Children’s death survey using death certificates in Chiba prefecture
（死亡診断書等を用いた千葉県未成年死亡の調査）

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Abstract

Background: In recent years, Child Death Review (CDR) has attracted attention in Japan. It is necessary to consider not only hospital deaths but also out-of-hospital deaths. However, recommending preventive measures may be difficult because statistics on Japanese child mortality are limited. We examined cause of death (COD) and its application to preventive medicine based on death certificates (DCs) in Chiba prefecture.

Methods: Death documents (DDs) and death slips (DSs) were created for those under 20 years of age who died between January 2012 and December 2016. They were based on DCs submitted to Chiba prefecture. We examined the trend of COD, occurrence of extrinsic mortality, and characteristics of doctors and compared CODs mentioned in DCs with autopsy results.

Results: For 1149 cases, the descriptions of DSs and DDs matched. Half of the extrinsic and undetermined deaths, which were examined by police doctors, occurred out-of-hospital. The autopsy rate was 13.5%. The COD mentioned in DCs did not match with autopsy results for 26 out of 69 autopsies performed at our institute. Approximately 70% of sudden infant death syndromes were diagnosed without autopsy.

Conclusion: Low autopsy rate, incorrect writings, and errors during the death diagnosis cannot be ignored while conducting a CDR. As more than half of preventable deaths occurred out-of-hospital, and there is no system to collect detailed information on them, the Japanese CDR system may not be reliable. It is necessary to improve the death investigation system by promoting autopsies for children and constructing a comprehensive database.

Introduction

Recently, Child Death Review (CDR), which verifies cases of child mortality and prevents similar accidents and abuses, has attracted attention in Japan. CDR began in Los Angeles in the 1970s and spread throughout the United States.[1,2] Following this, a CDR pilot study was conducted in the United Kingdom in 2006 and showed that 26% of child mortalities were preventable Subsequently, CDR has spread worldwide.[3-6] In Japan, the Act on the Prevention, etc. of Child Abuse was enacted in 2000, although there was no guideline for examining cases in accordance with the CDR.[7] A request from the Japan Pediatric Society lead to a small-scale study of child mortality.[8] Currently, not all fatal cases are considered in Japan, and only the cases registered by hospitals are included in the CDR.[9] Therefore, it is possible that unnatural deaths (including deaths outside of hospitals) are excluded. In Japan, 87% of accidental deaths in children may be preventable, but the autopsy rate is low and death investigation may not be sufficient.[10,11] In other countries, experts in forensic medicine, such as medical examiners and coroners, are the CDR core members .[12] However, in Japan, pediatricians are mainly responsible, and CDR relies mostly on clinical information. This can be problematic as an accurate cause of death (COD) based on autopsy and effective investigation is essential for a CDR and there is a lack of this information among pediatricians.

Death certificates (DCs) are readily available information sources, which are used as the basis of health statistics for improving public health conditions and performing population-based research.[13-16] If DCs are correctly described for all death cases, obtaining sufficient information for a CDR may be possible. While detailed information and specific CODs are often unclear on the DC, mortality statistics on Japanese children have been published in the form of simple summaries covering the top CODs and the number of deaths among children.[17] Discussing disease prevention based on currently published national data alone is

difficult. Previous studies investigated the usage of DCs for CDR.[8,18] However, the target age is only 1–4 years, and there is no comparison with deaths from forensic autopsies. Therefore, we examined the information obtained from DCs of children in Chiba prefecture from a forensic point of view to determine its application in preventive medicine.

Material and methods

Sample data

We included death documents (DDs) and death slips (DSs) based on the DC of 0–19-year-olds who died between January 2012 and December 2016. According to Article 33 of the Statistics Act (Act 53 of 2007), the Legal Medicine Department of Medicine was permitted by the Ministry of Health, Labor and Welfare (MHLW) to use information in questionnaires related to the statistical survey of child mortality in Chiba prefecture. They were accessed through the Chiba Medical Service Section with MHLW authorization. DDs are digitalized content containing DCs that municipalities send to the MHLW via prefectures and examined by the MHLW. All DDs are separated into DSs and assigned COD codes based on the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10). However, various administrative quality control procedures by the MHLW revealed that the numbers of the DDs and DSs did not match. Although some information of the DDs and DSs overlapped, we matched the cases based on their common specific identification numbers and defined them as “the matched group.”

The information contained was as follows: handling year, notified prefectures and municipalities, public health center identification number, identification number of cases, name, sex, birth date, death date , death place , ICD-10 code of COD, presence/absence of autopsy, remarks of the autopsy when it was performed,

additional items for extrinsic death, name of doctor who diagnosed the deceased, and address of the institution where the doctor belonged. This study was approved by the Chiba University Ethics Committee (approved June 13, 2018, No. 2987).

Study parameters

We retrospectively examined the following items regarding child mortality in Chiba prefecture: COD according to age group and comparison of childhood COD between Japan and Chiba prefecture; overview, occurrence place, and extrinsic mortality tendency; relationship between COD and the physicians' characteristics who made the diagnosis, the locations where the physicians practiced, and whether they were police doctors; autopsy numbers and rates; and comparison of COD between the DC and forensic autopsy. COD and the manner of death were determined using the ICD-10 codes. In cases of extrinsic mortality, we used the column for additional items for extrinsic death (the column of extrinsic death) in the DCs, which included detailed information of the cases. Based on their institutions, the doctors were classified into four categories: hospital, clinic, forensic medicine, and others. They were further divided based on whether they were police doctors or not. Japanese police doctors are mostly practitioners, do not necessarily have the knowledge of forensic medicine, and issue DCs based on external examination of unnatural deaths handled by the police, regardless of emergency transportation. The autopsy rate was calculated based on the information in the column indicating the presence or absence of autopsies on DCs and our autopsy database. Although we could get information on forensic autopsies at our institution, the data included were of autopsies performed at other forensic institutes and pathological autopsies performed at general hospitals in the Chiba prefecture. However, as 91.6% of forensic autopsies, including those of adults, were performed at our institution from 2012–2016, we compared the COD from our autopsy results with those mentioned in

the DCs.[19] For each item, the data group that gave the maximum number of results was used.

