

A retrospective study on solitary deaths (*kodoku-shi*) from the aspects of forensic and social medicine

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Abstract

This retrospective study evaluated 637 forensic autopsy cases of solitary death (*kodoku-shi in Japanese*) and clarified the present situation of solitary death from the viewpoints of forensic medicine. Of 637 cases who had solitary death, 471 were male and 166 were female, indicating that solitary death predominantly occurred in men. This tendency increased from the age of 40 years in men and 60 years in women. Among the cases, 349 and 199 were natural death and external death, respectively. Ischemic heart disease- and fire-related fatalities were most common in natural death and external death cases, respectively. Suicidal death was more frequent in women than in men. We found two peaks of postmortem interval until finding (PMI-f): < 1 d (182 cases, 28.6%) and 7 days to < 1 month (164 cases, 25.7%). The PMI-f in female cases was significantly shorter than that in male cases. The PMI-f of external death cases was significantly shorter than that of natural death cases. Kushimoto and Shingu, located in the southern part (Kinan region), had a high solitary death rate in forensic autopsy cases because of their small population and high aging rate. Few cases were welfare recipients in solitary death cases in Kinan region (non-urban area), and 23 of 36 welfare recipients lived in Wakayama City, indicating that the economic state would contribute more to the occurrence of solitary death in Wakayama City (urban area). We identified several risk factors and regional characteristics for solitary death cases, and our observations could contribute to administrative welfare measures for the prevention of solitary deaths.

Introduction

The development of medical technology and improvement of public health in Japan have established it as one of the countries with the longest life expectancy in the world. In contrast, low fertility and aging have rapidly progressed owing to changes in the Japanese population structure. Additionally, the number of traditional extended family households in Japan has decreased and the number of elderly single-person households has increased. These changes have created concerns about serious problems in the elderly population^{1, 2}.

The aging society in Japan has progressed rapidly since the 1970s. In the 1970s, when solitary death (*kodoku-shi in Japanese*) was first noted, it was regarded as a “symbolic phenomenon of an urban loneliness” or “an issue of the elderly”³. Currently, solitary death is a social and medical problem. In fact, solitary deaths frequently occurred among victims of the Great Hanshin-Awaji earthquake in 1995. Thereafter, solitary death has attracted public concern as it is a familiar phenomenon that is the result of disease, poverty, and isolation from families and communities, not a special phenomenon³⁻⁵. Since the 1990s, the relationship with poverty has become a problem, and in the latter half of the 2000s, solitary death became a social problem as a result of social exclusion, and countermeasures were taken³.

Recently, the Japanese government has presented a new term for isolated deaths. However, solitary death or isolated death has not yet been clearly defined. Therefore, the subjects of the survey slightly differed depending on the study. Regarding the definition of solitary death, the Tokyo Medical Examiner’s Office operationally defined solitary death “as an unnatural death at the home of a person living alone in a

private household”^{6,7}, limited to people living alone. In other studies, solitary death occurred not only among people living alone but also among people living with the family^{8,9}. There are various interpretations of this definition. Conversely, the Ministry of Health, Labor and Welfare in Japan defines isolated death as “miserable death that damages the dignity of a person, i.e., a death that was not found for a long period as a result of being isolated from society”¹⁰.

Available welfare measures are required to prevent solitary deaths, giving greater consideration to regional differences. Although some previous studies investigated the actual situation of solitary death, the living conditions differ depending on each region^{8,11-16}, and there are few reports that the actual situation of solitary death was thoroughly investigated¹³.

Forensic medicine, a type of social medicine, is indispensable for maintaining social order and has a mission to reflect the social situation of that era. Investigation of the cause of death is a major issue in forensic medicine. Moreover, information obtained from forensic practice can provide a basic academic reference for formulating effective policies to prevent solitary deaths. Thus, we performed a retrospective study of forensic cases of solitary death and clarified the present situation of solitary death from the viewpoint of forensic medicine.

Results

Tendency of solitary death cases in forensic autopsy

In the past 16 years, the number of forensic autopsies performed has progressively increased. In accordance with this tendency, the number of solitary deaths increased simultaneously. In 2003, the number of solitary deaths was only seven (10.3%, percentage of annual autopsy cases), and there were 64 cases of solitary death (29.4%) in 2018. Moreover, the rate of home deaths among forensic autopsy cases has increased from 26.5% in 2003 to 50% in 2018. The rate of solitary deaths among home death cases has increased from nearly 40% in 2003 to nearly 60% in 2018 (Fig. 1a).

Sex and age distribution

Of 637 cases who had solitary death, 471 (73.9%) were male, and 166 (26.1%) were female, indicating that solitary death predominantly occurred in men (Fig. 1b). As for age distribution, cases in their 70s were the most common, followed by those in their 60s. According to sex, men in their 60s and women in their 80s were the most common. Solitary death cases in men and women tended to increase from the age of 40 years and 60 years, respectively (Fig. 1c).

