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SUDDEN DEATH OF ADULTS IN JAPAN

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ABSTRACT

Epidemiological features, risk factors and preventive methods of sudden death (SD) derived from studies the authors have performed since 1987 together with colleagues in Niigata University School of Medicine were reviewed. When SD was defined as death occurring within 24 hours of the onset of symptoms, the annual incidence was 145/100,000 for people aged 15 years and older in Niigata Prefecture. The incidence increased sharply along with the advance of age, while the proportion of SD to natural death due to circulatory diseases was higher in younger people. Though diseases of the circulatory system made up approximately 90 percent of all causes of death, SD due to ischemic heart disease was less frequent in Japan than in western countries. SD showed various patterns in seasonal and "within-a-day" occurrences according to sex, age and cause of death. The months of the highest SD occurrence differed by occupation and matched the busiest work periods. A decrease in sleeping hours and mental stress experienced during the preceeding week were related to the occurrence of both sudden death and non-fatal acute myocardial infarction. People having structural circulatory diseases were shown to be predisposed to SD when stress occurred, because fatal arrhythmia is easily induced by the above factors in such people. Health examinations were shown to have preventive effects, though limited, against SD. Differences in the resuscitated rates in cases where a witness was present and where one was not indicates that educating people about correct resuscitation methods is important to minimizing SD.

Key Words: Sudden death, Incidence, Death cause, Stress-related factors, Previous illness

INTRODUCTION

Sudden death (SD), which reportedly accounts for 10 to 32% of all deaths by natural causes[1] has been drawing social attention recently in Japan because of its unpredictable and hence unpreventable mode of occurrence. The purpose of this paper is to review some results obtained from several epidemiological studies the authors did in Niigata Prefecture together with colleagues in the Department of Public Health and the First Department of Internal Medicine at the Niigata University School of Medicine. The studies comprise 1) a death certificate survey[2–5] to elucidate descriptive features of SD, 2) a case-control study[6,7] to investigate triggering effects of stress and sleep disturbance, together with background factors predisposing people SD, and 3) a registration survey to confirm findings obtained in the first two studies.

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DEFINITION OF SUDDEN DEATH

In the late 1960, the committee authorized by the International Society of Cardiology and the American Heart Association agreed that sudden unexpected (natural) death is defined as death occurring instantaneously or within an estimated 24 hours of the onset of acute symptoms and signs.[1] In the 9th version of the International Classification of Diseases,[9] SD had been listed as the disease entity fitting the definition above. Thereafter, in 1984, a WHO Scientific Group on Sudden Cardiac Death met in Geneva, and stated that although numerous definitions have been proposed for sudden cardiac death, no all-purpose definition can be applied to every situation.[8] They further stated it was more meaningful to define the specific characteristics surrounding cardiac arrest than to define the word "sudden" in the context of death. However, in the western countries where ischemic heart disease is prevalent, the term "sudden cardiac death" is usually applied to cases in which death occurres within an hour of the onset of symptoms. Hence recognition of whether SD is cardiac in origin or not seems to be dependent mainly on the time course, unless direct clinical, laboratory or autopsy findings are available. The term "sudden cardiac death" appeared in the ICD-10[10] without clear definition, except an explanation that deaths with any apparent heart disease should not be given this word.

In our study, we defined SD as natural death within 24 hours from the occurrence of the underlying cause of death. When death occurred within 2 hours, cases were called SD2. In collecting cases for the case-control study, however, we excluded cases involving people bed-ridden before the attack in order to confine our analysis to only those cases where death was unexpected.

DEATH CERTIFICATE SURVEY

1) Methods

In the death certificate survey,[2–5] all cases (10,471 cases) aged 15 years or over in which death occurred within 24 hours from the onset of a direct cause (excluding an external one) were selected from all the death cases registered during the period from 1984 to 1986 in Niigata Prefecture. The main cause of death was determined for each case according to our own rules. Our rules stipulated in brief that only those diseases which occurred 30 days before death qualified as candidates for the cause of death, and that only a single disease was chosen as the main cause of death according to priorities we set. All diseases which occurred more than 30 days before death did not qualify as the cause of SD, and were treated as a previous illness. Death from cancer and senile decay were excluded from SD cases. Finally, 8,519 cases where people died within 24 hours of the onset of the main cause were registered as SD. All causes of death were classified into four categories: acute myocardial infarction (AMI), other cardiovascular diseases (OCD), cerebrovascular accidents (CVA) and non-circulatory diseases (NCD).

2) SD incidence, death cause construction and previous illness

The annual incidence (per 100,000 population) of SD was 145 (male: 170, female: 122) and that of SD2 was 74 (male: 92, female: 58).[2] SD represented 17.5% of total natural deaths. The incidence increased sharply along with the advance in age from 24 for the people aged 15–54 years, to 206 for those aged 55–74 years, and further to 1,253 for those aged 75 or older.

