IJMS 2022 9(1): 45 - 52

International Journal of Multidisciplinary Studies (IJMS)
Volume 9, Issue I, 2022

The Importance of Computerized Mortuary Registers: A Study Conducted in Sri Lanka

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ABSTRACT

Monitoring of the trends and patterns seen in judicial autopsies is critical for planning interventions in the health sector. Statistical analyses about judicial post-mortems are not adequately performed to date. Anyhow, if there are computerized mortuary registers, such statistical analysis will be an easy task. This research enables the identification of pertinent demographic data, manner and cause of death, inquest types and police jurisdictions in the postmortem examinations conducted in a tertiary care hospital in Sri Lanka. A retrospective descriptive study was conducted over a 5-year period, from January 2015 to December 2019. The data were analyzed with SPSS software and Microsoft Excel 365. The p value, < .05 was set as significant in the chi-square test. Details of 4760 post-mortems were analyzed in total. The autopsies had a male to female ratio of 3.7:1. The number of postmortems performed varied by month, and no clear pattern was discernible. There was a nearly twofold increase in autopsies performed on people aged 50 and under. There was no significant relationship between the ability to provide the cause of death and sex. Significant associations were observed between age and the ability to provide the cause of death, between the ability to provide the cause of death and the type of inquest, and between the type of inquest and the manner of death. The ratio of magisterial inquests to those conducted by the Inquirer into Sudden Deaths (ISDs) was 1:11.5. The ratio of natural to unnatural to undetermined autopsies was 5:2:1. Mt Lavinia, Dehiwala, and Piliyandala were the three police areas most heavily involved. It is emphasized in this study that combining findings with a Geographic Information System in the context of geospatial technology can widely be used in the field of Forensic medicine too.

KEYWORDS: *cause of death, manner of death, inquest type, judicial postmortems, Geographic Information System (GIS), computerized mortuary registers*

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1 INTRODUCTION

Judicial autopsies play an important role in a country. Sudden, unexpected, unexplained and unnatural deaths are the ones that mostly undergo judicial postmortem under the order provided by a magistrate or by an inquirer in to sudden deaths (ISD). A judicial postmortem is held under one of the components of 'death investigation' or under a part of an inquest. Disease entities, for example, deaths due to Dengue fever, are frequently highlighted and measures to prevent such deaths are also frequently emphasized. But deaths due to unnatural causes and homicides are not adequately emphasized with the purview of prevention. The author believes that deaths that have undergone postmortem examinations are also to be studied in depth because such deaths also provide valuable information. Social development or a prosperity of a country depends on multiple aspects. If unnatural deaths are higher in a given country, such a situation does not favor the overall social development. A regular and detailed analysis of the profile of judicial postmortems are warranted in a given country in order to scrutinize the underlying causes and thereby to implement remedial actions. In some countries such as United Kingdom and Australia, there are national databases. Sri Lanka is also a country with such a potential and what is missing is only the correct emphasis.

The center where the study was carried out concerned maintains manual records of judicial autopsies. Records pertaining to judicial postmortems must be kept in such a way that they can be traced in a short period of time. Since the center's inception, manual data entry has been performed in a systematic manner. However, such an entry serves no purpose other than to record the event. As a result, the research problem of the current study was formulated as follows. How far will the computerized mortuary registers be beneficial to the country? The specific objectives of this current study are to classify the details of the postmortem examinations performed in the center, to identify the current trends and to discuss any significant associations between certain important factors and the possibility of integration of the Geographic Information System into the field of Forensic medicine (GIS Software). Significant associations between demographic factors and other critical variables are not revealed unless a statistical analysis of the raw data is performed. Demographic factors can systematically be used for future planning both in the center itself and also when comparing with other centers. A research done in India had indicated that different measures should be adopted to prevent untimely unnatural deaths (Kumar et al. 2013). Mortuary registers had helped immensely to spot certain discrepancies that may occur in hospital registers in certain countries (Mohammed et al. 2004).

Nature of the injuries along with correct demographics are certainly helpful to understand the spatial and temporal patterns of deaths. Based on those studies, effective policies and strategies will able to be implemented by identifying the patterns. Maintaining of databases does not

cost much or does not involve highly specialized manpower. Hence, if such a system is implemented, the benefits are unlimited.

