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Contents

Forensic Identification of Charred Human Remains Using Dental Remnants: A Review of Methods and Temperature Ranges (400-800°C)

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Abstract

Establishing the identity of a person is important in the field of forensic odontology. This field can be helpful in identifying charred corpses in cases involving intense heat. Bones and body tissues can be extremely damaged due to heat, in such cases dental records have become a reliable source of identification. Dental Identification of charred human remains begins with the examination of dental features such as teeth anatomy, morphology, dental implants, oral health, restorations, fillings, dental anomalies and overall dental structure. These features remain resistant to extreme heat and can thus be compared with that of the ante-mortem records. When the postmortem and ante-mortem records match a successful identification is done. Dental features may also be damaged and become less effective for identification when temperatures rise above a particular range. In order to help with the identification of charred human remains, this research intends to give forensic experts a clear understanding of the circumstances in which dental records can be used by examining the effects of extreme temperature within the 400–800°C range. By gaining insights into this particular range and its effects on dental tissues and records gives forensic experts a chance to solve complex cases involving burned corpses.

Key Words: Charred remains, Dental records, forensic odontology, restorations, dental implants

Introduction

Just like fingerprints or snowflakes, there are no two teeth that are alike. Not even identical twins have the same teeth. As teeth are specific to every individual, they are often used as an identifier (Manjunath, 2008)[1]. Burned skeletal remains can result from a variety of incidents, such as train and airplane accidents, suicides, and terrorist acts. These events produce severe damage on human remains. In such cases, forensic experts mostly rely on evidences that are unaffected post charring. Teeth are exceptional in that they can withstand extremely high temperatures.

Dental remains such as teeth are often more resilient to the effects of fire compared to other skeletal remains. Due to the high exposure to

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temperature different aspects of dental remnants are being affected. Teeth might get discolored as a result of exposure to intense heat. A fire's intense heat might result in teeth cracking or breaking. This may be particularly true if there are dental issues that already exist, like cavities or dental restorations that may compromise the tooth structure. Although enamel is very heat-resistant, enamel can be harmed by prolonged exposure to extreme heat. The pulp and dentin of the teeth both contain trace amounts of organic material. When heat is exposed to this organic material the internal structure of the tooth gets affected. Dental restorations can be lost when dental fillings, like amalgam or composite resin, melt or disintegrate under hot temperatures. Heat-induced alterations can cause the surface of teeth to become rough or uneven and can also cause a reduction in the overall size of the teeth.

Forensic experts face severe challenges in personal identification of the extremely charred bodies. Intense heat causes bones and body tissues to be severely damaged making it practically impossible to use traditional identifying techniques. In such cases dental records have become a reliable and strong substitute that offer a special way to confirm positive identifications. The teeth are the least destructible part of the body and may remain more or less intact for many years beyond death. In addition, because of their stability in a biological sense, and because during their formation disease may affect the hard tissues of the teeth themselves, they contain information about the physiological and pathological events in the life of the individual which remain as markers within the hard tissues of the teeth (Whittaker, 1995)[2].

Forensic Dentistry employs ante-mortem dental data and records in order to compare them with other post-mortem information through using the registers within patient's dental file (Frari, 2008)[3],which comprises all documentation regarding to dental treatment, including: anamnesis, treatment planning, executed procedures, complementary examinations, radiographs, photographs, dental casts, prescriptions, receipts, certificates, among others(Silva, 2011)[4].With comparing these records with that of the charred remains it can be used in age estimation, sex determination and dental anomalies that can be helpful in personal identification.

When other techniques, including DNA analysis, are rendered impracticable by prolonged exposure to high temperatures, dental tissues—including teeth and dental fillings—become essential for forensic identification. Even dental structures have their limitations, too. Dental features may also be damaged and become less effective for identification when temperatures rise above this range. In order to help with the identification of charred human remains, this research intends to give forensic experts a clear understanding of the circumstances in which dental records may or cannot be used by examining the effects of extreme temperature within the 400–800°C range.

Methodology

Materials and Methods

AIM FOR RESEARCH

The main aim of this study is to explore methods within which dental records prove to be a reliable means of identifying human remains that have been exposed to temperatures ranging from 400 to 800°C.

DATA COLLECTION

In this review, we meticulously compiled insights from a wide array of scholarly sources to evaluate methods and temperature ranges (400-800°C) used in forensically identifying charred human remains through dental remnants. Our data collection involved reviewing over 50 articles from diverse web resources and books pertinent to the subject.

DISCUSSION

Dental remains such as teeth are often more resilient to the effects of fire compared to other skeletal remains. Due to the high exposure to temperature different aspects of dental remnants are being affected. Teeth might get discolored as a result of exposure to intense heat. An intense heat might result in teeth cracking or breaking if there are already existing dental issues such as cavities or dental restorations. Enamel being heat-resistant, can only be harmed by continuous exposure to extreme heat. The pulp and dentin of the teeth both contain trace amounts of organic material. When heat is exposed to this organic material the internal structure of the tooth

gets affected. Dental restorations can be lost when dental fillings, like amalgam or composite resin, melt or disintegrate under hot temperatures. Surface of the teeth will become rough or uneven and reduction in the overall size of the teeth can be observed when teeth is exposed to extreme temperature.

DENTAL PULP:

The dental pulp is the innermost layer of the tooth and it contains blood vessels and nerves that are used for defense, sensitivity, and nourishment. Sex of the individual can be determined based on the morphology of canines. Apart from this method, it can also be determined by using X and Y chromosomes in the cells which are inactive. X chromatin in its inactivated form is present as a mass against the nuclear membrane in females is known as Barr body as it was first named by Barr and Bertem (1949). These Barr bodies are present in 40% of females who are considered as chromatin positive and absent in males who are considered as chromatin negative. Similar to X chromosome, Y chromosome (F bodies) can also be studied for sex determination of males. Both X and Y chromosomes are found to be present during interphase of the cell cycle (Patel, 2020)[5].At 400°C, the root tips of the teeth will show brownish discoloration. The teeth will be brittle and it will be difficult to extract pulp. The amount of pulpal tissue that could be extirpated was also being minimal. Histological analysis of male teeth will show disorganized collagenous matrix with hypocellularity. The few fibroblasts that are present will lack Barr chromatin condensation. The female teeth will show similar features such as hypocellularity and disorganized collagenous stroma, but the fibroblasts will show the presence of peripheral nuclear chromatin condensation. At 600°C, the roots were burnt. At 800°C, the entire tooth will be burnt and the crowns will break away from the roots (Reddy, 2017)[6].
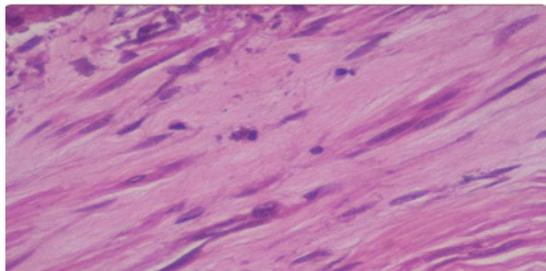
Figure 1: Female pulpal tissue at 4000c shows the presence of Barr chromatin in the nuclear periphery.

Sourced From: (Reddy, 2017)

ENAMEL AND CEMENTUM

Dental enamel is the hardest substance in the human body and serves as the wear-resistant outer layer of the dental crown**.** It forms an insulating barrier that protects the tooth from physical, thermal, and chemical forces that would otherwise be injurious to the vital tissue in the underlying dental pulp (Lacruz, 2017)[7].

Dental cementum is a living tissue that continues to grow throughout life. It is the calcified material that covers the outside of the tooth root, and provides the attachment site for the periodontal ligaments which hold the tooth to the alveolar bone within the socket. It can be used for age estimation by calculating the average age of emergence of the tooth to the number of dark and light line pairs counted (Emily Hammerl, 2012)[8].

a. Enamel- At 400°C, numerous crazing lines can be seen and it will be more pronounced at the level of cementoenamel junction. Crazing pattern and cracks will develop and multiply with the rise in temperature, leading to chequered look of the enamel at 600°C. . At 800°C a few zones with a molten appearance can be noted, which appears shrunken and smaller as the temperature rise (Pol, 2014)[9].

b. Cementum- At 400°C, numerous crazing lines can be seen and it will be more pronounced at the level of cementoenamel junction. At 600°C, crazing pattern and cracks will develop and multiply over cementum with some zones revealing the underlying dentine. Teeth will continue to crack near the cementoenamel junction, leading to a honeycomb appearance at these zones at 800°C (Pol, 2014) [9].

Figure 2: Scanning electron microscope(SEM) analysis of healthy unrestored teeth at magnification x1000.
Sourced from: (Pol, 2014)

DENTINE

Dentine is a layer of material that lies underneath the enamel. Dentin is formed from odontoblasts found in the outermost layer of the dental pulp. The dentin is covered by the enamel at the crown of the tooth, the portion that is visible in the mouth. They extend from the pulp outwards toward the outer enamel at the tooth's crown and the cementum at the tooth's base, all arranged in a radial pattern around the pulp. At 400°C, dentine a will reveal a slightly crazed pattern. At 600°C, will dentine show reduced diameter of dentinal tubules, which is a sign of elevation in temperature. At 800 ° C, debris can be noted covering the dentinal tubules (Pol, 2014)[9].

DENTINE	
At 400°C	
At 600°C	
At 800°C	
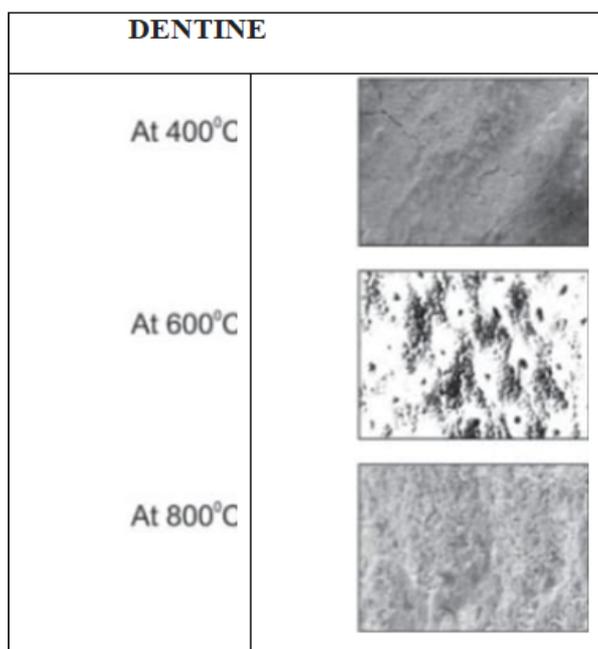
Figure 3: Scanning electron microscope(SEM) analysis of healthy unrestored teeth at magnification x1000.

Sourced from: (Pol, 2014)

AMELOGLYPHICS

Dental enamel is the highly mineralized tissue in the human body and resists post mortem degradation. Tooth prints are the enamel rod end patterns on tooth surface (Manjunath, 2008)[1]. The tooth prints are unique, exhibiting dissimilarity both between teeth of different individuals and of the same individual. This uniqueness of the tooth print could be used as a valuable tool in forensic science for personal identification (Bharanidharan, 2014)[10]. Tooth prints obtained from each tooth are unique, exhibiting dissimilarity both between teeth of different individuals and of the same individual. Tooth prints can be obtained at temperatures as high as 750° C (Juneja, 2016)[11].
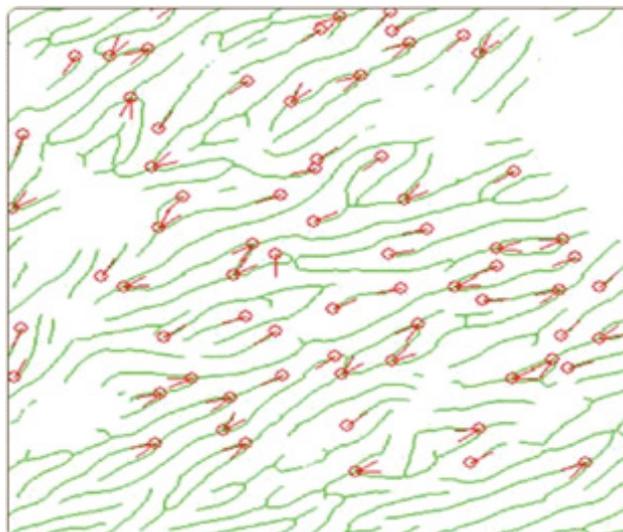
Figure 4: processed image of tooth print minutae points using Verifinger standard SDK version 5.0

Sourced from: (Juneja, 2016)

UNRESTORED TEETH

The term 'unrestored teeth' refers to teeth that have experienced no dental restoration treatments or procedures to replace or to restore a lost or decaying tooth. In cases where indispensable means of identification are lost due to fire or other disasters, partially burnt teeth can give precious information similar as bite mark identification, dental attestation and age identification. Unburned remains can be linked by their unique dental anomalies and characteristics, which aid in the identification of the departed existent. At 400° C, the color of the root will change to steel gray or black while that of the crown remains light brown. Stereomicroscope will show extension of the micro fractures from the root or appearance of new ones on the surface of the crown as well. At 600°C, the crown will be shattered into pieces while the root will be intact, and black in color. Stereo microscopic view shows numerous minute fractures on the root surface. At 800°C a drastic change in color of the root can be seen, which will turn to opaque white. The exposed dentin of the root continues to be

dark gray. Stereomicroscope shows vertical cracks on the chalky white root (Bagdey, 2014)[12].

Figure 5: Unrestored tooth at 600o C: macroscopic evaluation shows black discoloration of the whole tooth, a shattered part of the crown and detachment of the enamel.

Sourced from: (Bagdey, 2014)

RESTORED TEETH

Dental restorations such as implants and dental fillings are commonly seen in individuals. Restored teeth are those that have undergone restoration procedures to replace or restore damaged teeth. These are used to maintain teeth structure, appearance and its function. Commonly used restoration materials are amalgam, glass ionomer cement and composite. Identifying these features and type of restoration, location of placement can help identify the deceased

a. Amalgam restorations-At 400ºC the crown will show slight retraction of the amalgam filling from the light brown to black color crown and further retraction of the amalgam filling and loss of marginal seal can be seen when viewed under the stereomicroscope. At 600°C,the tooth will shatter, but the filling will be intact. Stereomicroscopic view will show fractures on the filling though the shape of the filling is maintained. At 800 ºC the filling remains in place with an intact

shape on the portion of the crown that is left. Exposed portion of the dentin is bluish white. Stereomicroscopic view shows cracks on the filling and loss of marginal seal (Bagdey, 2014)[12].

b. Glass ionomer cement restoration- At 400°C the filling will show a change in color to light brown. The root will appear charred due to carbonization. At 600°C, loss of superficial portion of the crown structure will be seen along with a portion of the filling. The root remains charcoal black in color. Stereomicroscope shows deep fracture lines along the length. At 800°C only a portion of the crown structure along with the filling will remain. The filling will remain intact within the crown, which had turned opaque white. Stereomicroscope shows loss of distinction between the anatomical crown and the root (Bagdey, 2014)[12].

c. Composite restorations- At 400ºC macroscopic cracks and carbonization can be observed. Higher temperature intervals (>500ºC) were not addressed because at this level the fragmentation process starts hampering further observations of the interaction and interface of the dental restorations and the tooth cavity (Conde, 2019)[13].

Temperature	Amalgam	Glass Ionomer Cement	Composite
400ºc			
600ºc			

Figure 7: Amalgam restoration and composite restoration when viewed macroscopically. And glass ionomer cement restoration viewed under stereomicroscope (42)

Sourced From: (Bagdey, 2014)(Vázquez, 2012)

ROOT CANAL

When a tooth's pulp—the innermost portion of the tooth—becomes injured or infected, it can be treated and saved via a root canal. An endodontist or dentist performs a root canal by extracting infected or damaged pulp, cleaning and disinfecting the tooth's interior, and then filling and sealing it. Dental records that include information regarding root canals may be a vital piece of evidence in determining the deceased's identity. When the condition of the remains compromises other means of identification, this information can be very helpful in forensic investigations. At 400°Tooth remains intact but voids can be seen in postmortem radiographs. At 600 C, scorched (partially burned) appearance can be seen and radio graphically honey-comb appearance can be seen in obturating material. At 800° C, tooth will become charred and softening of obturating material occurs which will cover the irregularities of root canal if present (Chandra, 2019)[14].
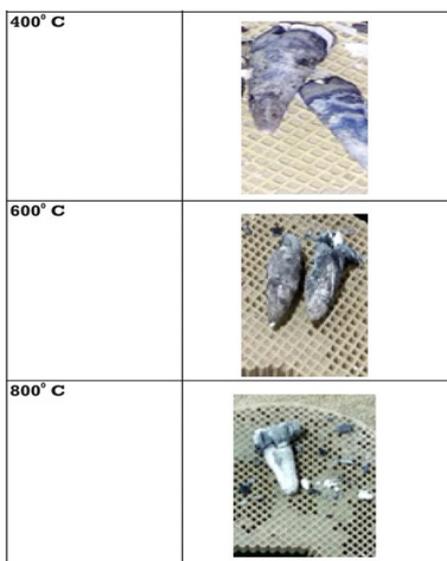
Figure 8: Morphological changes

Sourced From: (Chandra, 2019)

Conclusion

Comparing post-mortem dental records with ante-mortem dental records is a reliable source of information in identifying charred human remains. By doing a step by step examination, such as macroscopic inspection in order to know about the color change, radiographic examination to know about endodontic treatments, restorations and root curvatures and specialized technologies such as Scanning electron microscope(SEM) can be used to know the surface changes in the hard tissues and also aids in the extraction of the necessary data even after intense heat exposure. There is a possibility to identify the person through their teeth patterns even after death using modern software's such as Verifinger standard SDK version 5.0 and it can also be used in order to differentiate between male and female enamel rod patterns. However, it is important to note that there are certain limitations when dental remnants are exposed to temperature greater than 800°C. As teeth being more resistant than other skeletal remains, they can still suffer discoloration, cracking, and destruction when exposed to high heat but restorations, dental anomalies, enamel rod patterns and morphological anatomy of teeth are some features that are unique to individuals and can help in identifying charred human remains. Thus, dental records found to be more reliable source of partial personal identification in charred bodies.

Author Contributor ship Declaration: All authors have equally contributed in this research

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Comparative Study: Stature and Facial Measurements in Both Genders

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Abstract

The imperative for pinpointing a person's identity arises in various scenarios, including mass disasters, cases involving unidentified bodies, and both civil and criminal investigations. Given that any part of the human body can serve as potential evidence, a comprehensive study is essential to explore the noteworthy correlation between stature and facial dimensions within the human body.

