

Profile of Forensic Autopsy Practices in Small Towns and Cities in Rural Areas

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Forensic autopsy service in a metropolitan area of Korea is well established and optimized for high population density based on high social system and infrastructures. However, forensic autopsy in rural areas in our country might be affected due to their low population density, and inconveniences related to special and temporal limitations as well as cultural and traditional limitation. Therefore, for an advanced and optimized model of forensic autopsy service in rural areas, we performed a retrospective analysis on the profile of forensic autopsy based on the eastern part of our nation for 8 years between 2005 and 2013 and analyzed them by cause of death, manner of death, demographic data, toxicological results, and additional information. Through our study we presented the profile of forensic autopsy practice in rural areas and suggested that it can be affected by such regional characteristics.

Key Words: Forensic pathology; Forensic medicine; Rural population; Autopsy

Introduction

Forensic autopsy was introduced to meet the requirements of the judicial system [1]. Through forensic autopsy, reliable mortality data are collected, including cause of death, manner of death, documentation of injuries, and the presence of substances such as alco-

hol, drugs, or chemicals. On the basis of our laws, prosecutors determine whether a forensic autopsy is necessary, and the police consult our institute if the cause of death, or the situation surrounding the death, is unclear. In practice, this applies in cases involving sudden unexpected deaths, deaths related to a crime, suspected accidents, or where there is any potential controversy, even though the circumstances are clear.

In South Korea, large cities and metropolitan areas enjoy a highly sophisticated social system and infrastructure, thanks in large part to the economic success of the country. Moreover, the cities have a high population density. These features make it convenient for the police to consult our institute regarding cases. On the other hand, rural areas of South Korea consist of small cities and towns interspersed in naturalistic settings with low population densities. Furthermore, they lack the aforementioned social systems and infrastructures, and there is resistance against autopsy under the influence of Confucian culture. For these reasons, fulfilling legal requirements in rural areas takes a longer time, and necessitates travelling longer distances. Despite such constraints, the police have the same responsibilities and must consult with our institute regarding cases in the same way; this can influence the rate of forensic autopsies performed. It is an unfortunate reality that there are very few reports addressing the practice of forensic autopsy in rural areas, which take into account the specific nature of these regions [2,3].

Because there are such differences in South Korea between large cities or metropolitan areas on the one hand, and rural regions on the other, an advanced and optimized model of the forensic autopsy service is required. What is more, a comprehensive study exploring the current status of autopsy practice is necessary. We therefore conducted an investigation into current forensic autopsy practices in rural settings.

Materials and Methods

All forensic autopsy cases were retrieved that were performed by our institute which jurisdiction was Gangwon-do, and certain portions of the Gyeonggi-do and Gyeongsangbuk-do provinces, between December 2005 and November 2013. On the basis of the autopsy reports and related documents, we reviewed and analyzed the cause and manner of death, all autopsy findings, toxicological and other laboratory results, and demographical data (age, sex, etc.).

The manner of death is the circumstantial events classified as natural, accidental, suicidal, homicidal, or undetermined, and the same categorizations were applied in our study [4,5]. In cases of natural death, the cause was categorized into each group according to the rules of the International Classification of Diseases, 10th revision (ICD-10) [6]: diseases of the circulatory system (the heart and vascular system); diseases of the digestive system; endocrine, nutritional, and metabolic disease; certain infectious and parasitic diseases; certain conditions originating in the perinatal period (pregnancy, childbirth, and the puerperium); diseases of the respiratory system; and others (diseases of the nervous system, neoplasms, diseases of the genitourinary system, etc.). Sudden infant death syndrome (SIDS), sudden unexpected death of children (SUDC), sudden unexpected death by epilepsy (SUDEP), and sudden death of manhood were all classified as ill-defined mortality. Therapeutic complications were classified as natural or accidental, depending on the cause of death. If the risk of death was almost entirely attributable to the procedure, it was classified as accidental; however, if the underlying disease had the potential to cause death, or if the therapeutic procedure was risky, with an anticipated fatal outcome in some instances, it was categorized as natural [5]. Accidental deaths included falls and falls from height, traffic accidents (involving pedestrians, passengers of motor vehicles, bicycles, or motorcycles), thermal injuries (hypothermia, death due to fire), drowning, unintentional poisoning/intoxication, asphyxia (exclusion of oxygen, choking, traumatic asphyxia), and others (electrocution, sharps injury, therapeutic conditions, etc.). Death due to fire was defined as deaths from burn injuries, and carbon monoxide (CO) poisoning by fire. Other cases of CO poisoning not caused by fire came under poisoning/intoxication. Homicidal deaths included blunt injuries related to violence, sharp injuries (from knives or other sharp instruments), asphyxia (manual strangulation, ligature strangulation, etc.), poisoning/intoxication, and others. Suicidal deaths included asphyxia (hanging, self-stran-

gulation), poisoning/intoxication, drowning, thermal injury (fire), fall from height, sharps injuries, and others.

