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Incidental Systemic Hypothermia as a Contributing Factor in Accidental Deaths: A Comparative Study in Jayawijaya, Indonesia

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A B S T R A C T

Introduction: Accidental deaths pose a significant public health concern, especially in regions with challenging environmental conditions like Jayawijaya, Indonesia. This study investigates the role of incidental systemic hypothermia as a contributing factor in accidental deaths, comparing cases where hypothermia was identified to those where it was not. **Methods:** A retrospective comparative study was conducted, examining autopsy reports and medical records of accidental deaths in Jayawijaya from 2018 to 2023. Cases were classified into two groups: those with evidence of hypothermia and those without. Demographic data, circumstances of death, autopsy findings, and toxicology reports were analyzed. **Results:** A total of 350 accidental death cases were reviewed, with 78 (22.3%) exhibiting evidence of hypothermia. The hypothermia group had a significantly higher proportion of deaths occurring outdoors ($p < 0.001$) and during colder months ($p = 0.025$). Common causes of death in both groups included trauma, drowning, and poisoning. Hypothermia cases showed a trend towards lower core body temperatures at autopsy ($p = 0.062$). **Conclusion:** Incidental systemic hypothermia appears to be a contributing factor in a significant proportion of accidental deaths in Jayawijaya. Increased awareness of hypothermia risk, particularly in outdoor settings and during colder periods, is crucial for prevention and improved outcomes.

1. Introduction

Accidental deaths represent a significant global public health concern, exacting a profound toll on individuals, families, and communities. The World Health Organization (WHO) estimates that unintentional injuries account for approximately 4.4 million deaths annually, representing 7.9% of all global mortality. These deaths encompass a wide range of incidents, including road traffic accidents, falls, drownings, poisonings, and exposure to environmental hazards. The impact of accidental deaths extends beyond the immediate loss of life, often leading to long-term physical and psychological consequences for survivors and imposing substantial economic burdens on society. While accidental deaths pose a universal challenge, certain regions face unique vulnerabilities due to their environmental conditions, socioeconomic factors, and healthcare infrastructure. Jayawijaya, a district nestled in the highlands of Papua, Indonesia, presents a distinctive context for examining accidental deaths. The region's high altitude, ranging from 1,600 to 3,000 meters above sea level, coupled with its cool, subtropical climate, creates an environment where individuals are susceptible to a range of environmental hazards. Furthermore, limited access to healthcare facilities and emergency services in remote areas can exacerbate the consequences of accidents, hindering

timely intervention and increasing the risk of mortality.[1-3]

Among the various contributing factors to accidental deaths, hypothermia emerges as a particularly insidious and often underestimated threat. Hypothermia, defined as a core body temperature below 35°C (95°F), can occur even in non-freezing temperatures and has been implicated in fatalities across diverse settings, including outdoor activities, occupational exposures, and even indoor environments. The condition disrupts vital physiological functions, impairing the cardiovascular, respiratory, and nervous systems, ultimately leading to organ failure and death if not recognized and treated promptly. Although hypothermia is often associated with extreme cold exposure, its contribution to accidental deaths extends beyond the classic scenarios of mountaineering or winter storms. Studies have documented cases of hypothermia-related fatalities in surprisingly mild temperatures, particularly in individuals with predisposing factors such as advanced age, underlying medical conditions, or alcohol intoxication. In the context of accidental deaths, hypothermia can act as a primary or secondary contributing factor. It may directly cause death through its physiological effects or exacerbate the severity of other injuries, hindering survival and complicating rescue efforts.[4-7]

Despite the potential significance of hypothermia in accidental deaths, its prevalence and impact in Jayawijaya remain largely unexplored. Limited research has been conducted on the specific environmental and contextual factors that contribute to hypothermia-related fatalities in this region. Understanding the epidemiology of hypothermia in accidental deaths is crucial for developing targeted prevention strategies and improving the accuracy of death investigations. By identifying high-risk groups, activities, and environmental conditions, public health interventions can be tailored to mitigate the risk of hypothermia and enhance community resilience.[8-10] This study aims to address this knowledge gap by conducting a comprehensive comparative analysis of accidental deaths in Jayawijaya, with a particular focus on the role of incidental systemic hypothermia.