A comprehensive investigation was undertaken on a sample of 400 medical students of South Indian origin, revealing a substantial correlation between facial measurements and stature. This correlation not only enhances our understanding of the intricate interplay between various physical features but also underscores the significance of such studies in forensic and medical contexts. Correlation of facial measurements with stature in males was 0.633 where as in females coefficient was 0.754. Females were more correlated than males.

KEY WORDS: Anthropology, Facial measurements, Identity, Stature.

Introduction

Craniofacial anthropology is a specialized branch of anthropology dedicated to the biological analysis and interpretation of the skull and face, particularly for identification purposes[5,9]. While numerous studies have explored the relationship between stature and various percutaneous measurements of body parts such as arms, legs, feet, and hands, there is a limited body of research specifically addressing the correlation between stature and the skull alone.

One of the pioneering studies in this field, conducted by Sarangi and colleagues in 1981 on Indian cadavers, failed to identify a significant correlation between stature and skull measurements. Additional investigations have utilized radiographic measurements of the skull, with some Indian studies establishing equations for estimating stature based on percutaneous cephalofacial measurements in the north Indian population[2].

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However, there remains a scarcity of studies examining percutaneous cephalofacial dimensions and their correlation with stature, particularly in the South Indian population. Given that any part of the human body can serve as evidence, it is crucial to conduct a comprehensive study to elucidate the significant correlation between stature and cephalofacial dimensions[6]. The primary objective of the present study is to enhance the precision and accuracy of identification methods by estimating and establishing the relationship between stature and cephalofacial measurements. This research aims to fill the existing gaps in understanding and contribute valuable insights to the field of craniofacial anthropology.

AIMS:

1. To ascertain the comparison between facial measurement and stature.

2. To determine the relationship between facial measurements and stature in male and female participants.

Materials and Methods

After obtaining the ethical clearance from Institutional ethics committee,informed written consent was obtained from the study participants and cross sectional study was done on 400 medical students & others who are of South Indian origin. Study was conducted by getting ethical clearance from Yenepoya University Ethics Committee *(YUEC 276/17/12/2014)*. Materials used were measuring tape, digital vernier caliper, spreading caliper and stadiometer.

SAMPLE SIZE FORMULA:

Sample size was derived by the formula $n = 1+2C(s/d)^2$.

Where $C = (za+z1-b)2$. If we take $d = 1$, then $n = 391.18$, n approximated to 400.

INCLUSION CRITERIA:

Healthy subjects in the age group of 18 to 25 those who are of south Indian in origin& who have signed the consent form.Age and place of origin was confirmed from validated Government Identityproof.

EXCLUSION CRITERIA:

1. Participants who have underwent any cranial or facial interventions.

2. Participants with any congenital or acquired cranio facial defects.

3. Participants with deformity in lower limbs.

4. Participants who have deformity in vertebral column.

METHODS OF COLLECTION OF DATA:

All measurements were consistently recorded by a single researcher to ensure uniformity. To mitigate diurnal variation, all measurements were taken simultaneously. To minimize measurement errors, the average of two measurements was calculated. The recorded parameters included stature, as well as five cephalo-facial measurements: Maximum head length, Maximum head breadth, Horizontal circumference, Bigonial breadth, and Morphological facial length.

DATA ANALYSIS

Regression modeling was used for estimation. Data analysis was performed by SPSS (version 17) for windows. Alpha value was set as 0.05. Microsoft excel, word was used to generate graph and tables.

Results

Total of 400 students actively participated in the study, evenly divided between 200 males and 200 females. These participants fell within the age range of 18 to 25 years. Analysis revealed that the percentage of male participants was higher in the 22-year age group (29%) and lower in the 25-year age group (2%). Conversely, the percentage of female participants was higher in the 19-year age group (26%) and lower in the 23-year age group (4%).Statistical examination of the mean ages for the study subjects indicated significant differences between genders (males: 21.42±1.71; females: 20.62±1.90), with a p-value of less than 0.0001. The corresponding t-value was 4.447.

In terms of mean height, a substantial and statistically significant difference was observed between males (171.66±5.75) and females (153.55±11.22) with a p-value below 0.001. The associated t-value was calculated as 20.314.

Further exploration of gender disparities in morphological features unveiled significant differences in Bigonial Diameter (males: 11.62±1.43; females: 9.89±1.29), and Morphological Facial Length (males: 11.45±0.68; females: 10.47±1.16). These differences were statistically significant with a p-value less than 0.0001.

The recorded stature exhibited a notable difference between males (184.20) and females (175.50), with males having a higher stature. Notably, morphological facial length (13.30) was higher in females, while in males bigonial breadth (14.30) was greater.

All correlations between these morphological features and stature were found to be statistically significant, with p-values less than 0.0001. Specifically, the correlation coefficients between Bigonial diameter measurements with stature is 0.613 in males & 0.731 in females. The correlation coefficients between facial length measurements with stature is 0.673 in males & 0.728 in females.

TABLE 1: FREQUENCY OF MALES ACCORDING TO AGE.

MALES	FREQUENCY
18 Year	8
19 Year	26
20 Year	38
21 Year	10
22 Year	58
23 Year	44
24 Year	12
25 Year	4
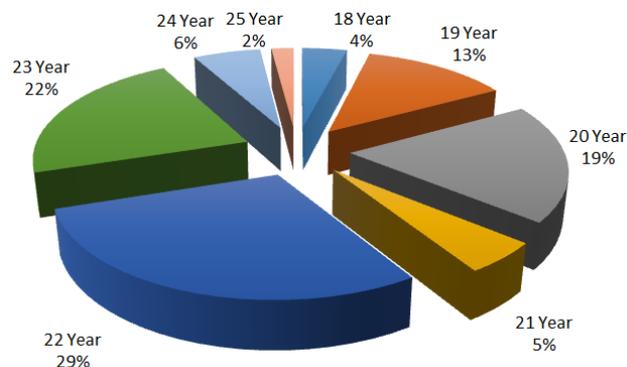
FIG 1: FREQUENCY OF MALE PARTICIPANTS ACCORDING TO AGE.

Percentage of male participants where more in age group of 22 years (29%) and less in 25 years (2%).

TABLE 2: FREQUENCY OF FEMALES ACCORDING TO AGE.

FEMALES	FREQUENCY
18 Year	20
19 Year	52
20 Year	30
21 Year	45
22 Year	22
23 Year	8
24 Year	13
25 Year	10
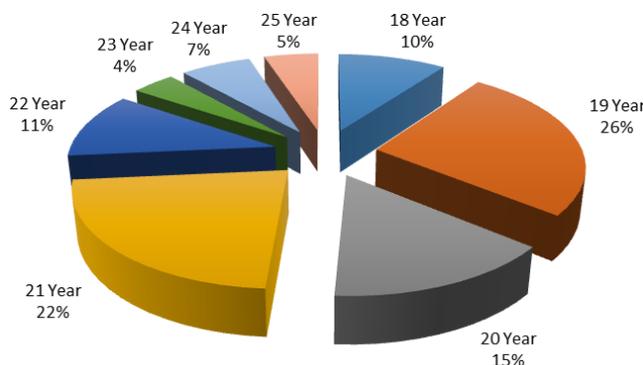
FIG 2: FREQUENCY OF FEMALE PARTICIPANTS ACCORDING TO AGE.

Percentage of female participants where more in age group of 19 years (26%) and less in 23 years (4%).

TABLE 3: COMPARISION OF MALES AND FEMALE AGE GROUP.

AGE	MALES	FEMALES
18 Year	8	20
19 Year	26	52
20 Year	38	30
21 Year	10	45
22 Year	58	22
23 Year	44	8
24 Year	12	13
25 Year	4	10

Male participants were more in number in age groups of 20 years, 22 years, and 23 years. Rest all age group females were more in numbers.

TABLE 4: DESCRIPTIVE STATISTICS FOR AGE, STATURE, CEPHALIC AND FACIAL MEASUREMENTS.

Variables	Gender	Minimum	Maximum	Mean	Std Dev	S.E. Mean	t value	p value
Age	Male	18.00	25.00	21.42	1.71	0.12	4.447	< 0.0001
	Female	18.00	25.00	20.62	1.90	0.13		
Stature	Male	158.00	184.20	171.66	5.75	0.41	20.314	< 0.0001
	Female	138.10	175.50	153.55	11.22	0.79		
Bigonial diameter	Male	8.10	14.30	11.62	1.43	0.10	12.623	< 0.0001
	Female	8.10	13.80	9.89	1.29	0.09		
Morphological Facial length	Male	9.80	12.80	11.45	.68	0.05	10.261	< 0.0001

TABLE 5: CORRELATION COEFFICIENT BETWEEN STATURE WITH CRANIAL & FACIAL DIMENSIONS

Parameter	Male		Female	
	Corr. Co-eff.	p value	Corr. Co-eff.	p value
Stature Vs Bigonial diameter	0.613	< 0.0001	0.731	< 0.0001
Stature Vs Morphological facial length	0.673	< 0.0001	0.728	< 0.0001
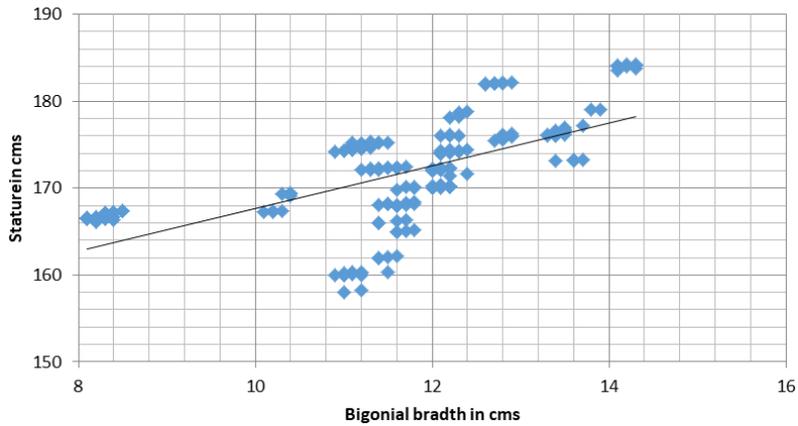
FIG 3: STATURE & BIGONIAL BREADTH MALES (r = 0.613).
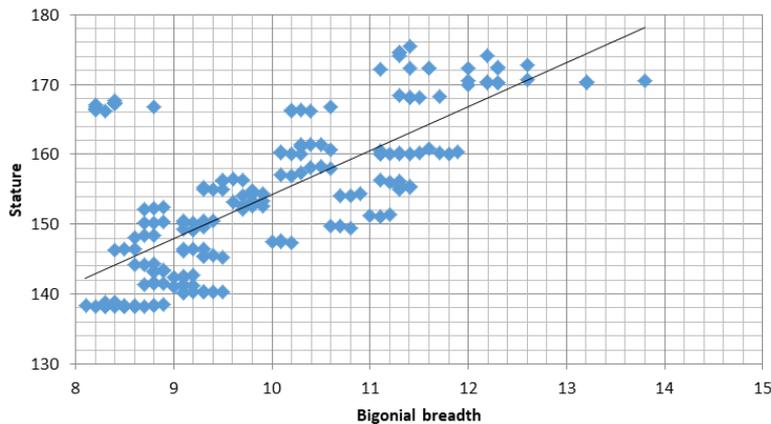
FIG 4: STATURE & BIGONIAL BREADTH IN FEMALES (r = 0.731).
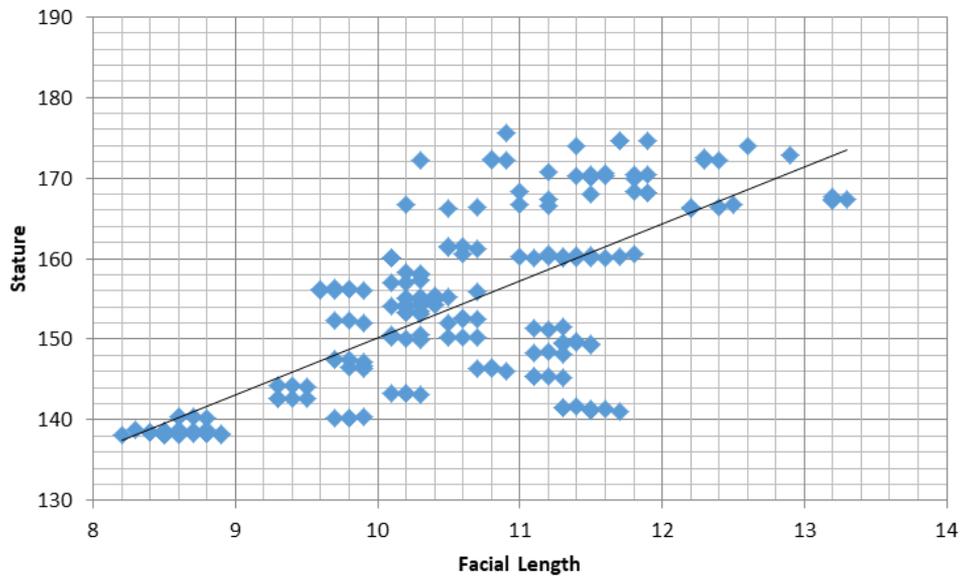
FIG 5: STATURE & FACIAL LENGTH IN MALES (r = 0.673).
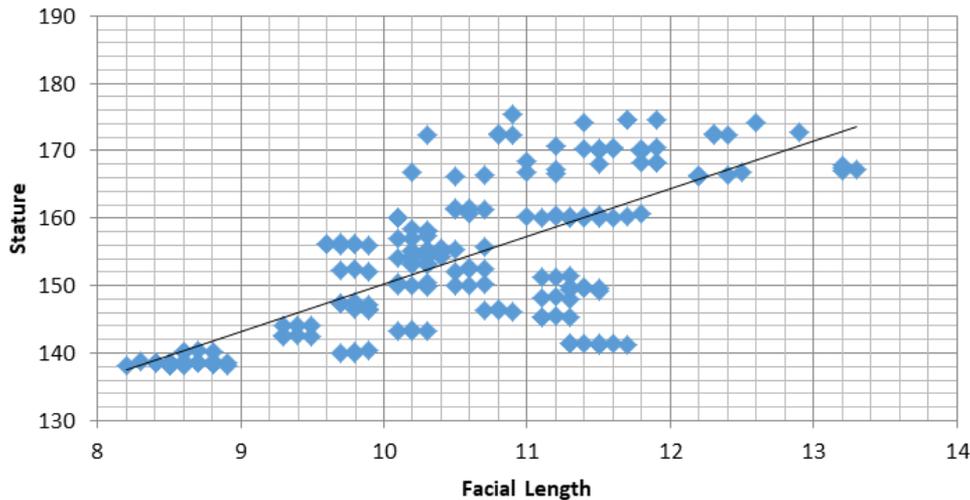
FIG 6: STATURE & FACIAL LENGTH IN FEMALES (r = 0.728).

SUMMARY OF REGRESSION EQUATIONS

1. Regression equation for prediction of stature from bigonial diameter:

    - For male: 142.99 + 2.466 x bigonial diameter
    - For female: 91.067 + 6.314 x bigonial diameter

2. Regression equation for prediction of stature from morphological facial length:

    - For male: 106.825 + 5.664 x facial length
    - For female:79.439 + 6.082 x facial length

Discussion

The primary objective of this study was to establish a comprehensive comparison between facial measurements and stature, aiming to identify and quantify correlations between these variables. A total of 400 samples were meticulously examined, and measurements, including stature, Bigonial Diameter, and Morphological Facial Length, were diligently recorded. To ensure accuracy and minimize potential errors, all measurements were conducted by the same researcher at a consistent time, and the averages of two measurements were taken for each parameter.

The mean ages of the study subjects were consistent between males (21±) and females (21±), and the statistical analysis indicated no significant difference between the two genders. However, the mean height of the study population displayed a noteworthy and statistically significant difference (p<0.001) between sexes, with recorded stature being higher in males. When examining specific measurements, Morphological Facial Length was observed to be higher in females, while in males, Bigonial Breadth exhibited greater values. Importantly, both males and females demonstrated significant correlations for all measurements with stature, emphasizing the relevance of these morphological features in understanding and predicting stature variations within the study population.

Although coefficient correlation was varying, study was consistent with other live percutaneous studies done by studies done by, Patil KR[22] (2005), Jibonkumar[13] (2008), Krishan K[16] (2008), Akhter Z[4] (2009), Ilayaperuma I[12] (2010), Singh R[27] (2013), Mounika S[20] (2015), Khan MA[15] (2015) and Garg P[10] (2016). Females had higher coefficient correlation than males which was consistent with the study done by Garg P[10] (2016) on medical students of Jaipur, Rajasthan. But study done by Colmenares GG[28] (2015) on Colombian population showed that female measurements had no correlation with stature.

In present study, morphological facial length was found to have more correlation with stature. This finding was consistent with study done by Colmenares GG[28] (2015) on Colombian population. But study done by Krishan K[16] (2008) on Gujjar population in India, showed facial length had the least correlation to stature. Study done by Jibonkumar[13] (2006) on male Kabuis from Imphal, Manipur showed low correlation between facial length and stature. These divergent results underscore the importance of considering population-specific variations in the relationship between morphological facial features and stature, highlighting the need for region-specific studies to capture the nuances in such associations.

Conclusion

This study makes a significant contribution to forensic anthropology by elucidating the correlation between specific facial measurements and stature. It addresses the crucial question of the feasibility of estimating stature from the cranium in the South Indian population. In situations involving incomplete remains, each identified factor becomes a pivotal indicator of an individual's identity. Stature, in particular, emerges as a key determinant capable of offering circumstantial or presumptive identification, ultimately leading to a positive and conclusive identification. This insight enhances the forensic toolkit, providing valuable implications for cases where comprehensive identification is imperative.

For the accuracy of the equations, further study should be conducted on a larger population. This would also help in determining to what extent the equations may overestimate or underestimate the shortest and tallest individuals in the population, respectively, and whether new equations need to be calculated for use at these extremes.

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Evaluation of all Medicolegal Cases Brought to Casualty of GMC & SSG Hospital, Vadodara

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Abstract

Background: Any medical college hospital's emergency room should constantly be prepared to treat a wide range of cases that are brought in. Knowing the patterns of cases that are presented before it is crucial for this reason, as is making the necessary arrangements to handle them.

Materials and methods: The present study is retrospective study to know the trends of medico legal cases brought to SSG Hospital, Vadodara from July 1st, 2016 to December 31st, 2016. Cases include those brought to the hospital's casualty department.

Results: A total number of 5408 cases were reported between July 1st, 2016 to December 31st, 2016. Among the 5408 cases reported, 79.99% were male and 26.01% were female making a male to female ratio 3:1. It was observed that urban victims constituted 51.09% and the rural victims were 48.91%. Similar 27.59% were in the age group 21-30 years followed by 21.95% in the 31-40 age group. The maximum number of cases were of RTA's (38.31%) followed by assault (20.25%) and poisoning (9.28%).