All toxicological tests of forensic autopsy specimens were retrieved and reviewed (postmortem blood, internal organs, muscle, vitreous humors, and urine). All positive results were classified into alcohol (positive for alcohol only), drugs (positive for any kind of drug or chemicals), and both (positive for both alcohol and drugs or chemicals). These results were analyzed on the basis of both manner of death and demographic factors (age and sex). A fatal concentration of alcohol (alcohol intoxication) was defined as more than 0.3% (300 mg/dL), and positivity for alcohol was defined as more than 0.01% (10 md/dL). Most toxicological results were based on postmortem blood samples; however, in several cases they were based on liver, kidney, spleen, or muscle tissue samples when blood sampling was not possible, as in cases of decomposition, massive trauma, or exsanguination.

The number of deaths in each region was extracted from the national statistics, which were in turn provided by the Korean Statistical Information Service [7]. On the basis of these data, annual forensic autopsy rates were calculated for the 7-year period from 2006 to 2012, because our data encompassed only one month of forensic autopsies in 2005, and 11 months in 2013; furthermore, national statistical data for 2013 were not yet available. In certain portions of the Gyeongsangbuk-do province, forensic autopsy was performed only over a period of 2 years (2006 and 2007); this was because, starting from 2008, the jurisdiction over these areas was transferred to another branch of our institute. The road distance between our institute and the relevant police station of each region was calculated using 'Road Plus,' provided by the Korea Expressway Corporation [8]. Pearson's correlation coefficient was calculated using the R program in order to estimate the correlation between forensic autopsy rate and road distance.

Results

The total number of forensic autopsy cases performed during the 8-year period between December 2005 and November 2013 was 2,619. Of the 5 manners of death listed, accidental deaths comprised the largest proportion (31.6%), followed by natural deaths (29.6%), suicidal deaths (17.8%), homicidal deaths (14.4%), and undetermined (6.6%). The ratio of male to female was 2.26:1. About half of the subjects (45.4%) were middle-aged (40–59 years old). Eighty-five cases involved foreigners; of these, most were Asians who had come to Korea to work at a farm or a factory. In 1,607 cases (61.4%), the subjects were positive for alcohol, or drugs or chemicals (Tables 1, 2).

1. Natural deaths

Cardiovascular diseases (62.4%) were the most common cause of death; these comprised ischemic heart disease and myocardial infarction, coronary atherosclerosis, aortic dissection, aortic aneurysm, pulmonary embolism, cerebrovascular disease (spontaneous intracerebral hemorrhage, non-traumatic aneurysmal subarachnoid hemorrhage), and esophageal varices. Thirty-eight cases (4.9%) involved emotional or physical agitation or stress, such as occurs during arguments, traffic accidents, vigorous activities, etc. In 221 cases (28.5%), the subjects were positive for alcohol, and in 396 cases (51.0%), the subjects were positive for drugs or alcohol. Most drugs detected were prescription, or were related to treatment that had been performed during admission or emergency management. There were histories of diabetes mellitus, hypertension, chronic alcoholism, etc. in 224 cases (28.9%). Most deaths related to the digestive system involved chronic liver disease (such as liver cirrhosis), and severe fatty change that is usually coupled with chronic alcohol abuse. Deaths related to pregnancy, childbirth, and the puerperium involved postpartum hemorrhage, uterine rupture, and amniotic fluid embolism. Perinatal deaths were mostly relat-

ed to fetal distress. Deaths related to the endocrine system, nutrition, and metabolism involved cases of chronic alcoholism, malnutrition, and dehydration by self-neglect. Deaths due to infection were caused by pneumonia, myocarditis, and pelvic inflammatory disease. Cases of SIDS, SUDC, SUDEP, and sudden death in manhood were classified as ill-defined mortalities, where most involved children and young adults. In addition, the manner of death of some cases where, through meticulous postmortem examination with documents of investigation and medical history, determined as a natural death but where determining the exact cause of death was not revealed due to decomposition, were also included into others (Tables 1–3).

2. Accidental deaths

Falls or falls from heights (23.7%), and traffic accidents (20.6%), were the most common causes of accidental deaths.

Among deaths due to falls or falls from heights, 81 cases (41.3%) involved falls and most of these were related to chronic alcohol abuse or drunkenness. Industrial accidents had occurred in 44 cases (22.4%), usually in factories, or on construction sites, farms, logging fields, or ships. In 76 cases (38.8%), the subjects were positive for alcohol.