Manner or cause of death

Among 637 autopsy cases of solitary death, 349 (54.8%) and 199 (31.2%) were natural death and external death cases, respectively. The remaining 89 cases (14.0%) were unknown because of advanced postmortem changes. Among 471 male cases, natural death and external death occurred in 273 (58.0%)

and 130 (27.6%), respectively. In contrast, in female cases, the number of natural deaths was similar to that of external deaths (Fig. 2a).

Cause of death in natural death cases

The causes of death in the natural death cases are presented in Table 1. Cardiovascular disease was the leading cause of death in both sexes, followed by gastrointestinal and cerebrovascular diseases. Particularly, ischemic heart disease (IHD) was the most prevalent cardiovascular disease. The age distribution of natural death cases is shown in Fig. 2b. Especially, solitary deaths due to natural causes increased in men in their 40s.

Table 1
Cause of death in natural death.

Disease	Male (%)	Female (%)	Total (%)	Most common disease
Cardiovascular	149 (54.6)	51 (67.1)	200 (57.3)	Ischemic heart disease (155)
Cerebrovascular	27 (9.9)	5 (6.6)	32 (9.2)	Cerebral hemorrhage (30)
Respiratory	11 (4.0)	0 (0.0)	11 (3.2)	Pneumonia (9)
Gastrointestinal	54 (19.8)	9 (11.8)	63 (18.1)	Gastrointestinal bleeding (34)
Malignant	13 (4.8)	3 (3.9)	16 (4.6)	Liver, Lung cancer (4 each)
Malnutrition	6 (2.2)	4 (5.3)	10 (2.9)	Malnutrition (10)
Other	13 (4.8)	4 (5.3)	17 (4.9)	
Total	273 (100.0)	76 (100.0)	349 (100.0)	
Other diseases were classified as urinary organs, metabolic diseases, dehydration, infectious diseases, etc.				

Cause of death in external death cases

Among 199 external deaths, 154 (77.4%) were accidental, and 45 (22.6%) were suicidal. As shown in Fig. 2c, the suicide rate was higher in women than in men. In accidental death cases, fire-related death (80 cases, 51.9%) was the most common, followed by asphyxia (23 cases, 14.9%) and traumatic death (22 cases, 14.3%). Among the fire-related deaths, 77 were caused by home fire. Among the asphyxia cases, drowning was the most common (11 cases). The traumatic cases included intracranial injury, hemorrhagic shock due to injury or fracture, and cervical dislocation (Table 2). The age distribution of accidental deaths is shown in Fig. 2d. Accidental deaths were common in the 70s and 80s age group. In suicide cases, asphyxia was the most common method, followed by hanging. There were 17 cases of intoxication among the suicidal cases. Among the 17 cases, psychiatric drugs were most frequently used

(Table 3). The age distribution of suicidal cases is shown in Fig. 2e, and most of them were in their 30s to 60s.

Table 2
Cause of death in accidental death.

	Male (%)	Female (%)	Total (%)
Fire-related	59 (56.2)	21 (42.9)	80 (51.9)
Heat stroke	6 (5.7)	2 (4.1)	8 (5.2)
Hypothermia	6 (5.7)	5 (10.2)	11 (7.1)
Drowning	6 (5.7)	5 (10.2)	11 (7.1)
Asphyxia	7 (6.7)	5 (10.2)	12 (7.8)
Drug	6 (5.7)	2 (4.1)	8 (5.2)
Alcohol	2 (1.9)	0 (0.0)	2 (1.3)
Trauma	13 (12.4)	9 (18.4)	22 (14.3)
Total	105 (100.0)	49 (100.0)	154 (100.0)

Table 3
Cause of death in suicidal death.

	Male (%)	Female (%)	Total (%)	Most common cause of death
Asphyxia	16 (64.0)	7 (35.0)	23 (51.1)	Hanging (15)
Hyperthermia	1 (4.0)	1 (5.0)	2 (4.4)	Fire (2)
Intoxication	5 (20.0)	12 (60.0)	17 (37.8)	Drug (12)
Trauma	3 (12.0)	0 (0.0)	3 (6.7)	Sharp weapons (3)
Total	25 (100.0)	20 (100.0)	45 (100.0)	

Postmortem interval until finding (PMI-f)

In each case, we evaluated the PMI-f of the body. Figure 3a shows that there are two peaks of the PMI-f: < 1 d (182 cases, 28.6%) and 7 days to < 1 month (164 cases, 25.7%). Comparing PMI-f by sex, in men, PMI-f of 7 days to < 1 month was the most common (135 cases, 28.7%), followed by PMI-f of < 1 d (124 cases, 26.3%). Conversely, in women, PMI-f of < 1 d was observed in 58 cases (34.9%), and that of 7 days to < 1 month in 29 cases (17.5%). Moreover, comparing PMI-f with the cause of death, the PMI-f of natural death cases tended to be longer than that of external death cases (Fig. 3b). Moreover, we divided the

cases in accordance with PMI-f of < 7days and that ≥ 7 days. Comparing PMI-f by sex, PMI-f in women was significantly shorter than that in men ($p < 0.001$) (Table 4). Comparing PMI-f between natural death and external death cases, PMI-f of < 1 week was observed in 152 natural death cases (43.6%) and 167 external death cases (83.9%). In contrast, PMI-f of ≥ 1 week was observed in 197 natural death cases (56.4%) and 32 external death cases (16.1%). PMI-f of external death cases was significantly shorter than that of natural death cases ($p < 0.001$).