2. Methods

This research employed a retrospective comparative study design, meticulously examining existing data to gain insights into the role of incidental systemic hypothermia in accidental deaths within the unique context of Jayawijaya, Indonesia. The study was conducted in collaboration with the Jayawijaya District Hospital and the local forensic medicine department, utilizing their comprehensive records to identify and analyze relevant cases. The geographical focus on Jayawijaya is particularly pertinent due to its distinctive environmental characteristics. Situated in the central highlands of Papua province, the region experiences a cool, subtropical climate with average temperatures ranging from 10°C to 25°C (50°F to 77°F). The high altitude, coupled with potential exposure to rain, wind, and cold temperatures, creates an environment where individuals are susceptible to hypothermia even in non-freezing conditions. The study period spanned from January 1st, 2018, to December 31st, 2023, providing a five-year window to capture a representative sample of accidental deaths in the region.

A multi-pronged approach was adopted for data collection to ensure comprehensiveness and accuracy. Detailed autopsy reports prepared by forensic pathologists were meticulously reviewed to identify cases where hypothermia was explicitly mentioned as a contributing factor or the cause of death. These reports provided critical information on the deceased's core body temperature, postmortem findings, and any other pathological conditions that may have contributed to the fatality. Hospital medical records of individuals who died due to accidents were scrutinized to gather additional clinical information, including pre-existing medical conditions, medications, and any documented signs or symptoms suggestive of hypothermia prior to death. Police reports pertaining to accidental deaths were consulted to ascertain the circumstances surrounding each incident, including the location, time of day, weather conditions, and activities of the deceased at the time of the accident. The data collection process adhered to strict ethical guidelines, ensuring the confidentiality and anonymity of all individuals involved. Only de-identified data were

used for analysis, and all research procedures were conducted in compliance with relevant institutional and national regulations.

To maintain the focus and integrity of the study, specific inclusion and exclusion criteria were applied. Cases were included if they met the following conditions; Classification as Accidental Death: The death was officially classified as accidental by the relevant authorities, excluding deaths due to homicide, suicide, or natural causes; Complete Information: Adequate information was available from autopsy reports, medical records, and police reports to enable a comprehensive assessment of the circumstances of death and any potential contributing factors. Cases were excluded if they met any of the following criteria; Incomplete Information: Insufficient data were available to make an informed judgment regarding the cause of death or the presence of hypothermia; Non-Accidental Death: The death was attributed to homicide, suicide, or natural causes; Age Restriction: The deceased was under 18 years of age, as the physiological responses to cold exposure may differ in children and adolescents.

Following data collection, cases were meticulously categorized into two distinct groups; Hypothermia Group: This group encompassed cases where hypothermia was explicitly documented in the autopsy report or medical records as a contributing factor or the primary cause of death; Non-Hypothermia Group: This group comprised cases where there was no evidence or mention of hypothermia in any of the reviewed records. The classification process was conducted independently by two experienced forensic pathologists to ensure objectivity and minimize bias. Any discrepancies in classification were resolved through consensus discussions. A comprehensive array of data points was extracted from the collected records and subjected to rigorous statistical analysis. The following variables were of particular interest; Demographics: Age, gender, occupation, place of Residence; Circumstances of Death: Location (Indoor/Outdoor), Time of Day, Season, Weather Conditions, Activity at the Time of Death; Autopsy Findings: Cause of Death, core Body Temperature at Autopsy, presence of Injuries or Other Pathological Conditions; Toxicology Results: Presence of Alcohol, presence of Drugs or Other Substances. Descriptive statistics were employed to summarize and characterize the data, providing insights into the distribution and central tendencies of key variables. Chi-square tests were utilized to assess the association between categorical variables, such as the presence of hypothermia and the location of death. Independent t-tests were employed to compare continuous variables, such as age and core body temperature, between the hypothermia and non-hypothermia groups. All statistical analyses were performed using SPSS software (version 28.0), with a significance level of $p < 0.05$ considered statistically significant. The study adhered to stringent ethical principles throughout its execution. All data were anonymized to protect the privacy of the deceased individuals and their families. The research protocol was reviewed and approved by the relevant institutional ethics committees, ensuring compliance with national and international ethical guidelines for research involving human subjects.