Concerning traffic accidents, 103 cases (60.6%) involved pedestrians who had died after being run over by a car; such accidents usually occurred at dusk, at night, or in the early morning. The subjects tested positive for alcohol in 92 cases (54.1%).

Among cases of thermal injuries, 128 (79.5%) involved fire-related deaths, most of which occurred in the home during winter. Hypothermia-related deaths had occurred in 31 cases, also during winter. In 20 cases, the subjects were positive for alcohol, whereas 6 subjects were positive for drugs or chemicals (4 for psychoactive drugs within the therapeutic range, 1 for butane, and the other for drugs related to emergency treatment). Four deaths were caused by an industrial accident, which had occurred while the subjects were mixing chemicals used in waterproofing.

With regard to drowning, 71 cases occurred in fresh water (rivers, lakes, etc.), 44 in the sea, and 2 in waste water. Seven cases involved industrial accidents, which had occurred during marine operations, drainage maintenance, construction sites, or while the subject was working with agricultural machinery. Sixty-six subjects (56.4%) were positive for alcohol.

Regarding poisoning, there were 40 cases of CO poisoning, and most of these were related to a holed briquette stove or a wood stove. Four cases of CO poisoning involved industrial accidents, which had occurred while the subject was working under water, in a manhole, using industrial machinery, or at a road construction site. Other causes of poisoning were related to alcohol intoxication, chemicals, inhalants, poisonous mushrooms, and agrochemicals.

Among cases of death from asphyxia, choking was the most common cause (14 cases), and 6 cases involved children. There were 7 cases involving industrial accidents that had mainly occurred in factories and consisted of traumatic asphyxia and asphyxia due to oxygen deficiency.

Miscellaneous accidental deaths (others) included shotgun accidents involving hunters, gun- or bomb-related deaths in military bases, electrocution, medical misadventure, decompression, sharps injury related to an industrial accident, and 1 dog attack (Tables 1–4).

3. Suicidal deaths

Asphyxia (30.5%) and poisoning (27.5%) were the most frequent means of suicide. There were past histories of depression, other psychological problems, chronic disease (diabetes mellitus, cerebrovascular accidents), or chronic alcoholic abuse in 125 cases (26.8%). In 32 cases (6.9%), a suicide note was found at the scene, or the deceased had often told those close to them that they wanted to die.

Among the 142 cases of asphyxia deaths, hanging was the most common method used (132 cases), followed by smothering and self-strangulation. In cases of poisoning, agrochemicals (herbicides and pesticides), CO (holed briquette coals or ignition coals),

medication (hypnotics, antidepressants, and aspirin), and cyanide were used. Concerning drowning, 85 cases (18.2%) occurred in fresh water or in the sea. All thermal injury cases (26, 5.6%) occurred in the home, in a burning car, or as a result of self-immolation. When death was due to a fall from height (21 cases, 4.5%), this mainly occurred at high rise buildings (apartments, hotels/motels/resorts, or dormitories). Other methods of suicide included sharp injury, traffic

accidents, and gun-related deaths in the military. Fourteen subjects used combined methods: hanging with poisoning, fire with poisoning, sharp injury with poisoning, drowning with poisoning, hanging with fire, and drowning with self-strangulation. In 220 (47.2%) the subjects were positive for alcohol (Tables 1-4).