Table 4
Comparison of < 7 days PMI and ≥ 1 week PMI by gender.

PMI-f	Male (%)	Female (%)	
< 7days	222 (47.1)	106 (63.9)	$p < 0.001$
≥ 7 days	249 (52.9)	60 (36.1)	
PMI-f: postmortem interval until finding.			

First finder

The first finder was defined as the first person to find the victim. The first finders were classified as family members/relatives, friends, owner of their house, neighbors, colleagues, nursing or welfare staff, delivery staff, police officer, passers-by, and unknown. In this study, we investigated 556 cases, excluding 81 cases that were discovered by police officers or firefighters due to a home fire. As shown in Fig. 3c, of the 556 cases who had solitary death, police officers were the most common (195 cases, 35.1%), followed by family members/relatives (166 cases, 29.9%). In men, Police officers were the most common (156 cases, 38.0%), followed by family members/relatives (112 cases, 27.3%). Conversely, in women, family members/relatives (54 cases, 37.2%), followed by police officers (39 cases, 26.9%).

Past medical histories

The medical history of cases is shown in Table 5. Cardiovascular disease (153 cases, 24.0%) was the most common in both sexes, followed by psychiatric disease (114 cases, 17.9%), excluding other diseases. Hypertension (HT) was the most prevalent cardiovascular disease worldwide. Depression was the most prevalent psychiatric disorder. Diabetes mellitus (DM) was the most prevalent disease. According to sex, men exhibited a twofold higher incidence of respiratory and gastrointestinal diseases and an approximately sevenfold higher incidence of malignancy than female cases. Alcoholic liver disease, alcoholism, and schizophrenia were more common in men than in women.

Table 5
Past medical histories.

Disease	Male (%)	Female (%)	Total (%)	Most common disease
Cardiovascular	107 (22.7)	46 (27.7)	153 (24.0)	Hypertension (106)
Cerebrovascular	24 (5.1)	8 (4.8)	32 (5.0)	Cerebral infarction (16)
Respiratory	20 (4.2)	3 (1.8)	23 (3.6)	Pulmonary emphysema (7)
Gastrointestinal	79 (16.8)	12 (7.2)	91 (14.3)	Alcoholic liver disease (21)
Malignant	33 (7.0)	0 (0.0)	33 (5.2)	Liver cancer (9)
Ophthalmic disorders	6 (1.3)	1 (0.6)	7 (1.1)	Glaucoma (4)
Orthopedic	13 (2.8)	11 (6.6)	24 (3.8)	Fracture (8)
Psychiatric	80 (17.0)	34 (20.5)	114 (17.9)	Depression (35)
Other	90 (19.1)	34 (20.5)	124 (19.5)	Diabetes (56)
Total	452	149	794	
Other diseases were classified as urinary organs, metabolic diseases, infectious diseases, etc.				

Regional characteristics in Wakayama prefecture

We aimed to clarify the regional characteristics of solitary deaths in Wakayama prefecture and divided the regions where solitary deaths occurred according to the jurisdiction of the Wakayama prefectural police. The jurisdiction of Wakayama prefectural police is shown in Fig. 4a. There are 14 police stations, and Wakayama City, the prefectural office of Wakayama Prefecture, is under the jurisdiction of three police stations: Wakayama north, east, and west police stations. The number of solitary death cases by police station and average annual number of autopsies for solitary death cases per 100,000 population are shown in Fig. 4b. The highest number of solitary deaths occurred at the Wakayama police stations (north, east, and west police stations). However, in terms of the average annual number of autopsies for solitary death cases per 100,000 people, the top was the Shingu police station, followed by the Kushimoto police station. The rate of solitary deaths among home death cases by police station is shown in Fig. 4c. The highest solitary death rate was noted at the Kushimoto police station (85.2%), followed by the Shingu police station (68.0%). The average rate of solitary deaths among home death cases in Wakayama Prefecture was 52.7%, and Wakayama, Kushimoto, and Shingu police stations exceeded the prefecture average.

