

Short communication: solitary deaths by suffocation from death certificates, 2011-2015

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Abstract

Background: Solitary deaths are very worth preventing in terms of financial and administrative points, and Japan is at the forefront of various problems by solitary deaths. We used statistical data from Yokohama City to ascertain the risks of solitary deaths by suffocation.

Methods: We conducted a cross-sectional study of adult deaths due to suffocation between January 2011 and December 2015. Data were collected from death certificates from the Medical Care Bureau of Yokohama City. Non-transported deaths were considered solitary deaths.

Results: 869 suffocation deaths were divided into “non-transported” (n=187) and “emergency transported” (n=682) groups, according to the place of death.

Pearson’s chi-square (χ^2) test revealed significant differences in sex and marital status. Logistic regression analysis showed that the female sex and an unmarried marital status were associated with non-transported suffocation death.

Conclusions: Being unmarried and female sex (both risk factors for living alone) were independent risk factors for solitary suffocation death in Yokohama City. Due to the quick process of suffocation, living alone might be a greater risk for solitary suffocation death than social participation, contrary to the risk for overall solitary deaths.

Key words: Suffocation death, solitary death, emergency transportation, marital status, aging society.

Introduction

The existence of solitary deaths, known as Kodokushi in Japanese, is gradually becoming apparent outside Japan. Although witnessed accidental deaths like suffocation, drowning, and toppling tend to be treated with surface check and minimal examination, each case of solitary death costs unnecessary several thousand dollars for autopsy or examination, and mobilizes an unnecessary investigation team of the police, even if the cause of death is the same as witnessed one. Hence, preventing each solitary death saves a large amount of money, time, and human resources.

To our knowledge, there are four studies about solitary death risks in Japan¹⁻⁴. Two of these lacked

the analysis of the control group and mentioned the characteristics of solitary death itself; the proportion of “men” and “not employed” were high^{3,4}. The other studies, including our previous one, found that “men”, “unmarried”, “with hepatic disorder” and “with alcohol abuse” were risks of solitary deaths compared to un-solitary deaths^{1,2}.

Considering that suffocation contributes most to accidental deaths, we aimed to investigate the risks of solitary and un-solitary deaths by suffocation. The risk factors for suffocation are already noted, but factors that determine whether suffocation results in a solitary or un-solitary death are not clear⁵⁻⁹. We used the data of death certificate notifications from Yokohama city and analyzed solitary and un-solitary deaths by suffocation.

Methods**Data collection**

We collected death certificate notifications from the Medical Care Bureau of Yokohama City and extracted anonymous data of suffocation deaths occurring between January 2011 and December 2015. From death certificate notifications, demographic characteristics such as age, sex, marital status, the cause of death, post-mortem interval, and place of death were obtained.

Statistical analysis

Yokohama citizens who died of suffocation between January 2011 and December 2015 were categorized into two groups: “solitary deaths” and “un-solitary deaths” groups, based on the place of death (i.e., home or hospital/clinic). In Japan, without the cases that apparent signs of death like rigor mortis or decomposition appear, suffocating persons are transported to medical facilities. Hence, non-transported deaths at home are limited to cases where dead bodies are not found for at least several hours and can be considered solitary deaths. We

Table 1. Characteristics of people with solitary and un-solitary deaths by suffocation in Yokohama City during 2011–2015