Table 1. Cause of death and manner of death according to demographic data

Manner of death	Forensic autopsy cases				Age (yr)									Unknown
	Total	Male	Female	Unknown	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	>80	
Natural														
Heart	357	310	47	0	2	4	12	48	111	91	50	31	7	1
Vascular	127	78	49	0	0	1	4	23	38	41	16	3	1	0
Digestive	51	41	10	0	0	1	1	7	19	21	2	0	0	0
Endocrine/Nutrition/ Metabolism	44	30	14	0	0	0	2	4	15	18	5	0	0	0
Infection	24	13	11	0	2	3	2	4	5	3	1	3	1	0
Perinatal	17	8	9	0	17	0	0	0	0	0	0	0	0	0
Respiratory	8	7	1	0	1	0	0	1	0	2	1	3	0	0
Pregnancy, childbirth and the puerperium	7	0	7	0	0	0	3	3	1	0	0	0	0	0
Ill-defined mortality	51	45	6	0	11	2	12	12	13	1	0	0	0	0
Others	90	59	30	1	7	1	5	15	16	22	11	10	1	2
Total	776	591	184	1	40	12	41	116	219	199	86	50	10	3
Accidents														
Falls/Blunt injury	196	165	31	0	4	7	12	28	54	47	25	11	7	1
Traffic accidents	170	127	43	0	5	9	15	26	33	41	16	11	13	1
Thermal injury	161	107	51	3	9	10	8	29	32	29	9	10	15	10
Drowning	117	94	20	3	1	8	9	21	22	30	11	7	4	4
Poisoning	76	50	26	0	0	1	6	12	22	18	9	8	0	0
Asphyxia	31	21	10	0	12	1	4	4	3	2	3	1	1	0
Others	76	41	33	2	2	4	2	13	13	13	11	9	4	5
Total	827	605	214	8	33	40	56	133	179	180	84	57	44	21
Suicide														
Asphyxia	142	75	57	10	0	2	22	26	31	19	9	4	8	21
Poisoning	128	82	45	1	0	7	20	13	32	27	16	7	2	4
Drowning	85	50	32	3	0	2	10	13	18	14	12	10	2	4
Thermal injury	26	20	5	1	0	0	1	2	9	7	2	1	0	4
Falls	21	8	12	1	0	2	5	4	5	2	2	0	0	1
Sharp injury	19	14	5	0	0	0	0	4	6	4	3	1	1	0
Others	45	29	12	4	2	1	1	6	14	6	4	3	0	8
Total	466	278	168	20	2	14	59	68	115	79	48	26	13	42
Homicide														
Violence	137	85	50	2	3	9	9	23	31	25	14	16	4	3
Sharp injury	129	82	47	0	0	4	15	15	53	23	11	4	4	0
Asphyxia	54	13	41	0	2	5	4	6	7	18	4	4	2	2
Poisoning	7	4	3	0	0	2	0	0	3	1	0	0	1	0
Others	50	20	28	2	7	3	3	5	10	9	6	2	1	4
Total	377	204	169	4	12	23	31	49	104	76	35	26	12	9
Undetermined	173	81	44	48	1	0	6	9	22	17	8	7	4	99
Total	2,619	1,757	779	83	88	89	193	375	639	551	261	166	83	174

Table 2. Positive for alcohol or drugs/chemicals by toxicological test

Manner of death	Forensic autopsy cases				Age (yr)					Unknown
	Total	Male	Female	Unknown	0–17	18–39	40–59	60–80	>80	
Natural										
Alcohol	194	166	28	0	1	36	127	28	2	0
Drugs	175	117	58	0	12	39	72	49	2	1
Both	27	24	3	0	4	17	6	0	0	0
Total	396	307	89	0	17	92	205	77	4	1
Accidents										
Falls/Blunt injury										
Alcohol	62	55	7	0	0	19	34	7	2	0
Drugs	54	42	12	0	3	8	32	11	0	0
Both	14	14	0	0	1	3	8	2	0	0
Traffic accidents										
Alcohol	77	67	10	0	1	30	40	5	1	0
Drugs	22	14	8	0	1	2	10	8	1	0
Both	15	12	3	0	3	9	2	1	0	0
Thermal injury										
Alcohol	26	18	7	1	0	10	9	4	2	1
Drugs	63	31	32	0	15	10	14	10	12	2
Both	64	53	10	1	0	18	34	4	1	7
Drowning										
Alcohol	61	50	10	1	1	21	23	12	3	1
Drugs	7	6	1	0	1	3	3	0	0	0
Both	5	3	2	0	0	1	3	1	0	0
Poisoning										
Alcohol	11	6	5	0	0	4	6	1	0	0
Drugs	41	30	11	0	1	10	19	11	0	0
Both	23	13	10	0	0	4	14	5	0	0
Others										
Alcohol	11	8	2	1	0	3	4	3	0	1
Drugs	28	8	20	0	5	6	9	8	0	0
Both	3	1	2	0	0	0	2	1	0	0
Total	587	431	152	4	32	161	266	94	22	12
Suicide										
Poisoning										
Alcohol	0	0	0	0	0	0	0	0	0	0
Drugs	66	31	34	1	2	22	26	11	2	3
Both	61	45	16	0	1	14	33	12	0	1
Others										
Alcohol	121	69	48	4	1	51	42	19	2	6
Drugs	44	24	20	0	2	8	20	8	3	3
Both	38	20	17	1	0	12	18	5	0	3
Total	330	189	135	6	6	107	139	55	7	16
Homicide										
Violence										
Alcohol	48	29	19	0	1	12	26	8	1	0
Drugs	32	23	9	0	0	6	14	11	1	0
Both	2	1	1	0	0	2	0	0	0	0
Sharp injury										
Alcohol	52	41	11	0	1	16	31	4	0	0
Drugs	20	11	9	0	0	2	14	3	1	0
Both	11	7	4	0	0	4	7	0	0	0
Asphyxia										
Alcohol	14	3	11	0	0	3	9	1	0	1
Drugs	7	4	3	0	3	0	3	1	0	0
Both	3	0	3	0	0	0	3	0	0	0
Poisoning										

