Evaluation of Kitchen Design for the General Elderly and Wheelchair Using Elderly

一般高齢者および車イス利用高齢者のための台所デザインの評価

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Summary

This study aims at evaluating conventional kitchens in Korea from the observation of kitchen work performed by the elderly and wheelchair using elderly. As research sites, L-type and L-type kitchens in Seoul were selected. Three subject groups; the general elderly, the wheelchair using elderly and healthy young adults, were selected and observed. Fifteen kitchen tasks performed by subject groups were recorded with video cameras and measured with a stopwatch. The time taken for performing tasks and the frequency of error occurrence were analyzed. Major findings resulting from this study are as follows: 1) The angle of the control panel, along with its height, should be carefully considered in the design of built-in type kitchen appliances. 2) A mobile cart is needed for a wheelchair user to carry hot or heavy foods or food waste. 3) Placing pull out or foldable shelves at various heights in relation to lower cabinets should be considered in addressing the lack of work surfaces in conventional Korean kitchens.

1. OBJECTIVE

Kitchen design has long been locked into kitchen plans that are suitable for "average" persons who are in good physical and mental condition. Traditional kitchen design does not take into account differences in size and abilities among people, therefore kitchens should be designed to accommodate a broader range of human needs.

Relating to the study of kitchen design for people of differing abilities, Peterson (1995) has introduced accessible kitchen designs that meet the needs of such people. Null and Cherry (1996) have also developed a set of general guidelines for residential kitchens to enhance accessibility. While much research on residential environments for people of differing abilities has been carried out, the studies focusing exclusively on kitchen designs are quite limited. We have found that results of studies done in such countries as America are not appropriate to the situation in Korea.

The size and abilities of Korean people are different from those of American people, and in comparison most Koreans use much smaller kitchens. Also, the culture related to the dietary habits of Koreans differs from that of American people. In particular, kitchen designs which deal with the conditions of the elderly and wheelchair users, while reflecting the general needs of Koreans should be developed.

The aim of this study is to evaluate conventional kitchens in Korea from the aspect of environment and product design in order to provide basic information on kitchen design. While performing tasks related to kitchen work, the problems caused by inappropriate designs will be identified, and then recommendations will be presented. As part of a series of studies, the results of this study will be applied to formulating kitchen design guidelines for the elderly in the long run.
2. METHODS
2.1. Sites of research

Kitchens are classified into five categories, namely I-type, L-type, U-type, Island-type and Peninsular-type. The pre-survey was conducted on 50 apartment model houses ranging from 10 to 60 pyong (note: Korean measuring unit. 1 pyong is equivalent to 3.3m$^2$ of floor size showed), the number of kitchen types employed in the order of I, L, U-type. Island and Peninsular-type kitchens were found to be less common. I-type kitchens occupied the largest portion, and were generally found in the small sized apartments under 30 pyong and 45 pyong. U-type kitchens appeared in large size homes over 45 pyong. For this study, we selected two typical kitchens, one I-type and

![L-type kitchen](image)

![I-type kitchen](image)

Fig. 1: Sites of research
one L-type, from apartment units located in the Seoul area (Fig. 1). Subjects' capabilities of performing tasks varied not only with differences in their physical conditions but also with kitchen environment such as the height of sinks and work counters etc. Therefore, the sizes of kitchen facilities were measured for this study.

### 2.2. Observation method

Using two video cameras, we recorded the motions of performing tasks individually while photographing major scenes with a snap camera. Periods taken for each task to be carried out were measured by a stopwatch and were recorded in task sheets along with frequency of error occurrence. In addition to the above objective research, we conducted subjective observation on key features while subjects were performing the tasks.

#### 2.3. Selection of tasks

A pre-survey of the contents of kitchen work was conducted to decide the tasks since each person has their own way of doing kitchen work and has a different kitchen environment.

