

## An Ergonomic Study of Muscular Fatigue during Ironing Clothes with Selected Irons

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**ABSTRACT** Muscular fatigue (hand grip) and body pains experienced during ironing of clothes in standing posture on 82 cms high board with selected irons of different weights were measured on 6 female subjects. Results showed that muscular fatigue and body pains while ironing with light weight iron (0.77 kgs) were found significantly less as compared to other selected irons. Muscular fatigue and body pains was found to be significantly higher while ironing with heavy weight iron (2.92 kgs) as compared to light weight iron and steam iron (1.29kgs). Thus ironing clothes with light weight iron causes minimum stress to body and using heavy weight iron is found to be most taxing to human body.

### INTRODUCTION

Owing to technological development, a large variety of automatic electric irons have become available to homemaker almost wiping out traditional charcoal iron and non electric ones. These irons conserve energy, reduce time and labour and give job satisfaction (Dhantiyagi, 1996). Electric irons are regularly used by 96.6 percent urban and 80.8 percent rural residents of Ludhiana district (Dhablania, 1992). However efficiency of different electric irons may vary, due to its design, weight, size and shape. In fact Grewal (1975) in her study on performance of automatic electric irons has found that weight of 2.75 Kg. is more appropriate than 3.43 Kg. Ironing clothes is however considered moderately heavy household activity which demands lot of muscular effort (Jindal, 1974). Many homemakers perform this activity without realising the extra muscular effort involved due to weight of irons which may result in higher muscular fatigue and body pains. Such static muscular effort can damage the intervertebral discs (Guyton, 1988). Hence it becomes important to assess muscular stresses caused by irons of different weights while ironing in standing posture, so as to isolate more fatiguing models of irons. Present study was therefore, undertaken with following objectives:

1. To assess muscular fatigue and body pains while ironing in standing posture with irons of varying weights.

2. To recommend the best iron on the basis of selected parameters for household use.

### METHODOLOGY

**Selection of Subjects:** 6 female students of mean age  $22.16 \pm .5$  years, mean weight  $51.00 \pm 1.5$  kg, mean height  $152.41 \pm 2$  cms, mean elbow height  $94.00 \pm 1$ cm and mean body surface area  $1.45 \pm .02$  sq.m., and basal metabolic rate, respiration and heart rate within normal physiological range were selected for the study.

**Selection of Irons:** Three automatic electric irons found commonly used at domestic level were selected viz light weight iron (.77 kgs) heavy weight iron (2.92 kgs) and steam iron (1.29 kgs).

**Standardization of Experiment:** Ironing was done in standing posture at 82 cms height as recommended by Jindal (1974). A fixed load of 21 garments, mixed lot of cotton, wool, silk, blended and synthetic fabrics, were ironed by subjects by following a standardized procedure for 60 minutes.

**Measurement of Muscular Fatigue:** The grip strength of left right and both hands was measured with the help of gripdynamometer. It consisted of a handle for hand grip connected with a spring to a position on a marked dial. The subject was asked to pull the grip handle with right and left hand separately and then both hands together and the reading given on the dial in Kgs was noted down separately was taken before and after the ironing activity. The grip strength was calculated in terms of percentage decrease in grip strength (grip fatigue) by

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subtracting grip strength during work (sw) from grip strength during rest (Sr)

$$\text{Percent decrease in grip strength} = \frac{Sr - sw}{Sr} \times 100$$

**Body Pains Experienced by the Experimental Subjects:** A questionnaire containing questions related to feelings of tiredness on different body parts of experimental subjects with selected irons was also scored from the degree of no pains to sever pains. It was repeated thrice for each iron with each subject.