The incidence of SD in Niigata Prefecture was higher than that reported in Kyoto City[11] and Hisayama Town[12] (102 and 89, respectively) (Table 1). This difference was probably due to a higher proportion of aged people in Niigata Prefecture. Although many reports from various countries show the incidence around 100, the cooperative research on sudden death, which started in 1992 directed by Dr. T. Omae supported by a Ministry of Health and Welfare grant,

Table 1. Death cause construction and incidence of sudden death

Subjects, method, and period of study	Time to death from the onset of symptom	Number of SD cases	Cardiovascular diseases (%)			Stroke (%)	Other diseases (%)		Annual incidence (per 100,000)
			Ischemic heart disease	Other cardiovascular diseases	All		Other organ	Unknown cause	
Autopsied cases in Tokyo Medical Examiner's Office, 1986 (Tokudome[14,15])	Within 24 hours	839	49.8	15.7	65.6	16.1	10.7	7.6	—
People in Kyoto City, Death Certificate, 1985 (Kawai[11])	Within 24 hours from the onset of direct cause	1,508	20+	—	72	16	12	—	102
People in Hisayama Town, Autopsy, 1961—'83 (Ueda et al.[12])	Within 24 hours	90	24.4	13.3	38	51	11	—	89
Honolulu Heart Program, Registration, 1965—'86 (Kagan et al.[16])	Within 1 hour	98	42.9	3.1	46.0	2.0	0	52.0	—
	1—24 hours	131	41.2	8.4	49.6	19.8	0.8	29.8	—
People in Niigata Prefecture (15 years or older), Death certificate, 1984—'86 (Toyoshima et al.[2])	Within 2 hours	4,361	20.5	58.3	78.8	14.7	6.5	—	74
	Within 24 hours	8,519	17.0+	51.4	68.4	20.0	11.4	(30.2*)	145
	(all natural death	48,608	4.1	17.2	21.3	23.3	55.4	—	829)
People in 9 regions in 7 Prefectures (20 to 74 years old), Death certificate and medical chart, 1989—'93 (Omae et al.[13])	Within 24 hours (Cases bed-ridden before death were excluded)	334	22.8	5.4	28.2	13.2	9.6	49.1	35**

* These cases are a part of those in the column of "other cardiovascular diseases" where the individual's cause of death could not always be identified.

** Values obtained from the 5 regions where the proportion of the cases confirmed by medical chart was high.

\+ Only the acute myocardial infarction cases were counted.

reported an incidence of 35 with regional variations of 22–67 for the population aged 20–74 years,[13] a considerably smaller value than the one shown above. In this study, all cases found by the death certificate survey were checked afterwards by medical charts, and those who were bed-ridden before death were excluded from inclusion in the sudden death category. This difference in incidence is most likely due to a difference in the definition of SD and the age-class examined, and does not represent a recent decrease in incidence.

The proportion of SD to all cases where death occurred was higher in younger people than in older people for diseases of the circulatory system; the highest being in AMI, then in OCD, with the lowest in CVA[2] (Fig. 1). Thus, as long as incidence is considered, SD is a problem for aged people. When the proportion is considered, however, SD is a matter of concern for younger people too.

Death cause construction showed that while NCD accounted for more than 50% of natural deaths, diseases of the circulatory system accounted for approximately 90% of SD cases[2] (Table 1). AMI accounted for only 4.1% of natural deaths but constituted 17% of SD. OCD accounted for a major part of SD at 51%.

When we examined the history of the OCD cases, cardiovascular diseases and atherosclerotic diseases occurred naturally more often with aging.[3] However, cases in which no diseases (except, for instance, acute heart failure) were described, represented the major part of OCD cases (approximately 50%). These cases were more frequent in the younger age group. The true cause of death remains to be elucidated, particularly in the young cases. The previous illnesses frequently seen on the death certificate were listed for each sex and age-group in Table 2.

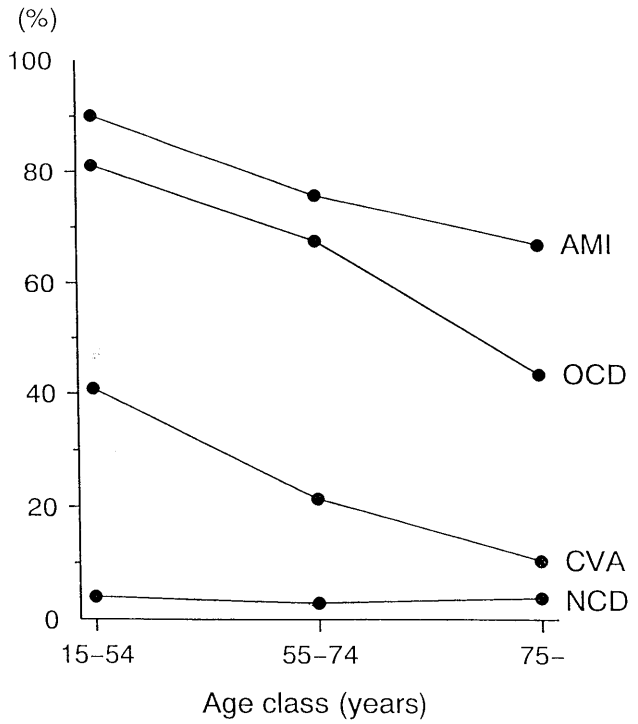

Fig. 1 Proportion of sudden death cases to all death cases according to death cause and age class.
AMI: acute myocardial infarction, OCD: other cardiovascular diseases, CVA: cerebrovascular accidents, and NCD: non-circulatory diseases.