Statistical analysis

All statistical analyses were conducted with SAS Version 9.4 (SAS Institute, Cary, NC, USA). We checked whether certain factors influenced the frequency using the chi-square test for comparison of proportions of physicians' characteristics and the place of death. Cohen's kappa coefficient with a two-sided 95% confidence interval (CI) was calculated to assess the agreement between DCs and autopsy results. The values of Cohen's kappa coefficient were interpreted according to the criteria defined by Landis and Koch: < 0.00, poor; 0.00–0.20, slight; 0.21–0.40, fair; 0.41–0.60 moderate; 0.61–0.80 substantial; 0.81–0.99 almost perfect; and 1.00, perfect agreement.[20] We also calculated the sensitivity and positive predictive values (PPVs) with the 95% CI. A p-value of < 0.05 was considered statistically significant. The data are presented as numbers with percentages.

Results

There were 1307 DSs, 1195 DDs, and 1149 matched groups. The matched group comprised 678 men (59.0%) and 471 women (41.0%). The majority (n = 473; 41.2%) of children in the age group were < 1 year (mean age, 6.4 years; interquartile range, 0–15 years) (Table 1).

COD according to age groups and comparison of childhood COD between Japan and Chiba prefecture

According to the 1307 DSs, congenital malformations, deformations, and chromosomal abnormalities were most frequent (276 cases). One-hundred-sixty-four cases of self-harm/suicide occurred and certain conditions originating in the perinatal period caused 160 deaths. Following this there were 160 accidents and

131 neoplasms (Table 2). Congenital malformations, deformations, and chromosomal abnormalities, which ranked first overall, were mostly observed among infants and preschoolers, i.e., of those 76.8% aged < 1 year and 16.7% aged 1–5 years (Table 3, Figure 1).

Chiba prefecture accounted for 5.2% of the total national deaths from 2012–2016 (Table 4, Figure 2). The most common CODs were congenital malformations, deformations, and chromosomal abnormalities. Suicide, certain conditions originating in the perinatal period, accidents, and neoplasms followed consecutively, although their ranks were mixed in both groups (Figure 3).

Overview, place of occurrence, and tendency of extrinsic mortality

Among 1149 cases of the matched groups, there were 319 cases of extrinsic mortality (27.8%). Half of them were suicides, followed by transport accidents (19.1%)-(Tables 5, 6). The overall autopsy rate was 16.0% for extrinsic mortality.

In the case of transport accidents, bimodal peaks were observed for 6–11- and 15–19-year-olds. Older children experienced accidents with passenger cars or large vehicles while younger children experienced accidents while walking or stopping (Figure 3). Accidents while riding vehicles, such as bicycles and skateboards, also caused deaths among younger children. In four cases (6.6%), a column of extrinsic death was absent. In 14 cases, details were not provided on whether the person was in the driver's or passenger's seat. There was only one autopsy (1.6%).

Among 13 cases of falls, 11 (84.6%) were from high places, and three autopsies were available (23.1%).

There were 30 cases of drowning among teenagers and infants, 13 (43%) of which occurred in the bathroom. Infant drownings occurred accidently in the absence of supervision, whilst teenage drownings occurred while bathing alone (Figure 3). In three cases, the column of extrinsic death was absent, and in one case, no

information was available. There were 10 autopsies (33.3%).

Asphyxia was recorded in 28 cases, and 12 cases were related to a sleeping environment. The latter included 0–1-year-olds, and circumstances were lying face-down, sleeping with one parent or families called “Kawa-no-ji” in Japanese, pressing comforters or cushions, and improper bedding (e.g., using baby bath instead of a baby bed) (Figure 3). In two cases, the columns of extrinsic death were absent. No information was available for three cases. There were four autopsies (14.3%).

Seven cases of exposure to smoke, fire, and flames occurred. The columns of extrinsic death for all cases were filled, and it was found that there was a fire in each of the houses. However, the origin of the fire, discovery place, and whether it was an accidental fire or arson were not stated. There were five autopsies (71.4%).

Although there were two cases of accidental poisoning by exposure to noxious substances, no autopsy was performed, and the results of toxicological examination were not described. There were two other accidental deaths, and for these, autopsies were not performed.

There were 148 suicides, and four cases (2.7%) alone underwent autopsies. Considering the age distribution, 11 years was the youngest age and the number of cases increased proportionately with age. The highest number of suicides (43) was among the 19-year-olds. Hanging included the largest number (92) of suicide methods, followed by jumping in front of trains (26), and falling from high places (14) (Figure 3). The reason for committing suicide was not recorded in all cases.

There were 14 cases of assault (homicide), and autopsies were performed for all of them (100%). The COD and the column of extrinsic death revealed that most common methods were falls and strangulation, followed by violence and carbon monoxide poisoning. Of the autopsy cases in our institution, 13 (seven

groups) were cases of homicide-suicide perpetrated by parents who also committed suicide at the same time and place.

Among all extrinsic mortalities, the column of extrinsic death was empty in 18 cases (5.6%), and the methods were insufficiently described in 13 cases (4.1%). According to our autopsy database, at least one case was of homicide or suicide among deaths due to falls, drowning, or fire. However, the COD mentioned on their DCs was an accident.

Relationship between COD and the characteristics of diagnosis, location the physicians practiced

Of the 1149 cases in the matched group, among the physicians who filed DCs, 834 (72.6%) belonged to hospitals, and 292 (25.4%) were from clinics (Table 7). Out of the latter, 242 (82.9%) were police doctors. There were 255 cases documented by police doctors and 10 by forensic pathologists. Our institution's doctors were not included.

Considering the place of death, 989 (75.7%), 212 (16.2%), 96 (7.3%), and 10 cases (0.8%) were in hospitals, at home, in other places, and in clinics, respectively (Table 8). Natural deaths were mostly in hospitals. Approximately 62.3% of the deaths at home were suicides, undetermined deaths (i.e., deaths with symptoms, signs, and abnormal clinical and laboratory findings, not elsewhere classified), and accidents. More than half of the deaths were due to external and undetermined causes as reported by physicians from the clinic (Table 8, Figure 4). Other physicians diagnosed 94% of the natural deaths, and police doctors diagnosed more than half of extrinsic and unexplained deaths. Considering the location, 91% of natural deaths occurred in medical institutions, and half of the deaths due to external and undetermined causes occurred outside medical institutions.