After having 6 people fully describe their kitchen work processes in scenario style, common activities were selected. Each activity was examined in terms of degree of significance in the result. Accordingly, the tasks covering the whole process of kitchen work ranging from putting groceries into kitchen storage products, cooking, meal preparation, dish washing and garbage disposals were selected for observation (Table 1).

<table>
<thead>
<tr>
<th>Table 1: A list of tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T1.</strong> Place meat (600g) and bunch of apples (5), respectively, into the freezer and the vegetable storage box within the refrigerator after taking them out of a grocery bag.</td>
</tr>
<tr>
<td><strong>T2.</strong> Pour 5kg of rice into a rice box.</td>
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<tr>
<td><strong>T3.</strong> Carry 2 servings of rice after taking it out of the rice box.</td>
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<tr>
<td><strong>T4.</strong> Turn the water tap on and wash the rice.</td>
</tr>
<tr>
<td><strong>T5.</strong> Take the meat out of the freezer, open the door of the microwave oven, and place the meat into the oven, set the timer for 1 minute for 'thaw' and 3 minutes for 'cooking'.</td>
</tr>
<tr>
<td><strong>T6.</strong> Place plates on the work counter after taking them out from both the top and the second shelves in upper cabinet.</td>
</tr>
<tr>
<td><strong>T7.</strong> Place a pot on the gas range burner after taking it out from the bottom shelf of lower cabinet.</td>
</tr>
<tr>
<td><strong>T8.</strong> Cut a radish into two pieces on a chopping board.</td>
</tr>
<tr>
<td><strong>T9.</strong> Turn the water tap on, fill half of the pot with water, and place the pot on the gas range burner.</td>
</tr>
<tr>
<td><strong>T10.</strong> Turn on the gas valve, operate the controls of the gas range oven, and turn on the rear burner.</td>
</tr>
<tr>
<td><strong>T11.</strong> Set the range hood's timer to 20 minutes, and set the oven on 'high', and then push 'stop' button.</td>
</tr>
<tr>
<td><strong>T12.</strong> Place a pot on a gas range burner and a plate containing food on a dining table.</td>
</tr>
<tr>
<td><strong>T13.</strong> Carry the pot and the plate from the dining table into the sink and the refrigerator, respectively.</td>
</tr>
<tr>
<td><strong>T14.</strong> Turn on the water tap, wash them and place two plates and a pot face down on the counter.</td>
</tr>
<tr>
<td><strong>T15.</strong> Carry food garbage bag from the kitchen to the apartment entrance.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2: Subject descriptions</th>
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</thead>
<tbody>
<tr>
<td><strong>General Elderly Group (5 females)</strong></td>
</tr>
<tr>
<td>Subjects</td>
</tr>
<tr>
<td>a1 female</td>
</tr>
<tr>
<td>a2 female</td>
</tr>
<tr>
<td>a3 female</td>
</tr>
<tr>
<td>a4 female</td>
</tr>
<tr>
<td>a5 female</td>
</tr>
</tbody>
</table>

| **Wheelchair Using Elderly Group (5 females)** |
| Subjects | Age | Physical characteristics |
| b1 female | 68 | paraplegic of the first degree handicap (120cm) |
| b2 female | 67 | paraplegic of the first degree handicap (119cm) |
| b3 female | 63 | paraplegic of the first degree handicap (110cm) |
| b4 female | 62 | paraplegic of the first degree handicap (115cm) |
| b5 female | 63 | paraplegic of the first degree handicap (116cm) |

| **Healthy Young Adults Group (5 females)** |
| Subjects | Age | Physical characteristics |
| c1 female | 23 | non-disabled (160cm) |
| c2 female | 23 | non-disabled (158cm) |
| c3 female | 22 | non-disabled (160cm) |
| c4 female | 20 | non-disabled (156cm) |
| c5 female | 21 | non-disabled (159cm) |
2.4. Subjects

Subjects consist of a general elderly group (5 females), wheelchair using elderly group (5 females), and healthy young adults group (5 females) (Table 2).