Table 2. Previous illunesses frequently described in the death certificate[3)]

Age group	Previous illnesses	
	Males	Females
15–54 years old	1. alcoholism (4.1%) 2. psychiatric disorder (2.9%) 3. valvular heart disease (2.6%)	1. psychiatric disorder (8.7%) 2. ischemic heart disease (5.8%) 3. valvular heart diseases (5.1%) 4. pregnancy, delivery or related diseases (4.4%) 5. chronic renal failure (3.6%) 6. common cold within one month (2.9%)
55–74 years old	1. ischemic heart disease (9.4%) 2. arrhythmia without organic heart disease (2.5%) 3. valvular heart disease (2.5%)	1. ischemic heart disease (10.2%) 2. valvular heart diseases (3.2%) 3. arrhythmia without organic heart disease (2.6%)
75 years or older	1. ischemic heart disease (11.4%) 2. bronchial athma (3.7%) 3. common cold within one month (3.6%) 4. cor pulmonale or related diseases (3.0%) 5. arrhythmia without organic heart disease (2.6%)	1. ischemic heart disease (11.8%)

( ): percent of total number of OCD cases.
Diseases that constituted 2.5% or more of SD cases in each sex- and age-group are listed.

The proportion of SD due to ischemic heart disease (IHD) has been reported to be 49.8% from Tokyo Medical Examiner's Office[14,15)] and 41.2–42.9% for Hawaiians with Japanese ancestors from Honolulu Heart Program[16)] (Table 1). We tried to obtain the proportion by applying values found for 203 SD cases from the case-control study and additional SD cases in the registration study, described in each section below, to the death certificate survey, since diagnosis was made by cardiologists in these two studies. The proportion of SD due to IHD was estimated by including the cases where individuals died suddenly from AMI and those who died from acute heart failure with a history of IHD. Such cases accounted for 28% or lower of all SD cases,[17,18)] and this rate was smaller than those rates reported from autopsy cases in Tokyo and for Japanese in Hawaii. However, when SD cases for which IHD could not be ruled out were also included, the proportion went up to 59%. When the fact that autopsied cases in Tokyo are not a community-based sample is take into consideration, the low frequency of SD due to IHD seems characteristic of people in Japan.

3) Seasonal and "within-a-day" variation in SD occurrence

When monthly occurrences of SD were totaled, SD due to diseases of the circulatory system occurred most frequently in winter and least frequently in summer.[4)] SD due to NCD did not show such periodicity. Such an increased incidence of SD due to circulatory disease in winter was similar to other reports.[19)] However, SD due to AMI in the youngest age class (less than 60 years) showed increased occurrence in winter, and though insignificant, also in summer, while older age classes showed an increase only in winter (Fig. 2). The temperature and sunshine

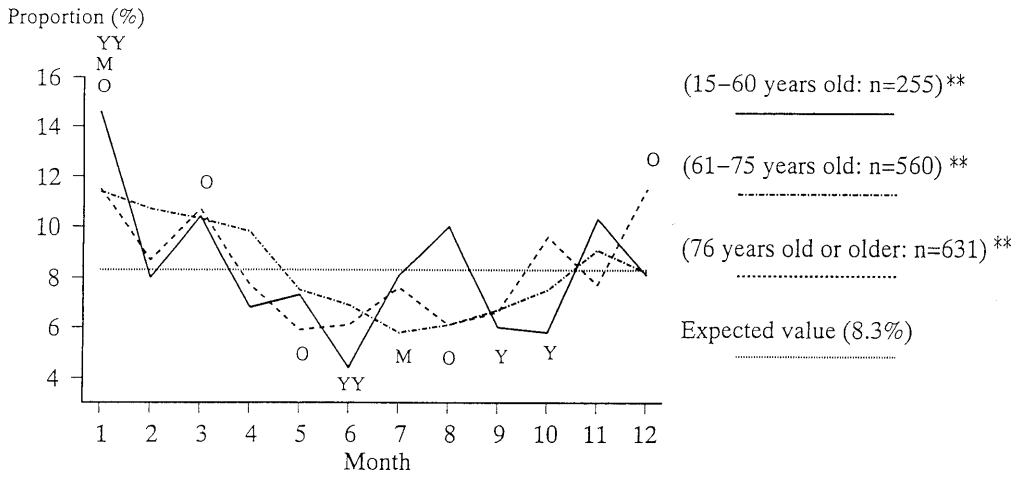

Fig. 2 Seasonal variation in the occurrence of sudden death due to acute myocardial infarction by age class.[4]
**$p < 0.01$ for seasonal variation.
The months of a significantly high occurrence compared with the month of the lowest occurrence were marked with alphabets over the lines, and the months of a significantly low occurrence compared with the month of the highest occurrence were marked under the line. Y, M, and O stand for age groups of 15–60 years, 61–75 years, and 76 years or older, respectively, and also show $p < 0.05$. YY shows $p < 0.01$.