Characteristics		Solitary deaths	Un-solitary deaths	P-value
		n=187	n=682	
Men +	Women, n (%)	102 (54.5%)	315 (46.2%)	0.043
Women	Age, mean (SD)	78.4 (13.7)	78.9 (12.6)	
	Age groups, n (%)			0.385
	Late elderly (aged \geq 95)	13 (7.0%)	28 (4.1%)	
	Late elderly (aged 85-94)	59 (31.6%)	232 (34.0%)	
	Late elderly (aged 75-84)	59 (31.6%)	236 (34.6%)	
	Early elderly (aged 65-74)	33 (17.6%)	99 (14.5%)	
	Not elderly (aged 20-64)	23 (12.3%)	87 (12.8%)	
	Marital status, n (%)			
	Unmarried	36 (19.3%)	87 (12.7%)	0.025
	Married	68 (36.4%)	311 (45.5%)	0.026
	Divorced or widowed	83 (44.4%)	284 (41.5%)	0.482
		n=85	n=367	
Men	Age, mean (SD)	76.4 (13.2)	76.7 (13.2)	
	Age groups, n (%)			0.509
	Late elderly (aged \geq 95)	3 (3.5%)	9 (2.5%)	
	Late elderly (aged 85-94)	22 (25.9%)	100 (27.2%)	
	Late elderly (aged 75-84)	30 (35.3%)	143 (39.0%)	
	Early elderly (aged 65-74)	18 (21.2%)	52 (14.2%)	
	Not elderly (aged 20-64)	12 (14.2%)	63 (16.1%)	
	Marital status, n (%)			
	Unmarried	27 (31.8%)	77 (21.0%)	0.035
	Married	45 (52.9%)	227 (61.7%)	0.139
	Divorced or widowed	13 (15.3%)	63 (17.2%)	0.685
		n=102	n=315	
Women	Age, mean (SD)	80.1 (13.9)	81.5 (11.2)	
	Age groups, n (%)			0.536
	Late elderly (aged \geq 95)	10 (9.8%)	19 (6.0%)	
	Late elderly (aged 85-94)	37 (36.3%)	132 (41.9%)	
	Late elderly (aged 75-84)	29 (28.4%)	93 (29.5%)	
	Early elderly (aged 65-74)	15 (14.7%)	47 (14.9%)	
	Not elderly (aged 20-64)	11 (10.8%)	24 (7.6%)	
	Marital status, n (%)			
	Unmarried	9 (8.8%)	10 (3.2%)	0.023
	Married	23 (22.5%)	84 (26.7%)	0.418
	Divorced or widowed	70 (68.6%)	221 (70.2%)	0.803

SD, standard deviation

excluded the cases of minors, including children, because suffocation in minors largely differs from that in adults in terms of the cause (food or not) and the presence of family. In the sex-stratified analysis, age groups (aged ≥ 95 , 85-94, 75-84, 65-74, and 20-64) and marital status (unmarried or not) were set as explanatory variables. Pearson's chi-square (χ^2) test was conducted to analyze differences in those explanatory variables between "solitary deaths" and "un-solitary deaths" groups. Multivariable odds ratios (ORs) were calculated using logistic regression analyses to estimate the strength of risk factors. The significance level was set at 5%. All data were analyzed using the SPSS Statistics v19.0 statistical software (IBM, Tokyo, Japan).

Ethics approval

The Ethics Committee of the Tokai University School of Medicine approved the study protocol and the use of patient data (approval number: 17R-101). We also received approval from the Ethics Committee of Yokohama City Institutes of Health. All methods were performed in accordance with

the relevant guidelines and regulations.

Results

Table 1 shows the number of cases and the characteristics of the subjects, such as sex, age groups, marital status, and p-values (Pearson's χ^2 test) of the two groups. For the groups of both sexes, the risk of solitary death by suffocation was significantly higher for women ($p=0.043$) and unmarried persons ($p=0.025$) and lower for married persons ($p=0.026$). Unmarried status was also a risk factor for the groups of men ($p=0.035$) and women ($p=0.023$).

Table 2 summarizes the results of the logistic regression analysis of the two groups. The multivariable ORs indicated that women ($p=0.010$) and unmarried persons ($p=0.003$) were significantly associated with solitary deaths by suffocation for the group of both sexes. Early elderly (aged 65-74) was associated with the group of men ($p=0.036$). Unmarried status was also associated with the groups of men ($p=0.011$) and women ($p=0.035$).