Autopsy numbers and rates, and comparison of COD with DC and forensic autopsy

Of the 1307 DSs, 164 mentioned that an autopsy had been performed. However, after matching DCs with our autopsy database, it was found that 10 DCs indicated that “no autopsy” had been performed, although an autopsy was performed at our institute. Furthermore, there were two autopsy cases that were possibly leaked from the national statistics and were not reflected in either the DDs or DSs. Thus, we counted the total number of autopsies as 176 with a rate of 13.5% (Table 9). Sixteen decedents diagnosed with sudden infant death syndrome (SIDS) (69.6%) did not undergo an autopsy, and they were statistically counted as natural deaths. Out of 176 dissections, 75 were at our institute. Sixty-nine cases were of the matched group (Table 10). There were only 43 cases (62.3%) at our institute in which the COD described in DCs coincided with the COD determined by autopsies. Cohen’s kappa statistic was 0.56 (95% CI, 0.43-0.69). Nine cases, which were reported as accidents or undetermined, were homicides based on the autopsy reports. Further, the reports revealed 13 cases of undetermined deaths. Five cases had been empirically designated by clinicians as natural deaths on DCs. Further, 10 autopsies of 18 undetermined deaths (as certified by clinicians on DCs) revealed their correct COD.

Discussion

We examined the DCs of all children from Chiba prefecture. It was a larger-scale study compared to the recent Japanese surveys.[21] It appears that the COD trends in Chiba prefecture are representative of those in Japan and may be used for creating a model to better understand child mortality nationwide.

Regarding extrinsic death, information on the occurrence of nearly 10% of accidental deaths (which represented preventable deaths) could not be obtained from DCs. DCs in other countries contain specific statements, such as suicidal ideation history and alcohol abuse, especially for suicides.[22] The amount of

space available to input data on the Japanese DC is limited, leading to a lack of space for a thorough note (about 1 cm × 12.5 cm).[23] We found some cases with only "hanging" or "a family member found him/her in the room" written in the DSs. Problems may be found with the DCs because the form officially presented by the MHLW has no detailed guidelines. We could not consider the occurrences of undetermined death or SIDS because they are not classified as extrinsic deaths and not documented in the column of extrinsic death. It is impossible to verify the proper COD later, unless it is differentiated from deaths from asphyxiation or other causes.[24] Although information was limited, we may suggest recurrence prevention measures, such as the installation of platform fences and maintenance of security cameras for suicide prevention, guidance for children regarding walking or playing near roads, and instructions on sleeping environments for preventing infant suffocation.

The death location and physician characteristics revealed that more than half of the extrinsic deaths happened out-of-hospital; therefore, clinicians could not examine them. The number of out-of-hospital extrinsic deaths was significantly high. Half of the extrinsic and undetermined deaths for which a CDR is strongly recommended may be leaked using the Japanese CDR methods. In Japan, physicians have to inform the police regarding cases of unnatural deaths, such as extrinsic death, cardiopulmonary arrest on arrival at a hospital, and death at home or outside. When the police intervene in these cases, a DC is usually issued by the police doctors who perform postmortem external examination or forensic pathologists who perform the autopsy. However, there is no system to provide feedback regarding postmortem information obtained by autopsies to the hospital where the deceased was transported and confirmed dead. In the US, forensic pathologists have been responsible for determining the COD and providing information on the death situation. They are the core members of CDR teams in over 30 states.[1] Discussion with forensic pathologists

and police doctors who diagnose COD is necessary because correct COD is critical.

In comparing the COD mentioned in the DC to that associated with the forensic autopsy, there was a non-negligible gap between them. Specifically, the PPV of SIDS and infections was found to be 0%. The autopsy rate of children in Chiba prefecture was 13.5%. The COD for children included natural deaths (10.5%), SIDS (30.4%), accidents (16.9%), and suicide (3.0%) according to the DSs. The death investigation system in Japan is in the developing stage.[25,26] For instance, the medico-legal autopsy rate of all deaths including adults was only 1.6%[10] and appears low compared with that in other countries and areas namely, England and Wales (21.1%), King County, Washington, USA (9.2%), Hamburg, Germany (5.8%), Sweden (5.9%), and Victoria, Australia (7.2%).[10] In Japan, only 11.2% of cases of unnatural deaths underwent autopsies; however, it was 89.1% in Sweden and 78.2% in Helsinki and Finland.[27] Some countries create databases to track the death process, so it can be used in research for comparative studies regarding differences in the death process within the society.[4,28,29] Verification of death is important for preventive medicine, and proper measures cannot be implemented if the COD is unrelated to the medical evidence reflected in the statistics. Although autopsy is the most relevant way of determining COD, for most cases in Japan, external examination is the main method, and COD is usually determined without considering autopsy and toxicological examination. Thus, there is also a possibility of treating accidents and homicides as natural deaths by determining the incorrect COD.[30-32] Furthermore, an SIDS case requires autopsy based on diagnostic criteria; however, 70% of SIDS cases were diagnosed without autopsy. This suggests that the COD may not have been properly investigated.[33-35] Promoting autopsy and identifying the COD accurately are necessary for laying the foundation for a CDR and hearing the sadness of the bereaved families.[36]

It was revealed that autopsies performed in 12 cases were mistakenly reflected in the statistics as “no

autopsy," and the rate of agreement between COD determined after forensic autopsy and that described in the DC was 62.3%. Cohen's kappa coefficient was 0.56, suggesting a moderate agreement, but it should be 1.0. Similar to some foreign areas, the clinicians in Chiba prefecture are supposed to draft the DC after only hearing the autopsy results from the investigation institutes.[37] Mieno et al. reported that the concordance rate of pathological autopsy results and the COD on DCs in the elderly was only 48% overall and 9% in cases of pneumonia.[38] Similarly, in our results, many clinicians did not accurately describe autopsy cases. DCs often contain errors, and it has been reported that DCs' accuracy has been doubtful for quite a long time.[37,39-42] The pediatric department has a high inaccuracy degree compared with that observed in other clinical departments.[43,44] Our results clarified that Japanese DCs were issued inadequately at least with respect to the presence or absence of autopsy and the COD identified from the autopsy cases. The original data source of statistical information was perhaps inaccurate and the diagnosis incorrect. It is necessary to educate clinicians on how to issue DCs and diagnose unexpected deaths correctly. One limitation of this study is that the results were based on one prefecture only, however, it appears that some CODs were representative of national data. Since Japan has different autopsy rates and systems in each prefecture, this result cannot be generalized. Error review of DCs is our next subject because the MHLW did not allow us using access to character information on COD.