Conclusion: The current study offers data on the trend of medico legal cases brought to SSG Hospital, Vadodara, including details on the cases' age, sex, and etiological factors. Data is examined statistically and shown in tabular form.

Key words: Medicolegal cases, Casualty, RTA, Poisoning, Assault, Urban cases, Rural cases.

Introduction

A medico legal case is an injury or illness case in which the attending physician determines, following patient examination and history taking, that law enforcement agencies should look into the matter in order to determine who is legally responsible for what in accordance with the law of the land. [1]

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This is necessary in order to carry out a detailed inquiry. Following an investigation of this kind, law enforcement can identify the offenders, make an arrest, take their case to court, and administer punishment. Justice is served to the victim. It is necessary to have knowledge of the patterns of medicolegal situations that are brought to the emergency or casualty department in order to make the necessary plans for personnel, medications, tools, and equipment to handle these cases.

The present study is conducted to assess the current trends of medico legal cases brought to SSG Hospital, Vadodara, Gujarat.

Ethical permission: Medical College & SSG Hospital, Baroda, ECR/85/Inst/GJ/2013/RR-16 Dated 05/06/2017.

Objectives:

1. To study the magnitude of various medico legal cases brought to casualty of SSG Hospital, Vadodara, Gujarat.

2. To estimate the pattern of medico legal cases with respect to age and sex and also from an etiological point of view.

3. To advise administrative authorities in light of the study's findings.

Material and Methods

A record based retrospective study is carried out to know the trends of medico legal cases brought to the Casualty department, SSG Hospital, Vadodara, Gujarat. All cases reported during the period July 1st, 2016 to December 31st, 2016 were analysed. Non medico legal cases were excluded. A total number of 5408 medicolegal cases were registered in the casualty. Data related to time of reporting the casualty, age, gender, cause of being MLC were collected from the records. The collected data was analysed and depicted in the form of tables, graphs by using various parameters and compared with other similar studies.

Observations and Results:

5408 medicolegal cases in all were reported for the current study; of these, males accounted for 73.99% of the cases and females for 26.01% (Table 1) (Chart 2) with a male to female ratio of 3:1. Majority of the cases 2763 (51.49 %) belong to urban areas and 2645 (48.91 %) cases came from rural background (Table 3). The maximum number of cases were reported in the age group of 21-30 years (27.59%) followed by the age group 31-40 years (21.95 %) (Chart 1). Majority

of the cases (36 %) reported to casualty between 6 pm to 12 am followed by 12 pm to 6 pm (33.52 %) followed by 12 am to 6 am (16.25 %) and 6 am to 12 pm (14.22%) respectively. Out of total reported cases, the majority (38.31 %) were of road traffic accidents (RTA), followed by Assault in 20.25 %, poisoning in 9.28 %. Cases including self-inflicting injuries, crush, found injured on road, bitten by police, drowning, chemical exposure, firearm etc. were contributing 13.35 % among all the cases. Least common cause of MLC was cases of blast injury, 2 cases. When a month wise distribution of cases was analysed, the maximum number of cases was observed in month of July and October followed by September, November, December and August (Table 2).

Discussion

In the present study, a total 5408 cases were registered as MLC and out of them 79.99% were male and 26.01% were female making a male to female ratio 3:1. Our observations are similar to the findings of various studies. [2-17] This is because males are more involved in outdoor activities so they are more vulnerable to accidents or injuries.

It was observed that urban victims constituted 51.09% and the rural victims were 48.91%. Similar findings were also observed by Hussaini SN et al,[5] who found 55.91% in urban population and 44.08% in rural population and Siddappa SC,[18] who found 52.48% in urban population and 47.52% from rural population.

In our study maximum numbers of cases reported to casualty were from the age group 21-30 years (27.59%), followed by 31-40 years (21.95%) and 41-50 years (15.59%), which is similar to other studies. [2-10,12,13,17] This may be due to the fact that individuals of this age group lead more active lives, are more involved in outdoor, sports and recreation activities and take risks for work, which leads to more injuries and accidents among these groups.

Present study revealed that the maximum number of cases were of RTA's (38.31%) followed by assault (20.25%) and poisoning (9.28%).

Present study revealed that maximum cases reported to casualty were of RTA (38.31%). This finding was consistent with other studies.[3,6–8,12,17–19] The maximum incidence of RTA cases could be attributed to rapid increases in vehicles, poor road infrastructure, rash and negligent driving, and drunken driving. Another reason to explain the high incidence of RTA cases is the proximity of the study area to the national highway which harbors heavy

traffic. Malik Y[2] and Yadav A[4] observed in their study that maximum cases reported to casualty were of poisoning which differ from our study. Our study was also in contrast with the findings of Hussain SN,[5] who observed the maximum number of cases reported to casualty were of burn.

Poisoning cases constituted 9.28% of the cases and this could be attributed to the fact that the study center was situated in the rural area and the livelihood of people around were agriculture and had easy access to pesticides. It was also noted that the gender ratio was reversed in poison cases which may be due to lack of proper knowledge in handling poisonous substances or emotional liability to consume poison. In the present males were commonly involved in most of the injury types except for poisoning, burns and rail accidents that showed female predominance. These observations showed clear indications that females were prone to accidental or self-harm by means of poisoning, burns and rail accidents in rural areas.

TABLE NO.: 1 DISTRIBUTION OF MLC WITH GENDER

DISTRIBUTION OF MLC WITH GENDER				
TYPES OF MLC	**MALE**	**FEMALE**	**TOTAL**	**%**
RTA	1678	394	2072	38.31
ASSAULT	719	376	1095	20.25
POISONING	310	192	502	9.28
BITE	241	131	372	6.88
FFH	260	89	349	6.45
RAILWAY ACCIDENT	3	4	7	0.13
INDUSTRIAL ACCIDENT	13	1	14	0.26
BURNS	79	122	201	3.72
ELECTROCUTION	29	5	34	0.63
HANGING	18	10	28	0.52
BROUGHT DEAD	10	2	12	0.22
OTHERS	559	163	722	13.35
			5408	100.00

TABLE NO: 2 DISTRIBUTIONS OF MLC FROM JULY – DECEMBER 2016.

DISTRIBUTIONS OF MLC FROM JULY – DECEMBER 2016							
TYPES OF MLC	**MONTHS**						
	JUL	**AUG**	**SEPT**	**OCT**	**NOV**	**DEC**	**TOTAL**
RTA	327	278	288	409	399	371	2072
ASSAULT	204	177	204	167	168	175	1095
POISONING	90	73	83	90	81	85	502
BITE	88	60	108	61	29	26	372
FFH	63	59	61	50	47	69	349
RAILWAY ACCIDENT	2	1	1	1	1	1	7
INDUSTRIAL ACCIDENT	5	4	5	-	-	-	14
BURNS	22	30	28	41	47	33	201
ELECTROCUTION	5	7	6	7	3	6	34
HANGING	4	3	5	8	5	3	28
BROUGHT DEAD	3	1	2	1	2	3	12
OTHERS	124	146	131	102	129	90	722
							5408

TABLE NO.: 3 REGION WISE DISTRIBUTION

REGION WISE DISTRIBUTION			
MONTHS	**URBAN**	**RURAL**	**TOTAL**
JULY	464	477	941
AUGUST	463	369	832
SEPTEMBER	479	423	902
OCTOBER	456	498	954
NOVEMBER	480	408	888
DECEMBER	421	470	891
			5408
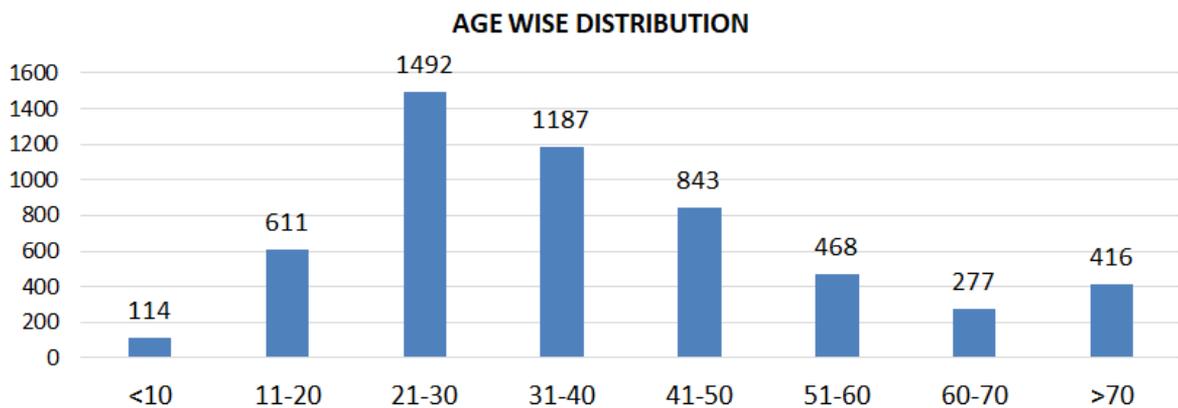
FIGURE NO.1 : AGE WISE DISTRIBUTION
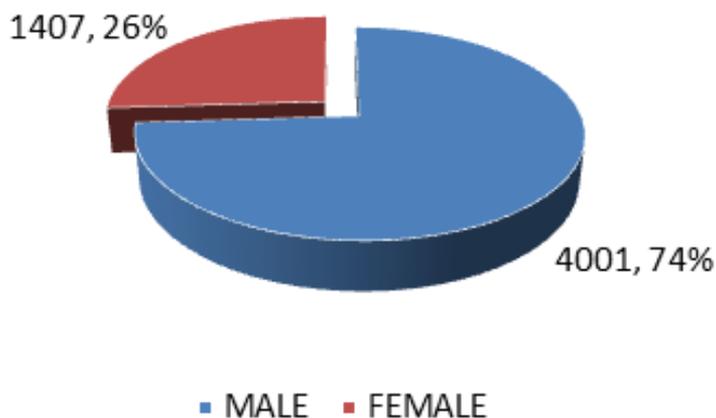
FIGURE NO. 2 : GENDER WISE DISTRIBUTION OF CASES

Conclusions and Recommendations:

A bad opinion is worse than none at all since the latter can distort the facts and result in the administration of injustice. According to the current survey, the majority of medico-legal cases involved traffic accidents, which primarily affected young people living in metropolitan areas. By providing appropriate information, awareness, and training on safety standards, administrators and law enforcement agencies can prevent such incidents. Under a road safety program, all of the cities in our nation should

be evaluated according to a number of criteria, such as the quality of the roads, how well traffic signals work, how well inhabitants follow traffic laws, etc.

This study evaluated medicolegal cases; the data could be utilized by the organization to secure sufficient medical personnel, obtain sufficient medical supplies, and implement health education initiatives in the community that target preventable illnesses such as safe pesticide use, road safety, and first aid protocols.

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Conflict of Interest: None Declared

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Medico-legal Profile of Homicidal Deaths Brought to the Mortuary at Civil Hospital, Ahmedabad

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Abstract

Homicide is a brutal crime where one person kills another, robs them of their life. Forensic pathologists must distinguish between suicide, murder and accidents using autopsy. Homicides can involve various methods, including assault, strangulation, drowning, burns and poisoning. The rising incidence of homicides prompts a study to identify vulnerable age groups, sex incidence, motives, injury patterns, crime locations and survival periods. The study was conducted from January to December 2023 on 103 cases from 4172 autopsies in the Department of Forensic Medicine & Toxicology at B. J. Medical College, Ahmedabad. In this study we included the cases with alleged homicide history and those later converted to homicide. Most of the cases were in the age group of 21 years to 30 years and least in the age group of 0 to 10 years. Injuries were most common (36.89%) between 6 pm and 12 midnight and least common (17.48%) between 12 noon and 6 pm. The majority of homicidal deaths involved hard and blunt weapons (39.80%), followed by sharp and penetrating weapons (31.06%). Argument was the most common reason for homicidal death in 42.72% of instances. Homicides occurred most common on the street in 38.83% of cases. The majority of victims died within 30 minutes to 24 hours (45.63%) of infliction of injuries. 42.72% of incidents involved an acquaintance as the assailant.

Keywords: Homicide; Weapons; Injuries; Hard and blunt; Sharp and penetrating.

Introduction

One of the most heinous crimes since the dawn of society is homicide.[1] Homicide is defined as killing of one human being by another human being.[2] The most heinous and brutal type of violent crime is homicide, in which one person robs another of their inalienable right to life.[3] Making the distinction between a suicide, a murder and an accident is crucial for forensic pathologists. In order to distinguish between homicide and suicide, autopsy is necessary.[4] Autopsy is useful to give an idea about homicide, suicide and accident, on the basis of pattern of injuries present over victim. The pattern of injuries is being changed

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because of population explosion, changing life style, drug and substance abusers and easy availability of various types of weapons. With the advancement of technologies human race is able to access to information regarding all sophisticated instruments and weapons that can be readily used for committing any offence and intoxication is an added menace to the existing problem.[5] The various patterns of homicidal deaths include assault by sharp weapon, blunt weapon, firearms, strangulation, smothering, drowning, burns or poisoning etc.[6] Every day, the newspapers scream headlines about the rising incidence of homicide. In view of rising such cases, presenting study is undertaken so as to find out the most vulnerable age group, sex incidence, motive, pattern of injuries, place of occurrence of crime and period of survival.

Materials and Method

The retrospective study was conducted from 1st January 2023 to 31st December 2023 in the Department of Forensic Medicine & Toxicology at B. J. Medical College, Ahmedabad for a period of 12 months. 103 cases corresponding to the inclusion criteria were selected from the 4172 autopsies performed in the mortuary at Civil Hospital, Ahmedabad, between study period. These cases were picked from the cases brought to mortuary for medico-legal autopsy with alleged history of homicide and also the cases which later converted homicide after autopsy findings and further investigation by investigating officer. Any cases subjected for autopsy with an alleged or suspected history of homicide but which were later registered as non-homicidal based on the autopsy findings, circumstantial evidence and investigation by the police and any cases where data was incomplete were excluded. For each case included in this study, the following parameters were recorded: age, sex, relation with assailant, place and time of incidence, motive, survival period etc. The data were collected from autopsy report, police papers and treatment papers. All the data was analyzed in excel and results are presented in tabular form and figures.

Result and Discussion

During January 2023 to December 2023, 4172 autopsies were performed at the mortuary of Civil Hospital in Ahmedabad, with 103 cases being homicidal.

Table 1: Age and sex distribution of study participants

Age group	Male	Female	Total (%)
0-10 years	0	1	1 (0.97)
11-20 years	9	1	10 (9.71)
21-30 years	24	7	31 (30.10)
31-40 years	26	2	28 (27.18)
41-50 years	12	2	14 (13.59)
51-60 years	10	1	11 (10.68)
61-70 years	5	3	8 (7.77)
Total	86 (83.5%)	17 (16.5%)	103 (100)

As observed in table 1, most of the victims were in the age group of 21 years to 30 years and least in the age group of 0 to 10 years. Young adults constituted the most. The majority of the deaths were of men (n=86, 83.5%) rather than women (n=17, 16.5%) with male to female ratio of 5.06:1. Males outnumbered females in all age groups except for children under the age of 10 years, in which females were more common victims of homicide. Because males tend to be more aggressive and engage in outside activities, making them more open to encountering assault. Similar findings were observed in the studies conducted by Sangal A et al.[1] on 227 cases, were male constitute 70.92 % and female constitute 29.07%, Mohanty M.K et al[7] reported 85.2% were males and 14.8% were females.
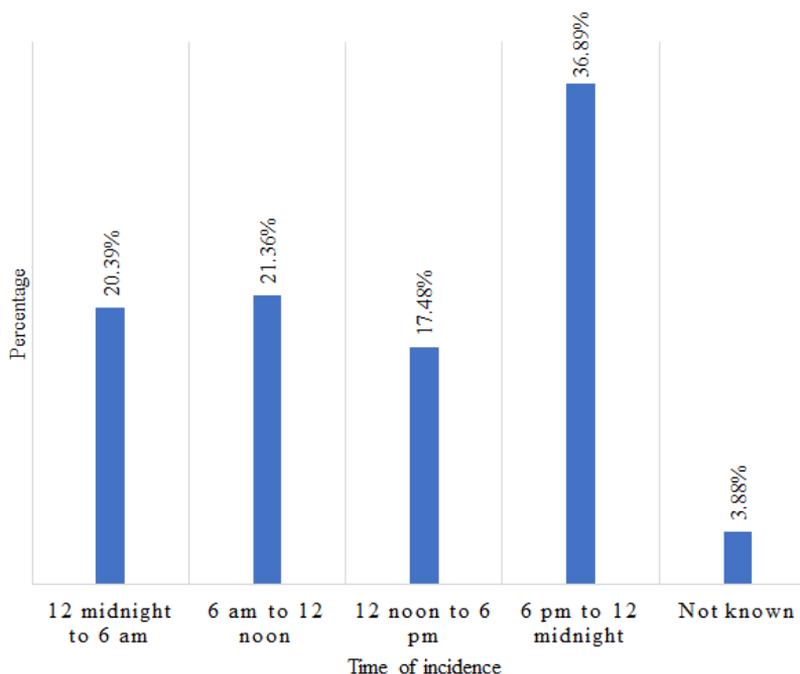
Figure 1: Time of incident

As seen in Figure 1, majority of incidence (36.89%) occurred between 6 pm to 12 midnight and least incidence (17.48%) occurred between 12 noon to 6 pm. However, study conducted by Sangal A et al[1] showed maximum killings (33.92%) occurred in late night (12 am to 6 am) and least (8.82%) in 6 PM to 12 midnights. Sumangala CN[3] reported maximum homicide in Afternoon (12pm-6pm) 24 (33.8%) and least 04 (5.6%) in late night (12am-6am), which contradicts our study.

Table 2: Distribution of cases according to type of weapon/method used

Type of weapon/method used	Male (%)	Female (%)	Total (%)
Hard and blunt	32 (31.06)	9 (8.73)	41 (39.80)
Sharp and penetrating	30 (29.12)	2 (1.94)	32 (31.06)
Both sharp and blunt	16 (15.53)	2 (1.94)	18 (17.47)
Asphyxia	0 (0)	2 (1.94)	2 (1.94)
Both blunt and asphyxia	0 (0)	1 (0.97)	1 (0.97)
Firearm	6 (5.82)	0 (0)	6 (5.82)
Burns	2 (1.94)	1 (0.97)	3 (2.91)
Total	86 (83.50)	17 (16.50)	103 (100)

As noted in table 2, the majority of homicidal deaths involved hard and blunt weapons (39.80%), followed by sharp and penetrating weapons (31.06%). Asphyxia was employed to kill predominantly female victims, whilst firearms were utilized to kill primarily male victims. However, Sumangala CN[3] reported majority of injuries inflicted by sharp weapon (38%), followed by blunt weapon injuries (25%). Hugar et al[6] also reported sharp weapon injuries in majority cases (33.25%), followed by blunt weapon injuries in 28% cases.