Economical condition

We examined the economic conditions of solitary death cases and selected individuals who had received welfare aid during their lifetime. Among the 637 cases of solitary death, 36 were welfare recipients,

accounting for 5.7% of all solitary death cases. Among the 36 welfare recipients, 29 were male, and 7 were female. The rates by sex were 6.2% and 4.2% for men and women, respectively. As for age distribution, those in their 50s were the most common, followed by those in their 60s. Particularly, in men, most cases were in their 50s and those in their 60s (Fig. 4d). Moreover, we divided the regions where 36 welfare recipients were found as solitary death cases, according to the jurisdiction of Wakayama prefectural police stations. The number of welfare recipients by police stations and the average annual number of welfare recipients per 100,000 population are shown in Table 6. Wakayama police stations (north, east, and west) showed most number of cases (23 cases, 63.9%, and per 100,000 population; 0.4). However, in Kushimoto and Shingu police stations, where the average annual number of autopsies for solitary death cases per 100,000 population and the solitary death rate among home death cases were extremely high, almost no welfare recipients could be confirmed.

Table 6
The number of welfare recipients among solitary death cases by police station and the average annual number of welfare recipients per 100,000 population.

Police stations	Number	Population	Average annual number welfare recipients
Wakayam	23	357,868	0.4
Iwade	3	113,442	0.2
Katsuragi	0	16,249	0.0
Hashimoto	1	68,833	0.1
Kainan	1	58,171	0.1
Arida	0	26,937	0.0
Yuasa	2	44,167	0.3
Gobo	1	61,119	0.1
Tanabe	3	98,757	0.2
Shirahama	1	20,787	0.3
Kushimoto	0	21,967	0.0
Shingu	1	45,754	0.1
Total	36	934,051	0.2

Discussion

The Annual Report on the Ageing Society in Japan¹⁷ revealed that half of single-person households with ages ≥ 60 years were concerned about “death without any care that was not found for a long period.” As if to support this result, the lack of relationships, such as “greetings only” and “almost no relationships,” regarding the degree of neighborhood relationships in single-person households of aged ≥ 65 is $> 60\%$ in

men and approximately 40% in women¹⁷. Similar situations have been reported in the Wakayama Prefecture¹⁸. These social situations prompted us to investigate the actual condition of solitary death cases from the viewpoint of forensic medicine.

In the past 16 years, the number of forensic autopsies has doubled from 123 in 2004 to 240–250 since 2012. In accordance with this tendency, the rates of home death and solitary death increased approximately 1.7-fold and 2.3-fold, respectively. This tendency seems to result from an increase in single-person households in Japan¹⁹. Particularly, in Wakayama Prefecture, the number of individuals in single-person households aged ≥ 65 years was 21.8%²⁰ in 2018, with one in five living alone. Moreover, the aging rate in Wakayama Prefecture was extremely high, at 31.5 rate in 2018²⁰, while the aging rate in Japan was 28.1%²¹. Thus, in Wakayama Prefecture, solitary death may easily occur because of the increase in the number of households and aging of the population.

Our study demonstrated that solitary death predominantly occurred in men in their 50s to 80s, with a peak in the 70s. Solitary death cases in men and women tended to increase from the age of 40 to 60 years. As for the manner of death, natural death accounted for half of all cases, and IHD was the leading cause of death in both sexes, as previously reported^{6, 8, 9, 11–14, 22–26}. In cases of solitary death, a large number of natural deaths are considered to reflect a large number of elderly people. Furthermore, in this study, men had a higher natural death rate than women, which tended to increase from a younger age. This may be due to lifestyle differences between men and women.

There was a difference in age distribution between accidental and suicidal death cases: accidental cases and suicidal cases were common in the 70s and 80s aged group and 30s to 60s age group, respectively. In line with a previous study⁹, fire-related death was the most common cause of accidental cases of solitary deaths because most fire-related deaths were usually subjects for forensic autopsy. According to a report by the Fire and Disaster Management Agency²⁷, approximately 70% of the deaths from fires at home were from elderly persons aged ≥ 65 years, indicating that single-person households of the elderly population have a high risk of accidental death due to fire at home. In line with previous studies^{13, 26}, our observations implied that the rate of suicide was higher in women than in men, and hanging was the most common method. Suicidal cases were more common in the younger generation than accidental death cases^{8, 13}.

We found two peaks in PMI-f: < 1 d and 7 days to < 1 month. The PMI in male cases was significantly longer than that in female cases. There was a significant difference in PMI between natural and external death cases. The PMI of external death cases was significantly shorter than that of natural death cases. In natural death cases, PMI-f cannot be found without visiting the victim's home; therefore, the strength of the connection with their families and communities has a great effect on PMI-f. Approximately half of the cases were found more than seven days after death, suggesting that the victims were likely isolated from their families and communities. This tendency was greater in women than in men.