We examined four different parameters using children's DCs from Chiba prefecture. From these examples along with our literature review, we demonstrated many factors associated with reporting child mortality; from this information we have devised recommendations based on a forensic point of view. During our investigation, we encountered serious obstacles such as a low autopsy rate in children. Additionally, inadequate death investigations were performed such as those for infants diagnosed with SIDS without

autopsies. Furthermore, an improper description of forensic autopsy results by clinicians was found in the issuing of DCs and the death diagnosis process. There are inconsistencies in current Japanese CDR methods because more than half of the out-of-hospital death cases recommended for CDR did not undergo a CDR. Death investigation systems may be improved by promoting autopsies of children and constructing comprehensive databases.

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Table 1. Sample characteristics of the matched group

		n	(%)
Total		1149	
Sex	Male	678	(59.0)
	Female	471	(41.0)
Age	0	473	(41.2)
	0day	86	(7.5)
	1~6 days	78	(6.8)
	7~27 days	56	(4.9)
	28 days~	253	(22.0)
	1	81	(7.0)
	2	40	(3.5)
	3	33	(2.9)
	4	28	(2.4)
	5	29	(2.5)
	6	25	(2.2)
	7	16	(1.4)
	8	19	(1.7)
	9	12	(1.0)
	10	16	(1.4)
	11	13	(1.1)
	12	23	(2.0)
	13	22	(1.9)
	14	31	(2.7)
	15	26	(2.3)
	16	44	(3.8)
	17	56	(4.9)
	18	64	(5.6)
	19	98	(8.5)
Area size[a]	Small-scale	264	(23.0)
	Middle-scale	390	(33.9)
	Big-scale	495	(43.1)
Place of death[b]	Hospital	872	(75.9)
	Clinic	9	(0.8)
	Home	186	(16.2)
	Other	82	(7.1)
Autopsy	Yes	145	(12.6)
	No	1004	(87.4)
Belongs of docters[b]	Hospital	834	(72.6)
	Clinic	292	(25.4)
	Forensic Medicine	10	(0.9)
	Unknown	13	(1.1)
Police doctor[c]	Yes	255	(22.2)
	No	894	(77.8)

[a] Area size is classified based on the population of the target age. Small-scale is less than 50,000, medium-scale is 50,000 to 100,000, and large-scale is more than 100,000.

[b] A hospital is a facility for admitting patients with 20 or more beds, and a clinic is a facility for admitting patients with 19 or less beds.

[c] Police docters are not a medical examiner. They are requested by the police for external examination and make death certificate when police need.

Table 2. Causes of death in children in Chiba prefecture

Top 10 Cause of death	ICD-10 codes	All	2012	2013	2014	2015	2016
Congenital malformations, deformations, and chromosomal abnormalities	Q00-Q99	276	63	53	56	62	42
Intentional self-harm (suicide)	X60-X84	164	37	34	37	28	28
Certain conditions originating in the perinatal period	P00-P96	160	41	25	30	29	35
Accidents	V01-X59	160	38	40	26	32	24
Neoplasms	C00-D48	131	24	31	21	27	28
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified[a]	R00-R99	76	13	16	19	9	19
Diseases of the circulatory system	I00-I99	68	16	11	17	14	10
Diseases of the respiratory system	J00-J99	65	15	14	8	16	12
Diseases of the nervous system	G00-G99	52	10	10	11	9	12
Certain infectious and parasitic diseases	A00-B99	43	11	8	7	9	8
⋮					⋮		
	Total	1307	291	264	253	263	236

[a] Excluding R95; sudden infant death syndrome

Table 3. Details on the causes of death by age groups in Chiba prefecture

age	Cause of death	n
0	Congenital malformations, deformations, and chromosomal abnormalities	212
	Certain conditions originating in the perinatal period	154
	Certain infectious and parasitic diseases	23
	Sudden infant death syndrome	23
	Diseases of the respiratory system	18
	Diseases of the digestive system	16
	Natural death, other	37
	Accidents	24
	Assault (homicide)	1
	Accident, other and unknown	3
	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified[a]	48
	Total	559
1~5	Congenital malformations, deformations, and chromosomal abnormalities	46
	Diseases of the respiratory system	34
	Neoplasms	25
	Diseases of the nervous system	19
	Certain infectious and parasitic diseases	14
	Diseases of the circulatory system	12
	Natural death, other	27
	Accidents	28
	Assault (homicide)	6
	Accident, other and unknown	1
	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified[a]	20
	Total	232
6~11	Neoplasms	38
	Natural death, other	43
	Accidents	17
	Intentional self-harm (suicide)	4
	Assault (homicide)	6
	Accident, other and unknown	2
	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified[a]	4
	Total	114
12~14	Neoplasms	22
	Natural death, other	22
	Accidents	12
	Intentional self-harm (suicide)	25
	Assault (homicide)	2
	Accident, other and unknown	1
	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified[a]	0
	Total	84
15~17	Neoplasms	24
	Natural death, other	23
	Accidents	30
	Intentional self-harm (suicide)	60
	Assault (homicide)	1
	Accident, other and unknown	1
	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified[a]	0
	Total	139
18~19	Neoplasms	16
	Natural death, other	29
	Accidents	49
	Intentional self-harm (suicide)	75
	Assault (homicide)	0
	Accident, other and unknown	6
	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified[a]	4
	Total	179

[a] Excluding R95, sudden infant death syndrome

Table 4. Comparison of the top 10 causes of death among children based on vital statistical data for all of Japan and Chiba prefecture

	Japan		Chiba pref.	
Top 10 of cause of death	n	(%)	n	(%)
Congenital malformations, deformations, and chromosomal abnormalities	4919	(19.5)	276	(21.1)
Accidents	3389	(13.5)	160	(12.2)
Intentional self-harm (suicide)	2702	(10.7)	164	(12.5)
Neoplasms	2487	(9.9)	131	(10.0)
Certain conditions originating in the perinatal period	2258	(9.0)	160	(12.2)
Diseases of the circulatory system	1216	(4.8)	68	(5.2)
Diseases of the respiratory system	747	(3.0)	65	(5.0)
Sudden infant death syndrome	618	(2.5)	23	(1.8)
Certain infectious and parasitic diseases	554	(2.2)	43	(3.3)
Assault (homicide)	172	(0.7)	16	(1.2)
⋮			⋮	
All	25195	(100)	1307	(100)

