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The Effect of Occupational Type of Household on Mortality in Japan

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ABSTRACT

The mortality of the Japanese population was examined focusing on the effect of household head occupation rather than individual occupations. The 'healthy worker effect' (HWE) which implies lower mortality observed in a working than in a non-working populations has been successively observed in comparative studies on mortality in different occupation populations. In this study we report quite similar results analysing the effect of household head occupation. We point out the possibility that HWE should have a component which is shared with the household members if the worker is a household head. We call this component the 'indirect effect'.

The results obtained in this study are as follows. The employee household had the lowest mortality followed by self-employed, agriculture and 'others' households. The self-employed household also had a low standardized mortality ratio (SMR) except for diabetes in male. The SMR of the agriculture household was significantly high especially for those above 65 years of age and for suicide in both male and female of age 45 years old and over but low for cirrhosis of liver in male and tuberculosis in both male and female. The SMR of 'Others' household was the highest among the occupational type of households especially between 20-64 years.

The similarity in SMR trend among male and female rather than in occupational type of household, despite the fact that males are more likely to be working than females, suggests the presence of indirect effect. Though it is difficult to distinguish direct and the indirect effects completely, we also discuss a method that enables us to distinguish the two effects more effectively.

Key words: *Occupational type of household, Healthy worker effect, Indirect effect, Standardized mortality ratio*

Epidemiological studies of occupational exposure have indicated that the mortality of a working population is often less than that of the general population[6,11]. The difference is due to a bias called 'healthy worker effect'. Most studies have employed an industrial population with a strong and consistent pattern of healthy worker effect. Such studies have dealt with Japanese mortality based on various kinds of working and non-working male population as in Araki and Murata[2], Araki et al[3] and Agematsu et al[1].

The survival factor of a population due to work is generally related to (1)the selection effect i.e. being selected for an industrial workforce, these individuals must be relatively healthy and active, (2)risk at work which includes occupational haphazards and exposure to life shortening eventualities, and (3)the welfare effect such as social security programs, socio-economic conditions and changes in life style accompanying employment. However, the selection effect and risk at work concerns only working individuals, while the welfare effect concerns working individuals and their household members. Thus, the healthy worker effect can be divided into two aspects: direct and indirect effects. The direct effect operates only among the working individuals where the healthy worker effect is at its best, whereas the indirect effect operates both among the working household heads and their household members.

This study concerns the indirect effect, to assess the mortality experience of Japanese population according to the occupational type of household for 10 selected causes of death. Occupational type of households are classified according to the labour force status, industry and employment status of the main employed person. Related household members, including working members and household members were typologically classified by household head not individually.

In addition to a comparison between working and household populations, our study is useful in other aspects. Firstly, to provide background mortality data on Japanese population so that the results of more specifically directed cohort studies can be placed in proper perspective. Secondly, to assess patterns of mortality in the Japanese occupational type of household population to determine possible differences in mortality. Finally, to assess the effect (or joint effect) on mortality of occupational type of households, sex, age group and calendar period.

MATERIALS AND METHODS

1. Source data

The population under study the general population aged 15 years and over for the years 1968 to 1987. The recorded number of deaths was obtained from Vital Statistics Japan (Japan Ministry of Health and Welfare, 1968–1987) i.e. tables of death from selected causes by occupational type of household, sex and age (5 year group) for the years 1968 to 1987[8].

The categories of occupational type of household are based on the Japanese nomenclature found in Vital Statistics Japan where 6 main households are distinguished. In this study two separate agricultural households are combined; the white collar and blue collar jobs are combined into employee household because the materials are obtained from various sources[7-9] with different kinds of classification of household occupations. Thus, the classification of occupational type of household used here are; (1)Agriculture (2)Self-employed (3)Employee, and (4)Others. The interpretation for the classification of occupational type of household is shown in Table 1.

Table 1. Interpretation table for classification of Occupational Type of Household used in this study and the sources

Study Population Classification	SOURCES	
	Vital Statistics	National Census
AGRICULTURE [farming, fishing forestry]	1) AGRICULTURE ONLY 2) AGRICULTURE WITH OTHER WORKS	1) Agricultural self-employed 2) Agricultural employees Mixed with main employed in 3) Agricultural self-employed 4) Agricultural employee
SELF-EMPLOYED [manufacturing, construction or mining, wholesale or retail trade, eating & drinking places, services, and other non-agricultural industry]	3) SELF-EMPLOYED	5) Non-agricultural self-employed mixed household (with main: self-employed) 7) Self-employed with all in non-agriculture household 9) Non-agricultural employee & self-employed household (with main: self-employed)
EMPLOYEE [manufacturing, construction or mining, wholesale or retail trade, eating & drinking places, services, government job and other non-agricultural industry]	4) WHITE COLLAR JOB 5) BLUE COLLAR JOB	6) Non-agricultural employees' mixed household (with main; employees) 8) Employees with all in non-agriculture household 10) Non-agricultural employees & self-employed household (with main: employees)
OTHERS	6) OTHERS	11) Household without worker 12) Household whose economic type is not classifiable

The expected deaths from selected causes by sex and age (5 year group) for occupational type of household from 1968 till 1987 are computed from:

(a) Annual age-disease specific mortality; obtained from the tables of 'Death rates for selected causes by sex and age distribution from 1968–1987'[7].

(b) Age-specific population of occupational type of household; obtained from the tables of private household members 15 years of age and over, by economic type (12 groups), labour force status, 5-year age groups and sex for Japan 1970, 1975, 1980, and 1985[9].