Table 2. Multivariable ORs (95% CI) of solitary deaths by suffocation according to age, sex, and marital status in Yokohama City during 2011–2015

	Characteristics	multivariable ORs (95% CI)	multivariable P-value	univariable P-value
Men + Women	Early elderly (aged 65-74 vs. 20-64)	1.53 (0.81-2.90)	0.188	0.385
	Late elderly (aged 75-84 vs. 20-64)	1.32 (0.72-2.42)	0.365	
	Late elderly (aged 85-94 vs. 20-64)	1.26 (0.69-2.31)	0.461	
	Late elderly (aged ≥ 95 vs. 20-64)	2.20 (0.93-5.17)	0.072	
	Sex (women vs. men)	1.59 (1.12-2.25)	0.010	0.043
	Marital Status (unmarried vs. married/divorced/widowed)	2.19 (1.31-3.64)	0.003	0.025
Men	Early elderly (aged 65-74 vs. 20-64)	2.53 (1.06-6.01)	0.036	0.509
	Late elderly (aged 75-84 vs. 20-64)	1.86 (0.80-4.35)	0.151	
	Late elderly (aged 85-94 vs. 20-64)	1.94 (0.81-4.68)	0.140	
	Late elderly (aged ≥ 95 vs. 20-64)	3.00 (0.66-13.70)	0.156	
	Marital Status (unmarried vs. married/divorced/widowed)	2.25 (1.21-4.19)	0.011	0.035
Women	Early elderly (aged 65-74 vs. 20-64)	0.77 (0.30-1.96)	0.581	0.536
	Late elderly (aged 75-84 vs. 20-64)	0.80 (0.34-1.89)	0.617	
	Late elderly (aged 85-94 vs. 20-64)	0.72 (0.32-1.66)	0.445	
	Late elderly (aged ≥ 95 vs. 20-64)	1.35 (0.46-3.93)	0.586	
	Marital Status (unmarried vs. married/divorced/widowed)	2.80 (1.07-7.29)	0.035	0.023

ORs, odds ratios; CI, confidence interval

All explanatory variables were incorporated into the multivariate model at once.

Discussion

While the information on transported cases is also obtained from hospital records, that of non-transported cases, equivalent to solitary deaths, can be obtained only by death certificates. In addition, little concern is paid to whether the death is solitary or not, because the problems caused by solitary deaths are not well known outside of the forensic community.

Difference from overall solitary death risks

This result shows that "women" and "unmarried" are the risks of solitary deaths by suffocation for the group of both sexes, while "early elderly" is the risk for the group of men. From previous studies, the risks for overall solitary deaths are "men", "unmarried", "with hepatic disorder" and "with alcohol abuse"^{1,2}. Even though the late elderly have greater risks of fatal diseases and especially elderly women tend to live alone due to their longevity, "late elderly" and "women" are not risk factors for overall solitary deaths. Solitary deaths in men occur five times more than in women⁴. Hence, the mechanisms of overall solitary deaths are estimated to be multifactorial; in addition to solitary living and fatal disease risks, sociability is a key factor. First, 50% of solitary deaths occur among people aged under 60 years, and comparing both sexes in that age, men tend to live alone, and have greater risks for fatal diseases like hypertension, metabolic syndrome, coronary heart diseases, and ischemic strokes^{4,10-14}. Second, women's sociability might significantly contribute to lowering solitary deaths among elderly women. In our study, the questions are why the opposite sex was the risk and why no significant relationship is found in "late elderly". We estimate that suffocation progresses so quickly that it might depend on solitary living rather than sociability. The distribution of suffocation is about the same in both sexes in Japan, but solitary deaths by suffocation tend to occur in women, reflecting their solitary living after middle age^{10,15}. "Early elderly" is the risk of solitary deaths by suffocation among men for three possible reasons. First, it is known that swallowing function begins to decline in the 60s¹⁶. Second, as mentioned above, the previous study shows that "men" and "hepatic disorders" are the risks of solitary deaths¹. Heavy drinking, a cause of hepatic disorders, sometimes causes vomiting and suffocation by aspiration. Third, among the early elderly, the prevalence of people certified for long-term care/support needs is less than the late elderly, and the

opportunities for welfare intervention, such as watching over at mealtime and teaching them appropriate forms of eating, will also be less¹⁷.