Table 5. The number of deaths due to external causes and related autopsies in Chiba prefecture

External causes	n	(%)	Autopsy No.	(%)
Transport accidents	61	(19.1)	1	(1.6)
Falls	13	(4.1)	3	(23.1)
Accidental drowning and submersion	30	(9.4)	10	(33.3)
Other accidental threats to breathing	28	(8.8)	4	(14.3)
Exposure to smoke, fire and flames	7	(2.2)	5	(71.4)
Accidental poisoning by and exposure to noxious substances	2	(0.6)	0	(0.0)
Other accidents	2	(0.6)	0	(0.0)
Intentional self-harm (suicide)	148	(46.4)	4	(2.7)
Assault (homicide)	14	(4.4)	14	(100)
Accident, other and unknown	14	(4.4)	10	(71.4)
Total	319	(100)	51	(16.0)

Table 6. Age distribution of external mortalities in Chiba prefecture

External causes	Age 0	1~5	6~11	12~14	15~17	18~19
Transport accidents	0	6	10	2	15	28
Falls	1	3	1	2	1	5
Accidental drowning and submersion	3	8	2	4	7	6
Other accidental threats to breathing	18	6	1	1	1	1
Exposure to smoke, fire and flames	0	2	0	3	0	2
Accidental poisoning by and exposure to noxious substances	0	0	0	0	0	2
Other accidents	1	0	0	0	1	0
Intentional self-harm (suicide)	0	0	4	24	54	66
Assault (homicide)	0	6	5	2	1	0
Accident, other and unknown	3	0	3	0	2	6
Total	26	31	26	38	82	116

Table 7. Causes of death by the characteristics of diagnostic physicians and deceased patient's location in Chiba prefecture

Cause of death	Belongs of doctors				Police doctor		Death in a medical institution		Total
	Hospital	Clinic	Forensic medicine	Unknown	Yes	No	Yes	No	
Natural	675 (61)	84 (10)	0 (0)	7 (1)	47 (10)	719 (62)	696 (65)	70 (7)	766 (72)
Extrinsic	134 (7)	172 (41)	8 (2)	5 (1)	171 (41)	148 (10)	151 (15)	168 (36)	319 (51)
Undertermined	25 (7)	36 (13)	2 (2)	1 (0)	37 (14)	27 (8)	34 (11)	30 (11)	64 (22)
Total	834 (75)	292 (64)	10 (4)	13 (2)	255 (65)	894 (80)	881 (91)	268 (54)	1149 (145)

( ): Autopsy case No.

Table 8.
Causes of death according to deceased patient's location in Chiba prefecture

Hospital	Clinic	Home	Other	Total
989	10	212	96	1307

At home	n
Intentional self-harm (suicide)	68
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified[a]	34
Accidents	30
Neoplasms	26
Other	54
Total	212

[a] Excluding R95, sudden infant death syndrome

At hospital	n
Congenital malformations, deformations, and chromosomal abnormalities	262
Certain conditions originating in the perinatal period	153
Neoplasms	104
Accidents	93
Diseases of the respiratory system	58
Intentional self-harm (suicide)	51
Diseases of the nervous system	43
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified[a]	43
Certain infectious and parasitic diseases	41
Diseases of the circulatory system	39
Diseases of the digestive system	28
Other	74
Total	989

Table 9. Autopsy number by the cause of death in Chiba prefecture

ICD-10 chapter	ICD-10 codes	Death no.	Autopsy no.	Autopsy rate
Certain infectious and parasitic diseases	A00-B99	43	3	(7.0)
Neoplasms	C00-C99	131	7	(5.3)
Diseases of the blood and blood-forming organs and certain disorders involving the immune system	D50-D89	12	2	(16.7)
Endocrine, nutritional and metabolic diseases	E00-E90	13	4	(30.8)
Diseases of the nervous system	G00-G99	52	4	(7.7)
Diseases of the circulatory system	I00-I99	68	6	(8.8)
Diseases of the respiratory system	J00-J99	65	11	(16.9)
Diseases of the digestive system	K00-K93	29	7	(24.1)
Diseases of the musculoskeletal system and connective tissue	M00-M99	4	1	(25.0)
Diseases of the genitourinary system	N00-N99	1	0	(0)
Certain conditions originating in the perinatal period	P00-P96	160	16	(10.0)
Congenital malformations, deformations, and chromosomal abnormalities	Q00-Q99	276	24	(8.7)
Sudden infant death syndrome	R95	23	7	(30.4)
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified[a]	R00-R99	76	26	(34.2)
Accidents	V01-X59	160	27	(16.9)
Intentional self-harm	X60-X84	164	5	(3.0)
Assault	X85-Y09	16	16	(100)
Event of undetermined intent	Y10-Y34	14	10	(71.4)
	Total	1307	176	(13.5)

[a] Excluding R95: Sudden infant death syndrome

Table 10. Comparison between death certificates and autopsy results regarding the causes of death in Chiba prefecture