Causes of death in National Health Trend[7] are categorized according to the 8th and 9th Revisions of the International Classification of Diseases (ICD) for 1968–1978 and 1979–1987,

respectively. Whereas in Vital Statistics Japan[8], the causes of death are categorized according to Japan's 117 rubric list of mortality, for this study the selected causes of death are as shown in Table 2.

The economic type classification consists of 12 groups under the Population Census nomenclature. For this study, economic type groups are recategorized according to occupational type of household classification. Therefore, the categorization gives rise to the population aged 15 years old and over for occupational type of household, age (5-year age group) and sex in Japan for 1970, 1975, 1980 and 1985. The summary of the population study employed is shown in Table 3.

Table 2. Selected causes of death and their ICD

Cause of Death	117 rubric list code	9th revised ICD
Tuberculosis	5, 6	010-018
Malignant neoplasms	28-37	140-208
Diabetes	39	250
Heart diseases	46, 51-52, 54-56	393-398, 410-429
Hypertensive diseases	48-49	401-405
Cerebrovascular diseases	58-60	430-438
Pneumonia & Bronchitis	62, 63, 66	466, 480-486, 490, 491
Cirrhosis of liver	73	571
Nephritis & Nephrosis	76-77	580-589
Suicide	E115	E950-E959

Table 3. Occupational Type of Household Population Aged 15 years and Over in all Japan in 1970, 1975, 1980 and 1985 by Sex (in percentage)

Occupational Type of Household	1970		1975		1980		1985	
	Male	Female	Male	Female	Male	Female	Male	Female
Agriculture	9.5	10.2	7.1	7.5	5.6	5.8	4.8	4.9
Self-Employed	8.3	9.4	7.9	8.8	7.8	8.6	7.0	7.8
Employee	28.5	31.2	31.0	33.4	32.5	34.0	33.7	34.8
Others	1.2	1.7	1.8	2.5	2.5	3.2	3.0	4.0
Study Population	74,152,795 (100%)		80,830,844 (100%)		88,023,953 (100%)		93,244,418 (100%)	

For the calculation of expected deaths, the annual age and disease specific mortality is multiplied by age-specific population of occupational type of household of the nearest census year. In this study, for a certain part of the analysis, the 20 year data are classified into 4 calendar periods of 5 years each, that is: 1)1968-1972 2)1973-1977 3)1978-1982 and 4)1983-1987. Since the populations of occupational type of household of the nearest census year are used, there are 4 standard populations in this study which are the population of occupational type of household of the census years 1970, 1975, 1980 and 1985 for the calendar period of 1968-1972, 1973-1977, 1978-1982 and 1983-1987, respectively.

The standardized mortality ratios (SMRs) are estimated as the ratio of the observed to expected number of deaths and multiplied by 100 i.e.

$$SMR = \frac{\text{observed no. of deaths(D)}}{\text{expected no. of deaths(E)}} \times 100 \quad ....(1)$$

P-values for SMRs are estimated by assuming the observed number of deaths to be distributed according to Poisson distribution. In this case, the normal approximation was adopted because the number of deaths was large.

2. Test of Significance

The preliminary interest relating to the SMR is simply whether the observed age-specific mortality in the study cohort is adequately explained by the standard rates, that is, whether the cohort and standard age-specific rates agree. The null hypothesis is that the cohort(λ) and standard(λ^*) age-specific rates agree in each age group(j);$\lambda_j = \lambda_j^*$ for $1 \leqslant j \leqslant J$. This means that the observed number of deaths $D = \Sigma_j d_j$ is approximately Poisson distributed with mean $E = \Sigma_j n_j \lambda_j^*$ where n_j is the cohort population size for age group j, and that the expected value of SMR, D/E, equals to 100.

In order to test whether the observed number of deaths is significantly different from the number expected, the simple continuity corrected

chi-square statistic

$$\chi^2 = (|D - E| - 0.5)^2/E \quad .....(2)$$

is used[12]. The level of statistical significance for SMR (significantly different from 100) is usually analysed by the table of Bailar and Ederer[4]. In this study, however, the P-values of the SMRs are calculated by using SAS[13] probability function.

The assumption that cohort rates(λ_j) are proportional to those of standard rates(λ_j^*) for each age group j where $1 \leq j \leq J$, that is

$$\lambda_j = \theta\lambda_j^*, \quad 1 \leq j \leq J \quad .....(3)$$

ensures that the SMR represents a good summary measure of the assoiation between cohort and standard rates. Thus, SMR is the maximum likelihood estimate of the multiplicative constant θ.Kilpatrick[10] suggested that the goodness of fit of this basic model, equivalent to a test of heterogeneity in the age-specific SMRs, could be evaluated via Pearson's chi-square statistics

$$\chi^2_{J-1} = \Sigma_{j=1}^{J} (d_j - e_j)^2/e_j \quad .....(4)$$

where $e_j = \theta n_j \lambda_j^*$ and n_j is the cohort population size for age group j, represents the expected number of deaths in the jth age group under the hypothesis.

For comparison of standardized mortality ratios, let us denote the observed number of deaths in the kth exposure group be $D_k = \Sigma_j d_{jk}$ and the expected number of deaths as $E_k = \Sigma_j n_{jk} \lambda_j^*$ where d_{jk} and n_{jk} is the observed number of death and population size for exposure group k and age group j, respectively. Thus, the standardized mortality ratios for kth exposure group is $SMR_k = (D_k/E_k) \times 100$.

Here, we are interested in comparisons among the different subcohorts, that is, among the different SMR_ks. The condition needed to assure comparability of the SMR_ks is that the stratum-specific(j) death rates for each exposure group(k) is proportional to the external standard rates.

