Ergonomic Assessment of Performing Selected Personal and Room Care Related Activities by Elderly Females and Technologies to Reduce Them

P. Sandhu and R. Bakhshi

INTRODUCTION

Women continue in their traditionally defined ‘work’ roles at home much longer than men in their formal work settings outside home. Recent studies on healthy women have shown that even at 70 years of age they can do far more work than merely taking care of themselves (Mahler, 1982), but they find every day tasks of normal life difficult because various parts of their bodies are becoming less efficient. With age heart becomes less efficient because oxygen supply is reduced to its tissues. It’s pumping capacity is reduced by 30 percent and lung’s breathing capacity by 50 percent. Muscles also loose bulk and tone. Joints also stiffen and enlarge due to loss of ela-sticity in connective tissue, so that changing of postures becomes difficult (Guyton, 1991). Decreased efficiency of heart and increased risk of coronary disease (after menopause) require them to keep beats on lower side. Heart rate has been more and more used in recent years to measure the physiological stresses and within certain limits can be used as indicator for the manual work load. Reducing work costs by devising helping aids and designing simple gadgets will reassure them of physical capabilities and will make it possible for them to live independently in their homes, if need be so. Hence, the present study was conducted with the following specific objectives:

1. To make ergonomic assessment of selected personal and room care related activities by the selected elderly women under existing working conditions.
2. To develop and test the efficiency of designed technologies in terms of reduction in assessed parameters.

METHODOLOGY

Study was conducted in two phases viz. field survey and field experiments. Field survey was conducted in Punjab and pre-tested interview schedule was used to identify age category of elderly and other parameters, and to isolate activities for selection in experiments.

Selection of Subjects

Field experiments were conducted in Ludhiana city on 20 selected elderly women of mean age $75 \pm 3$ years, mean height $61 \pm 2$ inches, mean weight $71 \pm 4$ kgs, mean heart rate $76 \pm 4$ (b.min$^{-1}$), mean systolic pressure $162 \pm 8$ mm Hg and mean diastolic pressure $76 \pm 4$ mm Hg. Based on the results of survey eight most routinely performed and preferred personal and room care related activities with maximum participation and difficulties faced were selected.

Standardization of Activities

Based on the results of exploratory study conducted in the houses of selected subjects, the procedure followed and the amount of work was standardized for selected activities. It included filling hot water in water bottle; opening 5 medicine bottles; splitting 5 pills in two parts; sorting out one set of 5 pills from a mix of pills; getting up from toilet seat; bathing; combing hair, wearing coat, pyjamas and sendil; making bed; dusting specified area and arranging 13 items by bed side.

Collection of Data

Heart rate and physiological cost of work while performing selected activities were assessed on subjects.

Improvements in existing methods were made with the help of help aids, techniques of work simplification, ergonomically suitable heights, furniture, features, labour saving devices and suitable environment. Major improvements included water bottle holder to fill hot water bottle, small bottle cap remover to open medicine bottle; pill cutter and weekly pill box to cut and sort out medicines (pills); rail-support to get up easily from toilet seat; 11.5 inches high stool to sit on and 46 inches high towel stand for bathing; long handled wide teethed comb, button-aid, velcro strapped shoes and pyjamas with elastic
tape for dressing up; bed raising blocks to raise
the height of beds to 24 inches and ‘one round-
tuck-in method’ to make bed; static duster to do
dusting and tray to carry items in one trip while
arranging items for night. Parameters were
assessed again twice when subjects performed
activities under improved working conditions.

Assessment of Parameters

Heart Rate: Five values of working and resting
heart rate (measured at the interval of 1 minute
each) were averaged to work out average heart
rate.

\[ \text{Average heart rate} = \frac{\text{average working heart rate} - \text{average resting heart rate}}{} \]

(Increase over base)

Physiological Cost of Work (PCW):

\[ \text{PCW} = \frac{\text{Total cardiac cost of work}}{\text{Total duration of activity}} \]

Where Total cardiac cost of work (TCCW) is

\[ \text{TCCW} = \text{Cardiac cost of work (CCW) + Cardiac cost of recovery (CCR)} \]

where CCW = AHR x duration of activity

AHR = average working heart rate – Average
resting heart rate

CCR = (Average recovery heart rate – Average
resting heart rate) x duration of recovery.

Analysis of Data

Paired ‘t’ test was used to find out signifi-
cance of differences between existing and impro-
ved working conditions. Two way ANOVA was
used to find out significance of differences
between percent reduction in assessed param-
ters and performed activities under improved
working conditions.

RESULTS AND DISCUSSION

Heart Rate

Heart rate increases in direct proportion to
amount of energy expended by the body. Increas-
ed blood supply is needed whenever some kind
of strenuous physical activity is performed to get
rid of accumulated lactic acid and carbon-di-
oxide for which heart has to pump faster to rush
blood to working muscles. Table 1 represents the
average heart rate values (under existing and
improved working conditions) of elderly subjects
while performing selected personal and room care
related activities. It may be observed that the heart
rate was found to be maximum when elderly
subjects made bed (105.11 beats/min); followed
by dusting (102.79 beats/min). Both these
activities required prolonged bending hence must
have resulted in steep rise in heart rate. Arranging
items for night (96.93 beats/min), bathing (94.38
beats/min) and filling hot water bottle (92.44
beats/min), too resulted in higher heart rate under
existing working conditions.