Suffocation in Japan

As mentioned above, the prevalence of suffocation itself is about the same in both sexes. However, due to traditional rice cake, the situation of suffocation in Japan is quite unique. First, Japan has a much higher incidence of suffocation deaths worldwide¹⁸. Second, globally, airway obstruction by food is commonly caused by meat and fish; in Japan, rice cake is the main cause^{19,20}. According to the Food Safety Commission of Japan, one mouthful of rice cake increases the risk of suffocation by 50–100 times more than that of meat²¹. Although the consumption of rice cake is 25 times less than meat in Japan, rice cake contributes to 25% of suffocation deaths, while meat attributes to 7%^{5,21}. In our study, we excluded the suffocation deaths among minors, including children, and most of the analyzed deaths were estimated to be caused by food, especially rice cake. Essentially, suffocation should also be considered from aspiration dysfunction or cognitive dysfunction. From death certificates, we could not identify such information, but solitary deaths by suffocation in Japan probably tend to ignore such dysfunctions related to aging due to the too risky food.

This study has some limitations. First, information from death certificates is limited, except for the cause of death. In addition, each certificate is written by each forensic doctor, and how much detail the cause of suffocation depends on them. In this study, analyzed deaths are limited to adults, and most suffocation deaths are estimated to be caused by food. Practically, death certificates are the only statistical data about solitary deaths, and some criteria regarding the detail of open-ended questions should be needed. Second, severe suffocation leads to solitary deaths with cohabitation, while mild suffocation leads to un-solitary deaths with solitary living after they get help from outside and are transported. We could not identify the severity of each suffocation case, but our results indicate that unmarried status, indirectly meaning solitary living, was a risk factor for solitary deaths by suffocation. Third, one example of confounding factors is the presence of social work and the use of nursing care services. Even for elderly persons living alone, the risk of death from suffocation can be reduced considerably if the home caregivers appropriately

provide dietary assistance and monitor the elderly. On the other hand, so-called "self-neglect," in which the elderly person does not want the intervention of the social work or nursing care services, has been increasing in Japan in recent years and is becoming a major cause of solitary deaths. Further research is needed to determine whether such "self-neglect" is prevalent among unmarried people. Fourth, our study focused on cases of suffocation deaths in Yokohama City. It is laborious to obtain death certificates throughout Japan, and whether our results are applicable to other regions of Japan is unsure. The previous studies about overall solitary deaths also used data in each region, but the risk factors were consistent with one another^{1,3,4}.

Conclusions

Unmarried" and "women" are both independent risks for solitary deaths due to suffocation in Yokohama City. Our results contradict previous studies noting that "men" are at a greater risk of overall solitary deaths due to the prevalent fatal diseases and lack of social participation. On this basis, we conclude that solitary deaths by suffocation depend on women's solitary living after 60 years, and women's social participation has a less protective effect due to the quick process of suffocation. The incidence of suffocation deaths by food in Japan is much higher, and it might explain that "late elderly", strongly related to aspiration dysfunction and cognitive dysfunction, was not a risk factor for solitary deaths by suffocation.

List of abbreviations

ORs, odds ratios; CI, confidence interval; SD, standard deviation

Declarations

Competing interests

The authors declare that they have no competing interests.