2.5. Statistical analysis

SAS program was used for the statistical analysis. Two-way ANOVA was used to analyze the differences in passage of time among three groups. Statistical significance was examined at 5% level. Scheffe's multiple comparison method was used to identify the differences among statistically significant factors.

3. RESULTS

3.1. Required task time

Performing in different kitchen types did not show any significant difference in required task time. For all tasks performed, the differences among the groups are significant (p < 0.05).

(1) Comparison by group

Average required time by each group in different kitchen types is shown in Fig. 2 and Fig. 3.

- The tasks of which the required time increases in the order of the healthy young adults group, the general elderly group, the wheelchair using elderly group respectively: T1 T2 T7 T8 T9 T14.

- The tasks in which the wheelchair using elderly spent more time than the general elderly and the healthy young adults: T3 T4 T12 T13 T15. (In this case, no significant time difference was noticed between the general elderly and the healthy young adults group.)

When performing the task of taking rice out of a rice box (T3), one elderly subject made a mistake of pushing a rice volume lever backward instead of pushing it downward and spent additional time. The wheelchair users group spent much more time than other groups in the tasks of carrying a pot and a plate (T12), the task of carrying them back to the sink and the refrigerator (T13), and the task of carrying the garbage bag to the entrance of the apartment (T15).

- The tasks in which the wheelchair using elderly group and the general elderly group spent more time than the healthy young adults group: T5 T10. (In this case, no significant time difference was found between the general elderly and the wheelchair using elderly).

During the process of operating a microwave oven (T5), no significant difference was noticed between the general elderly and the wheelchair using elderly. However, the time difference between both the general
elderly and the wheelchair using elderly groups and the healthy young adults group was significant.

- The tasks in which all the wheelchair using elderly couldn’t perform as their hands could not reach (T6 T11).

For the task of taking out plates from upper cabinets (T6) and operating the range hood (T11), the general elderly subjects spent more time than the healthy adults group. All the wheelchair using subjects were unable to carry out the task since they could not reach the upper cabinets while sitting in wheelchairs (Fig. 2, 3).

(2) Comparison by tasks

The comparison by group of tasks showed a significant difference (p < 0.05).

- Tasks related to storing groceries : T1 T2
- Tasks related to cooking : T3 T4 T5 T7 T8 T9 T10 (exclude T6 T11)
- Other tasks : T12 T13 T14 T15

Regarding tasks related to storing groceries, the task time required increases starting from the healthy young adults group, the general elderly group, and then to the wheelchair using elderly group. As to the tasks related to cooking, the wheelchair using and general elderly spent more time than the healthy young adults. In the other tasks, the wheelchair using elderly group spent more time than the general elderly and young adults groups.

3.2. Frequency of incorrect operation

Errors occurred mostly in performing the tasks related to the operations of such kitchen products as the microwave oven, range hood etc. As shown in Table 3, the general elderly and the wheelchair using elderly made errors in pushing a lever for drawing rice and taking out a rice drawer from a rice box.

Operating a microwave oven was found to be more difficult than doing any other kitchen work. Prior to performing the task, a demonstration of operating the microwave oven was conducted for all subjects. As the result the healthy adults group didn’t make an error, but the general elderly and the wheelchair using elderly made mistakes of forgetting the order of operation. Especially in selecting the ‘thawing’ and ‘cooking’ setting of a microwave oven, four subjects of these groups made errors respectively.

While opening a gas range valve 4 subjects performed incorrect operations. In the task of operating a gas range oven and turning on the rear burner, even a young adult made an error. Also in the process of operating a range hood two subjects of the general elderly group made errors two times respectively by incorrectly selecting buttons.