**Statistical Analysis of Experimental Data:** Data on different parameters were compiled and tabulated. Analysis of variance (ANOVA) test was used to test the significance of differences. Calculated value of variance ratio 'F' was compared with the corresponding table value. The critical formula was calculated with the following formula:

$$C.D. = \sqrt{\frac{2 \times \text{Error mean sum of squares}}{\text{No. of replications}}} \times t \text{ Value at } 0.05/0.01 \text{ level}$$

## RESULTS AND DISCUSSIONS

**Arm Muscular Strength:** The mean values of percentage decrease of the muscular strength for both the hands independently (right hand, left hand) and together (both hands) are presented in Table 1. It indicates that the minimum decrease occurred while ironing of the clothes with light weight electric iron 7.72 kgs, 12.63 kgs, 9.01 kgs for right, left and both hands respectively. Analysis of variance (Table 2) for both the hands independently and together and the differences of percent decline in the muscular strength of both the hands independently and together while ironing clothes with selected irons were statistically significant. The mean differences of percent decline in grip strength after ironing the clothes revealed a significant difference within the selected irons. The maximum significant difference of right hand (Table 3) was observed between heavy weight and light weight iron viz 16.35 kgs followed by difference between heavy weight and steam iron (8.47 kgs) and least difference was recorded between the steam iron and light weight iron (7.88 kgs). The difference of mean, values between steam iron and light weight iron were found to be non-significant for both the hands (Table 3). The data presented in Table 1 also indicate that the percent decrease in grip strength of right hand was more as

compared to left hand with the selected irons. This may be due to habitual use of right hand for ironing by all the subjects as compared to left hand. These findings are in accordance with the findings of Oberoi et al. (1987) who reported the muscular fatigue of right hand was more as compared to left-hand.

**Table 1: Mean percentage decline in grip muscular strength (kgs) with selected irons after ironing of clothes.**

| Irons | Mean percentage decline in grip muscular Strength (kgs) with selected irons (rest=100) |           |            |
|-------|----------------------------------------------------------------------------------------|-----------|------------|
|       | Right hand                                                                             | Left hand | Both hands |
| Light | 7.72                                                                                   | 12.63     | 9.01       |
| Steam | 15.60                                                                                  | 15.15     | 11.92      |
| Heavy | 24.07                                                                                  | 23.65     | 17.93      |

**Table 2: Analysis of variance of grip muscular strength (Kgs) of right, left, and both hands after ironing with selected irons.**

| Source of variation  | Degree of freedom | Sum of squares | Mean of sum squares | F-ratio |
|----------------------|-------------------|----------------|---------------------|---------|
| <i>a) Right Hand</i> |                   |                |                     |         |
| Between irons        | 3                 | 829.40         | 276.46              | 17.08*  |
| Within irons         | 20                | 323.77         | 16.18               |         |
| Total                | 23                | 1153.17        |                     |         |
| <i>b) Left Hand</i>  |                   |                |                     |         |
| Between irons        | 3                 | 415.64         | 138.54              | 3.59-   |
| Within irons         | 20                | 767.16         | 38.58               |         |
| Total                | 23                | 1182.77        |                     |         |
| <i>c) Both Hands</i> |                   |                |                     |         |
| Between irons        | 3                 | 704.1          | 237.7               | 20.62*  |
| Within irons         | 20                | 227.78         | 11.38               |         |
| Total                | 23                | 931.88         |                     |         |

\*Significant at P < 0.05 level; - Non significant; C.D = 3.98 at P < 0.05 and 5.41 at P < 0.01

**Table 3: Difference of values of mean percent decrease in right hand and both hands grip strength with selected irons after ironing of clothes.**

|                      | Heavy | Light   | Steam  |
|----------------------|-------|---------|--------|
| <b>a) Right Hand</b> |       |         |        |
| Heavy                | -     | 16.35** | 8.47** |
| Light                | -     | -       | 7.88** |
| Steam                | -     | -       | -      |
| <b>b) Both Hands</b> |       |         |        |
| Heavy                | -     | 8.93    | 6.01   |
| Light                | -     | -       | 2.91   |
| Steam                | -     | -       | -      |