The implementation of health policies (Mathers, Boerma & Ma Fat 2009) and imposing of laws should be aligned with the evidence based studies. Absence of evidence based findings prevents implementation of remedial actions if any. The Coroners Statistics Annual Report prepared by the Ministry of Justice, England and Wales is one such document that illustrates deaths of that country (National Statistics - Coroners statistics 2020 n.d.). A given postmortem case provides peculiar features in relation to the circumstances as to whether it is an unnatural death, sudden or unexpected death etc and such details should not also be overlooked. As a result, this type of statistical analysis is beneficial for developing health care policies, identifying the numbers and trends of judicial autopsies, presence of occupational hazards and for identifying the geographical distribution of certain critical facts, such as police jurisdictions involved and crime hotspots.

OBJECTIVE

The objective of this study was to determine demographic data, manner and cause of death, inquest type and police jurisdiction in judicial autopsies performed in a Tertiary Care Hospital in Sri Lanka over a five-year period with emphasis on computerization of the data available at the mortuary.

2 RESEARCH METHODOLOGY

Information regarding the postmortem examinations performed for the period of January 2015 to December 2019 was obtained from registers, reports and records maintained at the JMO's office of the Colombo South Teaching Hospital using pre-coded data collection forms. Ethical clearance was obtained from the Ethical Review Committee of the Colombo South Teaching Hospital. Data were analyzed using SPSS 23 version and Microsoft Excel. The original SPSS data was incorporated into a GIS software to illustrate the intensity of the colors (with a class break) based on the provided data, resulting in a quantity map. Incomplete and illegible data were omitted from the analysis. The frequency distribution and descriptive analysis were performed using chi-square tests of independence with a 95% confidence interval of $p < 0.05$.

3 RESULTS & DISCUSSION

RESULTS

3.1 The number of postmortem examinations performed

The total number of post-mortem examinations performed for the period was 4760.

The number of postmortems performed in each year is detailed here. During the year 2015, 761 (16%) postmortem examinations had been performed while in 2016 it was 874 (18%), in 2017 it was 985 (21%), in 2018 it was 1064 (22%) and in 2019 it was 1076 (23%). There was an increase in the number of autopsies performed across the study period.

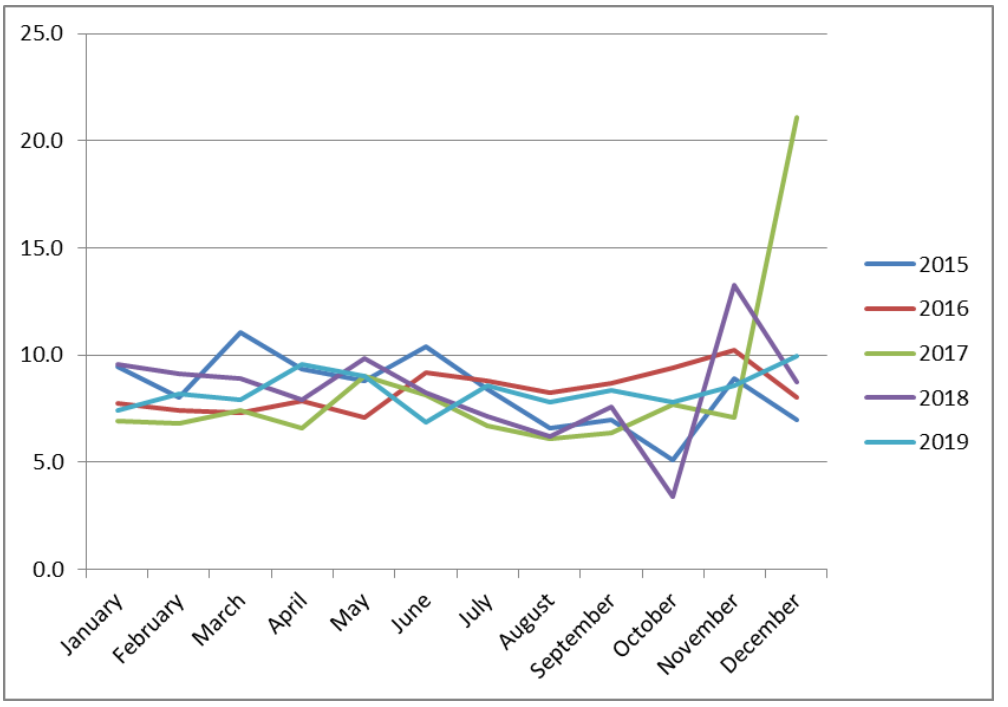

Figure 01: The number of autopsies performed in each year during the study period.