3. Results and Discussion

Table 1 provides the distribution of the 350 accidental death cases included in the study across the two groups: hypothermia and non-hypothermia. 78 cases (22.3%) were classified into the hypothermia group. This indicates that nearly a quarter of the accidental deaths in the study population involved hypothermia as a contributing factor or the primary cause of death. This finding underscores the significant prevalence of hypothermia in accidental deaths within the study setting. The remaining 272 cases (77.7%) were classified into the non-hypothermia group, indicating that hypothermia was not identified as a contributing factor in these deaths.

Table 1. Study population.

Group	Number of cases	Percentage
Hypothermia	78	22.30%
Non-hypothermia	272	77.70%
Total	350	100%

Table 2 presents a comparative analysis of age and sex distribution between the hypothermia and non-hypothermia groups. The mean age in the hypothermia group was 42.3 years, while in the non-hypothermia group, it was 38.7 years. The standard deviations (SD) indicate a fair degree of variability in age within both groups. The p-value of 0.102 suggests that the difference in mean age between the two groups is not statistically significant. This implies that age may not be a strong differentiating factor between those who experienced hypothermia and those who did not in the context of accidental deaths in this study. The proportion of males was higher in the hypothermia group (69.2%) compared to the non-hypothermia group (62.5%). However, the p-value of 0.247 indicates that this difference is not statistically significant. This suggests that sex may not be a major risk factor for hypothermia-related deaths in this population.

Table 2. Demographics.

Characteristic	Hypothermia Group	Non-Hypothermia Group	p-value
Age (Mean ± SD)	42.3 ± 15.6	38.7 ± 17.2	0.102
Gender (Male %)	69.20%	62.50%	0.247
Gender (Male Count)	54	170	-

Table 3 provides a comparative analysis of two key circumstances – location and season – between the hypothermia and non-hypothermia groups. A significantly higher proportion of deaths in the hypothermia group occurred outdoors (85.9%) compared to the non-hypothermia group (52.2%). The p-value of < 0.001 indicates a highly statistically significant difference. This strongly suggests that being outdoors significantly increases the risk of hypothermia-related deaths. This is likely attributable to the greater exposure to cold environmental conditions and potential challenges in seeking shelter or assistance in outdoor settings. The hypothermia group also experienced a higher percentage of deaths during the colder months (June-August) (34.6%) compared to the non-hypothermia group (23.2%). The p-value of 0.025 indicates a statistically significant difference. This observation further reinforces the role of environmental factors in hypothermia-related deaths, highlighting the increased risk during periods of lower temperatures.

Table 3. Circumstances of death.

Circumstance	Hypothermia Group	Non-Hypothermia Group	p-value
Location (Outdoor %)	85.90%	52.20%	< 0.001
Location (Outdoor Count)	67	142	-
Season (Colder Months %)	34.60%	23.20%	0.025
Season (Colder Months Count)	27	63	-

Table 4 provides a comparative analysis of autopsy and toxicology findings between individuals who experienced hypothermia at the time of death and those who did not. The leading cause of death in both groups was slightly higher in the hypothermia group (42.3% vs 38.2%). This suggests that trauma, such as accidents or injuries, is a significant contributor to mortality regardless of hypothermia. The second most common cause of death, was more prevalent in the non-hypothermia group (25.0% vs 21.8%). This might indicate a potential association between hypothermia and a reduced risk of drowning, possibly due to factors like decreased physical activity in cold environments. The third leading cause of death, with a slightly higher incidence in the hypothermia group (14.1% vs 12.5%). This could suggest a possible link between hypothermia and increased susceptibility to poisoning, perhaps related to impaired judgment or altered metabolism in cold conditions. As expected, the mean core body temperature at autopsy was significantly lower in the hypothermia group (32.1°C vs 34.5°C). This confirms the presence of hypothermia in this group and highlights its impact on body temperature regulation. Alcohol was detected more frequently in the hypothermia group (25.6% vs 18.4%), although this difference was not statistically significant. This observation raises the possibility of a potential association between alcohol consumption and an increased risk of hypothermia, possibly due to alcohol's vasodilatory effects and its impact on thermoregulation.

Table 4. Autopsy and toxicology findings.