Table 3: Distribution of cases according to motive of homicide

Motive	Number	Percentage
Argument	44	42.72%
Financial disputes	2	1.94%
Revenge	12	11.65%
Infidelity	5	4.85%
Not known	40	38.83%
Total	103	100%

As shown in table 3, argument was the most common reason for homicidal death in 42.72% of instances, followed by revenge (11.65%) and infidelity (4.85%). The motivation for the killing could not be determined in 38.83% of cases. In our study, comparable results were obtained by Cros et al[8], who discovered that dispute (44%) was the most common cause, however this contradicts the purpose of revenge, which was identified in only 2% of cases. Sumangala CN et al[3] discovered revenge motive in 61% of cases, which contradicts our findings.

Table 4: Distribution of homicides according to place of occurrence

Place of occurrence	Number (%)
Remote place	33 (32.04)
Street	40 (38.83)
Victim's home	20 (19.42)
Work place	9 (8.74)
Assailant's home	1 (0.97)
Total	103 (100)

According to table 4, 38.83% of homicides occurred on the street, 32.04% in a remote location, 19.42% in the victim's home and 8.74% at work place. Sumangala CN et al[3] reported similar data, with homicide occurring on the street/road in 73.2% of cases. But the significance difference in the percentage suggests that the environment whether urban or rural and crime rates could vary significantly between the two studies. Hugar et al[6] reported same in 29.82% of cases, which agreed with our findings.

Table 5: Distribution of victims based on survival period

Survival period	Number	Percentage
Spot dead <30min	22	21.36%
30 min to 1 day	47	45.63%
1 day to 7 days	25	24.27%
> 7 days	9	8.74%
Total	103	100.00%

Referring to table 5, the majority of victims died within 30 minutes to 24 hours (45.63%) of infliction of injuries, followed by surviving periods of 1 day to 7 days (24.27%), spot dead in 21.36% cases and the fewest dying after 7 days (8.74%) of infliction of injuries. It is apparent that the injuries inflicted on victims were potentially fatal. Hugar et al.[6] found

that the majority of victims died on the spot (82.5%), which contradicted findings observed by us.

Table 6: Distribution of homicides based on victim-offender relationship

Relation	Number (%)
Acquaintance	44 (42.72)
Stranger	12 (11.65)
Relative	11 (10.68)
Spouse	4 (3.88)
Parent	1 (0.97)
Not known	31 (30.10)
Total	103 (100)

As seen in Table 6, 42.72% of incidents involved an acquaintance as the assailant. The chance of the offender being a stranger or a relative was almost same. The victim-offender link could not be determined in 30.10% of cases. In a study conducted by Cros J et al[8] the assailant was a family member in 62% of the cases (wife/ husband, 32%; former wife/ husband, 4%; family members, 25%), a lover in 1%, and an acquaintance in 25%.

Conclusion

In 39.80% of cases, only hard and blunt weapons were used, while sharp and penetrating weapons and both (sharp and blunt) weapons were used in 31.06% and 17.47% of victims, respectively. Maximum number of cases occurred in the age group 21 to 29 years in both sexes constituting 30.10% of cases. Maximum homicide took place on the street (38.83%). Most of the homicides took place in between 6 pm to 12 midnight (36.89%). The main motive behind the homicide was an argument (42.72%). Maximum numbers of homicides were committed by acquaintances (42.72%). Most of victims (45.63%) died between 30 mins to 24 hours of infliction of injuries. The current analysis of homicidal death attempted to unravel numerous factors and construct a profile of homicidal fatalities. Depending upon the findings of this study we conclude that, one has to look into their life for the solution before committing any crime and law enforcing agencies should make necessary arrangements for the implementation of the laws. However, the observations may be influenced by a variety of regional, cultural, social, political and personal elements that change throughout time.

Limitation: The current study's limitation was that it was limited to a specific region and a one-year time period. Multicenter and long-term research are required to provide an accurate understanding of homicidal mortality rates in our country.

Ethical clearance: This study did not require ethical clearance because secondary data from the record were used. Permission for the data collection was taken from the Head of Department, Forensic Medicine Department, B. J. Medical College, Ahmedabad.

Conflict of interest: There is no conflict of interest.

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Determination of Gender from the Foot Measurements of Telanganite Adults: A Cross Sectional Study

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Abstract

Background: Dimensions of foot provide valuable information in determining the sex and stature of the individual based on various statistical formulae and equations. There were many physical anthropometric studies show the gender difference.

Objectives: 1. To determine the correlation of various measurements of the feet with gender. 2. To derive logistic regression equations for gender determination from foot dimensions among Telanganite adults.

Material and Methods: The present study was conducted in Prathima Institute of Medical Sciences, Karimnagar, Telangana State, India, amongst 436 students from Telangana state, aged between 18-22 years. After obtaining Institutional Ethics Committee clearance and informed consent from the participants, foot length, foot breadth and Bi-malleolar breadth were recorded and foot index was also calculated. The data was then subjected for statistical analysis using SPSS version 21.

Results: The mean values of Foot length, Foot breadth, and Bi-malleolar breadth were found to be significantly higher in males than females. The average foot index in males and females were 43.465 and 41.595 respectively. Prediction of gender with logistic regression equations using multiple parameters was found to be better than that with individual parameters.

Conclusion: The higher values of foot dimensions in males as compared to females proves the sexual dimorphism of foot dimensions.

Key words: Bi-malleolar breadth, Foot breadth, Foot dimensions, Foot length, Foot index.

Introduction

The determination of gender is an initial and essential component of any medicolegal investigations and in forensic anthropology casework, and requires foremost consideration in the examination of skeletal remains. Forensic anthropologists frequently

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employ morphologic and metric methods for sex determination of human remains [1,2].

The human foot is a basic unit of bipedal locomotion and it is a formed by a complex multi bone structure involving different 26 bones and numerous articulations [3]. Dimensions of foot provide valuable information in determining the sex and stature of the individual based on various statistical formulae and equations [4]. Many physical anthropometric studies show the gender difference [5,6,7].

The identification of human remains from the different anthropometric parameters is the main domain of forensic anthropometry and forensic podiatry. The recognition of a deceased individual is the mainstay of forensic analysis. So, theforensic anthropologists construct an osteo-biography consisting of a set of biological attributes like sex, stature, and age [8].

The average male is ten centimeters taller than the average female and this difference will also be translated in an overall trend that males will have greater foot length as compared to females [9]. The size, shape and morphology of human feet and foot-prints is greatly influenced by combined effects of heredity and living style and environmental factors, there by making those unique data to establish human identity [10].

For designing of various foot devices also the quantitative analysis of foot anthropometry is very important [11]. Different studies on foot dimensions have found significant clinical application of such studies. Rodier et al observed that children with autism had smaller feet compared with the control group [12]. Schultz et al reported that many girls with Rett Syndrome had small feet for their height[13].

The likelihood of retaining the foot mainly by the shoes in terrorist attacks, wars, mass disasters, high-impact transportation accidents and explosions, the detailed anthropometric analysis of the human foot has been emphasized in forensic identification [14]. In view of very few studies, the present study was an attempt to determine the correlation of various measurements of the feet with sex and to formulate the logistic regression equations to predict sex of a person by using dimensions offeet. It is expected to be useful for legal experts, forensic science researchers and different investigatorsin the person's gender determination.

Materials and Methods

The present study was conducted from August 2023 to November 2023 in Prathima Institute of Medical Sciences, Karimnagar, Telangana State, India, amongst 436 students from Telangana state, aged between 18-22 years. After obtaining Institutional Ethics Committee clearance, the informed consent was obtained from all the subjects willing to take part in the study. A structured, predesigned, pretested questionnaire was used to get the basic socio-demographic information like age, sex, native state, etc. The study subjects with any apparent physical foot anomalies, trauma, orthopedic deformities, inflammation, history of foot surgery in the past, metabolic or developmental disorders were not included. The participants were made to stand erect in anatomical position bare-footed on a horizontal flat surface to measure the foot dimensions.

The study included only the students above 18 years of age as most people attain their maximum growth and maximum foot length and breadth above this age. The following foot measurements were undertaken [8].

Foot Length (FL): It was measured as a direct distance from the most posterior point of the back of the heel (pternion) to the most distal part of longest toe (acropodian). Along the medial border of the foot, caliper was horizontally placed. The mobile part of the outer jaw was approximated to the acropodian and the fixed part of the outer jaw of the caliper was placed at pternion and then the measurements were taken on both sides.

Foot Breadth (FB): It was measured as a distance between metatarsal tibiale (medial margins of the head of the first metatarsal) and metatarsal fibulare, (the lateral margin of the head of the fifth metatarsal using the sliding caliper.

Bi-malleolar breadth: It was obtained as distance between the most medial projection of medial malleolus and the most lateral projection of lateral malleolus using sliding caliper [15]. All the measurements were recorded in centimeters to the nearest 1 mm. The measurements were taken by a

single observer for avoiding the inter-observerbias and at a fixed time to eliminateany diurnal variations.

Foot index [4,8]: It was calculated by the formula-

Foot Index = (Foot breadth/Footlength)x100.

The collected data was compiled, tabulated and analyzed by Statistical Package for Social Sciences (SPSS) version 21.

Results

The present study included 235 (53.90% girls and 201 (46.10%) boys. The results of foot dimensions of left and right sides in both sexes of 436 students in the present study were recorded.

Table 1: Gender and side wise descriptive statistics of foot dimensions

Foot Dimensions	Gender	Mean ± SD	Minimum	Maximum	P value b/w sides	Average	P value b/w Gender
Foot Length (cm)	**Male**						
	-Lt	21.86±3.66	16.9	28.5	0.29	21.865	
	-Rt	21.87±3.68	16.7	28.6			< 0.001
	Female						
	-Lt	20.51±2.56	16.8	26.2	0.51	20.515	
	-Rt	20.52±2.59	16.9	26.4			
Foot Breadth (cm)	**Male**						
	-Lt	9.51±0.72	6.9	11.3	0.49	9.44	
	-Rt	9.49±0.73	6.7	11.5			< 0.001
	Female						
	-Lt	8.52±0.69	6.5	10.7	0.47	8.53	
	-Rt	8.54±0.70	6.4	10.9			
Bi-malleolar Breadth (cm)	**Male**						
	-Lt	7.28±0.68	4.8	9.7	0.42	7.285	
	-Rt	7.29±0.71	4.6	9.6			< 0.001
	Female						
	-Lt	6.41±0.74	4.7	9.5	0.49	6.415	
	-Rt	6.42±0.75	4.8	9.7			

Table 1 shows the descriptive statistics of foot dimensions in both sides among both sexes. The mean values of Foot length, Foot breadth, and Bi-malleolar breadth in males were found to be 21.865 cm, 9.44 cm, and 7.285 cm respectively, which were significantly higher than that in females (p value < 0.05). However, there was no statistically significant difference in left and right sides in all these parameters in both the genders.

Table 2: Foot index in both genders for mean foot dimensions.

Gender	Male		Female	
Side	Lt side	Rt Side	Lt side	Rt Side
Foot Length (cm)	21.86	21.87	20.51	20.52
Foot Breadth (cm)	9.51	9.49	8.52	8.54
Foot Index	43.50	43.40	41.54	41.62

Table 3. Descriptive statistics for the Foot index in both genders

	Male		Female	
	Lt	Rt	Lt	Rt
Mean	43.51	43.42	41.55	41.64
Standard Error	0.54	0.56	0.76	0.78
Standard Deviation	7.13	7.16	9.12	9.19
Minimum	40.83	40.12	38.69	37.87
Maximum	62.61	62.64	57.59	57.64
Average Foot Index	43.465		41.595	
P value	<0.001			

The mean Foot index in males was found to be 43.465 and in females it was 41.595 as seen in Table 2 and Table 3. This observed difference was statistically significant (p value < 0.001). The minimum and maximum average foot index in males was observed to be 40.48 and 62.63 respectively with standard deviation of $\pm$ 7.15 while in females it was 38.28 and 57.63 respectively with standard deviation of $\pm$ 9.16.

Table 4: Logistic regression equations for gender determination from different foot dimensions.

S.No	Logistic regression equation	Percentage of average Prediction of Gender	R^2
1	G = -18.089+2.0052(FB)	75.71%	0.44
2	G = -2.36+0.108(FL)	63.30%	0.039
3	G = -10.197+1.502(BB)	73.59%	0.288
4	G = -16.015+1.76(BB)+0.2031(FL)	77.96%	0.359
5	G = -25.71+0.234(FL)+2.36(FB)	79.39%	0.478
6	G = -18.67+1.530(FB)+0.726(BB)	77.11%	0.428
7	G = -27.08+0.06(FL)+1.77(FB)+0.91(BB)	81.86%	0.509

FB – Foot breadth, FL - Foot length, BB – Bi-malleolar breadth, G- Gender.

R^2 – Percentage of variation in dependent variable (Gender). Cut off for all equations is 0.5 and the scores < 0.5 indicate male, while score >0.5 indicate female.

As seen in Table 4, the logistic regression equations were derived to determine the gender of a person by using different parameters of foot dimensions. The accuracy in prediction of gender with multiple foot parameters was better than with regression equations of individual parameters. Foot length showed least correlation with gender at R^2 value of 0.039.The correlation of foot breadth with sex was best with R^2 of 0.44.

Discussion

Determination of gender from foot dimensions has a major role in personal identification. The normal human foot shows great individual variation in breadth and length in males and females [16]. The human foot is the foundation forbi-pedal locomotion. It is a complex adaptation that evolved thorough extensive remodeling of the hind appendage of the human a boreal primate fore-bears [17]. The present study showed significantly higher mean values of foot length, foot breadth, and bi-malleolar breadth in males than in females. This sexual dimorphism in foot dimensions was also observed by other similar studies [4,8,18,19,20,21].

Males in the present study had an average foot length of 1.35 cm and foot breadth of 0.91 cm more than that infemales. Females had 0.87 cm less bi-malleolar breadth than in males. Longer and broader foot in males could be due to heavier bone structure of male skeleton causing weight bearing on the male foot compared to females [8,22].

There was no any significant differences in all the foot dimensions of both sides in both sexes similar

to the findings by Bindurani MK et al [8]. However, this was in contrast with the findings of a study on Nigerian adult population which observed longer and broader right sided foot than left foot [23]. A study by Walia S et al [17] among Haryanvi jat population in India found higher foot length and foot breadth on right side in males where as these parameters were higher on left side in females. Such variations could be attributed to the differences in community, heredity, living style and environmental factors [8,10].

Foot index in the present study were 43.465 in males and 41.595 in females similar to the observations by other studies [8,19,23]. However, the studies by Agnihotri AK et al [9] and Chiroma SM et al [24] reported higher foot index in females than in males. A study by Moudgil R et al [4] observed a slightly higher foot index in females on right side and in males on left side which also concluded that gender determination cannot be made conclusively from the foot index. The findings of present study was found to be comparable to the findings of a study by Sen J on Bengali Rajbanshi population [25] and the study on Nigerian population [24].

A study by Singla R on Haryanvi and North Indian population [26] and Danborno B on Nigerian population [19] reported lower foot index than the present study. The ethnical and regional variations in genetic background, physical activities, climatic factors, nutritional conditions, socio-economic status and practice of using different footwear could be the attributed reasons for such variations[8,20,27,28].

The logistic regression equations were derived by using different parameters of foot dimensions to determine the gender of aperson and were checked for their accuracy and reliability in determination of gender. Foot length showed least individual correlation with gender at prediction rate of 63.30% and R^2 0.039. The foot breadth showed highest individual correlation with gender at prediction rate of 75.71% and R^2 of 0.44 similar to the findings by Bindurani MK et al [8]. The foot length was seen to be least correlated and foot breadth at heel observed to be highest correlated with gender in a study by Koutilya [29]. However, foot length had better correlation with gender than foot width in a study by Ozden et al [30]. Prediction of gender with logistic regression equations using multiple parameters were better than with regression equations of individual parameters in the present study as observed by Bindurani MK et al [8]. The gender was correlated best when a combination of average foot breadth, average foot length and average bi-malleolar breadth were considered which was similar to the other studies [8,29].

Conclusion

The present study observed sexual dimorphism of foot dimensions like foot length, foot breadth, bi-malleolar breadth and foot index which were higher in males as compared to females. Foot length showed least correlation and foot breadth highest correlation with gender. The gender prediction with logistic regression equations using multiple foot parameters was better than with regression equations of individual parameters.The findings of the present study provide a scientific tool in determination of the gender of a person by investigators, forensic science researchers, legal and other public health experts.

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Profile of Medico-Legal Deaths Due to Thermal Burn Injury in Tertiary Care Centre of Northern Madhya Pradesh

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Abstract

Introduction: Fire is one of the greatest discoveries in the history of mankind. It fully transforms the way of living of humans. But just like a double edged sword it also affects the human life in a negative way. Fire is easy and dangerous weapon in kitchen to be used for suicide for females in developing country like India. Due to this, thermal burn is a big problem and have significant share in medico-legal autopsies.

Aim and objective: The aim of present study is to provide a brief analysis of thermal burn mortality across all age group brought in the mortuary of GRMC, Gwalior and to study the various medico-legal aspects of fatal thermal burn cases.

Material & Method: This is a retrospective analysis of 82 cases of thermal burns which were brought for medico-legal autopsy at Forensic Medicine & Toxicology department in Gajra Raja Medical College, Gwalior (Madhya Pradesh) during the whole year. The data was complied, tabulated and analysed statistically.

Results: 3.6% of total medico-legal autopsies are of thermal burn. Most of the thermal burn cases fall in the age group of 21-30years. 57.3% victims are female. 81.1% of the victims are married. Most of the victims (64.6%) showed total body surface area involvement between 71-100%. Most of the cases (39%) survived for 7 days or more. Most common cause of death (74.4%) in this study is Septicaemia. About 69.5% of thermal burn cases were accidental manner.

Conclusion: In most of the cases thermal burn is totally preventable and manageable. Education at school level plays a key role. Most of the accidental thermal burns can be avoided if, people know the proper safety measures for using fuels for cooking.

Keywords: Thermal burns, married females, young age group, accidental burn, suicide.

Introduction

Fire is one of the greatest discoveries in the history of mankind. It fully transforms the way of living of humans. Today, without fire the existence of humans is next to impossible. But just like a double-edged sword it also negatively affects human life.

