Statistical Analyses on Fatalities Characteristics of Residential Fires

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ABSTRACT

Fire death patterns in residences in Japan were examined through the statistical analyses of fire deaths data base made by Fire Defense Agency. It was identified that there are two typical fire death patterns in residences such as "Disaster-Vulnerable People and Daytime Fire" pattern and "Non Disaster-Vulnerable People and Night-time Fire" pattern. The former pattern can be described typically as the case that a person who needs help to move encountered a fire and failed to escape without any help while he was alone during daytime. The latter pattern can be also described typically as the case that a person who has normal physical function was killed in a fire mainly due to delay of detection while he was drunk or asleep at night. For the purpose of fire deaths reduction, the "Disaster-Vulnerable People and Daytime Fire" pattern should be noticed, because the fire death rate of this fire death pattern is much higher than the another fire death pattern and further the population of those disaster-vulnerable people like aged people 65 or older is increasing rapidly in the recent years and the near future in Japan.
KEYWORDS: residential fire, fire death, statistics, life loss risk, pattern analysis.

INTRODUCTION

Every year, about a half of structure fires occur in residences, and three fourths of fire deaths caused by structure fires are due to residential fires in Japan[1]. Moreover, Japan is facing the problem of the rapid aging of society which is expected to continue to a stage where one fourth of total population will be 65 and older at the beginning of the 21st century[2]. Since almost a half of the total fire deaths are 65 and older, the rapid aging of Japanese society would cause increasing number of fire deaths in the coming near future. Considering these facts, much more concern than before has addressed the residential fire problem in this decade from the viewpoint of fire deaths reduction in Japan.

The purpose of this study is to analyze the characteristics of fatalities due to residential fires for examining what kinds of residential fire protection measures are appropriate in terms of life safety especially for the people with disabilities like aged people.

SOURCE OF FIRE DEATHS DATA USED IN THIS STUDY

Every fire death as well as every fire incident is reported systematically in an unified format from municipal fire departments to Fire Defense Agency[3]. After those fire death reports are accumulated, the data base is made every year by Fire Defense Agency. The fire deaths data used in this study includes the information of the fire deaths that occurred in residences during five years from 1983 to 1987. However, the fire deaths caused by such fires as incendiary fires and suicide fires are excluded from analysis here, because these kinds of problems should be treated with from other viewpoints such as a crime or a social problem. Then, the total number of residential fire deaths analyzed here is 3,629. The information in a fire death report contains the building features of an origin house or an apartment, the data of a fire profile such as a cause, the first item ignited, extent of fire spread etc., and the fatality's characteristics such as age, sex, physical and mental conditions at a fire including incapacitation due to alcohol.

RESULTS OF ANALYSIS

Life Loss Risk by Structure Type of Residences

Table 1 shows the comparison of life loss risk by structure type of residences. Six structure types are determined here by combining three construction types (fire resistive construction, fire proof wooden construction, and ordinary wooden construction) and two housing types (a single-family dwelling and a multiple-family dwelling). As can be seen in Table 1, the number of fire deaths per year per million units of a corresponding structure type changes mainly according to the change of construction type rather than the change of housing type. For example,

TABLE 1. The number of residential fire deaths by structure type.

Structure type (Housing type / Construction type)	The number of fire deaths per year per million units of house by structure type
Single-family / wooden	35.1
Single-family / fire proof wooden	10.2
Single-family / fire rated reinforced concrete	5.1
Multiple-family / wooden	33.4
Multiple-family / fire proof wooden	17.1
Multiple-family / fire rated reinforced concrete	6.0
Total of above	21.3

Sources : Number of fire deaths from fire deaths data base, Number of houses from the literature [4].

ordinary wooden construction houses have more than twice as high fire death rate as have fire proof wooden construction houses in both housing types of "single-family" and "multiple-family". Also, ordinary wooden construction houses have more than five times as high fire death rate as have fire resistive construction houses in both housing types.
By contrast, there is not so much difference of fire death rate between two housing types of "single-family" and "multiple-family" in each construction type. Therefore, if characteristics of a fatality itself are omitted from consideration in analysis, fire severity such as an extent and/or rapidity of fire spread is naturally considered to be a dominant factor that affects life loss risk in residential fires.