duration were inversely related to the occurrence of SD due to all circulatory diseases, but not related to SD due to AMI. The high incidence of SD due to AMI in summer in young people was probably due to dehydration, as reported from countries with a hot climate.[20]

To examine the relationship between busy work periods and SD occurrence, monthly occurrences of SD were totaled according to the occupational group of the householders, that is, agricultural, employee, self-employed, and other occupational groups.[21] In male cases aged 15–65 years, the incidence in April and September was higher in the agricultural group, and the incidence in March and September was higher in the employee group than in the "other occupational" group. In males of older ages, the incidence was higher in April only in the agricultural group. There was no such spring rise in any group of females. The months wih the high incidence of SD matched the busy months of the respective occupations.

Within a given day, occurrence of SD2 showed a biphasic pattern having two peaks, one between 6 and 8 a.m., and one between 6 and 8 p.m. (Fig. 3) except in the subgroup of the youngest age or the subgroup which succumbed during summer.[5] Although SD2 due to AMI showed essentially a biphasic pattern, there were double morning peaks between 4 and 6 a.m. and between 10 a.m. and noon in the young male cases.[22] The morning increase of SD2 due to AMI was similar to that reported by others.[23] Increased platelet aggregability,[23] increased sympathetic nervous function[24] among others[25,26] are supposed to be probable causes for the late morning peak. A much earlier increase of SD2 due to AMI in the young males, however, probably resulted from a fatal arrhythmia induced by vasospasm of the coronary arteries. In contrast, the SD2 due to CVA also showed a biphasic pattern within a day with a more prominent evening peak. According to autopsy reports, 97% of SD due to strokes had cerebral bleeding.[27] Since fibrinolytic activity is increased and coagulative activity is decreased during the evening,[28] such a diurnal change may be a precipitating factor for SD due to CVA.

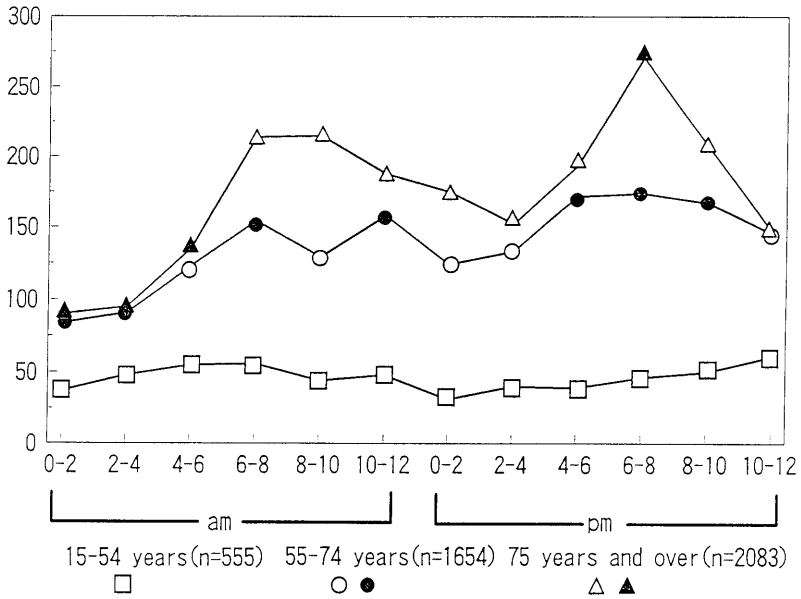

Fig. 3 The time of occurrence of sudden death by age class.[5]
Abscissa indicates the time of day and the ordinate indicates the number of sudden deaths.
The periodic change was significant ($p < 0.01$) using Roger's method for the age group of 55–74 years and 75 years and older. The time intervals with the occurrence belonging to the upper or lower quartiles are shown by closed marks.

CASE-CONTROL STUDY

1) Methods

19 major hospitals in Niigata Prefecture which have a cardiology section cooperated with this study. Whenever doctors in the hospitals encountered SD cases or AMI cases, they reported the cases to the Department of Public Health by a report form which covered diagnosis, serum enzymes, ECG findings, personal and family histories and so on. In total, 203 SD case reports (male: 139, felame: 64) and 245 non-fatal AMI case reports (male: 189, female: 56) were collected during a two year period from 1988.[5] Cases where the individual was bed-ridden before death were excluded from consideration as SD. AMI patients who died within 24 hours of symptom onset, as well as the patients who were resuscitated, were included in the SD cases. AMI patients who survived at least 24 hours were regarded as non-fatal AMI cases. Two kinds of healthy groups were set up as controls. One was a young control group made up of post office workers, and the other was an old control group made up of people in an agricultural village.