Figure 01 indicates the number of postmortems performed in each month of the study period as percentages.

3.2 Sex distribution

There had been 3755 (79%) postmortem examinations pertaining to male decedents and the number for the females was 1005 (21%). The male to female ratio in the population was 3.7:1 (3700:1000).

3.3 Age and age ranges

Table 01: Age of the study sample

1.1. Age ranges and Age distribution	**Number (%)**
<1 year	70 (2)
1-10 years	37 (1)
11-20 years	143 (3)
21-30 years	352 (7)
31-40 years	440 (9)
41-50 years	556 (12)
51-60 years	917 (19)
61-70 years	1171 (25)
71-80 years	692 (15)
81-90 years	329 (7)
>90 years	53 (1)
Total	**4760 (100)**
1.2. Three age categories	
<30 years	602 (13)
31-50 years	996 (21)
>50 years	3162 (57)
Total	**4760 (100)**

Twenty-five percent of all the autopsies were conducted on individuals aged between 61-70 years. The smallest number of autopsies were performed on children aged 1-10 years, followed by those aged over 90 years (Table 01; Section 1.1).

The sample was re-tabulated in to three age classes (below 30 years, 31-50 years and more than 50 years of age) to explain certain factors such as the presence of chronic illnesses and tendency to get suicide etc., based on the age. Indirectly, it indicates young, middle age and old age periods in this study as per the wish of the author.

The majority of the deceased were over the age of 50, n=3162 (66%). There were 602 (13%) individuals below the age of 30 years, 996 (21%) individuals from the age group of 31-50 years of age and the remainder were over the age of 50 (Table 01; Section 1.2).

3.4 The type of inquest

The majority, 4382 (92%), of inquests were held by an Inquirer into Sudden Deaths (ISDs), and the remainder by a magistrate (i.e. 378, 8%).

3.5 Whether the cause of death was revealed immediately following the autopsy or not.

The cause of death was determined in 4195 (88%) cases just after the postmortem examination and was unable to be determined in 565 (12%) cases immediately after the postmortem examination.

3.6 The manner/circumstances of death

A majority 2893 (61%) of deaths were due to natural causes, while 1302 (27%) were determined to be as unnatural deaths. The manner of death was undetermined in 565 (12%) autopsies.

3.7 The police divisions that conducted the inquest

Table 02: Distribution of police divisions which investigated the deaths

Police area involved in the inquest procedure	Number (%)
Mt Lavinia	762 (16)
Dehiwala	809 (17)
Mirihana	286 (6)
Kohuwala	571 (12)
Piliyandala	714 (15)
Boralesgamuwa	333 (7)
Maharagama	286 (6)
Kottawa	238 (5)
Homagama	190 (4)
Meegoda	64 (1)
Kahathuduwa	190 (4)
Moratuwa	238 (5)
Moratumulla	24 (1)
Angulana	5 (0)
Other	50 (1)
Total	4760 (100)

The police station Dehiwala had conducted the most inquests (17%), followed by Mount Lavinia, (16%), Kohuwala (12%), Angulana (0.1%) and Moratumulla (0.5%).