Analysis on Fatalities' Characteristics

The items concerning fatalities' physical functions obtained from a fire death report are age, whether one suffers from sickness or not, whether one is handicapped or not, and whether one is bedridden or not. Likewise, the items concerning a level of one's consciousness awakening in terms of ability of fire detection are whether one is drunk or not, and whether one is awake or asleep. Using these items, the fatalities' characteristics are analyzed hereafter. Also, through the analysis of fatalities' characteristics, fire death patterns are discussed.

Age of fatality. Figure 1 shows a histogram of the proportion of fire deaths by three age groups as 65 and older, 5 and younger, and 6 to 64. As shown in Figure 1, almost a half (47.8 %) of the total fatalities are 65 and older. By the way, Table 2 gives us another aspect of life loss risk among four high risk groups as 65 and older, 75 and older, handicapped, and bedridden. In terms of the death rate (the number of fire deaths per year per 100,000 population), the aged who are 65 and older have 4.5 times as high risk as the average, and the aged who are 75 and older have 8 times higher risk than the average. Handicapped persons, who are given a certificate by the government, have almost the same risk as the aged who are 65 and older. However, the most noticeable fact is that bedridden persons, 82 % of whom are 65 and older, have indeed 41 times as high risk as the average. From this fact, the most difficult condition is considered to be the case of a bedridden person among the groups categorized as the people with disabilities. Although two characteristics of fatalities, aged and bedridden, are likely to overlap each other, a substantial feature of physical functions like bedridden should be given priority for categorization of a high risk group.

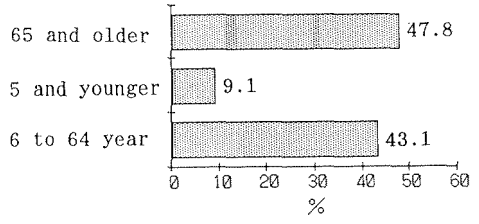

FIGURE 1. Proportion of residential fire deaths by age classification.

TABLE 2. Comparison of residential fire deaths rate among high risk groups

Category of high risk group	The number of residential fire deaths per year per 100,000 persons	Ratio of fire death rate to the average (1.0) of total population
The bedridden (≥65)	24.6	41.0
The handicapped*	3.0	5.0
The aged (a) (≥65)	2.7	4.5
The aged (b) (≥75)	4.8	8.0
Total Population	0.6	1.0

* Handicapped : The people who are given a certificate by the government
Sources : Number of fire deaths from fire deaths data base, Number of population by age group from the literature [5], Number of the bedridden from the literature [6], and Number of the handicapped from the literature [7].

Physical Functions. The conditions of physical functions can be sorted out into such seven categories as shown in Figure 2 on the basis of the items in a fire death report. Figure 2 shows a histogram of the proportion of fire deaths by these seven category groups. In order to think of a strategy of fire deaths reduction program, it is a considerably important fact that the total percentage of the six groups that have some handicap at some rate in terms of escaping ability reaches almost 70 %. This fact tells us that occurrence of fire death depends not only on severity of a fire itself but also largely on conditions of occupants' physical functions. Therefore, besides fire control measures, we should notice improvement of circumstances of disabled persons and the elderly as well as emergency assistance by their family or neighbors for reducing fire deaths.

The Level Of Consciousness Awakening. Combining the two items of drinking status and awakening status, the levels of consciousness awakening of fatalities can be sorted out into such five category groups as shown in Figure 3. From the histogram of the proportion of fire deaths

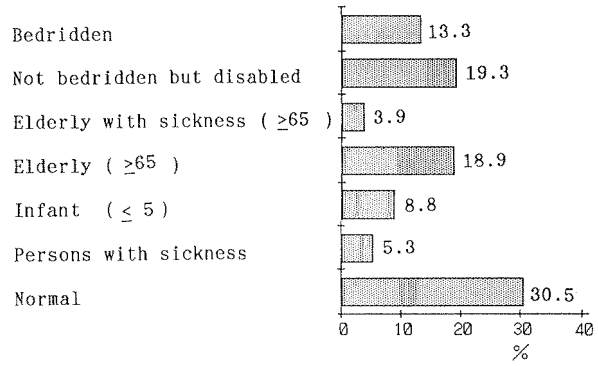

FIGURE 2. Proportion of residential fire deaths by condition of physical functions.