The general hypothesis that the age-specific rates for each comparison group are proportional to those of the standard population may be written as $\lambda_{jk} = \theta_k \lambda_j^*$. Gail[5] suggested that this should be tested by summing together K chi-square statistics of the form (4) to give

$$\chi^2_{K(J-1)} = \Sigma_{k=1}^{K} \Sigma_{j=1}^{J} (d_{jk} - \tilde{e}_{jk})^2/\tilde{e}_{jk} \quad .....(5)$$

where $\tilde{e}_{jk} = \theta_k n_{jk} \lambda_j^*$ and $\theta_k = SMR_k = D_k/E_k = \Sigma_j d_{jk}/\Sigma_j n_{jk}\lambda_j^*$.

Provided that the proportionality assumption holds, the hypothesis of equality among the SMRs in the K exposures categories ($\theta_1 = \theta_2 = ...= \theta_k$) is tested by

$$\chi^2_{K-1} = \Sigma_{k=1}^{K} (D_k - \tilde{E}_k)^2/\tilde{E}_k \quad .....(6)$$

where now $\tilde{E}_k = \Sigma_{i=1}^{K} D_i/\Sigma_{i=1}^{K} E_i)E_k$ are the expected numbers after multiplicative adjustment by the overall SMR. Form (6) should be referred to tables of the chi-square distribution with K-1 degrees of freedom.

RESULTS

1. Effect of household types

The mortality of the Japanese population aged 15 years old and over by occupational type of household and calendar period for selected causes of death is shown in Fig. 1(a). Whereas in Fig. 1(b), the mortality of the Japanese population is the same as in Fig. 1(a) with the calendar period pooled from 1968 to 1987. We can observe that self-employed and employee households have significantly lower SMRs than that of other occupational types of household. Employee household has a significantly low mortality for all selected causes of death. The self-employed household also have significantly low mortality (SMR below 100) for all selected causes of death except for diabetes in male where the SMRs were 105, 108, 103 and 101 for the calendar period 1968–1972, 1973–1977, 1978–1982 and 1983–87, respectively. Although the SMRs for diabetes in male were above 100, statistically the SMRs were not significantly different from 100 ($p<0.05$). The agriculture household that is farming, fishing and forestry, has a significantly high mortality compared with self-employed and employee households. However, in agriculture households cirrhosis of liver in male and tuberculosis both in male and female have low SMR (SMR below 100). Since the national mortality of tuberculosis was the lowest among the selected causes of death[7], this might have contributed to the low SMR for tuberculosis than in other causes of death in agriculture households. Whereas, the 'Others' occupational type of household has a significantly high mortality among the occupational type of households for all selected causes of death.

2. Effect of calendar years

The effect of calendar years on the mortality of the Japanese population by occupational type of household and calendar period is shown in Fig. 1(a). The mortality of employee households was either gradually decreasing or remained almost unchanged from 1968 to 1987 for all causes of death. On the contrary, the mortality of 'others' occupational type of household was significantly high, and there was a drastic decrease in mortality from 1968 to 1987 for all causes of death. In self-employed households, there was slight increase in mortality for malignant neoplasms, pneumonia and bronchitis, cerebrovascular diseases, hypertensive diseases and suicide. Howev-

er, in diabetes there was an increase in mortality during 1973-77 but decreasing from 1978 to 1987. However, tuberculosis, heart diseases, cirrhosis of liver and, nephritis and nephrosis remained almost unchanged through the years. The agriculture household exhibited a significant increase in mortality for diabetes, heart diseases, hypertensive diseases, suicide and cerebrovascular diseases throughout the calendar period. Tuberculosis, malignant neoplasms, pneumonia and bronchitis, cirrhosis of liver and, nephritis and nephrosis showed an increase in mortality from 1968 to 1982 and a decrease in the later part of the calendar period.

