	70	110	70	30	110	80	112	70
					Mean	**116.26**	**77.2**	**115.8**	**75.86**
					SD	**4.89**	**5.16**	**4.21**	**5.63**

APPENDICES - IV

Individual values of systolic and diastolic blood pressure (mm/ hg) of women after mopping the floor with selected types of mop

Sr. No.	Cloth mop		Basket mop		Sr. No.	Cloth mop		Basket mop	
	Syst -olic	Diast -olic	Systo -lic	Diasto -lic		Systol -ic	Diast -olic	Systol -ic	Diast -olic
1	124	72	114	72	16	124	72	120	72
2	122	78	120	78	17	122	82	122	82
3	124	76	120	72	18	124	74	122	72
4	118	84	112	82	19	128	84	122	80
5	124	84	120	82	20	114	72	114	72
6	118	76	112	74	21	120	80	118	80
7	118	80	114	82	22	122	80	120	80
8	110	80	110	82	23	112	72	112	72
9	122	80	114	84	24	122	80	122	80
10	118	82	118	82	25	112	72	112	72
11	120	82	120	82	26	122	90	122	90
12	118	80	118	82	27	116	80	118	84
13	120	82	118	82	28	114	76	124	80
14	112	72	114	72	29	116	74	110	74
15	112	72	110	70	30	116	80	112	80
					Mean	**118.8**	**78.26**	**116.8**	**78.26**
					SD	**4.62**	**4.71**	**4.35**	**5.13**

APPENDICES - V

Individual values of Vo2 max of women selected for the study

Sr. No.	lit/min	ml/min	Sr. No.	lit/min	ml/min
1	1.65	31.84	16	1.69	33.84
2	2.91	53.03	17	1.89	36.46
3	1.85	46.35	18	1.90	33.49
4	2.20	44.16	19	1.92	34.28
5	1.56	30.11	20	2.02	38.13
6	1.63	32.05	21	1.85	37
7	1.84	30.7	22	1.86	32.13
8	1.69	33.84	23	2.02	38.13
9	1.46	24.36	24	1.90	33.49
10	1.95	39.04	25	1.78	40.45
11	1.65	31.88	26	1.74	36.25
12	1.90	39.7	27	1.78	35.64
13	1.92	39.36	28	1.65	31.88
14	1.95	39.04	29	1.62	35.26
15	1.94	34.08	30	1.99	36.34
			Mean		**36.07**

APPENDICES - VI

Individual values of resting heart rate (bpm) of women before mopping the floor with selected types of mop

Sr. No.	Cloth & Basket mop	Sr. No.	Cloth & Basket mop
1	85	16	85
2	84	17	86
3	77	18	85
4	86	19	83
5	77	20	77
6	85	21	86
7	86	22	82
8	87	23	76
9	86	24	77
10	85	25	85
11	84	26	74
12	77	27	85.6
13	86	28	85
14	84	29	74.2
15	85	30	84.5
		Mean	**83**
		SD	**4.14**

APPENDICES - VII

Individual values of working heart rate (bpm) of women while mopping the floor with selected types of mop

Sr. No.	Squatting (cloth mop)	Standing (basket mop)	Sr. No.	Squatting (cloth mop)	Standing (basket mop)
1	110	99	16	105	101
2	106	102	17	102	99
3	107	102	18	106	107
4	112	107	19	102	99
5	105	101	20	104	104
6	110	105	21	109	109
7	113	113	22	106	101
8	107	103	23	102	109
9	111	107	24	101	103
10	105	103	25	106	101
11	111	109	26	96	99
12	108	105	27	111.5	107
13	110	104	28	100.5	102
14	106	100	29	107	106.4
15	109	109	30	99.4	101.3
			Mean	**106**	**104**
			SD	**4.11**	**4**

APPENDICES - VIII

Individual values of peak heart rate (bpm) of women while mopping the floor with selected types of mop

Sr. No.	Squatting (cloth mop)	Standing (basket mop)	Sr. No.	Squatting (cloth mop)	Standing (basket mop)
1	115	109	16	112	107.3
2	119	115	17	110	108
3	111	107.3	18	116	114
4	118.3	115.3	19	120	112
5	113.3	109.3	20	113.3	111
6	115	109	21	118	117.3
7	119	117	22	117.3	116
8	116	112	23	119	126
9	117.3	113.3	24	116.3	112
10	115	108	25	117.3	116
11	119	115	26	104	107
12	112	109.3	27	118.3	115.3
13	117.3	110	28	113	116
14	112	107.3	29	114.3	114.3
15	116	114	30	116	116
			Mean	**115**	**113**
			SD	**3.43**	**4.22**

APPENDICES - IX

Individual values of resting energy expenditure (kj/min) of women while mopping the floor with selected types of mop

Sr. No.	Squatting & Standing (Cloth & Basket mop)	Sr. No.	Squatting & Standing (Cloth & Basket mop)
1	4.79	16	4.79
2	4.63	17	4.95
3	3.52	18	4.79
4	4.95	19	4.47
5	3.52	20	3.52
6	4.79	21	4.95
7	4.95	22	4.31
8	5.11	23	3.36
9	4.95	24	3.52
10	4.79	25	4.79
11	4.63	26	3.04
12	3.52	27	4.89
13	4.95	28	4.79
14	4.63	29	3.07
15	4.79	30	4.71
		Mean	**4.41**
		SD	**0.65**