Table 3: Frequency of error occurrence

<table>
<thead>
<tr>
<th>Task</th>
<th>Contents</th>
<th>Times</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>T3</td>
<td>Incorrectly pushing a lever for drawing rice from a rice box</td>
<td>3</td>
<td>a2, a3, b2</td>
</tr>
<tr>
<td></td>
<td>Incorrectly taking out a rice drawer from a rice box</td>
<td>2</td>
<td>a3, b2</td>
</tr>
<tr>
<td>T5</td>
<td>Incorrectly selecting the ‘thawing’ function of a microwave oven</td>
<td>4</td>
<td>a2, a3, b2, b4</td>
</tr>
<tr>
<td></td>
<td>Incorrectly taking out a rice drawer from a rice box</td>
<td>1</td>
<td>a3</td>
</tr>
<tr>
<td></td>
<td>Wrong selection of ‘cooking’ setting of a microwave oven</td>
<td>4</td>
<td>a1, a3, b2, b4</td>
</tr>
<tr>
<td></td>
<td>Incorrectly inputting the ‘time’ for cooking of a microwave oven</td>
<td>3</td>
<td>a1, a2, b4</td>
</tr>
<tr>
<td>T10</td>
<td>Wrong opening of the valve of a gas range</td>
<td>4</td>
<td>a1, a2, a3, b1</td>
</tr>
<tr>
<td></td>
<td>Turning on a front burner instead of a rear one of a gas range</td>
<td>4</td>
<td>a1, a2, b4, c1</td>
</tr>
<tr>
<td>T11</td>
<td>Wrong selection of the ‘speed’ button while operating a range hood</td>
<td>2</td>
<td>a2, a4</td>
</tr>
<tr>
<td></td>
<td>Wrong input of ‘timer’ button of range hood</td>
<td>2</td>
<td>a2, a4</td>
</tr>
<tr>
<td></td>
<td>Incorrectly pushing the ‘stop’ button of a range hood</td>
<td>1</td>
<td>a2</td>
</tr>
</tbody>
</table>
3.3. Key features

From the observation of key features, in addition to the objective surveys such as time taken for performing additional difficulties tasks and frequency of error occurrence, the following were identified.

• T1: The wheelchair users opened the refrigerator holding the side of the door instead of using the recessed shape handle located on top of the door because they had difficulties in reaching and using the handle (Fig. 4). Two general elderly subjects also had difficulties in opening the door because of its heavy weight (Fig. 5). The observation reveals that the recessed handle replacing the D shaped handle caused wheelchair users severe uneasiness in using refrigerators.

All subjects in wheelchairs had difficulties in placing meat into the freezer located on top of the refrigerator because the height of the freezer (1700mm) in this experiment is beyond their optimal reach zone. According to Pheasant (1988), the floor to vertical grip reach of women in wheelchairs is 1460mm.

● T2: Elderly subjects had problems in pouring 5kg of rice into the rice box through a small opening in the upper part of the rice box while stooping (Fig. 6). Especially wheelchair using subjects found more difficulties when they tried to pull out the drawer in the lower part of the rice box to remove the rice.

● T5: Elderly subjects found operating the controls of a microwave oven very difficult since there were many buttons to control and the operation process was too complicated (Fig. 7).

● T6: In the L-shape kitchens, the height of the upper kitchen cabinets was higher than the ones in the I-shape kitchen. Several elderly subjects could not remove plates from the upper shelf unless they stepped on a step stool (Fig. 8). The wheelchair users were completely unable to reach the upper cabinets in both types of kitchens (Fig. 9).

● T7: Most elderly subjects did not look comfortable while stooping to carry out the task. For the wheelchair users, it was difficult to remove plates even from the lowest shelf (Fig. 10).

● T8: Shoulders were pulled back when the shorter elderly and wheelchair using elderly tried to cut radishes with knives on a chopping board (Fig. 11).

● T10: Even in the L-type kitchen, where the height of the
gas opening valve is lower than the one in the I-type kitchen, the opening valve on the pipe of the gas range was located too high and placed in the corner. The wheelchair users were barely able to use it by stretching out their hands (Fig. 12). We also found that rotary type handles caused inconvenience because they required the complicated motion of twisting while pushing (Fig. 13).