3. Effect of sex

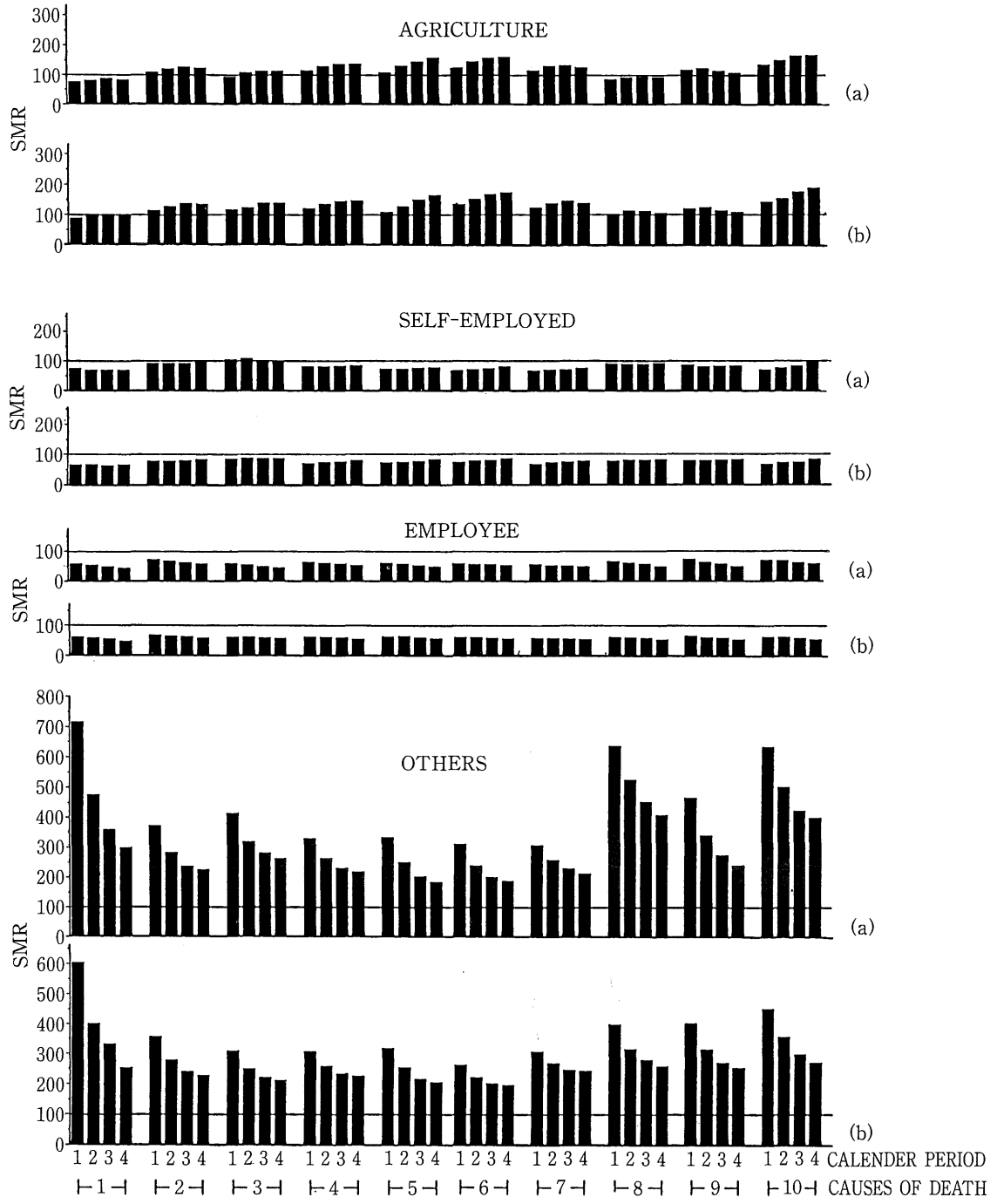
For the SMR of Japanese population by sex and occupational type of household for selected causes of death, the SMR of the Japanese male and female population was significantly different ($p<0.0001$) for all selected causes of death in each occupational type of household from 1968 to 1987. This is shown in Figs. 1(a) and 1(b). In the agriculture household, females have a higher mortality than males for all causes of death by calendar period. In the self-employed household, males have a higher mortality than females for all causes of death by calendar period except for pneumonia and bronchitis, and cerebrovascular diseases, where they were not significantly different through the calendar period. In the employee household, there appeared no difference in the mortality of male and female where both were experiencing good health. In general, in the 'others' household, males have a higher mortality than females. However, by considering the causes of death and the calendar period, there was a mixed mortality relationship between male and female. Firstly, males have a higher mortality than females for tuberculosis, diabetes, cirrhosis of liver and suicide. Secondly for pneumonia and bronchitis, females experienced a higher mortality than males. Thirdly for malignant neoplasms, heart diseases, hypertensive diseases and cerebrovascular diseases, males have a higher mortality than females at the beginning of the calendar period but vice versa in the later part of the calendar period. In general, the SMR trend is different for each household but there was similarity between male and female by calendar period. This will be discussed later in relation to the presence of indirect effect.

4. Features among different causes of death

As shown in Figs. 1(a) and 1(b), there were significant differences between the causes of death in different occupational types of household. However, in employee households, the differences among the causes of death were not highly significantly different because of low mortality. Among the selected causes of death as shown in Fig. 1(a), tuberculosis had the lowest SMR for both male and female except in 'Others' household. In fact in 'Others' household for 20-64 year age, the SMR of tuberculosis was the highest among the causes of death and malignant neoplasms was the lowest during the same age period. There was a reverse trend for employee household where in the 20-64 age range, the SMRs of malignant neoplasms was the highest and tuberculosis was the lowest among causes of death although in both cases the SMRs were below 100 (shown in Figs. 2a and 2b). The SMR trend of employee and 'Others' households for 65 year age and over was virtually similar where the difference in mortality between causes of death was low. This common feature is not observed in agriculture and self-employed households. Detailed results on the effect of age will be explained further in the next section. As in Fig. 1(a), the difference in mortality among causes of death in agriculture households remained almost unchanged for both sexes throughout the calendar periods; tuberculosis and cirrhosis of liver had the lowest and second lowest SMR, respectively, and suicide and cerebrovascular diseases had the highest and second highest SMR, respectively. However, in self-employed households, diabetes and tuberculosis remained the highest and lowest SMR, respectively, for both sexes and through the calendar periods. Differences emerged in the order of mortality among other causes of death in males and females during 1968-1987. There was a drastic change in mortality for suicide in males where the SMR was the second lowest during 1968-1972 to the second highest during 1983-1987. For 'others' household, there were differences in the order of mortality especially for tuberculosis, cirrhosis of liver and suicide which were the three highest SMR. During 1968-1972, the SMR of tuberculosis was the highest, followed by cirrhosis of liver and suicide, respectively. However, during 1983-1987, cirrhosis of liver and suicide had a higher SMR than tuberculosis.