Table 2. Continued

Manner of death	Forensic autopsy cases				Age (yr)					Unknown
	Total	Male	Female	Unknown	0-17	18-39	40-59	60-80	>80	
Alcohol	0	0	0	0	0	0	0	0	0	0
Drugs	5	2	3	0	2	0	2	0	1	0
Both	0	0	0	0	0	0	0	0	0	0
Others										
Alcohol	10	6	4	0	1	1	5	3	0	0
Drugs	6	2	4	0	2	0	3	1	0	0
Both	3	1	2	0	0	1	2	0	0	0
Total	213	130	83	0	10	47	119	32	4	1
Undetermined										
Alcohol	60	32	17	11	0	5	17	9	0	29
Drugs	7	1	5	1	0	1	1	0	2	3
Both	14	6	6	2	0	1	6	3	0	4
Total	81	39	28	14	0	7	24	12	2	36
Total	1,607	1,096	487	24	65	414	753	270	39	66

Table 3. Positive results of alcohol concentration

Manner of death	Postmortem alcohol concentration					Total
	<0.05%	0.05%-0.19%	0.2%-0.29%	0.3%-0.39%	>0.4%	
Natural	79 (18) ^a	102 (17)	29 (3)	8 (1)	3 (1)	221
Accidents						
Falls/Blunt injury	13	40 (3)	19	2	2	76
Traffic accidents	7	45 (2)	32	5	3	92
Thermal injury	4	41	30	13	2	90
Drowning	7 (4)	37 (7)	22 (3)	0	0	66
Poisoning	9 (2)	10 (2)	1	6	8 (1)	34
Others	2 (1)	8 (3)	1	3	0	14
Total	42 (7)	181 (17)	105 (3)	29	15 (1)	372
Suicide	58 (16)	117 (18)	36 (1)	8 (1)	1	220
Homicide						
Violence	8 (2)	21 (2)	16	4	1	50
Sharp injury	5 (1)	37 (1)	18	2	1	63
Asphyxia	2 (2)	11 (1)	3	0	1	17
Poisoning	0	0	0	0	0	0
Others	3 (2)	6 (2)	2	2 (1)	0	13
Total	18 (7)	75 (6)	39	8 (1)	3	143
Undetermined	20 (11)	46 (17)	8 (3)	0	0	74
Total	217	521	217	53	22	1,030

^aThe numbers in parenthesis are cases where n-propanol was also identified.

4. Homicidal deaths

Blunt injury related to violence (36.3%), and sharps injury (34.2%), were the most common means of homicide. The deceased in most violent deaths had been physically assaulted. Blunt instruments (hammers, bats, lumber, bottles, etc.) had been used in 30 of the cases (21.9%). Thirty-six cases (26.3%) involved assaults by a member of the deceased's own family (spouse, child, parent, sibling, or other relative), and

all other cases involved attacks by lovers, friends, roommates, acquaintances, or strangers. Three cases were related to school violence, 2 were cases of infanticide, and 1 case involved child abuse. In 50 cases of violent death (36.5%), the subjects were positive for alcohol.

In deaths due to sharp injury, a kitchen knife was the most commonly used weapon. Thirty-one of the cases (24.0%) involved assaults by a member of the

Table 4. Substances in poisoning/intoxication

Manner of death	Poisoning/Intoxication								Total
	Agrochemicals	Chemicals	CO	Medicine	Drug/Inhalants	Alcohol	Others	Combined ^{a)}	
Homicide	1	5	0	1	0	0	0	0	7
Suicide	60	15	26	21	0	0	0	5	127
Accidents	1	8	40	1	6	13	2	5	76
Undetermined	0	0	0	1	0	0	0	0	1
Total	62	28	66	24	6	13	2	10	211

^{a)}Combined: medicine+alcohol or medicine+CO.

deceased's family, and all others were attacks by lovers, friends, roommates, acquaintances, or strangers. Sixty-three of the subjects (48.8%) were positive for alcohol.

With regard to deaths due to asphyxia, manual strangulation was the most common means, while smothering, or ligature strangulation also occurred. Twenty of the cases (37%) involved attacks by a member of the deceased's family, and all others involved lovers, friends, roommates, acquaintances, or strangers. Seventeen of the subjects (31.5%) were positive for alcohol.

Fifteen cases involved attacks by combined methods: asphyxia and blunt injury, asphyxia and sharp injury, sharp injury and poisoning, and blunt injury and fire. There were also gun related deaths, poisonings, and drownings (Tables 1–4).