Life style information was collected through a questionnaire from the deceased's families, patients themselves, and healthy control people. When respondents chose an answer indicating that they had suffered from business and/or family problems the week before the adverse event occurred, they were considered to be under stress. For the control group, stress was defined as a business or family problem occurring before the health examination. Answers about decreased sleeping hours were considered relevant when the decrease was more than 1 hour during the period in question compared to usual sleeping hours. Respondents were taken to have a competitive personality when they answered affirmatively a question asking if they were competitive,

ambitious, aggressive and impatient. Ex-smokers were combined with current smokers. When the respondents drank alcoholic beverages more than three times a week, they were considered to have a drinking habit. Information was obtained from 54 male SD cases and 112 male AMI survivors.

The relationship of the above-described factors to SD and AMI occurrences were examined to see whether there was event specificity. Analyses were done for two age classes divided by 60 years. Each age class of the respective event groups was compared with the respective age-class matched controls. Odds ratios predicting the development of SD or non-fatal AMI according to the presence of each of the factors above were obtained through an unconditional multiple logistic regression analysis incorporating these factors as well as age into the explanatory variable. Background factors, such as medical histories reported from attending physicians, were also compared between the two events. Statistical significance was tested by the chi-square test or Fisher's exact probability test.

2) Profile of SD Cases

Male SD cases constituted 69% of the total 203 cases. Among causes of death, AMI made up 21.7%, OCD 69.5%, CVA 5.4% and NCD 3.5%. Proportion of CVA and NCD were smaller than those seen in the death certificate survey, since the reported cases were attended mainly by cardiologists. When we investigated the place of event occurrence, the event occurred most often (61%) within the home. The event occurred while the subject was either resting (slightly less than 30%) or during activity (also slightly less than 30%).

3) Comparison of Predisposing Factors between SD and non-fatal AMI

The relationship of life style factors to the event was analyzed for 54 male SD cases and 112 male AMI survivors. Life style factors were gleaned from questionnaires filled out either by SD case families or AMI survivors in two age classes: 60 years old or less and over 60 years old.[7] The control groups were 423 male post-office workers, aged 60 years or less living in Niigata City, and 304 people, older than 60 years of age, living in an agricultural village.

Stress was significantly related to the occurrence of both SD and non-fatal AMI in both young (Fig. 4) and old (Fig. 5) cases.[7] Decreased sleeping hours was related to SD in both age groups, and barely related to non-fatal AMI in the older group. A competitive personality was related only to AMI. Alcohol drinking was inversely related to the young SD cases and both young and old non-fatal AMI cases. The inverse relationship of drinking habits to SD could be due to the fact that SD cases had most likely been restricted from drinking because they had structural circulatory diseases, and does not mean that alcohol prevented the SD occurrence.

It is possible that our case-control study might have been biased in that the families of SD cases and AMI survivor cases complained of stress more often on recollection than did the control group members. Hence it is difficult to draw firm conclusions about the strength of the relationship between stress and the occurrence of SD and non-fatal AMI. However, the positive correlations[6,7] are in agreement with other reports.[29–31] It is interesting that there was no difference in the strength of the effects of stress in triggering these two events as far as the odds ratio was concerned. We hence infer that there must be some background factors which led to death in one group and to survival after AMI in another when the subjects were exposed to stress.

To find these background factors, we compared ECG findings recorded on arrival at hospitals and previous illness, reported by attending physicians, between the two event groups. Ventricular fibrillation or tachycardia (SD: 13.7%, AMI: 0.5%, $p < 0.001$), severe arrhythmias (SD: 5.0%, AMI: 0%, $p < 0.05$), and arrhythmias of unidentified type (SD: 28.8%, AMI: 1.1%,

$p < 0.001$) were more frequently seen in the SD group than in the male non-fatal AMI group.[7] This finding suggests that arrhythmias could have been a key factor related to death. When the previous illness was compared between the two groups, ischemic heart disease, other cardiovas-