5. Effect of age

The SMR distribution of the Japanese population by age group, occupational type of household for calendar period of 1983-1987 and selected causes of death for male and female are shown in Figs. 2a and 2b. There was a significant difference between age groups for each occupational type of household. Each type discussed here exhibited an easily recognizable mortality trend. The mortality of 'others' household was significantly high for all age groups and selected causes of death especially those of the working age 20-64 years both male and female. Among the causes of death, tuberculosis, diabetes, pneumo-



Label:

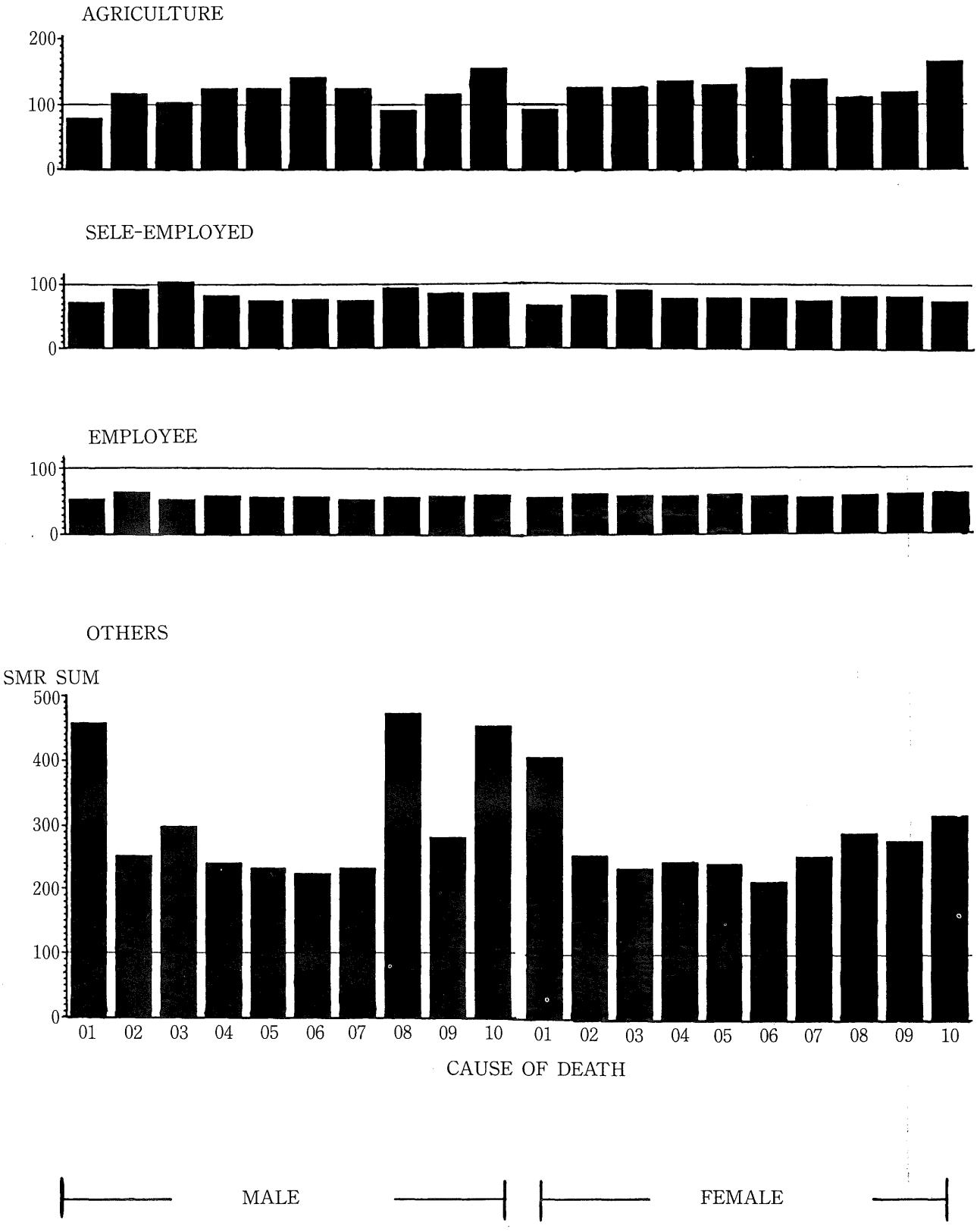
Calendar period:

1=1968-1972
2=1973-1977
3=1978-1982
4=1983-1987

Causes of death:

1=Tuberculosis
2=Malignant Neoplasms
3=Diabetes
4=Heart Diseases
5=Hypertensive Diseases
6=Cerebrovascular Diseases
7=Pneumonia & Bronchitis
8=Cirrhosis of liver
9=Nephritis & Nephrosis
10=Suicide

Fig. 1 (a) SMR distribution among different causes of death and calendar period shown by household and sex (a) male (b) female.



Causes of death:

1=Tuberculosis	6=Cerebrovascular Diseases
2=Malignant Neoplasms	7=Pneumonia & Bronchitis
3=Diabetes	8=Cirrhosis of liver
4=Heart Diseases	9=Nephritis & Nephrosis
5=Hypertensive Diseases	10=Suicide

Fig. 1 (b) SMR distribution among different causes of death by household and sex from 1968 until 1987.