Globally, thermal burns are one of the major causes of disability. It causes more than 8 million disability-adjusted life-years (DALYs). The majority of the incidences happened in low-income and middle-income countries (LMICs).[1] It is observed that, in South Asia where the festive season of Diwali, is celebrated each year in October or November, there is an increased incidence of thermal burns especially in children.[2] In 2019 more than 23 000 fire-related deaths were reported in India which is about 20% of the global mortality burden.[3] The thermal burns which involve more than 40% of TBSA (total body surface area) are associated with major morbidity and mortality.[4] If thermal burn patient survives; they become financially distressed, vocationally challenged, and socially excluded.[5] In India, Women (aged 15–49 years) are 3 times more susceptible to getting thermal burn injury as compared to men.[3] These high susceptibility in women are due to unsafe cooking and kitchen practices, suicides, and homicides associated with domestic violence and dowry-related conflict.[5] Prevention of thermal burns requires attention to gender-based inequities and upstream social determinants of health. In developed countries, the incidence, severity, mortality, and morbidity due to thermal burn injury have reduced significantly due to advancements in prevention, management, and rehabilitation; whereas in LMICs, particularly in the Indian subcontinent, the burden continues to be high.[6] Thermal burns are preventable. Efforts for prevention and care of the victims can reduce thermal burn-related mortality, morbidity and disability significantly. For the preventive, curative and rehabilitative care of thermal burn patients, GOI launched an initiative named as National Programme for Prevention, Management and Rehabilitation of Thermal Burn Injuries (NPPMRBI).[7]

Aim & Objective

The aim of present study is to provide a brief analysis of thermal burnmortality across all age group brought in the mortuary of GRMC, Gwalior during a period of 2023 and to study the various medico-legal aspects of fatal thermal burn cases.

Material and Method

This study is a retrospective analysis of 82 cases (out of total 2306 autopsies performed during the study period) in which cause of death was thermal burn injury and its complications, which were brought for medico-legal autopsy at Department of Forensic Medicine and Toxicology in Gajra Raja Medical College, Gwalior (Madhya Pradesh). The duration of the study was from 1st January 2023 to 31st December 2023. Data were collected from Post mortem registers/records, Inquest papers and Post mortem reports maintained in the department by keeping confidentiality strictly intact. The data was tabulated and analysis was done. Descriptive results are presented in table form.

Result and Discussion

Table 1 Total autopsy and thermal burn cases done in year 2023

Total Post-mortem done in 2023	2306
Number of thermal burn cases	82
% of total thermal burn cases	3.6

Table 2 Age wise distribution of thermal burn cases

Age group (in years)	Thermal burn cases	%
1-10	8	9.8
11-20	8	9.8
21-30	32	39
31-40	14	17
41-50	8	9.8
51-60	5	6.1
61-70	5	6.1
>70	2	2.4
Total	82	100

Table 3 Gender wise distribution of thermal burn cases

Gender	Thermal burn cases	%
Male	35	42.7
Female	47	57.3
Total	82	100

Table 4 Age and gender wise distribution of thermal burn cases

Age group (in years)	Male		Female		Total
	N	%	N	%	
1-10	5	14.3	3	6.4	8
11-20	3	8.6	5	10.6	8
21-30	11	31.4	21	44.7	32
31-40	6	17.1	8	17	14
41-50	4	11.4	4	8.5	8
51-60	3	8.6	2	4.3	5
61-70	2	5.7	3	6.4	5
>70	1	2.9	1	2.1	2
Total	35	100	47	100	82

N: number of thermal burn cases

Table 5 Month and gender wise distribution of thermal burn cases

Months	Male	Female	Total thermal burn cases
January	06 (17.1%)	07 (14.9%)	13 (15.9%)
February	03 (8.6%)	04 (8.5%)	07 (8.5%)
March	03 (8.6%)	02 (4.3%)	05 (6.1%)
April	06 (17.1%)	04 (8.5%)	10 (12.2%)
May	00(00)	02 (4.3%)	02 (2.4%)
June	02 (5.7%)	04 (8.5%)	06 (7.3%)
July	02 (5.7%)	08 (17%)	10 (12.2%)
August	02 (5.7%)	01 (2.1%)	03 (3.7%)
September	01 (2.9%)	05 (10.6%)	06 (7.3%)
October	03 (8.6%)	01 (2.1%)	04 (4.9%)
November	07 (20%)	07 (14.9%)	14 (17.1%)
December	00 (00%)	02 (4.3%)	02 (2.4%)
Annual thermal burn cases	35 (42.7%)	47 (57.3%)	82 (100%)

Table 6 Marital status wise distribution of thermal burn cases

Marital status	Thermal burn cases		
	Male	Female	Total
Married	28 (80%)	39 (83%)	67(81.7%)
Un-married	7(20%)	8(17%)	15(18.3%)
Total	35	47	82 (100%)

Table 7 Survival period and total burn surface area wise distribution of thermal burn cases

Survival period	Total burn surface area				Total
	31-70%		71-100%		
	N	%	N	%	
Brought dead	00	00	3	5.7	3 (3.6%)
<24hrs	1	3.4	12	22.6	13 (15.9%)
24 to <72hrs	3	10.3	6	11.3	9 (11%)
72hrs to <7days	10	34.5	15	28.3	25 (30.5%)
7 days and more	15	51.8	17	32.1	32 (39%)
Total	29 (35.4%)	100	53 (64.6%)	100	82 (100%)

N: number of thermal burn cases

Table 8 Cause of death wise distribution of thermal burn cases

Cause of death	Thermal burn cases	%
Shock	21	25.6
Septicaemia	61	74.4
Total	82	100

Table 9 Manner of death wise distribution of thermal burn cases

Manner of death	Thermal burn cases	%
Accidental	57	69.5
Suicidal	22	26.8
Homicidal	3	3.7
Total	82	100

As per table no. 1, a total of 2306 autopsies were conducted in the department, out of which 82 cases (3.6%) were died of thermal burn injury. About 20% thermal burn cases were observed by study conducted by Harid as SV et al.[8]

As per table no. 2, most of the victims were belonging to 21 to 30 years age group (39%) followed by 31 to 40 years age group (17%). Similar findings were also observed by Haridas SV et al.[8], where more than 50% cases comes from 21-40 years age group. Minimum number of cases seen in above 70 years (2.4%). The youngest victim in our study was 10months old female baby and the oldest one was 80yrs female.

As per table no. 3, most of the victims are female (57.3%) followed by male (42.7%). As per table no. 4, Predominance of female cases were seen in age group 21-30 years (44.7%) followed by 31 to 40 years (17%) which is similar to the findings of Buchade D et al.[9], Mazumdar A et al.[10], Harshitha K et al.[13], and Dhoble SV et al.[14] Involvement of most of the female in this age group is because female get married and involve in cooking in kitchen. In contrast, Memchoubi et al.[15] reported slight male preponderance in their study. Male also dominates in the age group of 21-30 and 31-40 years i.e. 31.4% and 17.1% respectively. High incidence may be explained by the fact that young adults are generally active and exposed to hazardous situations both at home and at work.

As per table no. 5, most of the thermal burn cases came in the month of November (17.1%) followed by January (15.9%). Similar finding observation made by Tandon R et al.[2]Since, in South Asia where festive season of Diwali, celebrated each year in the months of October or November, there is an increase incidence of thermal burns specially in children. Minimum number of case in May and December i.e. 2.4%. Most of the male cases came in the month of November (20%) followed by January and April (17.1%). Most of the females were victim came in the month of July (17%) followed by January and November i.e. 14.9%.

As per table no. 6, most of the victims are married (81.7%). Similar observation were made by Vaghela PC et al.[12], Harshitha K et al.[13], and Dhoble SV et al.[14]The proportion of married male was 80% whereas married female was 83%.

As per table no. 7, victims of total burn surface area of 71 to 100% were 64.6%, similar to the observations by Buchade D et al.[9], Mazumdar A et al.[10], DhobleSV et al.[14],Zanjad NP et al.[16], and Bhore DV et al.[17] Most of the thermal burn victims died after 7 or more days of hospitalization i.e. 39% (51.8% with less total burn area and 32.1% if the total burn area is more than 71%).Similar results were observed by Buchade D et al.[9] ,DhobleSV et al.[14]andBhore DV et al.[17] In contrast, 60.8 % of cases in Kumar V et al.[18], 59% cases in Mishra PK et al.[11], and 58% cases in Ragheb SA et al.[19] died within a week.

As per table no. 8, the most common cause of death were septicaemia (74.4%) followed by shock (25.6%). Septicaemia was the cause of death in which there was hospitalization for 3 or more days. Similar results were noted by Buchade D et al.,[9]DhobleSV et al.[14],Bhore DV et al.,[17] and Dasari H et al.[20] In contrary, shock was found to be most common cause of death in study done by Mishra PK et al.[11] Deaths due to Shock (neurogenic, hypovolemic) occurs in up to 3 days of hospitalization.

As per table no. 9, most of the thermal burn cases were of accidental manner (69.5%) followed by suicidal (26.8%) and least belong to homicidal (3.7%). Similar results were noted byBuchade D et al.[9], Mazumdar A et al.[10], &Usma B et al.[21] In contrary, Masud U et al.[22] found that most of thermal burn cases died due to homicidal thermal burn (59%).

Conclusion

In most of the cases thermal burn is totally preventable and manageable. Education at school level plays a key role. Most of the accidental thermal burns are avoided if, people knows the proper safety measures for using fuels for cooking. Standard Operating procedures are needed to ensure prompt resuscitation, wound care, infection control, and early surgery if needed. This will reduce the mortality in a tertiary care centre.

Source of funding: None

Conflict of Interest: None

Ethical Concerns: As per the law of India, if an autopsy is performed in a medico-legal case the consent of the family member is not desired. Identity

and credentials of the victims are kept confidential and the clearance from the institutional ethics committee is not warranted.

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Significance of Middle ear Haemorrhagein Cases of Drowning Deaths: An Autopsy Study of Rural Punjab

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Abstract

The diagnosis of death by drowning remains a difficult task for forensic experts at the time of postmortem examination. The presence of putrefaction and postmortem artefacts cover essential signs of drowning found on external and internal examination of dead body. This study involved gross examination of middle ear cavity for presence of haemorrhage to establish a diagnosis of antemortem drowning. It was planned considering the lack of research on this subject in the North Indian population. This study was conducted in the Department of Forensic Medicine and Toxicology, Guru Gobind Singh Medical College and Hospital, Faridkot, Punjab and included drowning deaths brought for autopsy. This study helped assessing the reliability of incidence of middle ear hemorrhage to affirm the diagnosis of antemortem drowning in the absence of other external and internal signs suggestive of drowning.

Keywords: Drowning, Autopsy, Middle ear, Haemorrhage, Asphyxia

Introduction

Death is not an event, but a process[1]. Death is said to occur when there is complete and irreversible stoppage of circulation, respiration and brain stem functions.

All types of asphyxia, whether mechanical, environmental, pathological, traumatic, or iatrogenic, involve a physical barrier preventing air entry into the lungs. Due to this violent interference, these deaths are termed violent asphyxial deaths[2]. Drowning is a form of asphyxia caused by aspiration of fluid into air passages caused by complete or partial submersion in water or other fluid[1].

Classical signs of asphyxia are petechial hemorrhages of the conjunctivae, viscera and/or skin, cerebral and/or pulmonary edema, cyanosis, visceral congestion and the fluidity of the blood[3]. These have been used in the diagnosis of asphyxial death for many years but are however not always visible in every individual because of the different ways violent asphyxia deaths present, which

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include drowning, hanging, ligature, and manual strangulation, smothering, traumatic asphyxia, suffocation and choking, where the leading causes are hanging and drowning [4].

Typical findings of drowning victims are wet clothes, skin and hair when recovered early. A typical fine tenacious froth from mouth and nose is observed in bodies who die of drowning and recovered before putrefaction sets in. Aquatic debris including silt, mud, sand, gravel, vegetation, algae, and shell fragments may be found on clothes, hair and body creases or orifices. Cutis anserine, or so-called "goose flesh," is observed in erector pilaie muscles of skin in bodies submersed in cold water as well as is related to be part of rigor mortis after death. Face, neck, chest, hands, lower extremities and feet are the most common areas of postmortem lividity in prone victims found in water, however the constant moving water makes it unapparent. Soddening and skin slippage observed in hands and feet ; called washerwoman hands; has been observed in drowning victims but this finding is not diagnostic of drowning as it is merely a sign of prolonged immersion[5].

These findings become less apparent due to onset of significant decomposition both externally and internally, prolonged passive inflow of water into the body and postmortemarte facts, especially those caused by predation by aquatic animals or fauna complicate the picture [5,6,7] and in such cases, the presence of middle ear hemorrhage act as an additional marker to diagnose death by antemortem drowning.

The probable mechanism for middle ear hemorrhage has been attributed to barotrauma, i.e. the pressure differences between the middle ear and the surrounding water which when an individual goes down in water produce a relative vacuum and this negative pressure within the closed cavity leads to inward stretching of the tympanic membrane and hemorrhages[8,9,10,11,12]. This hemorrhage has been cited as an autopsy finding in cases of death due to ante mortem drowning because it is attributed to vigorous breathing and movement which causes more water to propel inwards[13,14].

Materials and Methods

Study area and period: The prospective study was conducted on a total of 100 dead bodies in the Mortuary under the Department of Forensic Medicine and Toxicology, G.G.S. Medical College and Hospital, Faridkot, Punjab from April 2021 to October 2022

Inclusion criteria: All cases of drowning deaths brought to the mortuary.

Exclusion criteria: Cases with alleged history of direct head injury and any other forms of asphyxial deaths were excluded.

Methodology

After taking informed consent from relatives/ guardians of the deceased, Demographic information regarding the deceased including age, gender, religion, occupation, time of incidence, place of incidence, alleged cause for drowning and the circumstances of death was collected from the police and relatives. The duration, depth and medium of submersion was duly documented as available from the history and police records. The external state of the body i.e. fresh or decomposed was emphasized in documentation prior to conducting the examination.

The middle ear was opened with a chisel and five incisions were made through the petrous portion of the temporal bones. First incision started at the tip of the petrous bone and extended upto the jugular foramen. Then the groove of the transverse sinus from the jugular foramen upto where the groove of superior petrosal sinus reaches the groove of sigmoid part of transverse sinus was cut. Third line of incision started from the anterior tip of petrous bone and extended between it and the foramen ovale, laterally and slightly posteriorly upto 1cm beyond the foramen spinosum. The fourth line started at the posterior and lateral angle of middle fossa and extended from there towards the second line of incision. The fifth incision which connects lines three and four extended along the border of middle fossa and the squamous portion of temporal bone to open the osseous part. The middle ear cavity was viewed by knocking off the roof of the each side with a chisel and presence of any hemorrhage in the middle ear, petrous bone was documented **(Image 1)**
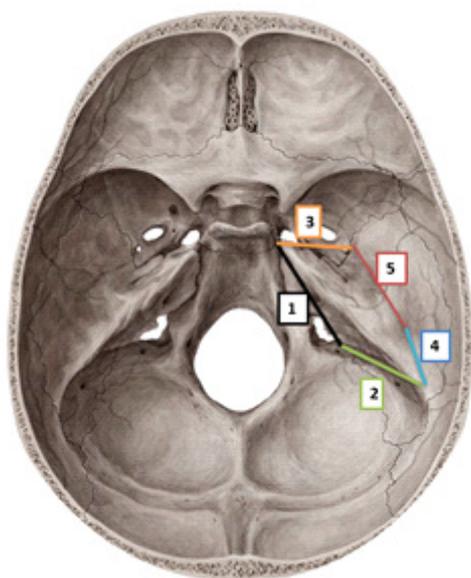
Image 1: showing the lines of incisions

Results and Discussion

Figure 1 and Table 1 show, in this study of 100 cases, 73 cases were identified and 27 were unidentified with a male to female ratio of 2.3 :1, which is in accordance with Chidanand C and Satish K.V, 2015 [11], NK Morris et al, 2015[15], Rao PS and Guntheti BK, 2021[16] and PatrickJ. Antonelli et al, 1993[17] which showed a predominance of male victims who died due to drowning.

The higher drowning rates among males may be due to being more active in the society and increased exposure to water and riskier behavior such as swimming alone, drinking alcohol before swimming alone and boating.
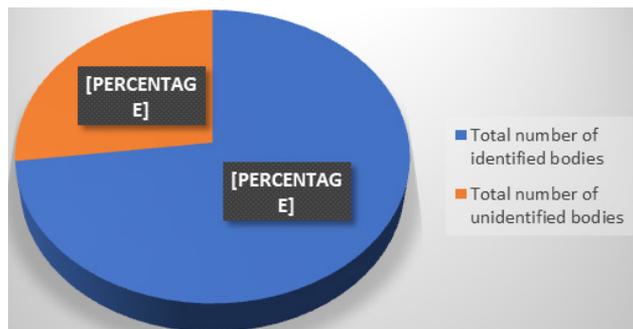
Figure 1: Represents burden of drowning deaths observed.

Table 1: Shows the Sex-wise distribution of drowning groups.

Sex	Number	Percent (%)
Males	70	70.0
Females	30	30.0
Total	100	100.0

Table 2 shows Majority of cases worked as laborers (29%), followed by private jobs(19%), 12% cases were unemployed, 8% were housewife, 5% were farmers and while in 27% cases the occupation was unknown. Rao PS and Guntheti BK, 2021[16] reported 30[44.11%] of victims were students, laborers comprised of 19[27.94%] cases and 5 victims were house- wives.

This is a study is set in rural Punjab, which is currently developing, where the underprivileged members of the society take up the job of daily wage workers and laborers who have to work in difficult terrains, including near water bodies. The insecurity of the job and low salary might be a reason for increased incidence of suicidal deaths.

Table 2: Distribution of study population according to occupation

Occupation	Frequency	Percent (%)
Farmer	5	5
Laborer	29	29
Private Service	19	19
Housewife	8	8
Unemployed	12	12
Unknown	27	27
Total	100	100

Table 3 and Figure 2 depicts around 50% of deaths occurred from July to October [maximum in September (19%), followed by July (18%), August (13%), February(12%)]. Least number of people died in month of march 1(1%).

Rainy season comprised of 57% cases, followed by winters(19%) and then summers(12%) and autumn (12%). This was in discordance with Chidan and C and Satish K.V, 2015[11], NK Morris et al, 2015[15] and Rao PS and Guntheti BK, 2021[16], who reported maximum deaths occurred in summer months, being 44%, 40% and 67.64% respectively.

Heavy rainfalls are associated with an increase in water level in canals, rivers and wetlands, and in those months, the weather is hot and humid and individuals may prefer to come out of their homes to a nearby water body to feel refreshed, to swim or

even to fill water for drinking. These increased risks, raise the number of deaths in these months.