Cause of deaths from DC	ICD-10 codes	Cause of death from forensic autopsies[a]																		Total DC	PPV (%)	95% CI
		A00-B99	E00-E90	J00-J99	K00-K93	P00-P96	Q00-Q99	R95	R00-R99	V00-V99	W00-W19	W65-W74	W75-W84	X00-X09	X40-X49	Other W00-X59	X60-X84	X85-Y09	Y10-Y89			
Certain infectious and parasitic diseases	A00-B99								1			1								2	0.0	
Endocrine, nutritional and metabolic diseases	E00-E90																			0		
Diseases of the respiratory system	J00-J99			2					1											3	66.7	13.3 - 100.0
Diseases of the digestive system	K00-K93				1															1	100.0	100.0 - 100.0
Certain conditions originating in the perinatal period	P00-P96					1			1											2	50.0	0.0 - 100.0
Congenital malformations, deformations and chromosomal abnormalities	Q00-Q99				1		1													2	50.0	0.0 - 100.0
Sudden infant death syndrome	R95								2											2	0.0	-
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified[b]	R00-R99		1	3	1				8	1					1			2	1	18	44.4	21.5 - 67.4
Transport accidents	V01-V99																			0		
Falls	W00-W19																	1	1	2	0.0	
Accidental drowning and submersion	W65-W74											5						1		6	83.3	53.5 - 100.0
Other accidental threats to breathing	W75-W84												2			1				3	0.0	
Exposure to smoke, fire and flames	X00-X09													4				1		5	80.0	44.9 - 100.0
Accidental poisoning by and exposure to noxious substances	X40-X49																			0		
Other accidents	Other W00-X59																			0		
Intentional self-harm (suicide)	X60-X84																3			3	100.0	100.0 - 100.0
Assault (homicide)	X85-Y09																	13		13	100.0	100.0 - 100.0
Accident, other and unknown	Y10-Y84																	4	3	7	42.9	6.2 - 79.5
Total forensic autopsies		0	1	5	3	1	1	0	13	1	0	6	2	4	1	1	3	22	5	69	30.3	50.9 - 73.8
Sensitivity %			0.0	40.0	33.3	100.0	100.0		61.5	0.0		83.3	100.0	100.0	0.0	0.0	100.0	59.1	60.0	62.3		
95% CI			0.0-0.0	0.0-82.9	0.0-86.7	100.0-100.0	100.0-100.0		35.1-88.0	0.0-0.0		53.5-100.0	100.0-100.0	100.0-100.0	0.0-0.0	0.0-0.0	100.0-100.0	38.5-79.6	17.1-100.0	50.9-73.8		

Kappa statistic 0.56(95%CI: 0.43-0.69)

Abbreviations: DC, death certificates; CI, confidence interval; PPV, positive predictive value,.

[a] It is the sensitivity and PPV of DC diagnosis with cause of death from forensic autopsy as the gold standard.

[b] Excluding R95, sudden infant death syndrome.