5. Undetermined and unknown deaths

There were 173 undetermined deaths (6.6%) in our study. In 74 cases, the cause of death could be determined or classified, but the manner of death could not because of uncertain circumstances—even after a thorough and meticulous investigation had been carried out. In 99 cases, neither the cause nor the manner of death could be determined because the bodies were severely decomposed, or because only skeletal remains were found on mountains, on the seashore, or under the sea (Tables 1, 2).

6. Autopsy rate and statistical analysis

A total of 17 cities and 22 administrative districts in Gangwon-do, and in certain portions of Gyeonggi-do

and Gyeongsangbuk-do provinces, were under the jurisdiction of our institute. The road distances between each pertinent police station and our institute were determined. Forensic autopsy rates were also calculated on the basis of the national mortality statistics of each pertinent city and district. The overall forensic autopsy rate was 1.6%. These data are presented in Table 5 and Fig. 1. Pearson's correlation analysis was performed to estimate the correlation between road distance from our institute and forensic autopsy rate. The results revealed that the Pearson's correlation coefficient was -0.559 ($p < 0.01$), indicating a negative correlation (autopsy rates decrease as the distance increases).

Discussion

Since our branch office in this area was established in December 2005, our jurisdiction has covered the eastern area of central South Korea, which includes the province where the branch office is located, as well as certain areas of nearby provinces. At the end of 2013, after about 8 years, there was a milestone in the history of our institute when, in accordance with the government's policy of relocation of public offices, our main office was transferred from Seoul, the capital, to Wonju, a city in Gangwon-do province. Following this move, the branch office had to be closed; with its closing, a new complex was replaced nearby to adopt the role of main office, and to function as the central facility for the country, in a smaller city in the rural area was in a smaller city in the rural area, not in the capital. Therefore, this forensic epidemiological investiga-

Table 5. Autopsy rates according to each area

Road distance (km)		Autopsy cases	Deaths	Autopsy rate (%)
Area	Distance			
Wonju	17	200	11,648	1.7
Yeoju	19	122	5,357	2.3
Hoengseong	35	38	2,983	1.3
Icheon	43	160	7,136	2.2
Chungju	45	145	9,926	1.5
Jecheon	53	135	6,930	1.9
Eumseong	57	89	5,232	1.7
Yangpyeong	60	104	5,334	1.9
Hongcheon	63	79	4,266	1.9
Jincheon	75	52	3,371	1.5
Pyeongchang	76	61	2,657	2.3
Chuncheon	86	166	11,042	1.5
Yeongwol	86	61	2,925	2.1
Danyang	86	25	2,377	1.1
Gapyeong	90	67	3,815	1.8
Jeongseon	108	71	2,591	2.7
Yeongju	112	14	1,872	0.7
Inje	115	37	1,747	2.1
Hwacheon	120	21	1,315	1.6
Yanggu	125	21	1,220	1.7
Bonghwa	126	6	817	0.7
Yecheon	130	11	1,285	0.9
Mungyeong	131	6	1,567	0.3
Gangneung	133	116	10,074	1.2
Andong	145	22	2,741	0.8
Sangju	150	4	2,292	0.2
Cheorwon	150	35	2,681	1.3
Taebaek	151	41	2,675	1.5
Donghae	165	112	4,368	2.6
Goseong	170	24	2,019	1.2
Uiseong	171	14	1,761	0.8
Samcheok	178	46	4,215	1.1
Sokcho	179	105	5,557	1.9
Gunwi	179	6	770	0.8
Cheongsong	186	3	723	0.4
Gumi	194	42	2,720	1.5
Gimcheon	201	18	2,229	0.8
Chilgok	207	1	1,253	0.08
Uljin	242	4	1,158	0.3
Total	—	2,284	144,649	1.6

tion into practices in rural areas over the past 8 years may give an overall insight into the situation and status, which may in turn provide preliminary data that will inform future plans for forensic and medicolegal operations in rural areas.

We postulated that topographical features may influence on autopsy rate and demographic profiles, and therefore analyzed all such features within the areas under Our jurisdiction; rural regions that contain

small cities, high mountains, rivers, and small lakes. The eastern edge of our jurisdiction faces the East Sea and contains small cities and seaside villages. There are also many resorts, tourist destinations, and beaches—none of which are not far from our metropolitan area. Many tourists visit these areas for vacations or excursions. However, because there is only one highway connected to these areas, heavy traffic jams are likely during vacation seasons or weekends.