Table. 3: Shows the Month-wise distribution of Drowning victims

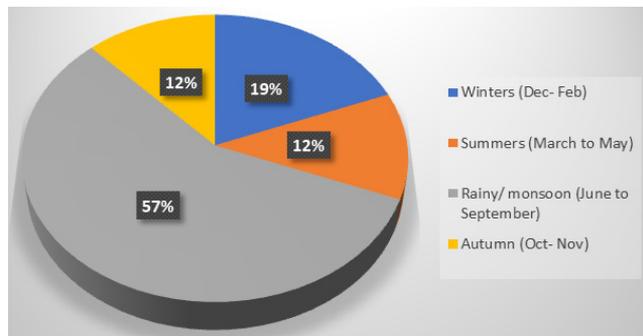| Month	Number	Percent (%)
January	5	5
February	12	12
March	1	1
April	6	6
May	5	5
June	7	7
July	18	18
August	13	13
September	19	19
October	10	10
November	2	2
December	2	2
Total	100	100

Figure 2: Shows a season- wise distribution of deaths by drowning

Table 3 shows presence of froth in 26 cases and was absent in 74 cases. It was observed that froth is mostly in present in bodies that are immersed in water for duration of 6-24 hours(97.1%). This association was statistically significant.

In comparision to the present study, Chidanand C and Satish K.V, 2015[11] saw presence of froth in 58% cases and NK Morris et al, 2015[15] recorded a plume of froth at the nostrils in 85 cases (31%). However, no correlation with increasing postmortem interval was done by both the authors. The presence of froth at nostrils and mouth is considered to be a major finding in diagnosing death by drowning and the absence of froth after 24- 48 hours in the present study indicated that with increasing submersion time, external foam is washed away or becomes so diluted with water that there is insufficient surfactant to produce external foam.

Another hypothesis is that after 24 hours surfactants can no longer function. This may be because the proteins are partially consumed or become too decayed, due to the combination of a warm and moist environment that bodies in water provide for the growth of micro organisms. Furthermore, a previous study demonstrated a poorer surfactant activity in mammals at 3 degrees Celsius than at 37 degrees Celsius. The cooling of a body after death may explain why external foam is not detected after a longer postmortem interval. Finally, another possible explanation for the disappearance of external foam after 24 hours is the half-life of surfactants, which has been described as ranging between 6.5 and 28 hours. Hence explaining the disappearance of froth beyond 24 hours[18].

Table 3: Relationship between presence of froth and Postmortem interval

Postmortem interval	Froth				p-value
	Present		Absent		
	Number	Percent%	Number	Percent%	
<6 hours	0	0.00	1	0.01	<0.001
6 –12 hours	11	42.30	0	0.00	
12 – 24 hours	14	53.80	4	0.05	
24 – 48 hours	1	3.80	26	0.35	
2-4 days	0	0.00	8	0.11	
3-5 days	0	0.00	14	0.19	
5-10 days	0	0.00	20	0.27	
>10 days	0	0.00	1	0.01	
Total	26	100.0	74	1.00	

Table 4 shows, middle ear hemorrhage is observed in total 77% of the bodies. 43% have unilateral hemorrhage while 34% have bilateral hemorrhage. The results are in accordance with Chidanand C and Satish K.V (2015) (21) who found middle ear hemorrhage in 73 cases (72.27%) and it was unilateral in 26 (25.74%) cases, bilateral in 47 (46.53%) cases. Rao PS and Guntheti BK (2021) (71) also observed 72 % cases with middle ear hemorrhage. The presence of middle ear hemorrhage is also in confirmation with Nelson R Niles (1963), who reported it in 80.4% of cases (bilateral in 68.63% of cases and unilateral in 11% of cases). Patrick .J . Antonelli et al, 1988[17] reported bleeding into middle ear as universal in all their cases and Alhemyari et al,1988[19] documented 75% of the cases that showed intracavitary hemorrhage in temporal bones, which included 75% of the right side and 73% of the 76 left side.

Maximum cases of middle ear hemorrhage were observed in time frame of 6 hours to 5-10 days, where it was present in 13 out of 14 cases with a postmortem interval of 3-5 days and 17 out of 20 cases with a postmortem interval of 5-10 days. It was observed that even with increasing postmortem interval, middle ear hemorrhage was a persistent finding with respect to the other significant finding of antemortem drowning such as presence of froth around mouth and nostrils which disappeared after 24 to 48 hours. This meant middle ear hemorrhage can be considered a reliable indicator to diagnose death due to drowning in decomposed bodies which are retrieved after a significant time, where other findings are inadequate and inconclusive.

Table 4: Shows the presence of middle ear hemorrhage and its relationship with Postmortem interval.

Time			Middle ear hemorrhage								p-value
	Unilateral		Bilateral		Absent		Total				
	n	%	N	%	n	%	n	%			
<6 hours	0	0.0%	0	0.0%	1	100.0%	1	100.0%			.04
6 –12 hours	6	54.5%	4	36.4%	1	9.1%	11	100.0%			
12 – 24 hours	10	55.6%	3	16.7%	5	27.8%	18	100.0%			
24 – 48 hours	5	18.5%	11	40.7%	11	40.7%	27	100.0%			
2-4 days	4	50.0%	3	37.5%	1	12.5%	8	100.0%			
3-5 days	10	71.4%	3	21.4%	1	7.1%	14	100.0%			
5-10 days	7	35.0%	10	50.0%	3	15.0%	20	100.0%			
>10 days	1	100.0%	0	0.0%	0	0.0%	1	100.0%			
Total	43	43.0%	34	34.0%	23	23.0%	100	100.0%			

Table 5 shows Multiple additional antemortem injuries were present in 29 cases and among those middle ear haemorrhage was present in 16 cases (55.10%). While in cases where additional injuries were absent (n=71), middle ear haemorrhage was observed in (n=61) 85.9% cases and was absent in (n=10)14.1% cases. This association was statistically significant signifying that before drowning even if an individual experienced external bodily trauma in the form of physical abuse by a perpetrator, or injuries sustained during the fall into the water or by the rocks or projections along the banks of the flowing water or if it's a false positive finding in case of postmortem submersion, this positive finding of Middle ear haemorrhage(85.9%) in the absence of any additional antemortem injuries becomes an important factor to conclude death caused due to drowning.

Table 5: Shows the relation between Middle ear haemorrhage and multiple additional antemortem injuries

		Multiple additional antemortem injuries					P- Value
		Present (n)	Percent (%)	Absent (n)	Percent (%)	Total	
Middle ear hemorrhage	Present	16	55.1 %	61	85.9 %	77	0.002
	absent	13	44.9 %	10	14.1 %	23	
	Total	29	100.0 %	71	100.0%	100	

Conclusion

Diagnosis of drowning in bodies recovered from water remains difficult and one of exclusion and is considered one of the most difficult tasks in the field of forensic medicine. Decomposition and delay in recovery of dead bodies from the water bodies may hamper the diagnosis of death by drowning. During the process of drowning, a negative pressure is created by violent gushing of the liquid medium in and out of lungs across the nasopharynx. It causes a suction effect within the middle ear through patent Eustachian tube. In the presence of intact tympanic membrane, a pressure differential is created across the membrane (positive pressure outside and negative pressure inside). It exerts a suction force on the walls of capillaries supplying the soft tissues of tympanic membrane, middle ear, mastoid air cells and inner ear, resulting in a spectrum of findings from mere congestion and oedema to frank hemorrhages due to rupture of the capillaries. The aforesaid negative pressure from the middle ear is very effectively transmitted to the mastoid than to the inner ear. Mastoid air cells are continuous with the middle ear cavity through Aditus antrum. Whereas, the middle and inner ears are separated by two membranous windows. Hence, the hemorrhages are more common in middle ear and mastoid [10,12].

The present study focused on the presence of middle ear hemorrhage as an additional marker to diagnose death by antemortem drowning along with presence of other findings or when other findings are negligible.

Conflict of interest: None

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Profile of Medico-Legal Autopsies Conducted at Tertiary Medico-Legal Centre in Northern Madhya Pradesh along with Effect of Lock Down

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Abstract

Introduction: Medico-legal post-mortem examinations are performed as mandatory legal procedures for establishing the cause of death for people dying in sudden, suspicious and unnatural circumstances. When COVID-19 came to India and Indian government declared a complete lockdown, the autopsy profile is changed.

Aims & Objectives: Demographic study and effect of lockdown on autopsy profile.

Methods: The present study is a retrospective study carried out in the Department of Forensic Medicine and Toxicology, GRMC, Gwalior Madhya Pradesh during the period of 1st January 2020 to 31st December 2020 and analysis of a total of 2170 cases, brought to the mortuary for medico-legal autopsy examination. Later on, the effect of lockdown is evaluated on the autopsy profile.

Result: The majority of victims were male 1571 (72.4%) cases and female 599 (27.6%) cases. The maximum number of post-mortem done in the age group 21-40 years was 1131 (52.12 %) cases and the minimum in the age group 0-10 year were 56 (02.58%) cases. Manners of death due to natural causes were 170 (07.8%) cases and unnatural 2000 (92.20%) cases. The Indian government declared a complete lockdown on the evening of 24 March 2020 for 21 days, which was further extended with some relaxation. Due to this event; the least number of autopsies was done in April (4.5%) which increased to its normal pattern by the end of June (10.6%). During this period i.e. April; there was a slight decrease in male victims (64.3%) and a slight increase in female victims (35.7%).

Conclusion: This study was conducted to determine the effect of lockdown on the autopsy profile. Our study shows that the effects of lockdownwere majorly seen in April month and later on, there was almost no effect of l ockdown.

Keywords: Autopsy profile, Covid-19, Lockdown, Suicide

Introduction

The term 'Autopsy' originates from ancient word 'Autopsia' which is derived from 'Autos' i.e. 'Oneself' and 'Opsis' i.e. 'to see for oneself'.[1] Post-mortem

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examination is just another term used for Autopsy. If we look in to the history, Imhotep (2980-2900 BC) who was the chief justice and chief physician to Pharaoh Zoster, the king of Egypt considered as a first medico-legal expert.[2]

Basically Autopsy is of two types: (1) Medico-legal and (2) Pathological. Here we discus about medico-legal autopsy. Medico-legal autopsy is done when police feels that death is sudden ordue to unnatural cause. In India, medico-legal autopsy is performed as a result of police or magistrate inquest i.e. 174CrPC or 176CrPC in a sudden, suspicious and unnatural death.[3] During autopsy all the body cavities are opened and examined.[4] Specific samples are preserved as per history and findings of autopsy to ascertain the cause of death. The basic aim of autopsy is to find out, cause of death, time since death and manner of death. In case of foetus, autopsy is performed to ascertain the viability status, live or dead born foetus along with sexing of foetus.[5] In case of unknown or decomposed dead bodies or human remains, the objective of autopsy is to find out the cause of death, time since death, manner of death and identification.

In India most of the centres for autopsy shows highest percentage of road side accident cases in its total autopsy profile. But when COVID-19 came in India and Indian government declare complete lockdown on the evening of 24 March 2020 for 21 days. Later on, Govt. extends this lockdown for more days with some relaxation.[6]

Aim and Objectives

Demographic study and effect of lockdown on autopsy profile.

Material and Methods

The present study is a retrospective study carried out in the Department of Forensic Medicine and Toxicology, GRMC, Gwalior Madhya Pradesh during the period of 1st January 2020 to 31st December 2020 and analysis of total 2170 cases, brought to the mortuary for medico-legal autopsy examination.

Data were collected using a pre-designed format from Post mortem registers/records, Inquest papers and Post mortem reports maintained in the department by keeping confidentiality strictly intact. The data was tabulated and analysis was done. Descriptive results are presented in table form.

Result and Discussion

Table no. 1: Age wise distribution of cases

Age group	No. of autopsies	Percentage %
Non-viable foetus	10	0.46
0-10 years	46	2.12
11-20 years	210	9.67
21-30 years	651	30
31-40 years	480	22.12
41-50 years	322	14.84
51-60 years	254	11.71
>60 years	197	9.08

Table no. 3: Sex and month wise distribution

Months	Male	Female	Total Post-mortem
January	112 (71.8%)	44 (28.2%)	156 (7.2%)
February	124 (78%)	35 (22%)	159 (7.3%)
March	128 (69.9%)	55 (30.1%)	183 (8.4%)
April	63 (64.3%)	35 (35.7%)	98 (4.5%)
May	120(69.8)	52 (30.2%)	172 (7.9%)
June	174 (75.6%)	56 (24.4%)	230 (10.6%)
July	139 (70.9%)	57 (29.1%)	196 (9%)
August	133 (72.3%)	51 (27.7%)	184 (8.5%)
September	140 (73.7%)	50 (26.3%)	190 (8.7%)
October	144 (72.4%)	55 (27.6%)	199 (9.2%)
November	139 (73.5%)	50 (26.5%)	189 (8.7%)
December	155 (72.4%)	59 (27.6%)	214 (9.9%)
Annual autopsy	1571 (72.4%)	599 (27.6%)	2170 (100%)

As per Table no. 1 majority of the autopsies done in the age group of 21-30 years where number of autopsies were 651 (30%) followed by the 31-40 years age group where 480 (22.12%) autopsies performed. In addition to this, a minimum number of autopsies was done in the age group of 0-10 years i.e. 46 (2.12%) including non-viable foetus i.e. 10 (0.46%). The findings of this study are consistent with the findings of Mugadlimath et al.,[7] Radhakrishna et al.,[8] Khanna et al.,[9] Patel et al.,[10] and Wasnik et al.[11] which shows similar trends in their studies. This is generally seen because 20-40 years age group are very active and economically productive and most of them perform daily commute for their livelihood.

Table no 2: Month and cause of death wise distribution

Month	Pathological	RSA	Poisoning	Hanging	Burn	Homicide	Drowning	Electrocution	snakebite	miscellaneous (decomposed bodies, skeleton, foetus, dog bite	Total
January	15(9.6%)	78(50%)	16 (10.3%)	13 (8.3%)	11 (7.1%)	15 (9.6%)	3 (1.9%)	1 (0.6%)	0 (0%)	4 (2.6%)	156
February	14(8.8%)	84(52.8%)	11(6.9%)	16(10.1%)	14(8.8%)	12(7.5%)	2(1.3%)	2 (1.3%)	0(0%)	4 (2.5%)	159
March	18 (9.8%)	90 (49.2%)	15 (8.2%)	20 (10.9%)	22 (12%)	10 (5.5%)	5 (2.7%)	1 (0.6%)	0 (0%)	2 (1.1%)	183
April	14 (14.3%)	27 (27.6%)	6 (6.1%)	23 (23.5%)	19 (19.4%)	3 (3.1%)	1 (1%)	1 (1%)	1 (1%)	3 (3%)	98
May	16 (9.3%)	84 (48.8%)	12 (7%)	19 (11%)	23 (13.4%)	10 (5.8%)	0 (0%)	2 (1.2%)	1 (0.6%)	5 (2.9%)	172
June	20 (8.7%)	102 (44.3%)	37 (16.1%)	32 (13.9%)	10 (4.3%)	14 (6.1%)	4 (1.8%)	7 (3%)	0 (0%)	4 (1.8%)	230
July	12 (6.1%)	93 (47.4%)	19 (9.7%)	32 (16.3%)	18 (9.2%)	8 (4.1%)	0 (0%)	4 (2%)	5 (2.6%)	5 (2.6%)	196
August	11 (6%)	75 (40.8%)	12 (6.5%)	31 (16.8%)	12 (6.5%)	11 (6%)	8 (4.3%)	9 (4.9%)	11 (6%)	4 (2.2%)	184
September	13 (6.8%)	95 (50%)	28 (14.8%)	20 (10.5%)	13 (6.8%)	9 (4.7%)	3 (1.6%)k	4 (2.1%)	4 (2.1%)	1 (0.6%)	190
October	8 (4%)	95 (47.7%)	22 (11.1%)	39 (19.6%)	17 (8.6%)	6 (3%)	1 (0.5%)	4 (2%)	4 (2%)	3 (1.5%)	199
November	14 (7.4%)	98 (51.9%)	26 (13.8%)	25 (13.2%)	16 (8.5%)	7 (3.7%)	1 (0.5%)	0 (0%)	0 (0%)	2 (1%)	189
December	15 (7%)	116 (54.2%)	20 (9.3%)	35 (16.4%)	16 (7.5%)	6 (2.8%)	2 (0.9%)	0 (0%)	0 (0%)	4 (1.9%)	214
Total	170 (7.8%)	1037(47.8%)	224(10.3%)	305(14.1%)	191(8.8%)	111(5.1%)	30(1.4%)	35 (1.6%)	26(1.2%)	41 (1.9%)	2170

As per Table no. 2, most of the victims were male i.e. 1571 (72.4%) followed by females i.e. 599 (27.6%) A similar finding was observed in a study by Mujadlimath et al.[7]Costache et al.,[12] Radhakrishna et al.,[8]Khanna et al.,[9] Saurav et al.,[13] males were in the range of 76.77% to 91% and females 9% to 24.23% cases. This is because in our society, generally earning members are males, while females are usually engaged in household work. So males are more prone to accidents and violence-related deaths.

As per Table No. 2, the maximum number of autopsy cases was done in the month of June i.e. 230 cases (10.6%) while the minimum in April i.e. only 98 cases (4.5%). Further, a trend was observed that the majority of autopsies were done in the month of June to December i.e. 1402 cases (64.6%) while minimum autopsies were done from January to May i.e. 768 cases (35.3%). This is slightly different from the findings of Singh et al[14] where more autopsy cases occurred between April to July (45.75%). Similar findings are seen in studies by Patel et al.[10] and Awdesh et al.[15] This change in trend was because of the nationwide lockdown implemented on 24th March 2020 for 21 days which was extended for further more days with some relaxation. This lockdown in March and later days led to fewer autopsies in earlier months and after relaxation in lockdown, movement of people increased which was responsible for majority of autopsies from June and later months.

As per Table no. 3, the leading cause of death was RSA about 1037 cases (47.8%) followed by hanging about 224 cases (14.1%), poisoning 224 cases (10.3%), Burn 191 cases (8.8%), pathological causes 170 cases (7.8%), homicide 111 cases (5.1%) and rest of cause of death share small percentage like drowning, electrocution, snake bite etc. Trends of RSA in our study are similar to the study of Radhakrishna et al.,[8] Junaidin et al.,[16]Amakiri et al.,[17] and Odesanmi et al.,[18] were RSA ranged from 55.7% to 78% cases. In a study conducted by Radhakrishna et al.,[8] found that death due to hanging was 40% and poisoning 25% cases which is similar as compared to the study done by us 14.1% and 10.3% cases respectively. In studies done by Mujadlimath et al.,[7] and Shrivastava et al.,[19] noticed higher 22.6% to 37.5% cases of death due to burns as compared to our study of burns 8.8% cases.