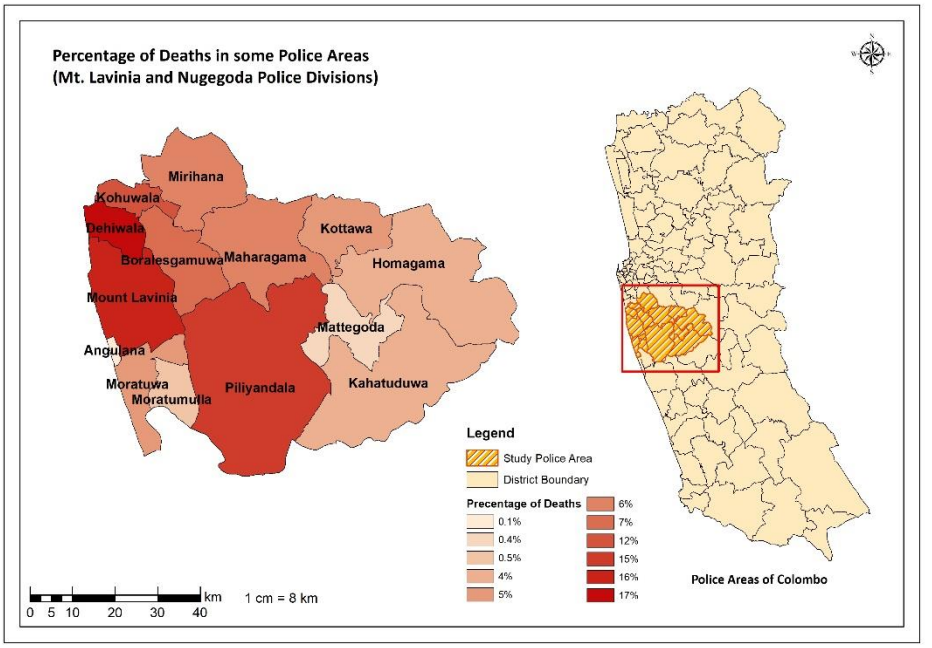

Figure 02: The police areas involved in the inquest procedures during the study period.

3.8 The body system that was responsible for cause of death

The cardiovascular system was the most affected, 1919 cases (40%) followed by combined organ systems in 937 decedents (20%). The respiratory system had been affected in 703 decedents (15%). The central nervous system in 440 (9%), the gastrointestinal system in 127 (3%), genitourinary system in 69 decedents (1%) and the underlying system was not identified in 565 (12%) decedents as the cause of death was also undetermined at the time of autopsy.

3.9 Association between the sex of the deceased and the age at death

Table 03: Association between the sex and age of the deceased.

					Significance
Age	Male		Female		
	No	%	No	%	X^2 =8.864, df=2, p= .012
<30 Years	479	80%	123	20%	
31-50 Years	821	82%	179	18%	
>50 Years	2455	78%	703	22%	

According to the chi-square test, the bivariate relationship was assessed between the sex and the age at death. There was a significant association of those two variables in each age class and there had been more males in each age class (p <0.05).

3.10 Association between sex of deceased and the ability of providing the cause of death

Table 04: Association between the sex and the ability of providing the cause of death.

Cause of Death					Significance
Gender	Given		Under investigation		X^2 =0.267, df=1, p= 0.605
	No	%	No	%	
Male	3314	88	441	12	
Female	881	88	124	12	

Sex was not a significant factor while considering the ability of providing the cause of death, $p>0.05$ according to the chi-squared test of independence.

3.11 Association between age categories and cause of death determination of deceased

Table 05: Association between age and cause of death

Cause of Death					Significance
Age	Given		Under investigation		X^2 =193.568 df= 2, p= 0.000
	No	%	No	%	
<30 Years	457	11	145	26	
31-50 Years	809	19	187	33	
>50 Years	2929	70	233	41	

When the association between the age of a deceased and the ability of providing the cause of death was considered, there was a significant association. With increasing age, the ability of providing the cause of death had showed a significant association.

When the decedents were below 50 years of age, the ability of providing the cause of death at the time of postmortem examination seemed difficult.

3.12 The type of inquest and the ability to determine the manner of death during the postmortem

Table 06: Association between the type of inquest and the ability to determine the manner of death

Death was							Significance
Type of inquest	Natural		Unnatural		Undetermined		
	No	%	No	%	No	%	X^2=189.062 df=2, p= 0.000
Magistrate	109	29	168	44	101	27	
ISD	2784	64	1134	26	464	11	

It showed that the type of inquest was a significant factor, while considering the ability to find the manner of death according to the chi-square test, since the p value was <0.05. The type of inquest was the independent variable. The inquiries held by Inquirers in to Sudden Deaths had ended up mostly as natural deaths when it was compared to the inquiries held by magistrates where they had mostly ended up as unnatural or as undetermined.