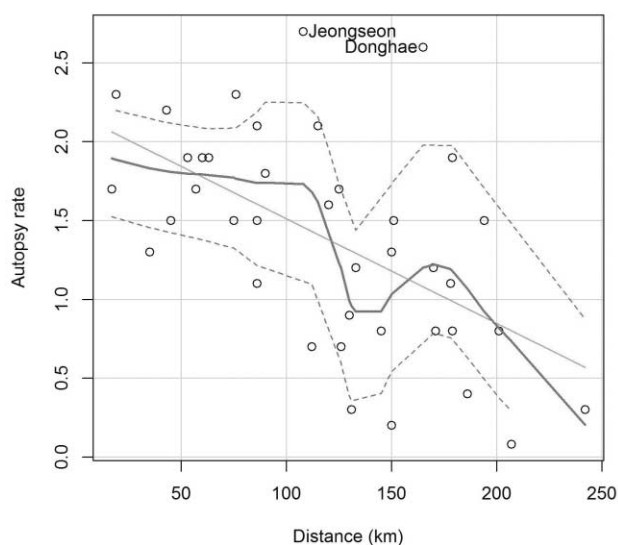


Fig. 1. Negative correlation is revealed between autopsy rate and the road distance. Each dot represents the autopsy rate and the road distance from Table 5. Jeongseon and Donghae show higher autopsy rates than other areas.

Furthermore, due to its rough terrain, all roads are very sensitive to the weather; particularly heavy snow or rain. Police officers are required to come to our institute to consult their cases, and this can be a great inconvenience because of long distance, weather, and traffic issues.

It is therefore reasonable to assume that this inconvenience may influence whether or not an autopsy is performed. Our analysis of the correlation between autopsy rate and distance from the institute revealed a negative correlation; autopsy rate significantly decreases as the distance increases. We also analyzed the frequency of autopsies; the number of cases per month in order to estimate the seasonal influence on autopsy rate. In cases involving death by external causes, each month showed a relatively fixed rate; in contrast to natural deaths, for which the rate varied. However, this difference was not statistically significant. We also analyzed the differences in autopsy rate between rural cities and other rural areas, but this also failed to reveal any statistically significant difference. In addition, there was a tendency for the areas in a different administrative district from our institute to have different autopsy rates from the areas in the

same administrative district as our institute; this despite the fact that both areas are the same road distance from our institute. This finding suggests that the awareness of being in a different administrative district influences on the autopsy rate. These results imply that the criteria determining whether or not an autopsy should take place differ in each circumstance, condition, or situation; this may undermine the establishment of reliable mortality data.

In terms of positive toxicological tests with all manner of deaths (51.0% of natural deaths, 71.0% of accidental deaths, 70.8% of suicidal deaths, and 56.5% of homicidal deaths) the tests were positive for alcohol or drugs/chemicals. Although there were a lot of cases where the positivity was not directly related to the cause of death, these results nonetheless suggest that alcohol, or drugs or chemicals, played an important role in the deaths, or in the circumstances surrounding the deaths. In cases of an alcohol concentration of more than 0.05%, deaths by external causes were more common than natural deaths: natural (18.3%), accident (39.9%), suicide (34.8%), and homicide (33.2%). Such measurements were mostly based on blood alcohol concentration, but some were made using vitreous humor or muscle tissue; particularly when blood sampling was not available due to decomposition or severe hemorrhage. This tendency for there to be a higher prevalence of deaths by external causes in cases of high alcohol concentration is consistent with a report from Norway [3].

In terms of suicidal deaths, approximately a quarter of the cases (26.8%) had a past history of depression, psychological problems, or chronic debilitating disease. According to a report from Australia, most suicides involve a history of mental illness, and suicide notes are often left behind [2]. Our study was similar in that the deceased had medical histories of mental illness, but the habit of leaving a suicide note was not common among our subjects. We assume that in most suicides where a note is indeed left, forensic autopsies are not usually performed due to the clear circumstances surrounding the death.

According to a statistical analysis of legal autopsies performed in South Korea in 2012 [9], the national autopsy rate was 1.9%, and the male to female ratio was 2.7:1. Natural deaths comprised 39.2% of the total, and death by both external causes and unknown causes comprised 60.8%. In our regional study, the male to female ratio of 2.26:1 was similar to the national ratio. Both the autopsy rate (1.6%) and the proportion of autopsy subjects who had had a natural death (29.6%) were lower than those of the national statistics (1.9% and 39.2%, respectively) [9]. This may be because our country still allows a written guarantee from the neighborhood, or a neighborhood certificate, especially in rural areas. When a person is believed to have died of disease, people in rural villages can make funeral arrangements and register the death without a death certificate, ostensibly because they knew the deceased very well for a long time. Because of such certifications, wherein there is very little due process, such cases may not be reported to the police. Furthermore, there is a lack of autopsy awareness, and suspicions regarding potential body disfigurement after the autopsy is performed [10], as well as a strong prevailing resistance against the practice (autopsy is considered "killing the deceased twice") with roots in traditions that are in turn influenced by a cultural background of Confucianism. All of these factors may also contribute to the lower rate of natural death among the autopsy subjects in our study. In terms of deaths by external causes and unknown causes, national statistics showed that accidental deaths comprise 44.8%, suicidal deaths 27.4%, homicidal deaths 17.6%, and undetermined deaths 10.3%; our study revealed similar proportions.