In April suddenly the rate of RSA, homicide, and drowning dropped significantly and the rate of pathological deaths, hanging, and burns increased as compared to other months. This sudden change in trend is due to lockdown policy of India government.

Conclusion

This retrospective study was done in the department of Forensic Medicine & Toxicology, GR Medical College, Gwalior, Madhya Pradesh to know the profile of autopsies done during 1st January 2020 to 31st December 2020. Total of 2170 autopsy details are noted. In our study we found that majority of victims are male. Age group from 21-40 years are mostly involved. Most of the autopsies were done after June. RSA is the major cause of death followed by hanging. Sudden drop in autopsy rate of RSA, homicide and drowning while rise in pathological deaths, hanging and burn in the month of April. The study will help the government and there policymakers to make necessary changes or improvement in health polices for effective implementation of medical and public health services.

Source of funding: None

Conflict of Interest: None

Ethical Concerns: As per the law of India, if an autopsy is performed in a medicolegal case the consent of the family member is not desired. Identity and credentials of the victim are kept confidential and the clearance from the institutional ethics committee is not warranted.

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A Cross Sectional Study of Medico-Legal Deaths in Adolescent Age Group Autopsied at Tertiary Care Hospital in Central Karnataka

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Abstract

Background: An adolescent is defined as an individual aged between 11-19 years. They constitute about 21% of the Indian population. Mortality and morbidity occurring in this age group are mostly due to preventable causes. Mortalities in adolescents are cause of concern because they are the future of nation forming a major demographic and economic force. The purpose of this study is to analysis mortality in adolescents.

Methods: The present study is a hospital based, cross sectional and observational study of autopsy reports, police inquest forms, medico-legal case register of medico-legal deaths of adolescent age group victims of ages from 11 to 19 yrs. for a period of three years from January 01, 2020 to December 31, 2022 autopsied at department of Forensic Medicine & Toxicology and in patient case records from Medical Record Department. The cases were evaluated according to age, sex, the cause and manner of death and findings of toxicological analysis. Data was classified and statistically analyzed.

Conclusion: The majority of adolescent deaths were found to be related to external causes, in particular unintentional injuries. The accidental deaths accounts for 75.75% followed suicidal deaths (21.21%). Use of appropriate safety measures and strict law enforcement may significantly reduce accidental deaths in adolescents. Suicides may be prevented by identification of risk factors significant family support and counselling by child psychologist.

Key Words: Adolescent's deaths, Accidents, Suicides, Autopsy.

Introduction

Adolescence is a transitional stage of physical, physiological and psychological development from puberty to adulthood. In the history, the term 'adolescent' was first used in 15th century.[1] WHO defines an adolescent as an individual aged from 11 to 19 years i.e., those in the second decade of their lives.

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In India about 21% (243 million) of population are adolescents.[2] The period of adolescence and puberty have a special importance because it is the most beautiful, most powerful, and most hopeful period of human life.[3] The adolescents are more prone to the dangers of life and are more vulnerable in the face of unnatural events. These characteristics can lead to death of adolescent victims.[4] Mortality and morbidity occurring in this age group is mostly due to preventable causes. Studies showed that about 70% of deaths among adolescents were due to preventable causes such as unintentional injuries, homicides and suicides.[5] According to a study which included the statistics of 187 countries and was reported by Lazano et al.,[6] the road traffic accidents constitute the primary reason of death among those aged 10-19 years. A study of Analysis of medico legal deaths in adolescence conducted by Lalchandra V, Vinod KG, Sachin KM[7] in Kota region of Rajasthan reported more than half of the total adolescent deaths (51%) were due to accidents, followed by suicides (43%). A study conducted in western country, by Minino A[8] in United States reported 68% of all deaths from 1999 to 2006 were between the ages of 12-19 years.

Adolescence is commonly regarded as a healthy time of life, with a peak in strength, speed, fitness, and many cognitive abilities. The unnatural deaths may be due to unintentional or intentional injuries. Unintentional injuries are mainly accidents. Intentional injuries are mainly suicides. During the last decade, unnatural deaths were more common than natural deaths (disease) among adolescents with vehicular accidents accounting for a lion's share.[9]

The use of poisons for suicidal and homicidal purposes dates back to the Vedic era in India. It is reported that 1 to 1.5 million cases of poisoning occur every year, of which nearly 50,000 died.[10] The last quarter of the century has seen tremendous advances in the fields of agriculture, industrial technologies, and medical pharmacology. These advances have been paralleled by remarkable changes in the trends of acute poisoning in developing countries, including India.[11]

Aims and Objectives:

1. To Analyze the Socio-Demographic Profile of Victims of Medico-Legal Deaths in Adolescent Age Group Autopsied from January 01, 2020 to December 31, 2022.

2. To Determine the Cause and Manner of Medico-Legal Deaths in Adolescents Autopsied from January 01, 2020 to December 31, 2022 and To Learn How to Prevent Such Mortalities.

Materials and Methods

The present study is a hospital based, cross sectional and observational study of autopsy reports, police inquest forms, medico-legal case register of medico-legal deaths of adolescent age group victims of ages from 11 to 19 yrs. for a period of three years from January 01, 2020 to December 31, 2022 autopsied at department of Forensic Medicine & Toxicology and in patient case records from Medical Record Department of S. S. Institute of Medical Sciences & Research Centre, Davangere, Central Karnataka , which form the material for the study.

Then, the information furnished by the police in inquest forms, history and detailed information regarding circumstances of death are reviewed for additional information in MLC registers and in patient case records which are usually not recorded in the autopsy reports. The cases are evaluated according to age, sex, the cause of death, the manner of death and findings of toxicological analysis are noted in autopsy case report form. Information pertaining to the time and manner of death, reasons for the death was sought from the police inquest &post mortem examination reports. The data is collected in autopsy case report forms and the collected data is processed using Microsoft Excel and tabulated to deduce findings of the study.

Observations and Results

The present study period isfor three years from January 01, 2020 to December 31, 2022. During the study period total 412 cases were autopsied, out of which 66 victims were adolescents, these cases PM reports, inquest forms and patient case records evaluated & analyzed at Medical Record department at SS hospital & Department of Forensic Medicine, S. S. Institute of Medical Sciences & Research Centre, Davangere. Statistical analysis results obtained using SPSS software, chi square test is formed and p value noted from the result is less than 0.05.

Distribution of cases during the study period: During the study period, total 412 cases were autopsied at S S Hospital mortuary, SSIMS & RC i.e., from 1st January 01, 2020 to December 31, 2022, out of which 66 cases were belonged to the adolescent age group of 11 to 19 years. So, the prevalence of adolescent deaths was 16.01%.**(Table-1)**

Table 1: Distribution of cases during the study period:

Total No. of autopsy cases	412
Total No of Adolescents autopsy cases	66
Percentage of Adolescents autopsy cases	16.01%

Sex wise distribution of cases: Out of 66 autopsied cases studied, 46 were male adolescents (69.69%) and 20 were female adolescents (30.30%). **(Fig- 1)**
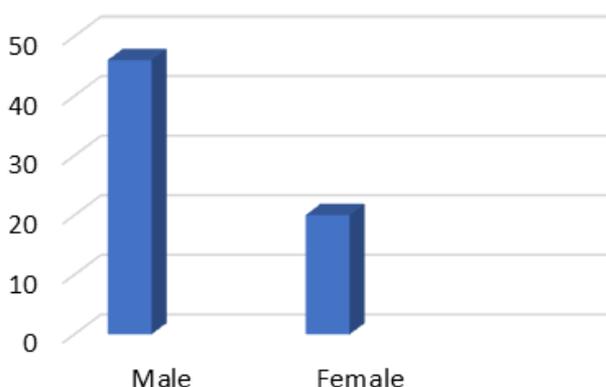

Fig 1: **Sex wise distribution of cases**

Age wise distribution of cases: Among 46 male adolescents, 11 males (23.91%) belonged to early adolescent age group of 11-14 years and 35 male adolescents (76.08%) were belonged to from 15 to19 years age group. Among female adolescents out of 20 cases, majority of the cases i.e., 15 female adolescents were belonged to from 15 to 19 years age group (75%) while only 05 (25%) cases were belonged to early adolescent age group of 11-14 years. (Fig 2) From the above observation it can be inferred that late adolescent period, i.e., 15 to 19 years age group is more prone and vulnerable group of adolescent unnatural deaths.
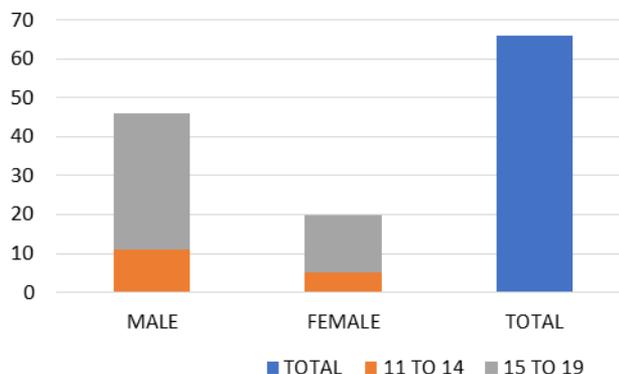

Fig 2: **Age wise distribution of cases**

Region wise distribution of cases: Among total of 66 adolescents 44 cases (66.66%) were in rural area and 22 cases (33.33%) were noted in urban area. (Fig 3) The incidence was highest in rural areas when compared to urban areas.
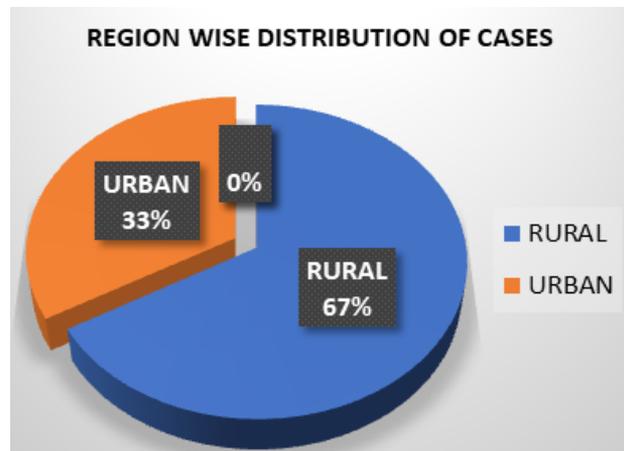
Fig 3: Region wise distribution of cases

Distribution of cases according to Manner of Death: Among 46 male adolescents, 34 male adolescents (73.91%) suffered accidental deaths followed by 10 cases of suicidal deaths (21.73%) and 2 male adolescents died due to natural diseases (4.34%).

Among 20 female adolescents, 16 cases (80%) were succumbed to death due to accidental manner (80.00 %) followed by 04 cases were suicidal (20.00%) in nature and no homicidal cases were noted in both male & female adolescents. (Table 2)

Table 2: Distribution of cases according to Manner of Death

	Accidents	Suicides	Homicides	Natural	Total
Male	34	10	00	02	46
Female	16	04	00	00	20
Total	50	14	00	02	66
Percentage	75.75%	21.21%	00%	03.03%	100%

Distribution of cases according to Cause of Death: Among 66 adolescent victims, 28 adolescent victims (M:22, F:06) were died due to Road Traffic Accidents (42.42%), 13 adolescent victims (M:04, F:09) were died due to Poisoning (19.69%), 08 adolescent victims (M:02, F:06) were died due to Hanging (12.12%), 06 adolescent victims (M:04, F:02) were died due to Fall from height (09.09%), 5 adolescent victims (M:04, F:01)were died due to Snake bite (07.57%), 2 male adolescent victims were died due to Drowning (03.03%), 2 male adolescent victims were died due to Electrocution (03.03%) and 2 adolescent victims (M:1,F:1) were died due to Natural diseases (03.03%). (Table 3)

Table 3: Distribution of cases according to Cause of Death

Cause of Death	Male	Female	Total No. of Cases	Percentage (%)
Road Traffic Accidents	22	06	28	42.42%
Poisoning	08	05	13	19.69%
Hanging	02	06	08	12.12%
Fall from height	04	02	06	09.09%
Snake bite	05	00	05	07.57%
Drowning	02	00	02	03.03%
Electrocution	02	00	02	03.03%
Natural diseases	01	01	02	03.03%
Total	46	20	66	100.00%

Distribution of cases according to Time & Days of Incident: Out of 66 adolescent cases in the current study, 34 adolescent victims suffered the incident during afternoon hours i.e., from 2pm to 6 pm, 16 adolescent victims in morning hours i.e., from 6 am to 2 pm and another 16 cases incident occurred during night hours (8pm to 6am). (Table 4)Most of the adolescent victims experience the hardship during holidays time (N= 38) followed by school days.(N=28) (Fig 4)

Table 4: Distribution of cases according to Time of Incident:

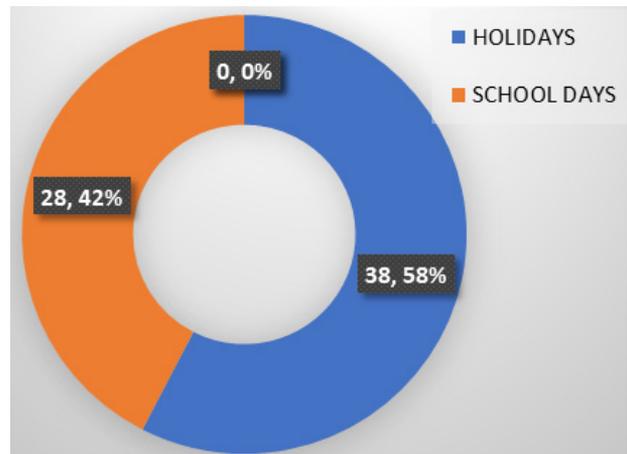| Time of Incident	No. of Cases	Percentage
Morning Hours (8am to 2pm)	16	24.24%
Afternoon Hours (2pm to 6pm)	34	51.51%
Night Hours (8pm to 6am)	16	24.2 %
Total	66	100%

Fig 4: Distribution of cases according to Days of Incident

Discussion

Unnatural deaths claim a substantial number of adolescents lives in developing countries like India. This particular section of society is verymuch needed for building the nation in the future.

The total of 412 cases were autopsied during the study period, out of which 66 cases were belonged to the adolescent age group of 11 to 19 years. So, the prevalence of adolescent deaths was 16.01%. the incidence correlates with study conducted by Sleet DA & others.[12]

Out of 66 autopsied cases studied, 46 were male adolescents (69.69%) and 20 were female adolescents (30.30 %). Out of 46 male adolescents, 11 males (23.91%) belonged to early adolescent age group of 11-14 years and 35 male adolescents (76.08%) were belonged to from 15 to 19 years age group. Among female adolescents out of 20 cases, majority of the cases i.e., 15 female adolescents were belonged to from 15 to 19 years age group (75%) while only 05 (25%) cases were belonged to early adolescent age group of 11-14 years. From the above observation it can be inferred that late adolescent period, i.e., 15 to 19 years age group is more prone and vulnerable group of adolescent unnatural deaths. This finding is similar to previous studies conducted in Bangalore.[13]

The incidence of adolescent deaths was highest in rural areas when compared to urban areas, which has concurrence with the observation made by Kumar A et.al who found in their study conducted at Varanasi involving adolescent age group that 88.37% were rural inhabitants.[14]

Among 66 adolescent victims, majority of adolescent deaths occurred due to Road Traffic Accidents (42.42%), followed by Poisoning (19.69%), Hanging (12.12%), Fall from height (09.09%), Snake bite (07.57%), Drowning (03.03%),Electrocution (03.03%) and Natural diseases (03.03%). Previous study reports by Sleet DA & others 20 show that among adolescent unnatural deaths, fatalities from road traffic accidents (RTA) are prevalent same as observed in the present study. Kanchan T et.al reported in their study conducted at Manipal that Road traffic injuries were responsible for maximum mortalities (38.4%). Males comprised 59.6% of cases. Male-to-female ratio was 1.5:1. Males predominantly died of traffic injuries (45.2%), whereas females as a result of burns (37.4%).[15]

In our study, out of 66 adolescent cases, 34 (51.51%) victims suffered the incident during afternoon hours i.e., from 2pm to 6 pm followed by 16 victims in morning hours i.e., from 6am to 2pm and another 16 cases incident occurred during night hours (8pm to 6am). More deaths during afternoon hours could be attributed to more traffic from 2pm to 6 pm, reckless riding by teenagers after school hours and negligence by the parents/care-takers Most of the adolescent victims experience the hardship during holidays time (N= 38, 57.57%) followed by school days (N=28, 42.42%)due to more exposure of adolescents with their peers to the external environment like bike ride, lakes/pools, playful and careless attitude during holidays time. Similar observation is reported in the study conducted by Amy E Peden et al.[16]

In the present study, out of 66 adolescent victims 14 victims (21.21%) committed suicide by employing various methods. Poisoning was the most preferred method used to commit suicide with 08 cases (12.12%) out of 66 cases, followed by 06 cases (06.06%) of Hanging. In the current study suicide was the second leading cause of death in adolescent's secondary to accidental deaths, this correlates with the previous studies.[17, 18]

The studies conducted in rural areas of India poisoning are the first preferred method to commit suicide because of the easy availability of poisons. Drowning is more in studies conducted in coastal regions. Drowning as a method of suicide is known to occur, but has primarily been described in environments with readily available access to water, such as coastal regions. Drowning remains a significant public health concern, as it is a major cause of disability and death, particularly in children.[19]

In this study most of the cases took place in the rural area which might be due to multiple causes like high probability of snake bite, drowning, death caused by easy accessibility of pesticides at household level etc. As per Ghatak S[20] the most suicidal deaths took place in rural areas because of the higher availability of pesticides combined with poorer access to emergency medical care in such areas. The study by Meel B L[21] reported that trauma accounted for 70.9% deaths and 29.1% deaths were due to other causes such as hanging, drowning, falls from a height and poisoning.

In the present study majority of suicidal deaths in adolescents occurred due to love failure, failures

in exams, after a quarrel with parents for silly issues. As it is possible that Internet-based social sites may facilitate these suicidal phenomena, investigations should include an evaluation of the victim's internet access before the incidence & if so, measures to be taken to curb the potential risk of similar actions by peers.

Conclusion

Adolescence is viewed as a transitional period between childhood and adulthood, whose cultural purpose is the preparation of children for the adult roles. Death in adolescent age is a potential life loss to family and society and reflects socioeconomic and Medical Health Care status at the National and Regional level. Accurate information on the causes and circumstances of such deaths must be obtained by medico-legal investigations and is essential in creating awareness among National policymakers and educators/caregivers, to prevent adolescent deaths.