3.13 Type of inquest and identification of the cause of death

Table 07: Association of the type of inquest and identification of the cause of death

Cause of Death					Significance
Type of inquest	Given		Under investigation		X^2 = 86.557, df=1, p= 0.000
	No	%	No	%	
Magistrate	277	73	101	27	
ISD	3918	89	464	11	

The type of inquest has a strong relationship with the ability of ascertaining the cause of death. ISDs were able to provide the cause of death during the death investigation process in a significant way when it was compared to the magisterial inquiries.

3.14 Association between age and the manner of death

Table 08: Association between age and the manner of death

Manner of death							Significance
Type of inquest	Natural		Unnatural		Undetermined		X^2=999.320, df=4, p= 0.000
	No	%	No	%	No	%	
<30 years	131	5	328	25	143	25	
31-50 years	348	12	463	36	189	34	
>50 years	2414	83	511	39	233	41	

The manner of death was able to be determined as natural in a statistically significant manner when the relationship was considered against the independent variable of age.

DISCUSSION

Postmortem examinations are conducted only in cases where a death investigation (inquest) has been initiated. In other words, such postmortem examinations are referred to as judicial post-mortem examinations. A judicial postmortem examination is also described as Medico-legal (ML) autopsy. Such postmortem examinations are performed to help the law enforcing agencies and are performed as stipulated by the law of the country (mentioned below) and the postmortem examination is only performed upon request by the relevant authorities.

During such procedure, it is expected to find the cause of death, manner of death (how the cause of death came about, whether accidentally, naturally, by an act of suicide or as an act of homicide), identification of the deceased and many other important issues that are important to a given death. The law governing the death investigation process is embedded in the Sri Lanka's Criminal Procedure Code and a judicial post-mortem should be conducted in accordance with it. (Code Of Criminal Procedure Act (No. 15 of 1979 n.d.)

During the five-year period, a total of 4760 autopsies were performed at the tertiary care hospital in Colombo, where the study was performed. Sri Lanka's current male population is 49.3%, while the female population is 50.7% (countrymeters.info 2019). However, according to this study, 79% of judicial autopsies were on males while 21% were on females indicating that males had suffered a greater number of

sudden, unnatural, or unexpected deaths. Numerous studies conducted in various parts of the world revealed a male predominance in judicial postmortems (Shah et al. 2021), (Solano, Mayedo & Seyoumk 2017).

Considering the age groups, the greatest number of deaths occurred between the ages of 61 and 70 years, followed by 51-60 years. The age range of 1-10 years had the fewest deaths, followed by over 90 years and less than one year. In contrast to the findings of this study, two studies conducted in India and Nigeria had revealed that the greatest number of autopsies were performed on people aged 21–30 years (Shah et al. 2021) and 16- 30 years (Solano, Mayedo & Seyoumk 2017). The number of postmortem examinations performed on people over the age of 90 was relatively low in this study. One of the conditions for having a significantly reduced number of post-mortem examinations for those over the age of 90 is that by that age, there are already diagnosed co-morbidities that enable inquirers to ascertain the cause of death without conducting an autopsy examination. When the association between sex and age was considered, a significant difference was noted, (p= .015) (Table 03).

There are instances where it is unable to provide the cause of death just after the postmortem examination since further lab tests and investigations are warranted before finalizing the cause of death. In such situations, it is customary to keep the cause of death as 'under investigation' until all the results are available to come to the conclusion. Eighty-eight percent (4195) of the sample had a cause of death recorded at the time of autopsy, while only 12% (n=565) had been kept under investigation. According to a study conducted in Korea, that category was 15.9% (Park et al. 2016). In the present study, there were no discernible relationship between sex and the possibility of determining the cause of death through a postmortem examination, (p = .605) (Table 04).

When a person was less than 30 years old, the cause of death was more likely to be kept as under investigation/pending than when they were more than 30 years old. In 26% (n = 145) of the under-30 age group it was not possible to provide a cause of death during the postmortem examination. The older the deceased was the probability of providing the cause of death at the time of postmortem examination itself was significantly higher (p = .00) (Table 05).