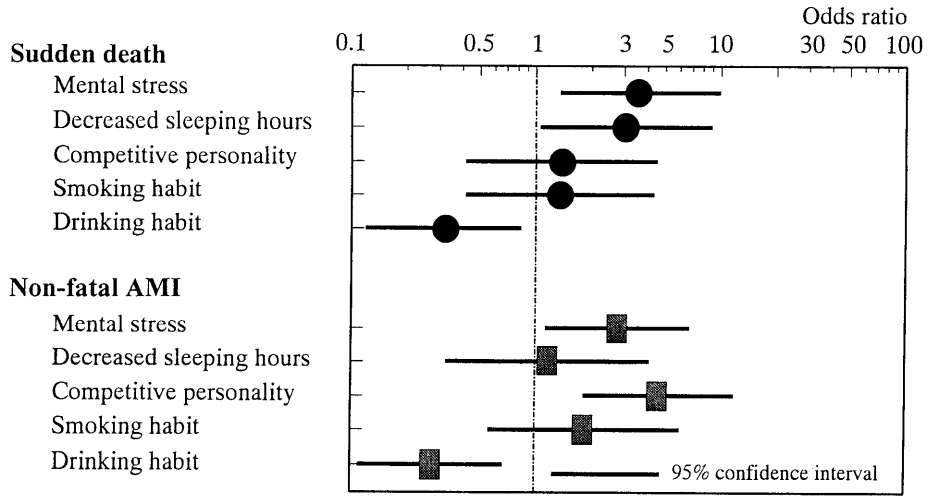

Fig. 4 Odds ratio for occurrence of sudden death and non-fatal acute myocardial infarction according to the presence of each stress-related factor in males aged 60 years or younger.[7]
19 sudden death cases, 27 acute myocardial infarction survivors and 423 controls who were post-office workers in an urban area were used in this analysis. Confounding effects of the 5 factors and age were adjusted for by the unconditional logistic regression analysis.

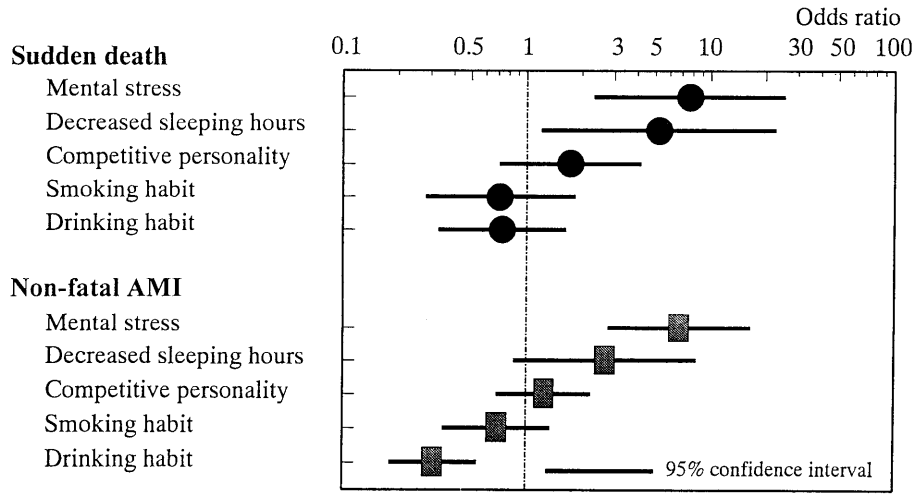

Fig. 5 Odds ratio for occurrence of sudden death and non-fatal acute myocarcial infarction according to the presence of stress-related factors in males aged 61 years or older.[7]
35 sudden death cases, 85 acute myocardial infarction cases and 304 controls (who werer agricultural people in a rural community) were used in this analysis. The same analytic method empolyed in Fig. 4 was used.

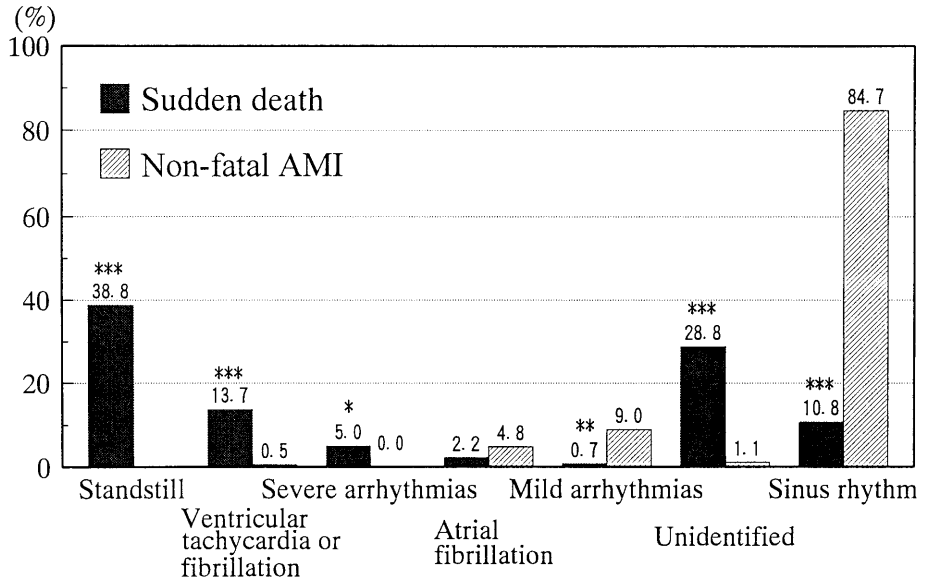

Fig. 6 Arrhythmias recorded on ECG on arrival at hospital in sudden death and non-fatal acuate myocardial infarction groups (males).[7]
AMI: acute myocardial infarction. Case number and mean age with standard deviation were 139 and 63 ± 15 years, respectively, for the sudden death group, and 189 and 65 ± 11 for the non-fatal acute myocardial infarction group. Severe arrhythmias included idioventricular rhythm, severe bradycardia and spiky deflections. Mild arrhythmias included paroxysmal supraventricular tachycardia, pacemaker rhythm, atrioventricular condition block, ventricular extrasystole and other arrhythmias.
*$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$ represent the difference between the two groups.