Several lines of accumulating evidence imply that a PMI of \leq three days is the most common^{8, 11, 22, 28}. In contrast, Hatake et al.¹³ reported that a PMI of > 7 days was the most frequent. This discrepancy depends on regional differences. In contrast, in line with our observations, PMI of solitary death cases tended to be longer in men than in women^{6, 13, 15, 22, 23, 29, 30}. It is important that social exclusion is closely related to solitary and isolated deaths. The evaluation of PMI might be useful as an indicator of the isolated state²⁹⁻³¹. Morita et al.²⁹ reported that the PMI-f was 3 days on average in solitary death cases with social ties.

According to several previous studies^{8, 11, 28}, the rate of discovery by family members/relatives was the highest (40–90%). In contrast, in this study, police officers were the most frequent finders, followed by family members/relatives. However, according to the sex of the victims, the rate of discovery by family members/relatives was higher in women than in men. Between PMI-f and the first finders, the rate of discovery by family members/relatives became lower in cases with long PMI-f^{11, 14}. Thus, these observations imply that the type of first finder might be another indicator for the evaluation of the isolated state.

Hypertension was the most common, followed by DM and depression in both sexes, according to past medical history. Alcoholic liver disease, alcoholism, and schizophrenia were more frequent in men than in women. In line with this, previous studies have reported a higher prevalence of hypertension and alcohol-related disease in solitary death cases^{9, 12, 23, 26, 30}. Our results are consistent with this finding.

Accumulating evidence has shown that solitariness or isolation from the social community increases the risk of alcohol abuse, frailty, and sarcopenia^{32, 33}. Moreover, welfare recipients often develop alcohol-related diseases³⁵. These observations imply that alcohol abuse, mental health, and physical health should be considered as risk factors of solitary death.

Several lines of accumulating evidence implied that there are regional characteristics and differences in the background of solitary deaths^{8, 11–16}. Wakayama Prefecture has a long north–south terrain and consists of three areas: Kihoku, Kichu, and Kinan³⁶ (Supplementary Fig. 1a). Population concentration in urban areas and local depopulation are serious issues. The aging rate tended to be high, particularly in depopulated areas (Supplementary Fig. 1b). In the present study, we found regional characteristics in the background of solitary deaths in the Wakayama Prefecture. The average annual number of solitary deaths per 100,000 population was 4.3 in Wakayama Prefecture. However, Kushimoto and Shingu, located in the southern part (Kinan region), had a high solitary death rate in forensic autopsy cases because of the small population and high aging rate of $> 40\%$. Several lines of accumulating evidence suggest that low income, unemployment, and welfare are risk factors for solitary death^{6, 7}. With focus on economic conditions, 36 participants were welfare recipients. However, few cases were welfare recipients in solitary deaths in the Kinan region (Kushimoto and Shingu). In contrast, 23 of 36 welfare recipients, who had solitary death, lived in Wakayama city, indicating that the economic state would contribute more to the occurrence of solitary death in Wakayama city. These observations indicate a difference in the background of solitary deaths between urban and non-urban areas.

Finally, the present study demonstrated several risk factors and regional characteristics of solitary death cases. However, this study has a limitation in that all data were obtained from forensic autopsy cases. Therefore, it should be noted that it does not reflect all solitary deaths in Wakayama Prefecture. Previous studies have reported that some cases had long PMI-f despite living with family^{12, 29, 30, 37}. Therefore, in future studies, it will be necessary to conduct a survey that is not limited to living alone. However, these observations could contribute to administrative welfare measures for the prevention of solitary deaths.

Methods

Autopsy cases

A total of 3,000 forensic autopsies were performed at the Department of Forensic Medicine, Wakayama Medical University, from April 2003 to December 2018. We retrospectively reviewed the autopsy reports of all cases and selected cases of solitary death or presumed solitary death. In this study, "solitary death" was defined as death in people living alone that occurred at home or on the premises of home. We excluded homicide cases and those in which the deceased were discovered outside of their home premises and nursing homes or in homeless individuals. Among 3,000 autopsy cases performed at our department, 637 cases were selected as solitary death cases or presumed solitary death cases in accordance with the abovementioned definition. Based on the autopsy records and police reports, the tendency of solitary death in forensic autopsies, sex, age distribution, manner or cause of death, PMI, first finder, past medical histories, and economic conditions were investigated. Moreover, the regional characteristics in Wakayama Prefecture were also examined.

Statistical analyses

A chi-square test was used only for PMI, compared the differences between < 7days and \geq 7days with regard to sex and cause of death. P-values < 0.05 were considered significant. Statistical analysis was performed using Microsoft Excel Office version 16.

Declarations

Data availability

The authors declare that all data are available in the article file, or available from the authors upon reasonable request.

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Author contributions

Conceptualization: Y.H., T.K.; Formal Analysis: Y.K., A.I., Y.I., M.N., Y.K., H.Y., J.M., H.Y., and S.H., E.S.; Funding Acquisition: Y.K., Y.I. and T.K; Investigation: Y.H., A.I. and Y.I.; Project Administration: T.K.; Validation: M.N. and A.K.; Writing—Original Draft Preparation: Y.H.; Writing—Review and Editing: F.F., A.K. and T.K.