According to a study conducted in Republic of Korea, there were 45.2% unnatural deaths, 32.9% natural deaths, and 12.8% deaths from unknown causes, respectively (Park et al. 2018). The findings of the current study was not in accordance with the study finding of the above. The reason for this is that the laws governing inquest procedures and the criteria for including a case in a judicial postmortem vary significantly between countries.

The manner of death is one of the primary medico-legal issues that a postmortem will resolve. The majority of deaths in this study were natural, n= 2784 (64%) and the

number of unnatural deaths were, n= 1134 (26%). The manner of death was unknown at the time of autopsy in 464 deaths (11%). The ratio of natural to unnatural to unknown was 20:9:4. To compare this figure to the findings of studies, from overseas jurisdictions, Ghana's rate of undetermined was 1.3% (Sampene & Eric 2017) and in Korea it was 10.3 % (Mathers, Boerma & Ma Fat 2009)

The relationship between the type of inquest and the manner of death is also worthwhile to be investigated. Magisterial inquests are held for certain types of deaths, including suicide, killed by machinery or by an animal or an accident, died suddenly or from unknown cause, when bodies are to be exhumed (Code Of Criminal Procedure Act (No. 15 of 1979 n.d.). Among all deaths investigated for magisterial inquests, 168 were determined to be unnatural (44%), while the majority of inquests conducted by Inquirers into Sudden Deaths resulted in natural deaths, (n=2784; 64%). In 565 instances, the manner of death was unknown (12%). The relationship between the type of inquest and the ability to determine the manner of death was examined and found to be statistically significant (p =.00). The ability to determine the manner of death as natural was significantly noticed in the autopsies held by the ISD (Table 06). A study conducted in Australia sought to determine the impact of coronial investigations into the manner and cause of death (Studdert & Cordner 2010). The said coronial investigation was able to assume the manner of death. Anyhow, according to the death investigation system that is prevailing in Sri Lanka at present does not provide such assumptions at the time of initial case notification.

The current study also considered the possibility of establishing a link between the type of inquest and the determination of the cause of death. The cause of death was mostly determined during ISD-conducted inquests (Inquirer into Sudden deaths) when compared to the magisterial orders. When there is a higher level of suspicion or when the death is more complicated, a magisterial inquest is ordered. In that case, additional and ancillary examinations will be conducted, requiring additional time. Thus, at the time of autopsy, it is impossible to conclude until the results of ancillary investigations become available. There is a statistically significant correlation between the type of inquest and determination of the cause of death (p = .00) (Table 07). Postmortem examinations performed under the magisterial inquests were comparatively unable to provide the cause of death at the time of the postmortem examination when compared to ones conducted by ISD.

Traceable published literature indicated that the cardiovascular system was the most commonly affected system leading to death as determined in postmortems. The current study corroborated the aforementioned finding, that the cardiovascular system was the most frequently affected system. In a study conducted in Sri Lanka, coronary artery disease was found to be the leading cause, accounting for 33.9% of deaths (Fernando 2003) .

There were no traceable studies in the review of literature that indicated a relationship between age and manner of death. Individuals younger than 30 years of age who underwent postmortems died primarily from unnatural causes, n= 331 (55%). Individuals over the age of 50 died primarily from natural causes (n= 28933, 83.4%), indicating that the cause of death was primarily natural. The manner of death was unknown in the under-30 age group (n=143, 25%), followed by the 31-50 age group (n=189, 34%), and the over-50 age group (n=233, 41%). There was a significant correlation between the manner of death and age (p = .00; Table 08).

In general, the number of postmortems conducted each month over a five-year period was not constant, and no discernible pattern emerged. However, when examining each year as a whole, there was an increase in the number of post-mortems conducted towards the end of the year, particularly in the years 2016, 2017 and 2018. Towards the end of the year 2017, there had been a significant increase in the number of postmortems performed. One reason that had been identified was acceleration of the procedure of disposal of unidentified dead bodies accumulated within the mortuary coolers during the respective year (Figure 01). If properly studied, a country's deaths, particularly those subjected to inquest/postmortem examinations, provide valuable information about the health status of the country. Such discoveries will have a wide range of medical and even social implications for a country's public health system (Ylijoki-Sørensen et al. 2014). The review of the literature revealed no comparable statistical analyses published in Sri Lanka that could be compared to the findings of this study.