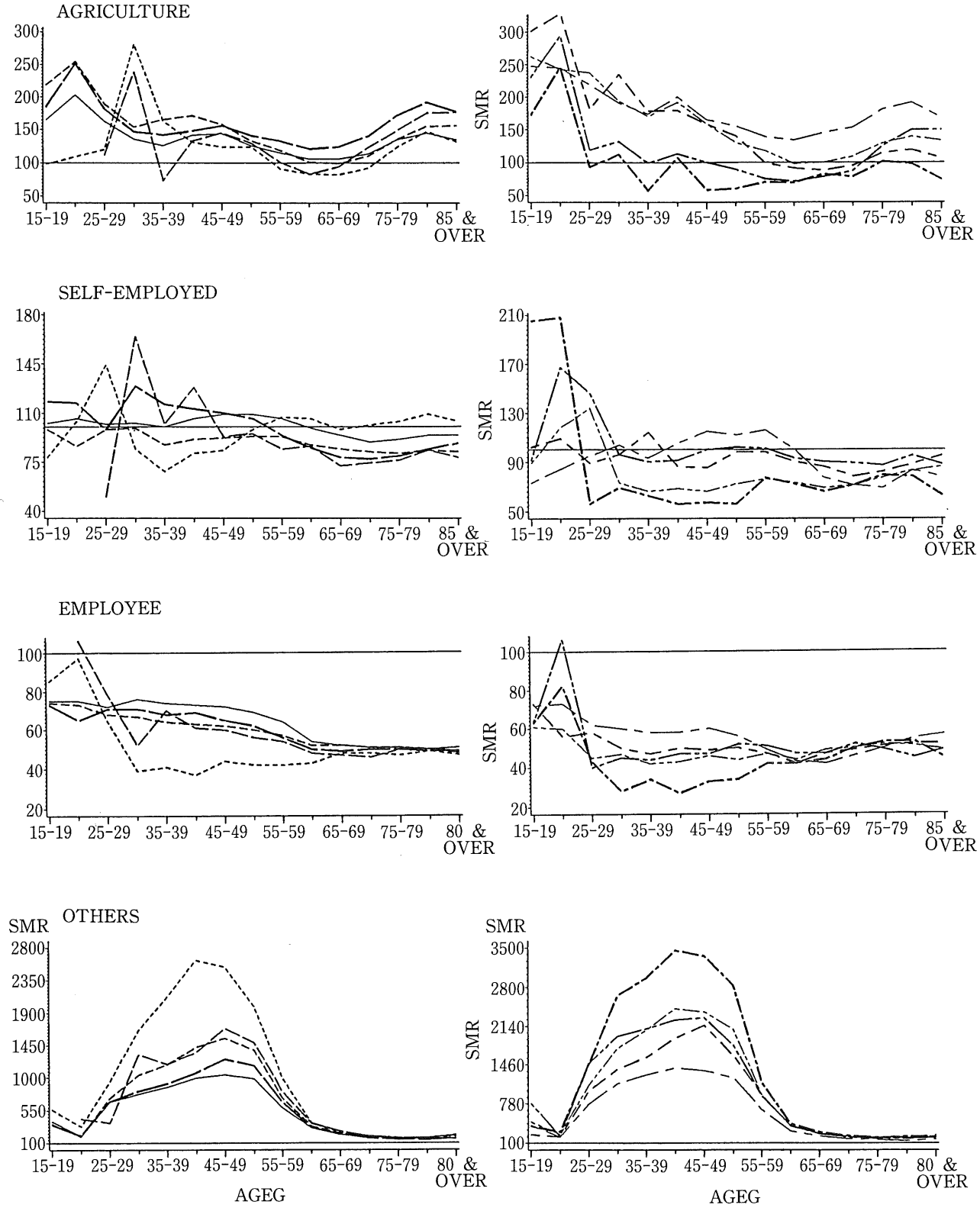


Fig. 2 (a) Comparison of SMR change as age increases among different causes of death for 1983–1987 shown by household in male.