Competing interests

The authors declare no competing interests.

Ethical approval

Our study was approved by the Research Ethics Committee of Wakayama Medical University (No. 3228). All procedures were carried out in accordance with the Declaration of Helsinki Principles. Moreover, this study was conducted using autopsy records from the past, and we could not obtain informed consent from the bereaved family for the use of the records. Therefore, in accordance with the “Ethical Guidelines for Medical Research Involving Human Subjects (enacted by the Ministry of Health, Labor and Welfare in Japan),” Sect. 12–1 (2) (a) (c). Thus, the review board of Research Ethics Committee of Wakayama Medical University waived the need for written informed consent from relatives of individuals studied since this was a de-identified retrospective study of archived autopsy records.

Conflict of interest statement

The authors have declared that no conflict of interest exists.

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Figures

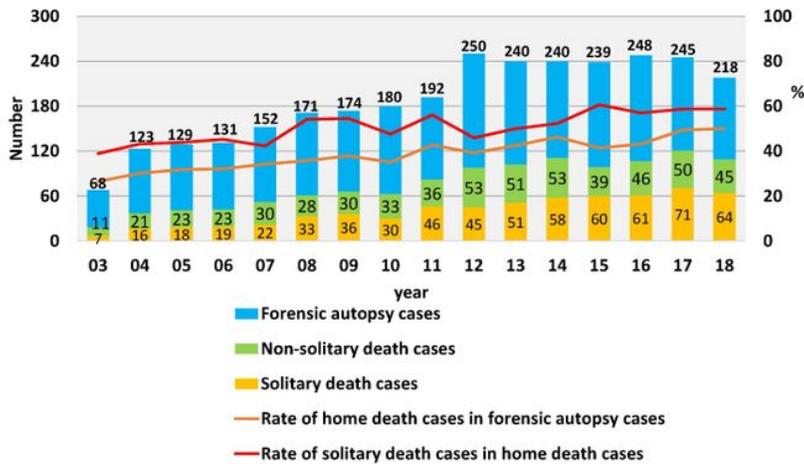


Figure 1.(a)

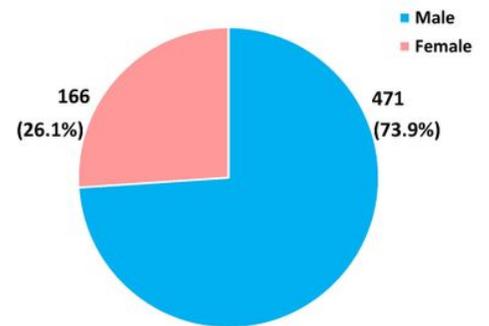


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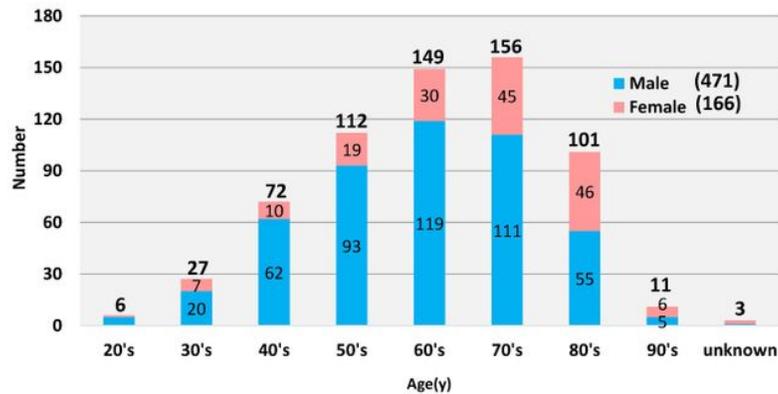


Figure 1.(c)

Figure 1

(a) Change in cases of home death and solitary death.

Home death cases: Combined solitary and non-solitary death cases.

(b) Sex distribution.

(c) Age distribution.

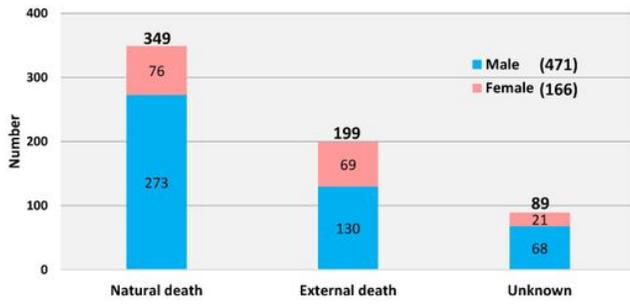


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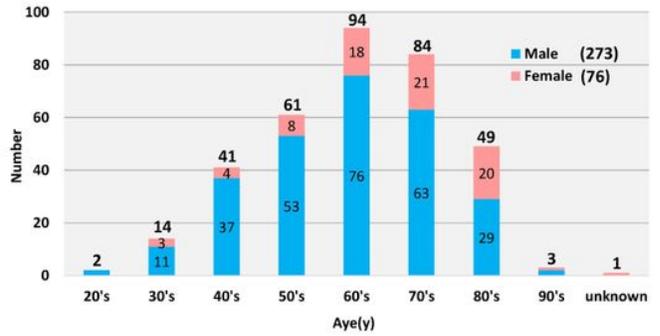