by these five groups, about a half (53.1 %) of the total number of fatalities come under such status as drunk or asleep. Figure 4 shows the breakdown by three age groups as described in Figure 1 for each level group of consciousness awakening. In the cases of drunk status to some extent, the proportion of the age group "6 to 64" is over 65 %. On the other hand, the proportion of elderly group "65 and older" exceeds that of "6 to 64" in the cases of sober status.

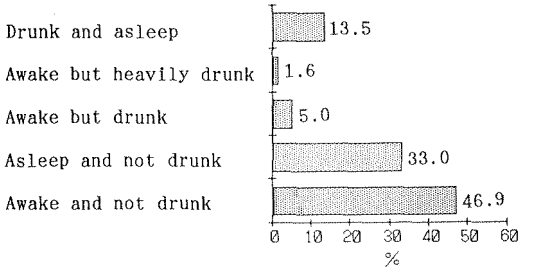

FIGURE 3. Proportion of residential fire deaths by level of consciousness awakening at a fire.

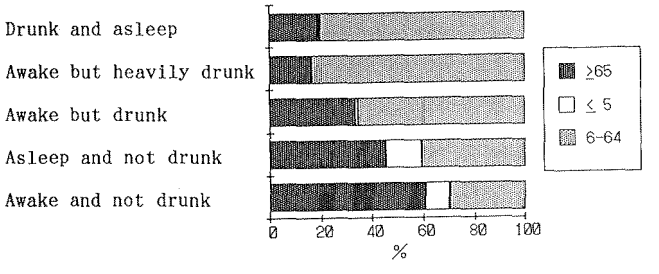

FIGURE 4. Breakdown by age classification in each category of levels of consciousness awakening at a fire.

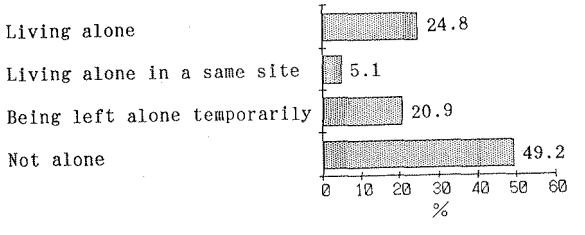

FIGURE 5. Proportion of residential fire deaths by situation of presence of others at a fire.

Presence of Others at a Fire. Situation of presence of others at a fire, i.e. whether one is staying alone or not at a fire, is also a very important factor as circumstances of fatalities especially for the people who need help to move. The status of staying alone here includes being left alone temporarily and living alone separately from one's family in the same site, and living alone. Figure 5 shows a histogram of the proportion of fire deaths by the four category groups of presence of others at a fire. A half of the total fire deaths (50.8 %) correspond to the status of staying alone at a fire in any case. Although the living alone case has the most proportion (24.8 %) among the cases of staying alone at a fire, the case of being left alone temporarily has a quite large proportion (20.9%). The number of fire deaths in this case could increase in the future, because there is an increasing tendency for elderly persons to be left alone during daytime, since more and more women go out to work in recent Japan. In either case of staying alone at a fire, emergency communication system for help by neighbors and/or home sprinkler system besides home detectors are needed for disabled persons to be rescued.

Fire Deaths Incidence by Time of Day

For each of three items such as age grouping, whether one is bed-ridden or not, and the situation of presence of others at a fire, fire deaths incidence by every two hours in a day is illustrated respectively in Figure 6 through Figure 8. The distribution pattern of each category in these figures can be clearly identified as "more in daytime" type and "more in night-time" type. Namely, as to the categories of the aged, infants, bedridden persons, and being left alone temporarily, fire deaths tend to occur much more during daytime than during night-time. In contrast to above categories, as to "6 to 64" year age group, persons who are not bedridden, and living alone, fire deaths incidence during night-time is considerably higher than that during daytime.