A similar retrospective analysis from Australia was performed [2], in which the researchers analyzed the autopsy profile of rural areas from 2005 to 2011. In Australia, rural areas often serve as holiday destinations and are a home to many retirees; similar conditions to those under which our study was carried out, to a certain degree. However, the major difference between the Australian study and our own is that

homicide and suspicious deaths were not included in the former. In the study from Australia, the male to female ratio was 2:1, and natural deaths comprised 58%, accidental deaths 22.5%, suicidal deaths 17%, and undetermined death 2.5% of cases. The higher proportion of natural deaths compared with that of other deaths may be partly attributable to the fact that hospital autopsies are rarely performed in our country, and that the study from Australia included both coronial and hospital autopsies, performed at the hospital mortuary. With regard to natural deaths in the Australian study, acute myocardial ischemia was the most common cause (66.7%) followed by infection (12.5%) and massive hemorrhage (10.3%). Although these classifications of cause of death were different from ours, cardiovascular diseases were the most common cause in both studies. Among accidental deaths in the Australian study, the male to female ratio was 5:1, whereas the same ratio was 4:1 in our study. Traffic accidents were the most common cause of death (60.7%), followed by drowning (15.3%), drug and alcohol intoxication (15%), falls from a height (6.2%), etc. Acute alcohol intoxication, often combined with other recreational drugs, was responsible for many accidental deaths also (14.9%). Despite the fact that both studies covered areas that contain popular tourist spots, the Australian study showed a higher rate of traffic accidents, whereas our study showed a higher rate of falls and falls from height, as well as industrial accidents—mostly related to alcohol intoxication. In contrast to our study, which showed that pedestrians were involved in most traffic accident cases, traffic accidents in Australia mostly involved only drivers and passengers. This may suggest that forensic autopsies of drivers or passengers would rarely be performed in our areas of jurisdiction. In terms of suicidal deaths, hanging (36.5%) was the most common in the Australian paper, similar to our study, followed by drug overdose (31.1%), CO poisoning (19.3%), fatal shotgun injuries (6.5%), drowning (2.9%), etc. Hanging occurred mainly at home in the Australian study (garage, bedroom, backyard, bush),

whereas in our study, asphyxia deaths occurred in outdoor areas (mountains), as well as at home. Drug overdoses mostly involved prescription medications in Australia, whereas in our cases, agrochemicals (herbicide or pesticide) and cyanides were the main culprits. CO intoxication from car exhausts was common in Australia, whereas we found that holed briquette coal or ignition coal was often used. Regarding unknown manners of death, presumed cardiac death or overdose cases were included in the Australian study, and severe decomposition cases comprised only 17.7%. However, in our study, presumed cases were also classified into each pertinent group, and most of the undetermined cases were attributable to decomposition.

Analysis of the autopsy rate and toxicological findings in a rural setting from Central Norway was reported in spite of no regional characteristics being mentioned [3]. Their autopsy rate was 3%, which is higher than ours (1.6%). In contrast to our country, where mostly only forensic autopsies are performed and hospital autopsies are rarely carried out, clinical autopsies and forensic autopsies in Norway were performed at a rate of 7%–9% from 2002–2010. The male to female ratio was 2.91:1, and natural deaths comprised 34.9%, accidental deaths 44.0%, suicidal deaths 18.7%, and homicidal deaths 2.5% of cases. These overall proportions are similar to ours, except for the lower homicidal death rate. In terms of toxicological tests in Central Norway, 64.8% of natural deaths, 76.1% of accidental deaths, 70.6% of suicidal deaths, and 55.6% of homicidal deaths involved positivity for drugs or alcohol. The major substances were benzodiazepines, opioids, alcohol, etc. The proportions of each pertinent positive case was similar to ours, but alcohol was the most frequently detected substance in our study.

This study was based only on forensic autopsy and limited to certain areas of our country. Hence, the results do not represent the entire country, or all deaths, and should be interpreted cautiously. Further, direct comparison of our study to those of other nations is not recommended, because there are a lot of differences in legislation and culture, as well as region-

al characteristics. For instance, the autopsy rate of our study was lower than that of other countries, and it is known that low autopsy rates can reduce the quality and validity of cause of death statistics, thus compromising information regarding the status and trends in causes of death [8]. In addition, our analysis implies that the decision of whether or not to perform an autopsy is not based on specific, fixed criteria, but that it often depends on external factors such as topographic features.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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