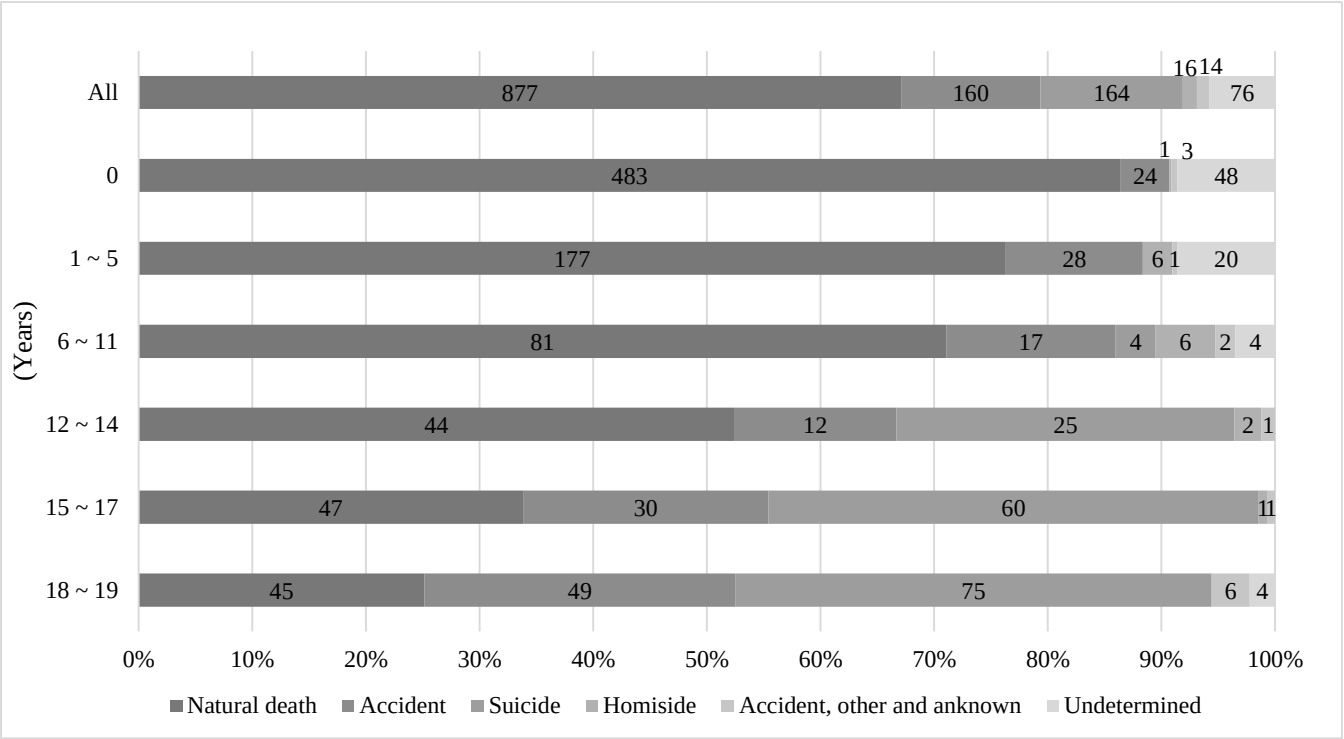


Figure 1. Causes of death by age groups

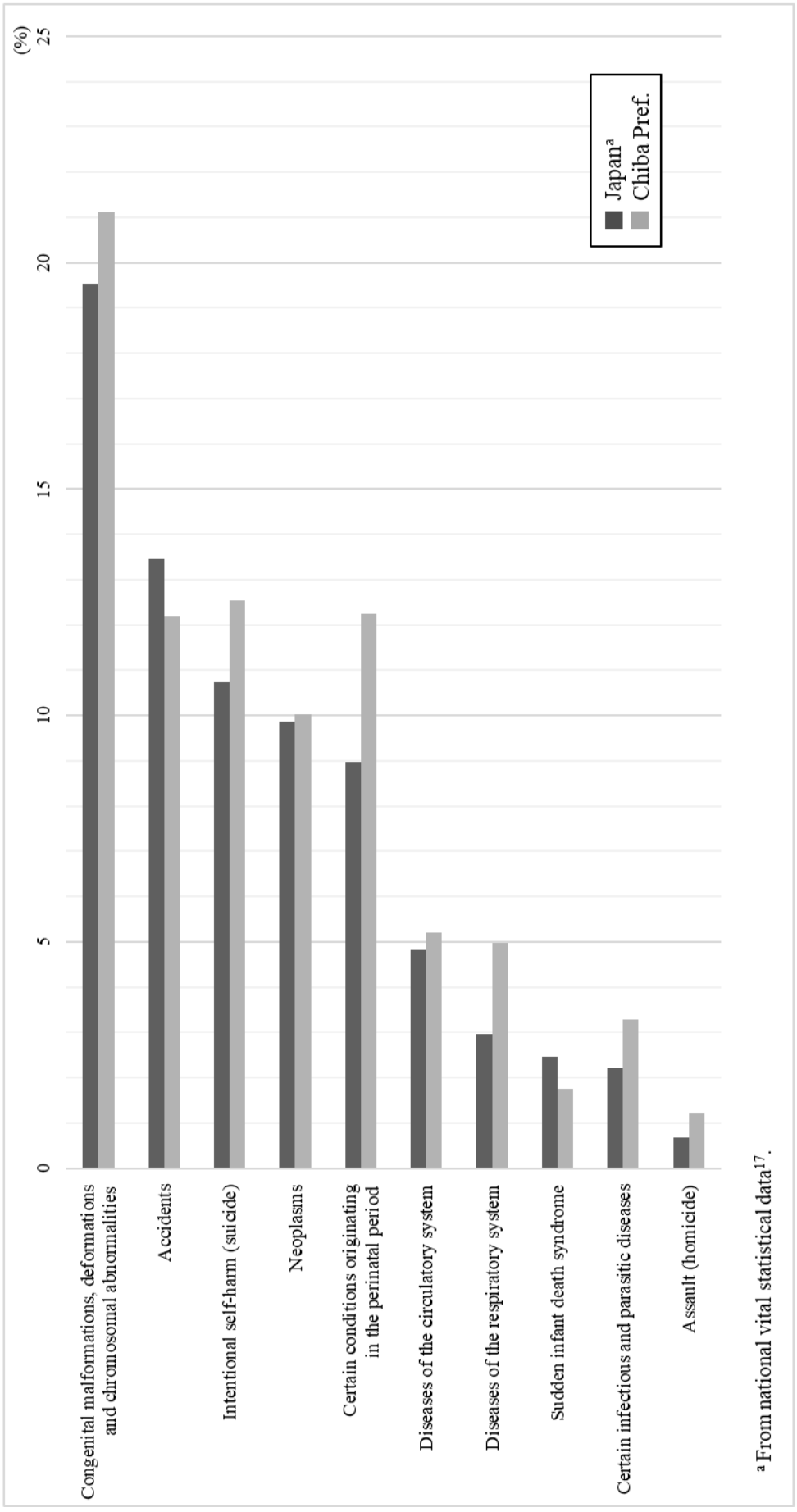
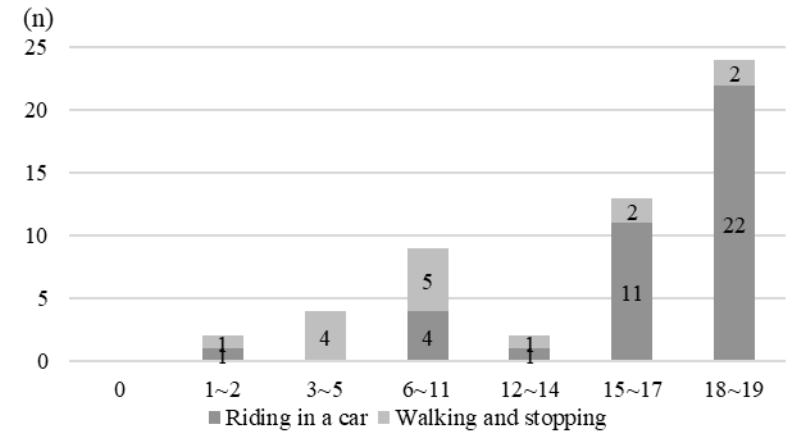
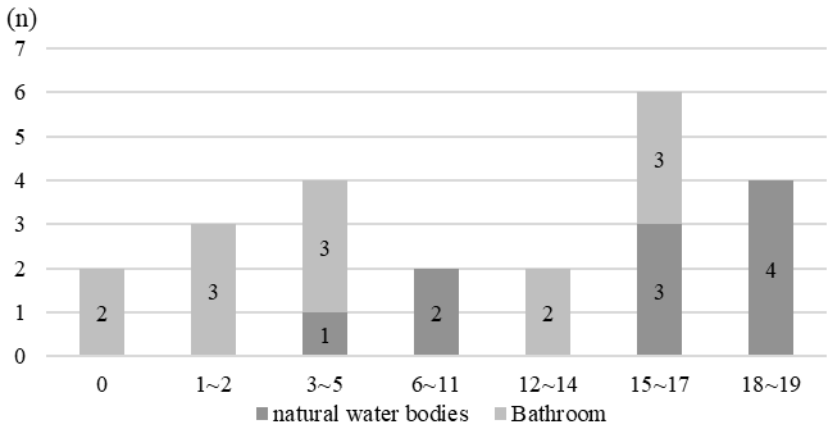


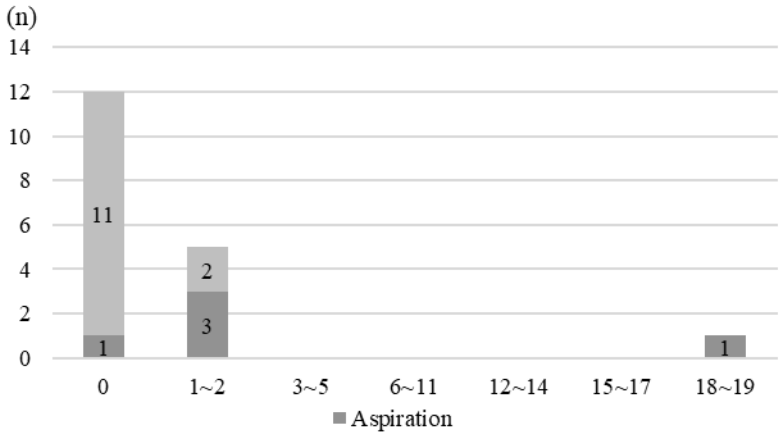
Figure 2. Comparison of the causes of death among children based on vital statistical data for all of Japan and Chiba prefecture