cular diseases, stroke and arrhythmias occurred more frequently in the SD group, while hypertension, diabetes and hyperlipidemia occurred more frequently in the non-fatal AMI group (Fig. 7). Among the arrhythmias, atrial fibrillation and ventricular tachycardia showed a significant difference in frequency between the two groups. All 16 SD cases in which arrhythmia had occurred in the past also had some structural disease of the circulatory system. In other words, the SD group had experienced structural diseases of the circulatory system and accompanying arrhythmia more often, while the AMI survivors had coronary risk factors more often than the SD group.

It has been known that stress triggers fatal arrhythmia easily in a heart whose ventricular fibrillation threshold is decreased.[32] Therefore, the presence of such structural diseases seems to be one of the key factors predisposing victims to SD. On the other hand, changes in blood coagulation-fibrinolysis ability and/or vasospasm might have been caused by stress resulting in coronary arterial occlusions unaccompanied by fatal arrhythmias in people who had risk factors but no structural heart disease.

REGISTRATION STUDY

Since 1994 we began a project to register all AMI and SD cases which occurred in the cities of Niigata and Nagaoka to clarify the incidence of these events and the factors related to their occurrence.[33] Doctors at 45 hospitals and 329 private clinics were asked through a local

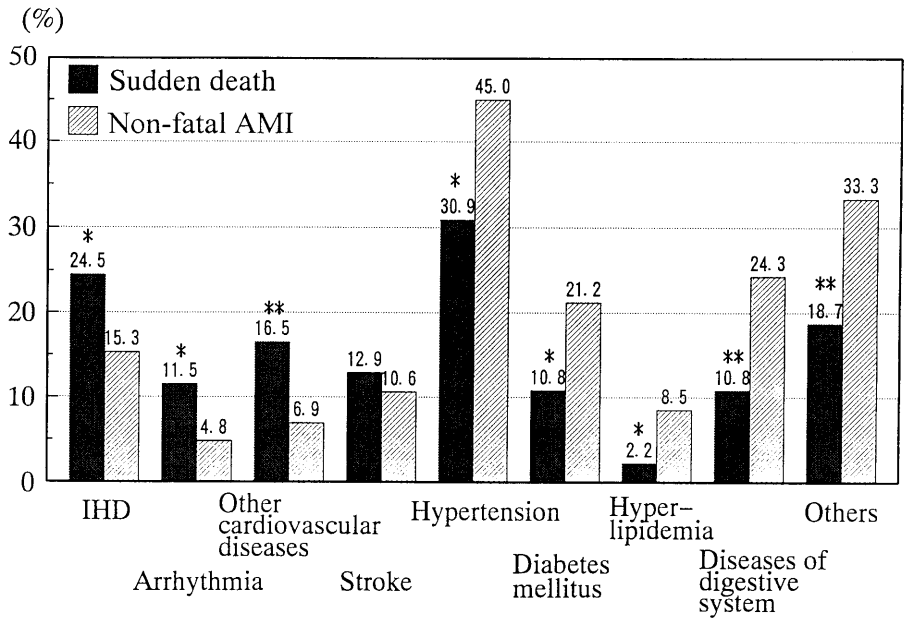

Fig. 7. Comparison of previous illnesses between the groups of sudden death and non-fatal acute myocardial infarction (males).[7]
AMI: acuate myocardial infarction, IHD: ischemic heart disease. Subjects are the same as those in Fig. 6.
*$p < 0.05$ and **$p < 0.01$ represent the difference between the two groups.

doctor's association to report every case as it occurred to the registration office. A doctor in the office visited the institute periodically to check the medical chart and confirm the diagnosis for every patient. Approximately two months after each event occurrence, all surviving patients or the families of the deceased were asked to answer questions similar to but more detailed than those asked in the case-control study described above. The interview was done by a trained nurse over the telephone. Thus information was obtained only from those who consented to the request. The same telephone interview by the same nurse was done for the control group, which consisted of 544 examinees at a health check-up facility in Niigata City. This study is still ongoing and the results described here are preliminary.

During the first year, 38 male SD cases and 54 male AMI survivors responded to the telephone interview. Two controls were randomly chosen for one case after matching sex, age, and ten categories of occupation. Unconditional logistic regression analyses were done by employing age, occupation, decrease in sleeping hours, stress, type A behavior score by our own criteria, coronary risk factors such as hypertension, diabetes and hyperlipidemia, and the history of structural circulatory diseases as the explanatory variable.