Cross Analysis of Fatalities' Physical Functions by Causes of Fire Death

Table 3 shows the result of cross analysis between seven categories of fatalities' physical functions and reported causes of fire deaths. Within the fire death causes in Table 3, the causes such as "Difficult to escape" and "Attempt to escape but fail" are considered to relate to fatalities' physical functions. As for these two causes, the physical function category groups such as "Bedridden","Not bedridden but disabled", and "Infant" have considerably high percentages. To the contrary, these three physical function category groups have quite smaller percentages than other groups in the fire death cause of "Delay of detection". The group "Elderly with sickness" has the highest percentage (23.3%) in the fire death cause of "Wearing apparel ignited" among seven category groups of physical function. On the other hand, as for the fire death cause of "Delay of detection" which is not related directly with physical function, the group "Normal" has the highest percentage (43.6%) and the group "Persons(6-64) with sickness" has the secondary high percentage (36.6%). And, the group "Normal" has lowest percentage (4.9%) in the fire death cause of "Difficult to escape".

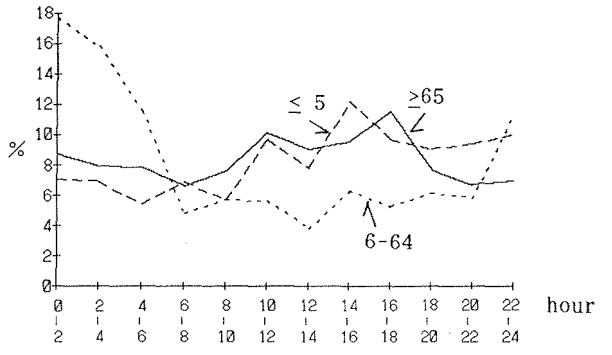

FIGURE 6. Fire deaths incidence by time of day for each category of age classification.

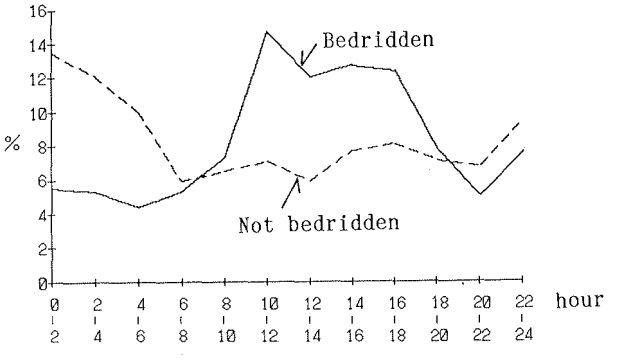

FIGURE 7. Fire deaths incidence by time of day for each category of the "bedridden" and the "not bedridden".

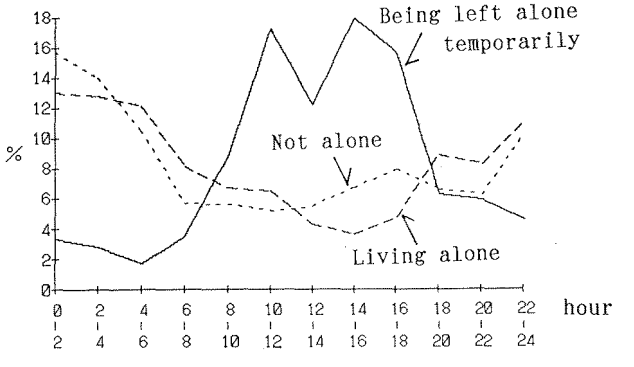

FIGURE 8. Fire deaths incidence by time of day for each category of presence of others at a fire.

TABLE 3. Cross analysis of fatalities' physical functions by cause of fire deaths.