• T11: The control panel of the range hood was located very high compared with the eye level of subjects and angled so that the elderly subjects could not operate it easily (Fig. 14). We found that the angle of the control panel, along with its height should be considered carefully in designing built-in type kitchen appliances. All wheelchair users in this experiment couldn't perform the task at all because their hands could not reach the range hood. Compared to the product lettering 'RANGE HOOD', the size of the function button lettering was so small, that the subjects could barely read them even when squinting their eyes (Fig. 15).

• T12: The wheelchair users looked uncomfortable when moving by rolling the wheel with one hand while carrying a pot with the other (Fig. 16). In the L-type kitchen where the distance between the gas range and the table was relatively far, they could continue the task only after laying the pot once or twice on their laps. In this experiment, performing the task did not do any harm because the pot contained cold water. But, in real situations, it will be dangerous since they may get burnt when they carry pots filled with hot food. Accordingly, in wheelchair users' kitchens, a cart can be useful to carry hot foods or food waste.

• T14: Since the height of the sink (850mm) and the faucet were high, the wheelchair users had to stoop forward to wash dishes in the sink (Fig. 17, 18). Karagelis (1982)5, using a number of performance criteria, demonstrated that the optimal kitchen work top height for wheelchair users was around 700mm. Subjects using wheelchair experienced pain in their arms caused by placing their arms on the edge of the sink while doing dishes. We found that mounting the faucet controls on the front aprons of counters can be helpful for an easier approach from a wheelchair.

• T15: Wheelchair users carried garbage bags moving their wheelchairs with one hand while holding it with the other.
hand. In the L-type kitchen, it was inconvenient for a
wheelchair user holding a garbage bag to pass through
because the width (850mm) between the refrigerator and
table was not enough (Fig. 19). Although Goldsmith
(1997) states 750mm accommodates for wheelchair users
to pass through, it is observed that wider passage should be
provided to accommodate the wheelchair users rolling
wheelchairs with one hand while carrying something such
as a garbage bag with the other hand.

4. CONCLUSION

In this study, we asked three groups of subjects to perform
the tasks related to kitchen work and analyzed their
performances. As the result, we ascertained that overall the
general elderly and elderly wheelchair users' abilities of
carrying out kitchen work are much lower than the healthy
young adults. Nevertheless, we found that conventional
kitchens in Korea do not accommodate for their physical
and mental decline. The following are major findings
resulted from this study.

1) Physical work capacity

① Recessed handles on top of refrigerator doors are not
appropriate for the elderly who are weak and for wheelchair
users who are short.

② Wheelchair users usually move things by piling them on
their laps. But they are not able to do this when they have to
carry hot food or food waste. To address this problem, a
movable cart is recommended, especially since a lot of
Korean meals, such as "soy bean paste stew", are hot.

③ For wheelchair users who are not able to stand, freezers
located on the top of refrigerators are beyond the optimal
reach zone. Therefore, instead of an upright refrigerator
design, two separate units (one for refrigerating the other for
freezing) is recommended. These shorter units can be placed
anywhere around the kitchen.

④ Moving continuously while holding something is very
difficult for elderly wheelchair users.

2) User interface

The angle of the control panel, along with its height,
should be considered carefully in designing built-in type
kitchen appliances. For example, for the range hood and the
gas valve, the efficiency of operation would be much
improved if the angles of the control panels are
conveniently set.

3) Work space

① The incorporation of variable height pull out or foldable
shelves should be considered in order to address the lack of
work surfaces in conventional Korean kitchens.

② The pathway for wheelchair users in kitchens should be
as straight as possible. Each corner or turn requires extra
effort and increases the time required to complete tasks.

③ In order to allow wheelchair users ample work and
maneuvering space, there should be more clear space in
front of appliances with doors than the 760mm x 1220mm
recommended by Leibrock and Behar (1993).

④ Faucet controls can be mounted on the front aprons of
counters or the length of faucet levers can be extended to
allow easier access from a wheelchair.

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information on wheelchair users and introduced us to
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