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References

1. Kakiuchi Y, Nagao R, Ochiai E, Kakimoto Y, Osawa M (2019) A descriptive study of solitary death in Yokohama

- city. *Environ Health Prev Med* 24(1): 12
2. Miyamori D, et al. (2022) Alcohol abuse as a potential risk factor of solitary death among people living alone: a cross-sectional study in Kyoto, Japan. *BMC Public Health* 22(1): 545
3. Kanawaku Y, Ohno Y (2019) Solitary deaths in the Tokyo metropolis and labor force status: characteristics of unnatural deaths at home among persons living alone. *J Nippon Med Sch* 86(6): 360-363
4. The small amount & short-term insurance association of Japan (2022) Recent reports about solitary deaths. <https://www.shougakutanki.jp/general/info/kodokushi/> (In Japanese) Accessed September 2022
5. Kiyohara K, et al. (2018) Epidemiology of out-of-hospital cardiac arrest due to suffocation focusing on suffocation due to Japanese rice cake: a population-based observational study from the Utstein Osaka Project. *J Epidemiol* 28(2): 67-74
6. Sasso R, Bachir R, Mazen ES (2018) Suffocation injuries in the United States: patient characteristics and factors associated with mortality. *West J Emerg Med* 19(4): 707-714
7. Komiya K, et al. (2013) Risk factors for unexpected death from suffocation in elderly patients hospitalized for pneumonia. *Geriatr Gerontol Int* 13(2): 388-392
8. Chung CH, Lai CH, Chien WC, Lin CH, Cheng CH (2013) A population-based study of inpatients admitted due to suffocation in Taiwan during 2005-2007. *Accid Anal Prev* 50: 523-529
9. Sehgal IS, et al. (2015) Foreign body inhalation in the adult population: experience of 25,998 bronchoscopies and systematic review of the literature. *Respir Care* 60(10): 1438-1448
10. Statistics bureau, ministry of internal affairs and communications (2015) The result of census survey in 2015. <https://www.stat.go.jp/data/kokusei/2015/kekka.html> (In Japanese) Accessed September 2022
11. Silventoinen K, Pankow J, Jousilahti P, Hu G, Tuomilehto J (2005) Educational inequalities in the metabolic syndrome and coronary heart disease among middle-aged men and women. *Int J Epidemiol* 34(2): 327-334
12. Park T, et al. (2014) Gender differences in the age-stratified prevalence of risk factors in Korean ischemic stroke patients: a nationwide stroke registry-based cross-sectional study. *International Journal of Stroke* 9(6): 759-765
13. Merz AA, Cheng S (2016) Sex differences in cardiovascular ageing. *Heart Br Card Soc* 102(11): 825-831
14. Iso H, et al. (2007) Metabolic syndrome and the risk of ischemic heart disease and stroke among Japanese men and women. *Stroke* 38(6): 1744-1751
15. Consumers affairs agency (2019) Information about drowning, suffocation, and falling among elderly. https://www.caa.go.jp/policies/policy/consumer_safety/caution/caution_009/ (In Japanese) Accessed September 2022
16. Wang C, et al. (2015) Aging-related changes in swallowing, and in the coordination of swallowing and respiration determined by novel non-invasive measurement techniques. *Geriatrics & Gerontology International* 15(6): 736-744
17. Gender equality bureau cabinet office (2017) Number of persons certified as requiring long-term care and certification rate (by age group). https://www.gender.go.jp/about_danjo/

- whitepaper/h30/zentai/html/zuhyo/zuhyo01-00-43.html(in Japanese) Accessed October 2022
18. Tokyo metropolitan institute of public health (2010) Detailed analysis for accidental deaths in Japan. <https://www.tmiph.metro.tokyo.lg.jp/sage/sage2010/> (In Japanese) Accessed March 2022
 19. Ekberg O, Feinberg M (1992) Clinical and demographic data in 75 patients with near-fatal choking episodes. *Dysphagia* 7(4): 205-208
 20. Sternbach G, Kiskaddon RT (1985) Henry Heimlich: a life-saving maneuver for food choking. *J Emerg Med* 3(2): 143-148
 21. Food safety commission of Japan (2010) Risk assessment report choking accidents caused by foods. <https://www.fsc.go.jp/english/> Accessed March 2022