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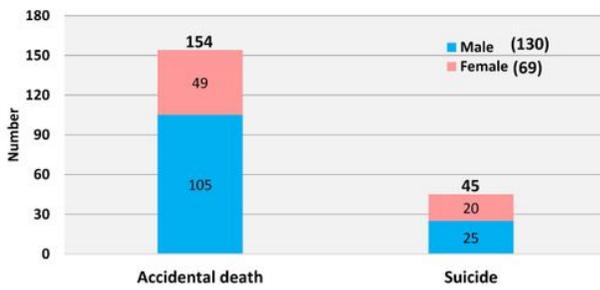


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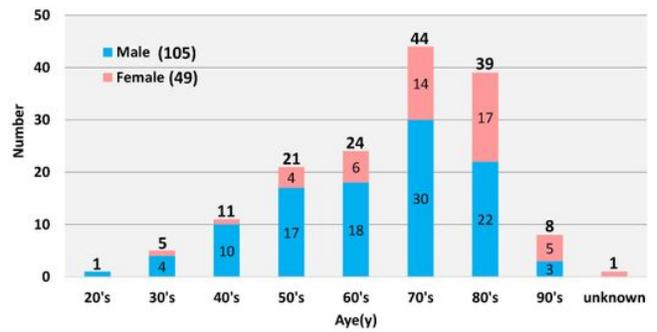


Figure 2.(d)

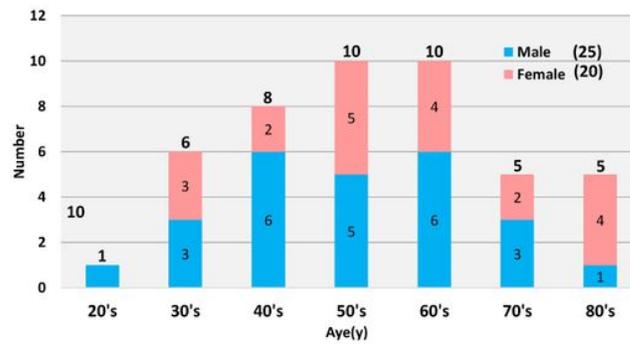


Figure 2.(e)

Figure 2

(a) Manner of death.

(b) Age distribution of natural death.

(c) Manner of external death.

(d) Age distribution of accidental death.

(e) Age distribution of suicidal death.

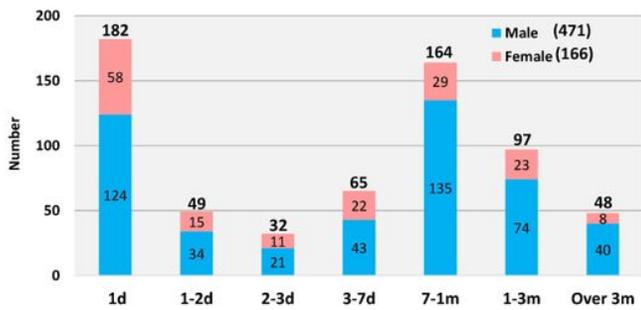


Figure 3.(a)

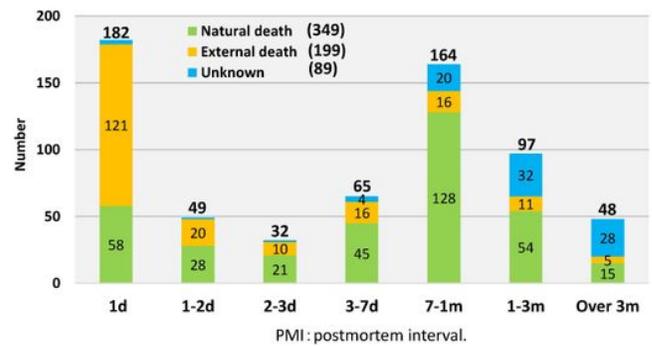


Figure 3.(b)

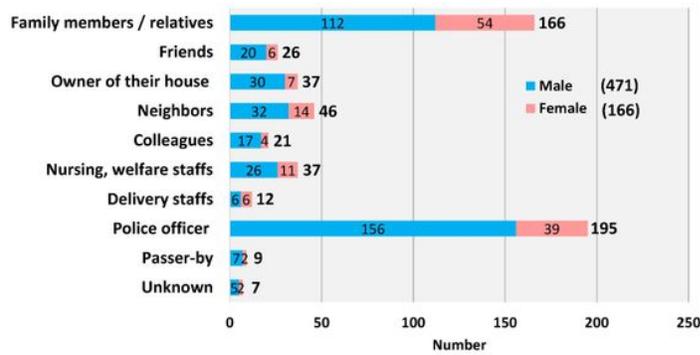


Figure 3.(c)

Figure 3

(a) Postmortem interval until finding.