Physical function category	Cause of Fire Death					
	Delay of detection	Difficult to escape	Attempt to escape but fail	Wearing apparel ignited	Others	Row total
Bedridden	66 13.7%	269 55.8%	88 18.3%	44 9.1%	15 3.1%	482 13.3%
Not bedridden but disabled	140 20.0%	148 21.2%	184 26.3%	109 15.6%	118 16.9%	699 19.3%
Elderly (≥65) with sickness	30 21.1%	15 10.6%	17 12.0%	33 23.2%	47 33.1%	142 3.9%
Elderly (≥65)	193 28.2%	37 5.4%	88 12.8%	112 16.4%	255 37.3%	685 18.9%
Infant (≤5)	48 15.0%	218 68.3%	16 5.0%	6 1.9%	31 9.8%	319 8.8%
Persons (6-64) with sickness	71 36.6%	31 16.0%	16 8.2%	15 7.7%	61 31.4%	194 5.3%
Normal	476 43.0%	54 4.9%	146 13.2%	42 3.8%	390 35.2%	1,108 30.5%
Column total	1,024 28.2%	772 21.3%	555 15.3%	361 9.9%	917 25.2%	3,629 100.0%

Sources : fire deaths data base.

TABLE 4. Two typical fire deaths patterns derived from study of fire deaths incidence by time of day.

Fire Death Pattern	Distinctive Features from the viewpoint of fire protection
Disaster-Vulnerable* People & Daytime Fire	* Victims are people who are disabled, elderly, or infant. * There are relatively few victims who are drunk or asleep. * There are many such cases that victims are left alone at a fire during other family members' absence. * For this pattern, home sprinkler system and/or neighbor's assistance is needed.
Non Disaster-Vulnerable People & Night-time Fire	* Most of victims are people who are 6 to 64 years old and with normal physical functions. * There are many victims who are drunk or asleep. * Many cases of living alone as well as staying with other family members at a fire come under this pattern * For this pattern, efficient fire detection system would save many lives.

* Disaster-Vulnerable : The people who are vulnerable to disaster

CONCLUDING REMARKS

Considering fire deaths incidence by time of day described above, residential fire deaths can be grouped as "the Disaster-Vulnerable People & Daytime Fire" pattern and "Non Disaster-Vulnerable People & Night-time Fire" pattern. Table 4 gives a summary of the distinctive features of these two typical fire death patterns. The former pattern can be described typically as the case that a person, who needs help to move, encountered a fire alone and was killed while other family member(s) was absent for work or shopping. On the other hand, the latter pattern could be the probable case that a person, who has normal physical functions, was killed in a fire mainly due to the delay of detection while he was drunk or asleep at night.

Towards the goal of reduction of fire deaths, "Disaster-Vulnerable People & Daytime Fire" pattern is more important than "Non Disaster-Vulnerable People & Night-time Fire" pattern, because the death rate as well as the number of deaths in the former pattern is quite high and further the population of such a high risk group corresponding to this pattern like aged people is increasing rapidly in Japan.

Similar fire death patterns in residences in the United States are introduced in the report entitled "Patterns of Fire Deaths Among the Elderly and Children in the Home" by Karter, M.J.[8]. However, there is one big difference between the United States and Japan. It is the fire death rate of preschool children. From the former analysis by the author [9] and the analysis by Hall, J. of NFPA, preschool children (ages 0-5) in the United States are a high risk group with a fire death rate per million population nearly twice the average for all ages. On the other hand, preschool children in Japan have about the same risk as the overall average. As one reason for this difference, the study entitled "Fatal Fires and Unsupervised Children" by Fahy, Rita [10] suggested that many of the children in the United States were either unattended or unsupervised at the time of their fire deaths probably because there is a higher incidence of single-parent families in the United States.

In the end, this kind of pattern classification of fire deaths makes it easy to understand what kinds of fire protection measures such as a smoke detector, home sprinkler system, and emergency communication system, and their combination would be appropriate for a specified target group like the aged, the handicapped, or the persons who tend to be left alone during daytime. In addition, on the basis of statistics on the proportion of some fire death pattern and the population of the corresponding target high risk group, an estimation of the effect of a specified fire protection measure would be possible when fully equipped for the target group. Also, international fire comparison studies using the same pattern classification would be very helpful to understand what kind of situation is a common problem and/or a distinctive problem in each country.

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