Inappropriate media reporting practices can sensationalize and glamourize suicides and increase the risk of copycat suicides (imitation of suicides) among vulnerable people. Responsible reporting by media includes, avoiding detailed description of suicidal acts, avoiding sensationalization and glamorization, using responsible language& try to minimizing these suicide reports. The media must start educating the public about the suicide and providing information as to where they can seek help (E.g.: Help line numbers) for their mental health issues. The education department must mandate the school's administrations to make the availability of *child psychologists* around the clock for seeking necessary help by the adolescents and parents.

The current study is throwing light upon the magnitude of adolescent's mortality and urgent need of preventive measures in order to curb these unnatural deaths and to save these valuable lives. The study results providing us a valuable information on unnatural deaths in adolescents and the study data can be used by the stake holders and law enforcement authorities to decrease such preventable mortalities in future like use of appropriate safety measures and strict road traffic rules, which might significantly reduce the accidental deaths in adolescents. Suicides

may be prevented by identification of risk factors (mood disorder, impulsive behaviour) by school teachers, parents / caretakers and timely referral to child psychologist. Additionally, we think that the expansion of free youth counseling centers to provide psychological support for adolescents and teenagers will reduce mortality in this age group.

Behaviour change communication by parents, teachers, child psychologists / psychiatrists, career guides, law keepers and other stake holders for fostering friendly environment for upbringing of adolescents is needed to decrease such preventable medico-legal / unnatural deaths and to save these valuable lives for their better future as they are considered as strength of our nation.

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An Analysis of Head Injury in Fatal Motorized Two-Wheeler Accidents and its Association with Compliance with the Traffic Laws in a City in Central India

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Abstract

In developing nations, road traffic accident is the leading cause of mortality for people under the age of 50. 80,000 people die in road accidents every year, accounting for 13% of all deaths worldwide. The motorized two-wheelers are one of the most common mode of transport in India. Skull fracture is the most common type of head injury in fatal motorized two-wheeler accidents. Creating an effective enforcement campaign with targeted compliance rates, combined with a well-planned public awareness campaign, can increase compliance and save thousands of lives. Motorized Two-Wheelers should be subject to strict speed control regulations. The government should imply rules for increasing safety features in the Motorized Two-Wheelers, particularly of the cheaper ones. The sale and purchase of the used Motorized Two-Wheelers should be regulated through proper channels. Periodic testing of the Motorized Two-Wheelers should be made mandatory. In this study, we analyzed the head injuries sustained in fatal motorized two-wheeler accidents as seen in postmortem examination of the fatalities due to the mentioned cause. We hope that the results of this study contribute valuable insights which would further help in formulating necessary policies and work towards to a safer community by helping in reducing the toll of motorized two-wheeler accidents.

Keywords: Road traffic accident, motorized two-wheelers, head injury, helmet, compliance with the law

Introduction

Accident is an event that occurs suddenly, unexpectedly and inadvertently under some unforeseen circumstances. In developing nations, road traffic accident is the leading cause of mortality for people under the age of 50. The pattern of injury, fatal or not, varies a lot depending upon whether the victim is a vehicle occupant, a motorcyclist, a cyclist or a pedestrian. In spite of recent advancement in the

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fields of technology and medical sciences, death and deformities following road-traffic accidents are yet to be controlled successfully rather incidences of RTA have been increasing at an alarming rate everywhere.[1] As two-wheelers are very inexpensive to acquire and maintain compared to other vehicles, the number of two-wheeled vehicles is rising worldwide, especially in developing nations. The motorbike has become a common mode of transportation due to its mobility, speed, and ease of avoiding traffic jams on the road as well as its ability to maneuver over challenging terrain.[2] Traffic accidents cause the loss of thousands of lives and serious injuries to millions of people every year. In India itself, around 80,000 people die in road accidents every year, accounting for 13% of all deaths worldwide. The man behind the wheel plays an important role in most accidents.[3] Although the number of people killed in traffic accidents in high-income countries has declined in recent decades, the burden of traffic accidents on the majority of the world's population is increasing significantly in terms of social and economic costs. Injuries and deaths from road traffic accidents (RTA) are a major public health concern in developing countries, where more than of the 85% of all deaths and 90% of disability-adjusted life years are lost to road traffic injuries. The risk to the community from traffic accidents on the roads is serious. At the time of a road accident, several factors play a role, the main ones being human error in relation to the driver and the victim due to bad traffic feeling, driving on the wrong side of the road, speeding, mechanical failure of the vehicle, road and weather conditions, traffic congestion, interventions into the road, violating traffic rules, drunk driving, using mobile phones/headphones while driving, tripping, poor compliance with signs, poor lighting conditions, bad parking habits, not using the turn signal, allowing animals on the road etc.[4]

Aims & objectives:

1. To analyze the head injuries sustained in fatal motorized two-wheeler accidents.

2. To find out the association of compliance of the law and fatal motorized two-wheeler accidents.

Materials and Methods

The present study was conducted at Department of Forensic Medicine & Toxicology, Gandhi Medical College, Bhopal (M.P.) from September 2021 to August 2022. All the deaths pertaining to the fatal motorized two-wheeler accidents brought to the Gandhi Medical College Mortuary during this study period have been included. The history regarding the circumstances of the accidents and other relevant data was collected through the autopsy requisition form and through the thorough history taking from the police personnel, friends, relatives etc.

Study design:

A descriptive, observational, cross-sectional study.

Results

Present study was done in Department of Forensic Medicine & Toxicology, Gandhi Medical College, Bhopal, from January 2021 to August 2022. Out of 4590 autopsies performed in the Department of Forensic Medicine & Toxicology, Gandhi Medical College, Bhopal, over the study period, 878 cases of fatal motorized two-wheeler accidents were reported. Therefore, the proportion of deaths due to fatal motorized two-wheeler accidents is 19.13%.

Head injury was the cause of death in majority of the victims, (69%). Among all the victims, only 57 (6.5%) were wearing helmet at the time of the accident and all of them were driving. None of the pillion rider was wearing helmet at the time of accident. Even among the helmeted riders, traumatic head injury was the most common cause of mortality (56.1%).

Analysis of head injuries shows that skull fracture was the commonest form of injury seen (67.65%). The subdural haemorrhage (86.3%) was most common type of haemorrhage seen in the head injuries (Table 1), which was followed by the subarachnoid haemorrhage (56.9%). Linear fracture was the most common type of skull fracture in all the skull bones (table 2). Diastatic fracture of the sagittal suture was most common followed by the fracture of the coronal suture (Table 3).

In helmeted riders, skull fracture was observed in 22 out of 57 (38.6%) cases, the most common being the fracture of the base of skull. Anterior cranial fossa is the most common (n=21) followed by middle cranial fossa fracture (n=19).

Table 1: Internal injuries over head seen in fatal motorized two-wheeler accidents

Internal Injuries	Number
Subscalp haematoma	106
Extradural haemorrhage	163
Subdural haemorrhage	523
Subarachnoid haemorrhage	345
Blood in Ganglia	12
Blood in Ventricles	10
Blood in both ganglia and ventricles	12
Contusion necroses	77
Frontal bone fracture	211
Parietal bone fracture	204
Temporal bone fracture	179
Occipital bone fracture	64
Anterior cranial fossa fracture	217
Middle cranial fossa fracture	187
Posterior cranial fossa fracture	64
Diastatic fracture	183

Table 2: Types of skull bone fractures seen in fatal motorized two-wheeler accidents

Bone	Linear Fracture	Depressed Fracture	Comminuted Fracture
Frontal	148	32	31
Parietal	163	23	18
Temporal	179	3	10
Occipital	52	7	5

Table 3: Sutural fractures seen in fatal motorized two-wheeler accidents

Fracture	Number
Coronal	50
Sagittal	72
Squamous	33
Lamboid	28

Discussion

Analysis of head injuries shows that skull fracture was the commonest form of injury seen (67.65%). The subdural haemorrhage (86.3%) was most common type of haemorrhage seen in the head injuries, which was followed by the subarachnoid haemorrhage (56.9%). The frontal bone was most common bone fractured (34.8%), followed by parietal

(33.7%) and temporal (29.5%) bones. Among the base of skull fractures, the anterior cranial fossa fracture was most common, accounting for 35.8%, followed by the middle cranial fossa (30.9%) and least common was posterior cranial fossa fracture (10.7%). Sutural or diastatic fractures were present in 30.2% of the cases with head injury. Linear fracture was the most common fracture encountered in all the skull bones (n=542). The 2nd most common fracture of temporal bone is comminuted fracture (n=10) while the depressed fracture is the 2nd most common in the remaining skull bones (n=59). Among the diastatic fractures, the fracture of the sagittal suture was the most common (39.3%), followed by the fracture of coronal suture (27.3%). The lambdoid suture fracture was the least common (15.3%). These findings are consistent with the findings done by Anand Menon et al[5] and K. Ravimuni et al.[6] However, in a study done by Nguyen Tuan Anh et al in Vietnam, it was observed that fractures of the temporal bone (68.6%) were most common and the fractures of the parietal bone were least common[7], which is in contrast to the findings of this study.

In helmeted riders, 22 out of 57 (38.6%) suffered any kind of skull fracture. The most common fracture in helmeted riders is fracture of the base of skull. Anterior cranial fossa is the most common (n=21) followed by middle cranial fossa fracture (n=19). The probable reason for that may be over speeding or sub-standard helmets. This finding is consistent with the findings of Tom Gibson et al who observed that in the majority of the cases, full-face helmets were worn and in 59% of these cases, base of skull fracture was present.[8] The prevalence of base of skull fracture could be primarily caused by due to the severity of the impact causing migration of the skull fracture to the base of the skull (and other regions of the head).

Anand Menon, Vishwas K Pai, A Rajeev in their study done in Mangalore found that there were skull fractures in 88.88% of the patients. In 88% of instances, vault fractures, skull fractures, or a combination of both were discovered. Fissured fractures were discovered in the majority of patients (23%). Subdural and subarachnoid haemorrhages made up the majority of intracranial haemorrhages (52.63% and 27.27%, respectively).[5] Wittayarungruengsri et al in Bangkok also reported that head injuries

accounted for 51.4% of the cause of death of victims of fatal motorcycle injuries in that series.[9] Kraus et al. revealed in a research conducted in California, USA, that brain damage accounted for 56% of fatally wounded motorcycle accident victims.[10] Deceleration forces, particularly rotational kinetics, are commonly responsible for brain damage.[11] Deceleration injuries, such as multifocal vascular injury, concussive brain injury, or diffuse axonal injury, may happen as a result of the differential movement of the body's fixed and non-fixed components, such as the skull and brain.[12] Serious traumatic brain injuries really cost 13 times more to treat than damage to other parts of the body.[13] Even among helmeted motorcyclists, traumatic brain injury remains the greatest cause of mortality.[9]

There are many different kinds of helmets for motorcycles; full-face, half-face, open-face, flip-up, and full-coverage helmets.[14] The effectiveness of the various types of helmets has not been thoroughly examined.[15] According to the US Centers for Disease Control, full face helmets provide the maximum protection, shielding the eyes with a face shield and safeguarding the chin.[16] Fitzharris et al. discovered in India that the chance of receiving a mild to severe head injury was 5 times higher if a helmet was not worn.[17]

Carasco et al, on the other hand, stated that, despite mandatory helmet wear in Brazil, head trauma was remained the most prevalent injury found.[18] According to the author, the trauma dynamics in a motorbike collision are so severe that even wearing a helmet is unable to safeguard against brain injury.

Fixed and non-fixed components of the body, such as the skull and brain, move differently at high speeds, and brain damage due to deceleration may occur.[19] Ritchter et al. also noted that if the chin strap is not tightly attached, a helmet might be lost at high speeds.[11]

Helmet use laws in India and their compliance:

Many people in India do not take helmet-wearing laws seriously. A third-party insurance policy for bikes is also required by the Indian Motor Vehicles Act, in addition to the helmet. The law requires pillion riders, as well as riders in the front, to wear helmets. If one does not follow the helmet rules in India,

he/she may face hefty fines. The Motor Vehicles Amendment Act 2019 included 63 new clauses that increased penalties for a variety of traffic offences. One of the offences mentioned in the amendment was the failure to wear a helmet. Section 129 of this Act states that anyone over the age of four must wear "protective headgear" while riding a bike.[20]

Half helmets are not permitted under Indian helmet laws because they do not provide adequate head protection. The Government of India has issued guidelines requiring all helmet manufacturers in India to produce helmets that comply with the Bureau of Indian Standards (BIS). Certain regulations regarding the helmets include:[20]

a. The helmet's thickness should be 22-25mm, and good-quality foam should be used.

b. The helmet's weight limit was reduced from 1.5kg to 1.2kg.

c. The ISI (IS 4151:2015)[21] mark is mandated by law on all helmets.

d. The material of the eye-covering in the helmet must be completely transparent to avoid any kind of obstruction to driver's vision and all helmets must pass the BIS's prescribed tests. [20]

However, there are certain instances like limiting the helmet use for women and children and eliminating the helmet requirement for light capacity motorized two-wheelers by Karnataka Government, demonstrate that state governments have repeatedly acted outside the law within the scope of their rule-making authority and have made rules that are contrary to MVA Section 129.[22]

The Ministry of Road Transport and Highways published the Central Motor Vehicles (Second Amendment) Rules, 2022. The new rules state that the speed of a motorcycle with a child under the age of four years on the pillion cannot exceed 40 km/h. These rules will take effect one year after the Central Motor Vehicles (Second Amendment) Rules, 2022 are published.[23]

In a study done in Pune, Maharashtra, total of 769 motorcycle riders were observed, with 20% of them riding as pillion passengers. An examination

of the photographs revealed a dismal 16% use of helmets. Helmets were worn by only 2% of the pillion riders observed. The study also discovered a significant gender disparity in compliance, men (18%) are more than twice as likely to wear a helmet as women (8%). People wore helmets more in areas with a lot of commercial and educational establishments, possibly because they were travelling longer distances, whereas in quieter and residential areas, compliance was almost non-existent. In the same study, 110 interviews were also conducted, and the results show that weight, an unattractive and poor design, the belief that accidents were unlikely, and the belief that short distances and low speeds did not necessitate the wearing of helmets were the major reasons given for non-compliance. Feeling hot and uncomfortable was the main justification, followed by "restriction of vision." 59% of respondents said "tighter enforcement" would encourage helmet use, and 32% said "changes in helmet design" would have an effect. The rationale included a small increase in fines and more affordable pricing. 63% of two-wheeler riders felt unsafe riding their bikes in the city, and 70% did not believe that pillion riders needed to wear helmets.[24]

In another study done by S. Wadhiwa et al, it was found that in Hyderabad, India, self-reported helmet use is 1.3 times higher than actual helmet use. Men, young people, having less education, and not owning a helmet are linked to not wearing helmets. Male gender, youth, lack of education, riding a motorcycle with a smaller engine capacity, and using the motorcycle for leisure are all linked to over reporting of helmet use.[25]

Several countries have successfully implemented helmet laws, thereby reducing the mortality and morbidity due to motorized two-wheeler accidents. Some of the examples of such programmes are:

1. The wearing of helmets by motorcycle drivers and passengers was made mandatory nationwide in Thailand in 1994 with the implementation of a helmet law. Following the enactment, the helmet law was enforced in Bangkok for 90 days, for 180 days in other 17 provinces, and for 360 days in the remaining areas of the country. Within Khon Kaen province, the promotion of the helmet law was extensive, and these campaigns persisted even after fines were imposed by the police. As a result of the combined efforts of the helmet law, enforcement, and promotion, the rate of helmet usage in Khon Kaen increased by five times, while head injuries decreased by 41.4% and deaths decreased by 20.8%.[26]

2. In Italy, the law mandated that only motorcycle drivers (not passengers) had to wear helmets, while moped drivers over 18 were exempt. However, in 2000, a more extensive law was implemented, requiring all motorcycle and moped drivers as well as passengers to wear helmets regardless of age. This law was reinforced with enforcement and promotion efforts. As a result, helmet-wearing rates increased significantly, reaching up to 95% in some regions. There was a 66% decrease in hospital admissions for traumatic brain injury, and the occurrence of blunt head injuries (epidural haemorrhages) among motorcycle and moped riders was almost completely eradicated across the country.[27]

3. In 2007, a new helmet law was introduced by the Vietnamese government, requiring all motorcycle drivers and passengers to wear helmets on any road. According to national statistics, the enforcement and promotion of this helmet law resulted in an 18% decrease in road traffic fatalities within the initial three months, ultimately preventing around 1,557 fatalities and 2,495 severe injuries in the first year.[28] Another study found that from 2008 to 2013, the legislation stopped 20,609 fatalities and 412,175 severe injuries, with more than 90% of Vietnamese motorcyclists wearing helmets by 2013.[29]

4. A study conducted between June 2011 and December 2014 observed the use of helmets and found that the percentage of correct helmet use rose from 34.3% to 76.9% in Ha Nam, and from 68.9% to 72.2% in Ninh Binh. The increase was credited to the enforcement and promotion of laws, as well as the benefits of wearing standard helmets correctly.[30]

5. An in-depth analysis of 60 research papers from the United States discovered that the introduction of a mandatory helmet law (UHL) for all motorcycle riders and passengers led to a 47% rise in helmet usage,

along with a decrease in head injuries and fatalities among motorcyclists.[31]

Helmets for Hope is an initiative started by the UN and India to lower traffic deaths. The comprehensive initiative uses a multi-pronged strategy that includes manufacturer incentives, legislation, awareness campaigns, and private sector cooperation to standardize and compel the use of approved ventilated helmets for all two-wheeler riders worldwide. Another crucial area of concentration is making sure that buyers only purchase authentic, high-quality helmets.[32]

Conclusion

To ensure strict compliance, there should be a more focused and strategic plan for traffic law enforcement. This enforcement strategy must be comprehensive, with no exemptions. More public education campaigns are needed to raise awareness about the traffic law that prohibits the use of motorcycles on major roads and bridges. All prospective Motorized Two-Wheeler riders should have access to a well-coordinated training and licensing system. A motorcycle license should only be issued to someone who has successfully completed the required training program. The helmet rule has been enforced sporadically, with a few awareness campaigns that have had little success. Creating an effective enforcement campaign with targeted compliance rates, combined with a well-planned public awareness campaign, can increase compliance and save thousands of lives. Motorized Two-Wheelers should be subject to strict speed control regulations. The government should imply rules for increasing safety features in the Motorized Two-Wheelers, particularly of the cheaper ones. The sale and purchase of the used Motorized Two-Wheelers should be regulated through proper channels. Periodic testing of the Motorized Two-Wheelers should be made mandatory.

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