For AMI survivors, stress and coronary risk factors resulted in odds ratios significantly greater than 1.0, while a decrease in sleeping hours and a history of structural circulatory diseases did the same for SD cases as shown in Table 3. Although stress increased the risk of SD occurrence, the odds ratio was not significant in a manner different from the previous case-control study described before. It seems likely that recall bias on stress was decreased compared with the previous study since information was obtained through an interview by a trained nurse. Furthermore, occupations were matched in a more detailed manner in this study. These factors

Table 3. Odds ratio and its 95% confidence interval for developing events according to life style factors and previous illnesses

	Acute myocardial infarction (Cases: 54, Controls: 106)	Sudden death (Cases: 38, Controls: 68)
Decrease in sleeping hours during preceding one week	1.19 (0.34– 4.13)	4.99 (1.03–24.28)
Under stress or pressed by business during preceeding one week	3.63 (1.55– 8.49)	2.16 (0.74– 6.36)
Score for type A behavior	1.06 (0.92– 1.23)	0.02 (0.79– 1.07)
Had hypertension, diabetes, or hyperlipidemia	4.60 (2.11–10.01)	0.83 (0.32– 2.15)
Had structural diseases of circulatory system	1.42 (0.47– 4.28)	9.03 (2.39–34.10)

Age, occupation, and the five factors in the left column were used as the explanatory variable in the unconditional logistic regression analysis.

might have contributed to slightly different results regarding the contribution of stress and decreased sleeping hours to SD occurrence.

PREVENTION

The role of health examination in preventing SD was analyzed in 75 SD cases, whose family answered the questionnaire, out of 203 cases collected during 1988 through 1990.[34] Out of the 75 cases, 36 (48.0%) had received a health examination before death, and 39 had not. The proportion of SD cases who had been medically treated was significantly higher for those cases which had received health examination than for those which had not (88.9% vs 64.1%, $p<0.05$). Those who had been treated had a higher prevalence of previous illness than those who had not (85.2% vs 55.6%, $p<0.05$). Therefore, assuming that medical treatment would have postponed death, health examination had an indirect effect in preventing SD by identifying and referring those with abnormal findings to medical facilities. However, when we refer to a report from Finland[35] that the patient group intensively corrected for risk state by medical intervention had a higher death rate than patients who were not so corrected, or to the CAST report[36] which stated that some kinds of antiarrhythmia drugs induced more death in the users than those who were given a placebo, the assumption stated above may not always be true. We still have to establish an adequate intervention methodology.

Fourteen cases (18.7%) neither received health examinations nor medical treatment. Since nine of these previous illnesses, successful life saving intervention, or at least a postponed death, may have been possible had they received medical treatment. The five cases reportedly having no past history of medical problems may actually have had an abnormality which could have been identified by a health examination and properly treated.

Three out of four cases where the individual had received a health examination had no previous illness, and the ages of two of the three were in their early thirties. The existence of these cases makes apparent that there are limits as to how much health examinations can prevent SD.

Among the 203 cases, the resuscitated rate was higher in the SD subgroup which were attended by a witness than those who were unattended (Table 4). The SD event occurred most frequently at home where it was noticed immediately by someone.

In another study, where the disappearance time of vital signs was checked and an electrocardiogram was recorded in 61 SD cases by ambulance men in the Niigata City Fire Department, we investigated factors related to life-saving.[37] Among 52 SD cases in which vital signs

Table 4. Proportion of resuscitated cases according to presence of witness

State on arrival	Witness	Number of cases	Number (proportion of) resuscitated cases
Dead#	+	77	8 (10.4%)[1)]
	−	61	1 (1.6%)*
Alive	+	25	4 (16.0%)
	−	24	1 (4.2%)
All cases including unknown ones	+	112	12 (10.7%)[1)]
	−	91	2 (2.2%)*

Cardiac standstill or ventricular fibrillation.

1) Dead (2 cases), brain death or vegetable state (4 cases).

* $p < 0.05$ against the proportion for cases without witness.

disappeared before arrival at hospitals, there were 31 cases in which the attack was witnessed within 3 minutes. Tachyarrhythmia (ventricular fibrillation or tachycardia) was present in 39% of the witnessed cases and bradyarrhythmia was present in 32% of the witnessed cases based on electrocardiograms recorded in the ambulance. Even in the cases where emergency personnel arrived within 10 minutes, 46% of the cases showed bradyarrhythmia. Therefore, not only defibrillating maneuvers but also maneuvers for bradyarrhythmia can be seen as important life saving techniques. These findings as well as experiences in Seattle,[38)] where the resuscitation rate doubled after people were educated in proper resuscitation methods, tell us that educating citizens as to proper resuscitation methods could be an important way to help minimize SD.

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