(d: day, m: month)

(b) Postmortem intervals in accordance with the manner of death.

(d: day, m: month)

(c) First finder.

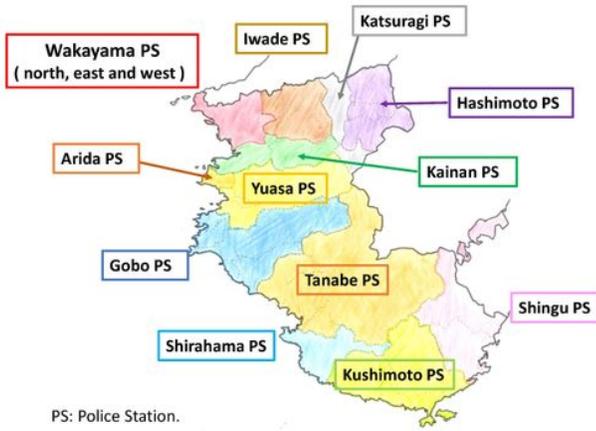


Figure 4.(a)

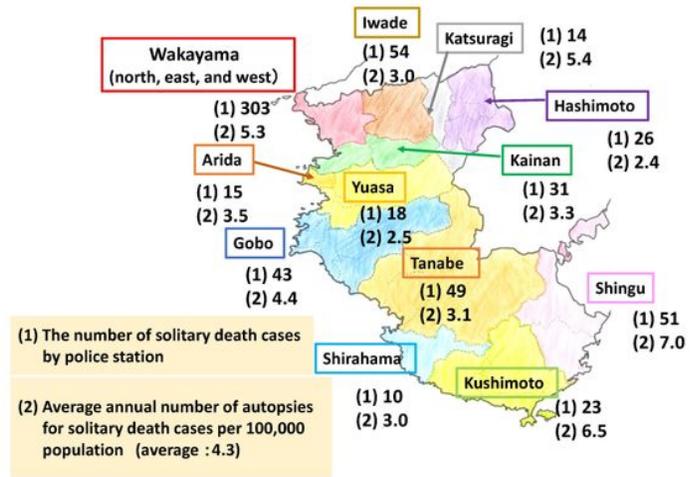


Figure 4.(b)

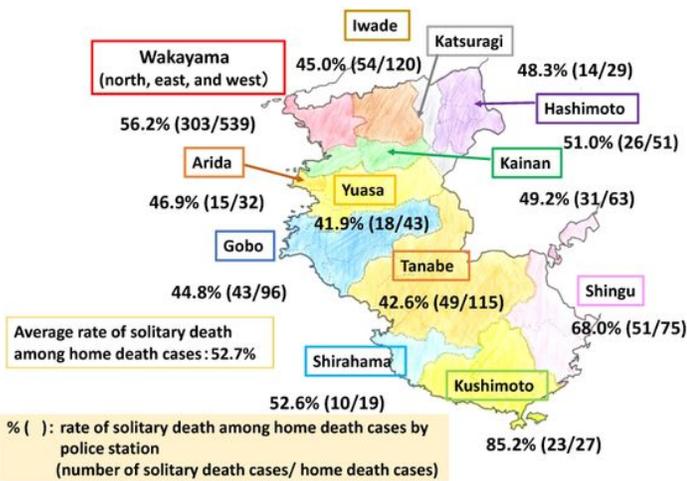


Figure 4.(c)

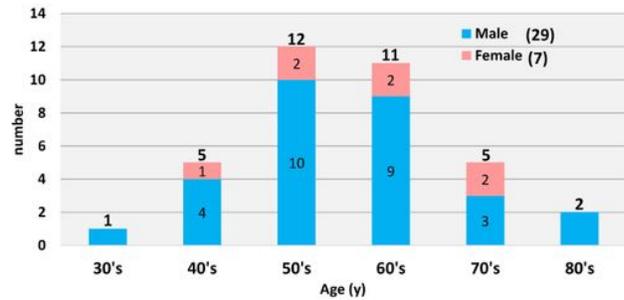


Figure 4.(d)

Figure 4

(a) Wakayama Police Station in Wakayama Prefecture.

(b) The number of solitary death cases by police station and average annual number of autopsies for solitary death cases per 100,000 population.

(c) The rate of solitary death among home death cases by police station.

(d) Age distribution of welfare recipients.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryDatasetfilelessolitarydeath.pptx](#)