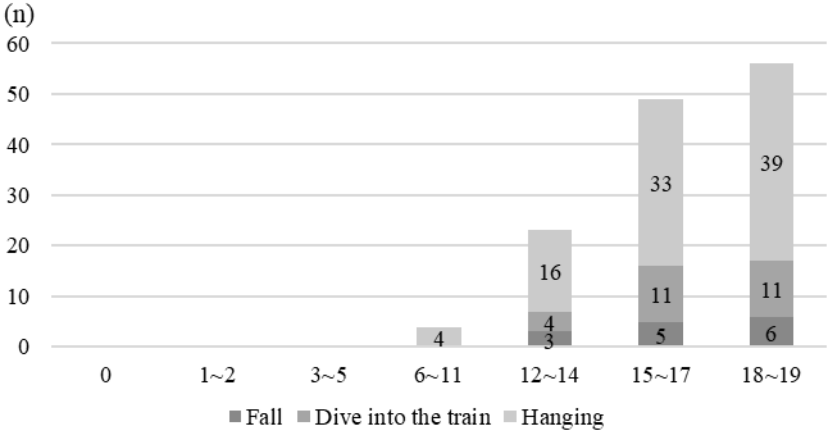
Specific occurrences of transport accidents.



Specific locations of drowning.

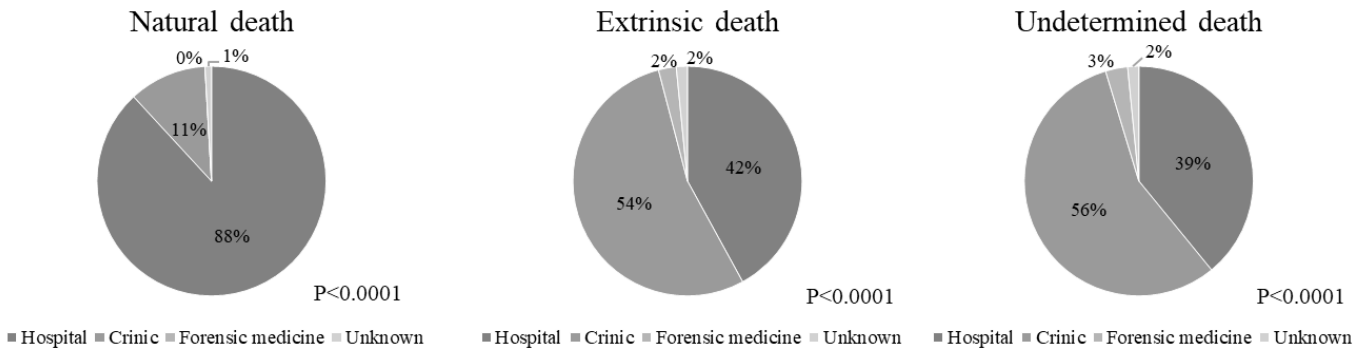


Specific occurrences of asphyxia.

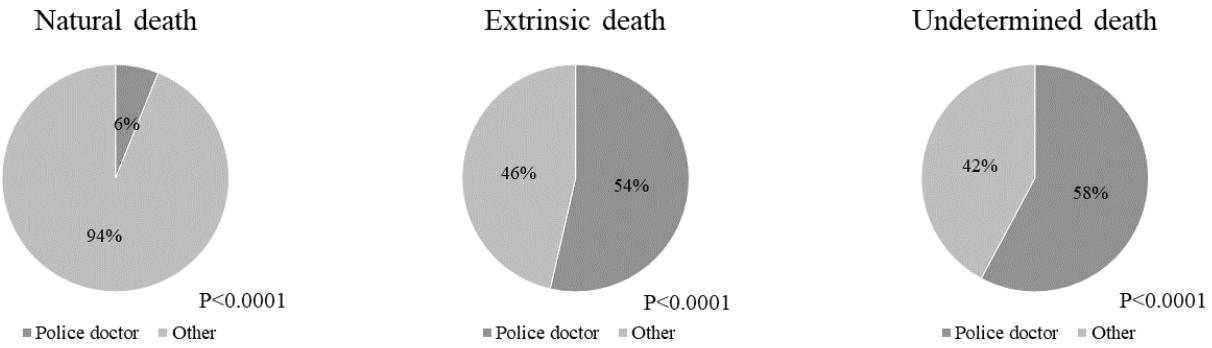


Specific methods of suicide.

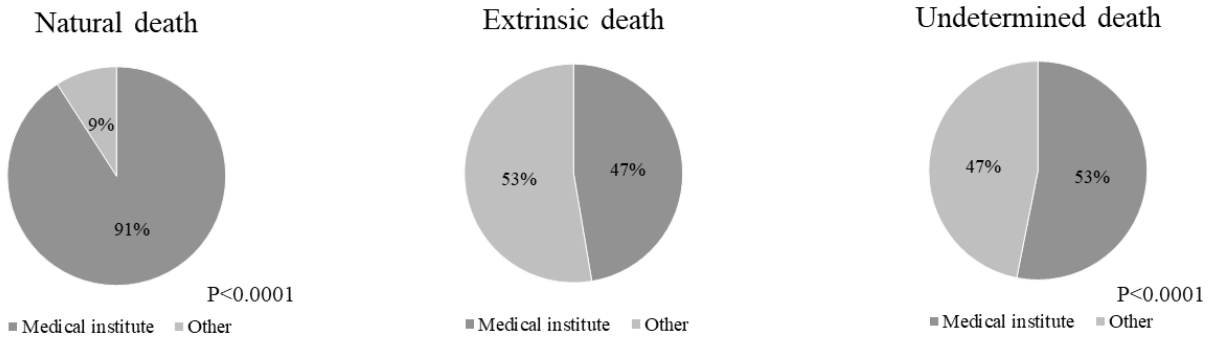
Figure 3. The trend of extrinsic deaths according to some specific circumstances in Chiba prefecture



Relationship between causes of death and where the doctors belonged



Percentage of police doctors



Percentages of the locations of death

Figure 4. Relationship between the cause of death and the characteristics of the diagnostic physician and location of the physician's practice