Increase over base in average heart rate was
also maximum while making bed (29.01 beats/
min) followed by dusting, arranging items for
night, bathing and filling hot water bottle (28.18,
19.78, 18.03, and 15.19 beats/min respectively)
under existing working conditions. Reilly et al.
(1993) also estimated energy expended on
physical activities with the help of heart rate
monitoring in healthy elderly women and
observed that it was higher than those observed
in some studies on young adults in the U.K.

Improved technologies used were found
effective, except for dressing activity which
resulted in slight increase in beats. As the table
shows decrease in working heart beats during the
performance of all selected activities under
improved working conditions (with the use of help
aids, and other devised technologies) by elderly
subjects. It is clearly seen from the table that maxi-
mum reduction in percent increase (18.45) in
mean heart rate was observed during dusting with
static duster followed by making bed with new
method on raised bed, using pill cutter and weekly
pill box to cut and sort out pills, bathing in ergono-
metrically re designed bathroom and filling hot water
in water bottle with the help of water bottle holder
with 18.12, 11.02, 10.76 and 7.62 percent,
respectively.

However not much reduction in percent
increase in heart-rate was found with the use of
new technologies while subjects, opened
medicine bottle and used rail support to getup
from the toilet seat, This may be due to the reason
that subjects were not familiar with some of the
aids which were used; resulting in awkward
motions, thus accounting to less than expected
decrease in heart rate. Table 3 also illustrates the
percentage reduction in mean heart rate (beats/
min) under improved working condition. Maximum percentage reduction (86.46 percent)
was observed by the use of pill cutter and weekly
pill box in cutting and sorting out of medicines
(pills); followed by opening medicine bottle with
bottle opener, making bed and dusting with 52.71,
46.94 and 46.52 percent respectively. For rest of
the activities ( except for dressing activity which
showed upward trend) percentage reduction ranged from 40 to 30 percent; indicating considerable success of tested technologies in reducing heart rate.

Paired t-test demonstrated statistically non-significant differences between existing and improved working conditions in case of dressing up and confirmed that the improved methods used were not very effective to bring down heart rate significantly. The differences in heart rate between existing and improved working conditions were found to be statistically significant at 1% level of significance for making bed, dusting and cutting and sorting out medicine (pills). Thus it can be concluded that introduced technologies were highly effective in minimizing increase in heart rate of subjects in case of above mentioned activities.

Physiological Cost of Work (PCW)

Table 2 indicates the mean values of physiological cost of work of performing selected activities by elderly subjects under existing and improved working conditions. Maximum physiological cost of work (27.45 beats/min) was observed for dusting by elderly subjects in the normal fashion. Apart from difficulty in bending due to old age, it was breathlessness of elderly subjects which adversely affected the recovery of heart rate; thus resulting in increased physiological cost. High physiological cost of work was also observed for making bed, arranging items for night, filling hot water bottle and bathing (25.54, 22.18, 22.17 and 18.90 beats/min, respectively).

Use of improved technologies in all the selected activities resulted in decrease of physiological costs of work. Maximum reduction in physiological cost of work (19.54 beats/min) was seen when elderly subjects filled hot water bottle using water bottle holder followed by making bed with improved technology and dusting with static duster which also resulted in average reduction of 17.30 and 16.23 beats/min, respectively. Minimum average reduction in physiological cost of work occurred for opening medicine bottle with bottle cap removing aid, followed by dressing up with the use of improved ways i.e. 0.50 and 2.95 average beats/min respectively. It can also be seen in Table 3 that maximum percentage reduction of physiological costs of work was observed while filling hot water bottle using water bottle holder.
followed by making bed using improved techniques (88.13 and 67.73 percent, respectively) by elderly subjects. Dusting; cutting and sorting out medicines (pills); bathing and using rail support to get up from toilet seat also led to high percentage reduction in physiological cost being 59.11, 55.24, 50.09 and 49.13, percent respectively.

It was opening medicine bottle (25.58 percent), dressing up (32.93 percent), and arranging items for night (32.68 percent) which resulted in minimum percent decrease in physiological cost of work being 59.11, 55.24, 50.09 and 49.13, percent respectively.

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Highest significant differences existed between existing and improved working conditions while arranging items for night which were significant at 1 percent level of significance. These were the clear indication of effectiveness of new help-aids, devices and technologies used on elderly subjects while performing these activities.

**Evaluation of Improved Technologies for Elderly Subjects**

Overall reduction in all assessed physiological parameters viz heart rate and physiological cost of work by elderly subjects is presented in Table 3. Maximum overall percentage reduction (70.85 percent) in assessed ergonomic costs was observed for using pill cutter and weekly pill box to cut and sort out medicines (pills); followed by 63.55 percent reduction brought about by the use of hot water bottle holder for filling water in the bottle. Making bed with the use of bed - raising blocks and use of ‘one trip tuck - in method’ and dusting with the use of static duster also showed remarkable overall reduction in assessed parameters (57.28 and 52.81 percent, respectively).