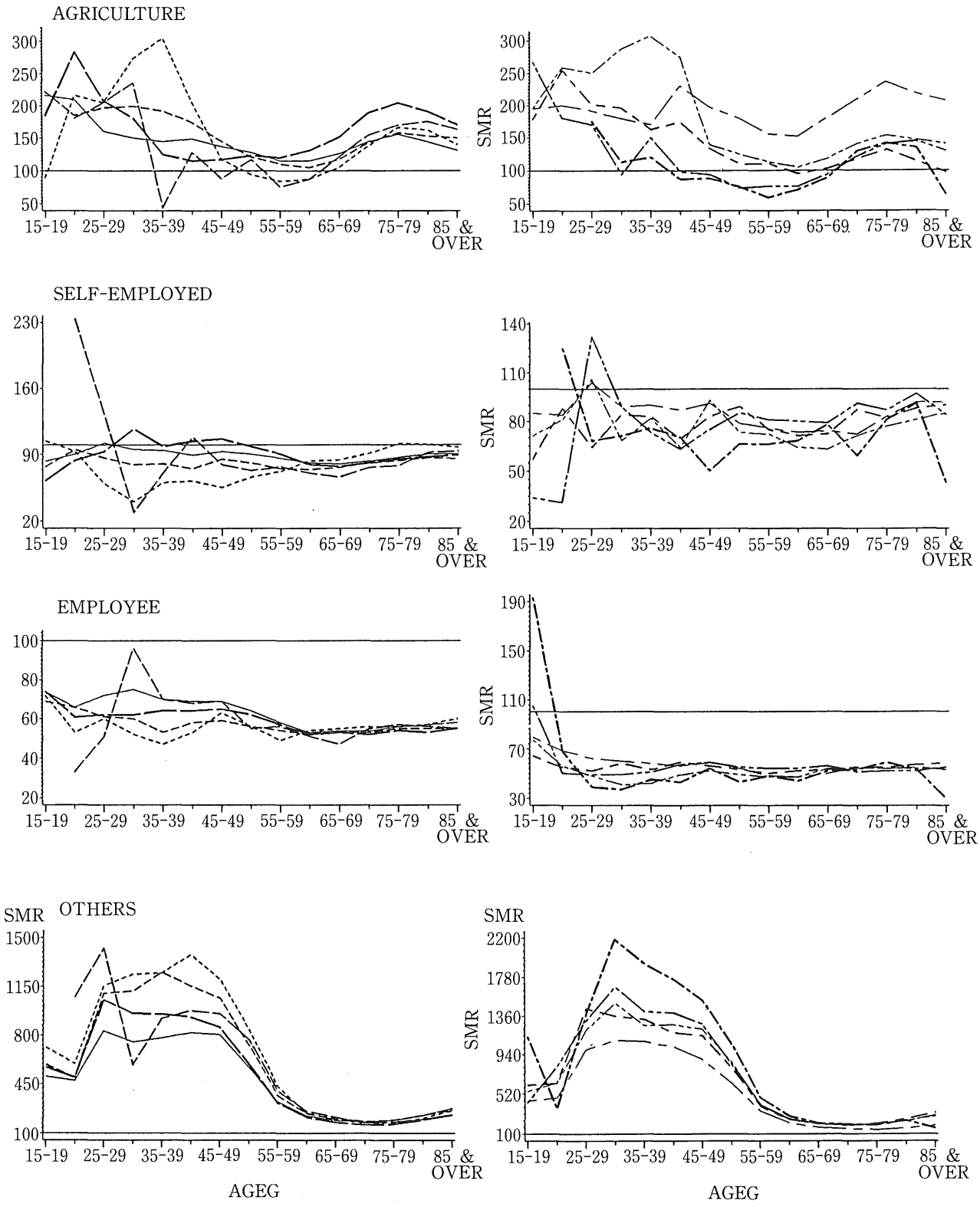


Fig. 2 (b) Comparison of SMR change as age increases among different causes of death for 1983-1987 shown by household in female.

nia and bronchitis, and cirrhosis of liver had the highest mortality. The high mortality in the working age in the 'others' household was due to the fact that these people were rejected or left out of employment through selection processes because of health reasons especially those suffering from tuberculosis, diabetes and, pneumonia and bronchitis. However, there was a rather low SMR for all causes of death from 65 years old and over. The employee household still had a low SMR in each age group; the SMRs were below 100 in almost all cases except in the male age group 20–24 years for cirrhosis of liver (SMR=(15/14.09)×100=106), hypertensive diseases (SMR=(3/2.8)×100=106), and the female age group 15–19 years for tuberculosis (SMR=(6/3.09)×100=193) and cirrhosis of liver (SMR=(13/12.3)×100=105) due to a sampling error when calculating the mortality. However, there was a slightly high mortality in the young age range (below 25 years old) as compared to those in the working age range. This was due to the fact that those of working age had already been subjected to a selection process and were considered to be in a good health condition. The trend between working age (age 20–64 years) and post-retirement age (65 years old and over) groups was different where the mortality among the causes of death at age 20–64 years were distinctively different. However, mortality among the causes of death at age 65 years and over was almost the same. The self-employed type of household experienced low SMRs but not for all age groups. For male self-employed households aged between 15–64 years, the SMR was above 100 for all causes of death except heart diseases. However, for males aged 65 years and over, the SMR was below 100 for all causes of death except diabetes. The mortality of the female self-employed household was, however, lower than that of the male. In a certain age group, the SMRs were over 100, due to the small number of death and occupational population census stratum in calculating the mortality such as in hypertensive diseases at age 20–24 years (SMR=(3/1.28)×100 =234), in tuberculosis at age 20–24 years (SMR=(2/1.6)×100=125), and in cirrhosis of liver at 25–29 years of age (SMR=(5/3.76)×100=132). According to Figs. 1(a) and 1(b), the female self-employed household, ignoring age, had a low SMR (below the value 100) for all causes of death. The mortality trend for self-employed household was different from employee and 'others' households where there was no large change in the mortality trend between the 20–64 years old group and the 65 years old and over group. The mortality of agriculture household was significantly different for all age groups and selected causes of death in both male and female. In agriculture households, the difference in mortality between causes of death is clearly seen for all age groups as shown in Figs. 2a and 2b. In fact, for the 40 years old and over both male and female, suicide had the highest SMR. This was followed by cerebrovascular disease from the age of 50 years old. Fig. 1(a) shows that for agriculture households, the SMR of suicide gradually increased as in cerebrovascular disease from 1968 to 1987. For age 65 years and over in both male and female and causes of death, the mortality began to increase; this was the opposite mortality trend to the other households. This was due to the fact that while those in agriculture at age 65 years and over continue with their occupation, those retired from other employment industries might enter or return to agriculture works especially those from an agriculture household background. In other words, agriculture households have a high mortality in the young age range and mortality showed a decreasing trend towards 60–64 years of age. However, at age 65 years and over the mortality began to increase gradually. This was not observed in other households mortality trend.

DISCUSSION

Characteristics of mortality observed in different occupational types of household were explained as follows in terms of influential factors. The absence of direct and indirect effects contributed to a very high mortality for 'others' occupational type of household especially among the working age group of 20–64 years old. This is because those at hiring age with bad health status and also those who cannot sustain the required health status during employment were left out of the workforce; if their household is without a working household head then they are in the 'others' occupational type of household with a very high mortality. However, for age 65 years and over, mortality is relatively very low compared with the 20–64 years. This is because those who have reached retirement age began to enter the 'others' occupational type of household. However, they still enjoy welfare benefits such as social security, maintenance of a good level of health due to previous good health during employment, and their social and life style also remains unchanged. In other words, they are experiencing the indirect effect of the healthy worker effect though the good level of health due to good health during employment by itself should be attributed to the direct effect.