\* Significant at P < 0.05 level; \*\* Significant at P < 0.01 level

**Table 4: Scores of body pains after ironing with different irons as experienced by subjects.**

| Body parts | Steam iron | Light weight iron | Heavy weight iron |
|------------|------------|-------------------|-------------------|
| Forehead   | 5.0        | 5.0               | 5.0               |
| Neck       | 5.0        | 5.0               | 5.0               |
| Back       | 5.0        | 5.0               | 5.0               |
| Arms       | 4.5        | 4.8               | 4.0               |
| Shoulder   | 4.8        | 5.0               | 2.3               |
| Hand       | 4.7        | 4.8               | 3.7               |
| Upper leg  | 3.5        | 3.5               | 3.5               |
| Lower leg  | 3.2        | 3.2               | 3.2               |
| Feet       | 4.2        | 4.2               | 4.2               |
| Total      | 39.9       | 40.5              | 35.9              |
| Average    | 4.43       | 4.5               | 3.98              |

**Table 5: A comparative evaluation of different selected irons during ironing of clothes with respect to grip muscular strength**

| Grip muscular strength | Steam iron | Light weight iron | Heavy weight iron | Steam iron | C. D. at 5% | C. D. at 1% |
|------------------------|------------|-------------------|-------------------|------------|-------------|-------------|
| Right hand (kgs)       | 15.06      | 7.72              | 24.07             | 15.6       | 4.75        | 6.45        |
| Left hand (kgs)        | 15.15      | 12.63             | 23.65             | 15.15      | -           | -           |
| Both hand (kgs)        | 11.92      | 9.01              | 17.93             | 11.92      | 3.98        | 5.41        |

———— line joining the values show non - significant differences..

===== line joining the values show significant differences at P<0. 01 level.

**Body Pains as Experienced by the Experimental Subjects During Ironing:** The mean scores of feelings of body pains while ironing by the subjects are given in Table 5. Five-points scales was chosen for the scoring of body pains from no pains to severe pains. Higher the Score, lesser the pains and vice-versa was experienced by the experimental subjects during ironing with selected irons. Slight pains were experienced while ironing with steam iron in arm, hand and shoulder with a mean score of 4.5, 4.7 and 4.8 respectively. As compared to steam iron less pain was experienced with the light weight iron in arm and hand with a mean score of 4.8 for each and absolutely no pain was experienced in the shoulders. It might be due to the lightest weight of the iron, much pressure was not experienced by the subjects, on the shoulders. Highest

degree of discomfort was experienced in the arm, hand and shoulder while ironing with the heavy weight iron with mean scores of 4.0, 3.7 and 2.3, owing to its heaviest weight and lowest temperature setting. The activity was performed while standing so the feeling of discomfort was experienced in upper leg, lower leg and feet with all the three irons. The mean scores for upper leg, lower leg and feet are 3.5, 3.2, and 4.2 for each iron respectively. The pain in the legs was experienced in the lower region, resulting in the reduced circulation of the blood. There was pain in the feet because of accumulation of the blood in the feet (Bridger, 1995). It was further observed that the severity of the pain was related to the amount of work (Grandjean, 1973).

**Comparative Evaluation of Best Iron for Ironing Clothes in Standing Posture:** Comparative evaluation of different iron was done on the basis of physiological stresses grip Muscular strength of right left and both hands of body to find out best iron which would be least taxing. Table 5 indicates that using light weight iron (.77 kgs) to iron clothes averaged significantly lower values of grip muscular strength of right, left and both hands, when compared to using steam iron (1.29 kgs) and heavy weight iron (2.92 kgs). On the basis of this comparison light weight iron (0.77 kgs) was found to be best among other selected irons because it has lowest value of grip muscular strength of right left and both hands. It was also found that steam iron accounted for lower increase in heart rate and respiration frequency as compared to use of heavy weight iron. It can thus be concluded that light weight iron is best followed by steam iron whereas heavy weight (2.92 kgs) iron was rated most taxing for human body and should not be adopted to use commonly in households.

## CONCLUSIONS

It can be thus concluded that muscular fatigue and body pains while ironing clothes by light weight iron (.77 kgs) was found significantly low as compared to other selected irons. The increase in all the parameters while using steam iron (1.29 kgs) and heavy weight iron (2.92 kgs) was found to be significantly higher than light weight iron. Results of comparative evaluation for all selected irons while ironing selected clothes revealed that light weight iron (.77 kgs) is best suitable because it is least taxing to body

as compared to other irons. Heavy weight iron is rated most taxing to body while ironing clothes.

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