APPENDICES - X

Individual values of working energy expenditure (kj/min) of women while mopping the floor with selected types of mop

Sr. No.	Squatting (cloth mop)	Standing (basket mop)	Sr. No.	Squatting (cloth mop)	Standing (basket mop)
1	8.77	7.02	16	7.97	7.33
2	8.13	7.49	17	7.49	7.02
3	8.29	7.49	18	8.13	8.29
4	9	8.29	19	7.49	7.02
5	7.97	7.33	20	7.81	7.81
6	8.77	7.97	21	8.61	8.61
7	9.24	9.24	22	8.13	7.33
8	8.29	7.65	23	7.49	8.61
9	8.92	8.29	24	7.33	7.65
10	7.97	7.65	25	8.13	7.33
11	8.92	8.61	26	6.54	7.02
12	8.45	7.97	27	9	8.29
13	8.77	7.81	28	7.25	7.49
14	8.13	7.18	29	8.29	8.19
15	8.61	8.61	30	7.08	7.38
			Mean	**8.16**	**7.79**
			SD	**0.65**	**0.59**

APPENDICES - XI

Individual values of peak energy expenditure (kj/min) of women while mopping the floor with selected types of mop

Sr. No.	Squatting (cloth mop)	Standing (basket mop)	Sr. No.	Squatting (cloth mop)	Standing (basket mop)
1	9.56	8.61	16	9.08	8.34
2	10.2	9.56	17	8.77	8.45
3	8.92	8.34	18	9.72	9.4
4	10.08	9.61	19	10.36	9.08
5	9.29	8.65	20	9.29	8.92
6	9.56	8.61	21	10.04	9.93
7	10.2	9.88	22	9.93	9.72
8	9.72	9.08	23	10.2	11.31
9	9.93	9.29	24	9.77	9.08
10	9.56	8.45	25	9.93	9.72
11	10.2	9.56	26	7.81	8.29
12	9.08	8.65	27	10.08	9.61
13	9.93	8.77	28	9.24	9.72
14	9.08	8.34	29	9.45	9.45
15	9.72	9.4	30	9.72	9.72
			Mean	**9.61**	**9.18**
			SD	**0.54**	**0.67**

APPENDICES - XII

Individual values of perceived exertion of women while mopping the floor with selected types of mop

Sr. No.	Squatting (Cloth mop)	Standing (Basket mop)	Sr. No.	Squatting (Cloth mop)	Standing (Basket mop)
1	4	2	16	2	2
2	3	2	17	2	2
3	3	2	18	3	3
4	4	3	19	3	2
5	2	2	20	3	3
6	3	3	21	4	3
7	4	3	22	3	2
8	3	2	23	3	3
9	3	3	24	3	2
10	2	2	25	3	2
11	3	3	26	3	2
12	3	3	27	4	3
13	3	2	28	3	2
14	3	2	29	4	3
15	3	3	30	3	2
			Mean	**3.06**	**2.43**
			SD	**0.58**	**0.50**

APPENDICES - XIII

Individual values of postural deviation at cervical joint of the body of the selected women while mopping the floor with selected types of mop

Sr. No.	Squatting (cloth mop)	Standing (basket mop)	Sr. No.	Squatting (cloth mop)	Standing (basket mop)
1	10	5	16	9	2
2	8	3	17	6	4
3	6	5	18	8	2
4	6	4	19	8	4
5	6	4	20	7	2
6	12	5	21	11	4
7	14	4	22	10	4
8	6	3	23	15	3
9	7	5	24	6	4
10	15	3	25	9	4
11	6	4	26	8	5
12	6	2	27	12	4
13	6	4	28	7	3
14	8	2	29	10	5
15	13	4	30	8	2
			Mean	**8.76**	**3.63**
			SD	**2.84**	**1.03**

APPENDICES - XIV

Individual values of postural deviation at lumbar joint of the body of the selected women while mopping the floor with selected types of mop

Sr. No.	Squatting (cloth mop)	Standing (basket mop)	Sr. No.	Squatting (cloth mop)	Standing (basket mop)
1	10	3	16	16	3
2	8	3	17	20	5
3	7	4	18	17	3
4	15	5	19	16	3
5	12	4	20	12	4
6	17	2	21	10	5
7	8	3	22	10	4
8	8	2	23	15	4
9	15	5	24	10	4
10	10	4	25	12	6
11	14	4	26	12	2
12	14	5	27	9	5
13	12	3	28	10	3
14	8	4	29	15	4
15	10	6	30	18	3
			Mean	**12.33**	**3.83**
			SD	**3.46**	**1.08**

APPENDICES - XV

Individual values of postural deviation at elbow joint of the body of the selected women while mopping the floor with selected types of mop

Sr. No.	Squatting (cloth mop)	Standing (basket mop)	Sr. No.	Squatting (cloth mop)	Standing (basket mop)
1	10	4	16	7	5
2	8	4	17	6	4
3	10	6	18	5	5
4	8	3	19	8	5
5	10	4	20	5	3
6	8	4	21	10	6
7	7	5	22	9	6
8	9	5	23	8	4
9	5	3	24	5	3
10	7	4	25	7	3
11	6	4	26	8	5
12	5	5	27	8	5
13	8	5	28	9	5
14	8	5	29	10	7
15	6	4	30	7	4
			Mean	**7.56**	**4.5**
			SD	**1.65**	**1.008**