

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

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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 elasticity 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 ± 3 years, mean height 61 ± 2 inches, mean weight 71 ± 4 kgs, mean heart rate 76 ± 4 (b.min⁻¹), mean systolic pressure 162 ± 8 mm Hg and mean diastolic pressure 76 ± 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 teathed 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.

Average heart rate = average working heart rate - average resting heart rate.

(Increase over base)

Physiological Cost of Work (PCW):

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

Where Total cardiac cost of work (TCCW) is
 $TCCW = \text{Cardiac cost of work (CCW)} + \text{Cardiac cost of recovery (CCR)}$

where $CCW = AHR \times \text{duration of activity}$

$AHR = \text{average working heart rate} - \text{Average resting heart rate}$

$CCR = (\text{Average recovery heart rate} - \text{Average resting heart rate}) \times \text{duration of recovery.}$

Analysis of Data

Paired 't' test was used to find out significance of differences between existing and improved working conditions. Two way ANOVA was used to find out significance of differences between percent reduction in assessed parameters 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. Increased blood supply is needed whenever some kind of strenuous physical activity is performed to get rid of accumulated lactic acid and carbon-dioxide 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 (29.01beats/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 maximum 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 ergonomically 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

Table 1: Reduction in average heart-rate (beats/min.) of selected elderly subjects while performing selected personal care related activities under the existing and improved working conditions

Activities performed	Average heart-rate (beats/minute)								Reduction in per cent increase	't' - value
	Existing working conditions				Improved working conditions					
	At least	During activity	Increase over base	Percent increase	At least	During activity	Increase over base	Percent increase		
Filling hot water bottle	77.25 ±4.64	92.44 ±5.78	15.19	19.66 ±5.72	77.00 ±5.11	86.27 ±3.71	9.27	12.04 ±6.96	7.62 ±2.06	3.69***
Opening medicine bottle	76.25 ±5.51	81.96 ±6.49	5.71	7.49 ±3.91	77.40 ±5.18	80.10 ±5.49	2.70	3.49 ±1.84	4.00 ±0.09	4.03***
Cutting and sorting of medicines (pills)	75.05 ±4.39	84.58 ±8.28	9.53	12.70 ±8.56	76.60 ±6.09	77.89 ±6.00	1.29	1.68 ±2.83	11.02 ±2.06	5.33***
Using toilet	77.85 ±5.59	87.00 ±7.50	9.15	11.75 ±6.43	77.65 ±6.40	83.17 ±6.25	5.52	7.11 ±4.45	4.64 ±1.79	2.59***
Bathing	76.35 ±4.24	94.38 ±8.25	18.03	23.61 ±6.78	78.30 ±5.48	88.36 ±5.07	10.06	12.85 ±7.62	10.76 ±2.34	4.60***
Dressing	78.35 ±6.89	85.78 ±8.50	7.43	9.48 ±5.91	78.15 ±6.76	85.67 ±7.62	7.52	9.62 ±5.04	-0.14 ±1.78	0.08
Making bed	76.10 ±4.29	105.11 ±5.98	29.01	38.12 ±7.75	77.10 ±5.45	92.52 ±4.61	15.42	20.00 ±9.04	18.12 ±2.73	6.63***
Dusting	74.60 ±3.32	102.79 ±5.49	28.18	37.77 ±9.38	78.00 ±5.25	93.07 ±5.96	15.07	19.32 ±8.84	18.45 ±2.95	6.25***
Arranging items for night	77.15 ±3.98	96.93 ±6.62	19.78	25.64 ±4.78	76.50 ±4.23	90.75 ±3.34	14.25	18.62 ±4.50	7.02 ±1.50	4.65***

*Significant at 10%, ** at 5%, *** at 1% level of significance

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. .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

Table 2: Reduction in average physiological cost of work (beats/min.) of selected elderly subjects while performing selected personal care related activities under the existing and improved working conditions

Activities performed	Average physiological cost of work (beats/min.)		Average reduction	Percentage reduction	't'-value
	Existing working conditions	Improved working conditions			
Filling hot water bottle	22.17± 19.06	2.63 ± 25.63	19.54 ± 7.33	88.13	2.67***
Opening medicine bottle	1.95± 4.07	1.45 ± 7.18	0.50 ± 1.89	25.58	1.80*
Cutting and sorting of medicines	8.93± 25.93	4.00 ± 11.28	4.93 ± 6.49	55.24	1.99**
Using toilet	7.89± 6.23	4.01 ± 4.29	3.88 ± 1.73	49.13	2.23**
Bathing	18.90± 6.03	9.43 ± 5.92	9.47 ± 1.94	50.09	4.88***
Dressing	8.95± 19.17	6.00 ± 7.65	2.95 ± 4.73	32.93	0.62
Making bed	25.54± 10.52	8.24 ± 20.74	17.30 ± 5.33	67.73	3.24***
Dusting	27.45± 10.11	11.22 ± 13.91	16.23 ± 3.94	59.11	4.11***
Arranging items for night	22.18± 4.46	14.93 ± 4.43	7.25 ± 1.44	32.68	5.02***

*Significant at 10%, ** at 5%, *** at 1% level of significance

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 of work 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. Paired t-test showed statistically non significant differences between existing and improved working conditions while dressing up which shows the inability of the introduced technology to bring about sufficient improvement in existing method of work.

Highest significant differences existed between existing and improved working conditions while arranging items for night, bathing, and dusting 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

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

Personal and room care related activities	Percentage reduction		Overall percentage reduction
	Heart Rate	Physiological cost of work	
Cutting and sorting of medicines (pills)	86.46	55.24	70.85
Filling hot water bottle	38.97	88.13	63.55
Making bed	46.84	67.73	57.28
Dusting	46.52	59.11	52.81
Bathing	44.2	50.09	47.14
Using toilet	39.67	49.13	44.4
Opening medicine bottle	52.71	25.58	39.14
Arranging items for night	27.96	32.93	30.44
Dressing	-1.21	32.68	15.73
CD (5%) Between the parameters		15.02	
Between the activities		32.91	

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 ergonomically redesigned 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.

3. 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.
4. Maximum physiological cost of work (27.45 beats/min) was observed for dusting by elderly subjects in the normal fashion. 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).
5. 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.

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 of work 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 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

- Guyton, A. C.: *Text Book of Medical Physiology*. 8th Ed. Prism Books (Pvt.) Ltd., Bangalore, India (1991).
- Mahler, H.: Add life to years: Message from Director General, WHO on World Health Day, 1982. *Social Welfare*, **29**: 8-10 (1982).
- Reilly, J. J., Lord, A., Bunker, V. W., Prentice, A. M., Coward, W. A., Thomas, A. J. and Briggs, R. S.: Energy balance in healthy elderly women. *British J Nutrition* **69**: 21-27 (Original not seen. Abstr. in *CAB Abstracts* (1993-94).

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