In any case, judicial postmortems are a critical tool that can be used in a variety of ways. Combining other disciplines, such as Geographic Information Systems, can improve the efficiency with which information is captured, analyzed, and then corrected. The GIS technology had successfully been amalgamated to study the patterns of crimes already in Sri Lanka (Ratnayake 2015). But currently, GIS technology is not used in the field of forensic medicine. The concept is introduced in this paper to the field of forensic medicine; as forensic pathologists, we can effectively and meaningfully communicate certain facts to authorities. The police areas involved in inquests were mapped in this article in order to create a quantity map using the analyzed data and GIS software (Figure 2). In this study, only a basic technique had been used to introduce the concept with the available data. Anyhow, the value of geospatial applications should not be under estimated or overlooked (eds Elmes, Roedl & Conley 2014).

As discussed above, it was possible to discern significant and valuable trends and findings through statistical analysis of available data on judicial postmortems. Anyhow, this research could have been more fruitful if the registers contained additional data such as previous medical history, occupation, and so on. However, such entries may raise certain ethical concerns. The importance of computerized data is emphasized because it enables the

retrieval of critical facts without exhaustive data handling. This type of statistical analysis is beneficial for developing health care policies, identifying the numbers and trends of judicial autopsies, presence of occupational hazards and also for comprehending the geographical distribution of certain critical facts, such as police jurisdictions involved and crime hotspots.

4 CONCLUSION & RECOMMENDATIONS

This center's autopsy rate was increasing, in contrast to the global trend of decreasing autopsy rates. This study revealed a striking gender disparity in number of postmortems performed in comparison to Sri Lanka's demographic data. There was a statistical association between age and the capacity to provide information about the manner and cause of death, depending on the type of inquest. The importance of computerizing of such data is emphasized in order to formulate evidence based interventions.

Similar studies are recommended island-wide to bring to light obscure but critical facts about improvements to the health status of our country. A synthesis of the Geographic Information System and the research findings should be introduced to the field of forensic medicine in order to efficiently convey important inferences to stakeholders, to map crimes, identify disease patterns associated with occupational hazards, identify crime hot spots and identify the workload performed by police.

Limitations

Certain records contained incomplete or illegible data. The laws governing death investigation systems vary significantly by country. As a result, it may not be entirely valid to compare the findings of other countries' research to those of this study.

ACKNOWLEDGMENTS

Mr. Sithum Manjika (Statistical officer, Department of Community Medicine, University of Sri Jayewardenepura) is gratefully acknowledged for the assistance of data analysis. Ms. K.A.D.K.G. Jayasinghe, from the Department of Geography, University of Sri Jayewardenepura is also kindly acknowledged for the assistance provided with GIS. The temporary demonstrators attached to the Department of Forensic Medicine, Dr. E.L.P.A. Jayathilaka, Dr. P.H. Jayawardana, Dr. R.M.T.S. Weerasingha, Dr. P.A.C.T. Kumarasiri, Dr. Thilini Sandamali Senevirathna are greatly acknowledged for supporting of data collection, with many thanks. The entire staff of the JMO's office, Colombo South Teaching Hospital, Dr. P.B. Dassanayaka (Consultant JMO), Ms. Manel Perera, Mr. M. P. G Samarasingha, Ms. Thanuja Shamali, Ms. M. Manel, Mrs. Chandima Niroshani, Mr. V. C. M. Ferdinandz, Mr. Wasantha Priyalal Hewadulage, Mr. Samantha Senevirathna and Mr. Pasan Kalana Weddikkarage are also acknowledged for the miscellaneous supports. Further, the Police Officers at the Hospital Police Post for providing

instructions. Mr. Mahesh Premawardana, Mr. M. D. Alosiays, Mr. R. A. L. D. Ranawake and Ms. A. I. Rangika from the Department of Forensic Medicine are also kindly acknowledged for the miscellaneous support.

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