Among the working household head groups, the employee occupational type of household can be regarded as experiencing direct and indirect effects at their best. In Japan, employees are subject to regular health checkups especially in hazardous industries and employers are compelled to provide a social security scheme and

welfare benefits to their employees. Not only are employees' socio-economic but also health status is looked after. Thus, they are able to provide the benefits to their household members. However, the self-employed are not subject to compulsory medical checkup; they themselves determine whether they are healthy enough to work. Although the selection process does occur here, they are not subject to strict selection processes as in the case of employee household head. They provide the welfare benefits to household members according to their own need. Since they are self-employed household head, there is no fixed retirement age. The agriculture household had a relatively high mortality for certain causes of death as compared with other working household head groups. By considering age distribution, female agriculture household members experience a higher mortality as that of male members. In agriculture, especially family-run agriculture, not only is the household head working but household members also perform tasks. Thus, almost all the household members are exposed to the risks at work and also work stress which can be seen with a high mortality for suicide found both in male and female starting from 40 years old. Since both self-employed and agriculture are not subject to a strict selection process and retirement age, their mortality reflects differences in occupational, socio-economic and life style experience.

One of the purposes of this study was to make a comparative study between previous investigations and the results of our own study. Previous studies, especially McMichael[11], elaborated many aspects on the healthy worker effect of the working population. These studies have not concerned themselves with the indirect effect. However, comparison can be made between the mortality of male population for agriculture households in our study and the mortality of the male population aged 15 years and over for agriculture type of industry employment with a population study consisting of a working population only for the year 1985 by Agematsu et al[1] (Table 4). It was shown that the SMR for agriculture household is high compared with that of agriculture industry employment except in cirrhosis of liver and suicide. This was because the population of agriculture households consists of the agriculture working household head and household members. In Agematsu et al[1], however, the population in agriculture industry employment consists of a working population which is strong and fit to work. This implies the presence of the healthy worker effect' in the working population. However for suicide and cirrhosis of liver, the agriculture industry employment had a higher mortality than that of the agriculture household. This indicates that agriculture workers have a higher risk of suicide and cirrhosis of liver than their household members. From our results, the employee household showed the lowest SMR and below the value 100. This result is similar to the study of Araki and Murata[2] on the working male population. From these comparisons, the results obtained are generally similar but the healthy worker effect intensively used to explain the mortality effect of working population in previous studies could not be used in a similar manner in this study. To explain this, we have indicated the possibility that the healthy worker effect should have a component which is shared with the household members, namely the indirect effect.

Table 4. Comparison of SMRs between Agriculture Occupational Type of Household and Agriculture Industry Employment

Cause of Death	SMR of male age 15 years & over				
	Agriculture Occupational Type of Household				Agriculture Industry for 1985
	1968-72	1973-77	1978-82	1983-87	without non-working
Malignant Neoplasms	107	118	125	121	109.3
Heart Disease	111	126	134	133	113.2
Cerebrovascular Disease	125	144	157	160	128.0
Pneumonia & Bronchitis	115	131	132	126	101.7
Cirrhosis of Liver	85	91	95	93	100.1
Suicide	137	151	167	168	183.8

It is difficult to say whether the differences in mortality obtained from different households reflect the indirect effect in mortality rather than the direct effect or both. However, similarity in mortality trend observed between male and female rather than occupational type of household strongly suggests the existence of indirect effect because males are more likely working than females. In trying to separate direct and indirect effects, we must analyse more carefully the effects of sex and age group.

Let us now discuss the issue of risk groups and public health policy. The risk group most worthy of attention was 'Others' household especially in

the 20-64 years old age group because most of those who have been unemployed or left out of the workforce due to health reasons, mainly with chronic diseases, are in this age group. Health prevention and rehabilitation programs for the high risk groups are required. We may cite the unemployed or those left out of the workforce through selection processes due to health reasons. They should enter programs where their health will be monitored and supervised. Next, in agriculture households the high risk groups concerned are those under 30 years of age where the mortality was high, females with higher SMR than males, especially those over 45 years old in suicide also among males. Special attention should also be paid to 65 years of age and over where the SMR began to increase for all selected causes of death which was not the case in others households in the same age group. In agriculture households, agricultural work is performed by women, children, and the elderly, as well as by men of 20-64 years old. It is difficult for the farmer to change jobs if not suited medically to farming; rehabilitation after illness or accident is often left to the individual. Since high risk groups in the agriculture household were recognized, appropriate health prevention and rehabilitation programs for the agriculture household should be provided according to needs. In the self-employed household the high risk groups are those under 25 years old and also males who experienced a higher SMR than females. The employee household had low mortality. However, the young, below 25 years old, that experienced a higher SMR than those in different age groups are considered to be a high risk group. School leavers and the unemployed are included in the below 25 years old group who are supported by their household heads. For the employee household head, medical benefits and health prevention programs such as physical examination are strictly provided by their employers and the Ministry of Labour; the rest are left to their individual initiative in following health prevention programs provided by the Ministry of Health and Welfare. Those still studying in schools are subject to health prevention programs supervised by the Ministry of Education, Science and Culture. Thus, those under the supervision of the Ministry of Education, Ministry of Labour and employer's health programs, have their health monitored constantly and have a good health background records. The aforementioned high risk groups might be useful in specifying subpopulations, especially of the below 65 years of age group, upon which public health efforts according to Health Services for the Elderly Act are concentrated.

However, we recognize that more detailed analysis of the mortality of the occupational type of households and direct and indirect effects are necessary for the establishment of an effective public health policies.

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