Overall percentage reduction with the use of help-aids, devices and improved methods was also noticed for bathing, using toilet, opening medicine bottle and arranging items for night (47.14, 44.4, 39.14 and 30.44 percent, respectively). However minimum overall percentage reduction in assessed parameters was observed for dressing up which suggest that techniques devised for making the activity feel easier were only marginally effective.

The highlighted figures in Table 3 shows that percentage reduction in selected activities with the use of introduced technologies were not significantly different from each other. Hence the improved method used for activities namely cutting and sorting out medicines (pills), filling hot water bottle, bed making, dusting, bathing and using toilet can be labelled equally successful in reducing physiological stresses in elderly subjects. The highlighted assessed parameters as seen in table were also not significantly different from each other. This may be due to the reason that the assessment of these parameters was based on rise in heart rate of the subjects, which may have accounted to proportionate rise in rest of the parameters.

**CONCLUSIONS**

1. Heart rate was found to be maximum when elderly subjects made bed (105.11 beats/min); followed by dusting (102.79 beats/min).
2. Maximum reduction in percent increase (18.45) in mean heart rate was observed
ERGONOMIC ASSESSMENT OF PERFORMING SELECTED PERSONAL

Table 3: Overall percentage reduction in assessed parameters by elderly subjects while performing selected personal and room care related activities under the existing and improved working conditions

<table>
<thead>
<tr>
<th>Personal and room care related activities</th>
<th>Percentage reduction</th>
<th>Overall percentage reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Rate</td>
<td>Physiological cost of work</td>
<td></td>
</tr>
<tr>
<td>Cutting and sorting of medicines (pills)</td>
<td>86.46</td>
<td>55.24</td>
</tr>
<tr>
<td>Filling hot water bottle</td>
<td>38.97</td>
<td>88.13</td>
</tr>
<tr>
<td>Making bed</td>
<td>46.84</td>
<td>67.73</td>
</tr>
<tr>
<td>Dusting</td>
<td>46.52</td>
<td>59.11</td>
</tr>
<tr>
<td>Bathing</td>
<td>44.2</td>
<td>50.09</td>
</tr>
<tr>
<td>Using toilet</td>
<td>39.67</td>
<td>49.13</td>
</tr>
<tr>
<td>Opening medicine bottle</td>
<td>52.71</td>
<td>25.58</td>
</tr>
<tr>
<td>Arranging items for night</td>
<td>27.96</td>
<td>32.93</td>
</tr>
<tr>
<td>Dressing</td>
<td>-1.21</td>
<td>32.68</td>
</tr>
<tr>
<td>CD (5%) Between the parameters</td>
<td>15.02</td>
<td></td>
</tr>
<tr>
<td>Between the activities</td>
<td>32.91</td>
<td></td>
</tr>
</tbody>
</table>

CD (5%) Between the parameters: 15.02
Between the activities: 32.91

Table 3: Overall percentage reduction in assessed parameters by elderly subjects while performing selected personal and room care related activities under the existing and improved working conditions

6. Maximum percentage reduction of physiological costs of work was observed while filling hot water bottle using water bottle holder followed by making bed using improved techniques (88.13 and 67.73 percent, respectively) by elderly subjects.
7. Maximum overall percentage reduction (70.85 percent) in assessed ergonomic costs was observed for using pill cutter and weekly pill box to cut and sort out medicines (pills); followed by 63.55 percent reduction brought about by the use of hot water bottle holder for filling water in the bottle.

KEYWORDS Cardiac Cost of Work, Physiological Cost of Work

ABSTRACT Ergonomic assessment of performing selected personal and room care related activities in terms of heart rate and physiological cost of work was made on twenty elderly women. These activities were: filling water in water bottle; opening medicine bottle; cutting and sorting out pills; using toilet; bathing; dressing; making bed; dusting and arranging items. Results revealed that heart rate was found to be maximum when they made bed (105.11 beats/min); followed by dusting (102.79 beats/min). Maximum percentage reduction (86.46 percent) was observed for use of pill cutter and weekly pill box in cutting and sorting out of medicines, followed by opening medicine bottle with bottle opener, making bed and dusting with 52.71, 46.94 and 46.52 percent respectively. Maximum physiological cost of work (27.45 beats/min) was observed for dusting in the normal fashion. Maximum percentage reduction of physiological cost was observed while filling water bottle using water bottle holder followed by making bed using improved techniques (88.13 and 67.73 percent respectively). Maximum overall percentage reduction (70.85 percent) in assessed ergonomic costs was observed for using pill cutter and weekly pill box followed by dusting with 63.55 percent reduction brought about by use of water bottle holder, by making bed with new technology (57.28 percent), and dusting with use of static duster (52.81 percent).

REFERENCES

Authors’ Address: P. Sandhu, Assistant Professor and R. Bakhshi, Professor, Department of Family Resource Management, PAU, Ludhiana, Punjab, India
Corresponding Author: P. Sandhu, E-mail: spushi@rediffmail.com, pushi12@yahoo.com