Findings	**Hypothermia Group (%)**	**Non-Hypothermia Group (%)**
Trauma	42.3	38.2
Drowning	21.8	25
Poisoning	14.1	12.5
Mean core body temperature (°C)	32.1	34.5
Alcohol detected (%)	25.6	18.4

Our study has brought to light a disturbing truth: incidental systemic hypothermia, a condition often associated with extreme cold exposure, is claiming lives in Jayawijaya, Indonesia, even in the absence of frigid temperatures. The revelation that nearly a quarter (22.3%) of the accidental deaths we investigated involved hypothermia is a stark reminder of the insidious nature of this condition. Hypothermia once considered a concern primarily in polar regions or during severe winter storms, is now recognized as a potential threat in more temperate climates, particularly in high-altitude regions like Jayawijaya. The significant prevalence of hypothermia in our study population is alarming. It suggests that a substantial number of accidental deaths in Jayawijaya could potentially be prevented or mitigated through increased awareness and proactive measures. The current perception of hypothermia as a risk primarily associated with extreme colds may be contributing to a lack of vigilance and preparedness in milder climates. This study serves as a wake-up call, emphasizing the need to re-evaluate our understanding of hypothermia and its potential impact, even in regions where the temperatures may not seem overtly threatening. The high prevalence of hypothermia-related deaths in Jayawijaya is likely influenced by a complex interplay of environmental, physiological, and sociocultural factors. Situated in the central highlands of Papua province, Jayawijaya boasts a unique environment characterized by high altitude, cool temperatures, and frequent rainfall. These conditions create an environment where individuals are particularly susceptible to heat loss, even in the absence of freezing temperatures. The high altitude plays a crucial role in this vulnerability. As altitude increases, the air becomes thinner and colder, leading to increased heat loss through convection and radiation. Moreover, the physiological adaptations to

high altitude, such as increased respiratory rate and decreased oxygen availability, can further compromise the body's ability to maintain core temperature. The region's cool subtropical climate, with average temperatures ranging from 10°C to 25°C (50°F to 77°F), may create a false sense of security, leading individuals to underestimate the risk of hypothermia. However, even these seemingly mild temperatures can pose a significant threat, especially when combined with other factors such as wind, rain, and physical exertion. Furthermore, Jayawijaya's rapid and unpredictable weather changes can exacerbate the risk of hypothermia. Sudden drops in temperature, accompanied by rain or wind, can quickly overwhelm the body's thermoregulatory mechanisms, leading to a dangerous decline in core temperature. Individuals caught unprepared in such conditions may find themselves in a life-threatening situation. Sociocultural factors may also contribute to the prevalence of hypothermia-related deaths in Jayawijaya. Traditional clothing and housing practices may not always provide adequate protection against the cold, particularly in outdoor settings or during periods of inclement weather. Furthermore, limited access to healthcare and emergency services in remote areas can delay diagnosis and treatment, further increasing the risk of mortality. Perhaps most importantly, a lack of awareness about the risks of hypothermia in milder climates may be a significant contributing factor. The perception that hypothermia is a concern only in extreme cold environments may lead to complacency and a failure to recognize the early signs and symptoms of the condition. This can delay seeking help or taking appropriate preventive measures, ultimately increasing the risk of a fatal outcome. The findings of our study underscore the urgent need for a multifaceted approach to address the issue of incidental hypothermia in Jayawijaya. Comprehensive public awareness campaigns are needed to educate the community about the risks of hypothermia, even in seemingly mild temperatures. These campaigns should emphasize the importance of proper clothing, shelter, and preparedness when venturing outdoors, particularly in high-altitude areas. Specific interventions may be necessary for high-risk groups, such as individuals engaged in outdoor occupations, the elderly, and those with underlying health conditions. These could include providing access to warm clothing and shelter, training in recognizing and responding to hypothermia and improving access to healthcare and emergency services in remote areas. The accurate diagnosis of hypothermia in deceased individuals is crucial for understanding the true burden of this condition and developing effective prevention strategies. The development and implementation of standardized protocols for identifying and documenting hypothermia in forensic investigations, along with research into potential biomarkers for antemortem hypothermia diagnosis, are essential steps in this direction.[11,12]

Our research has painted a stark picture: the environment in Jayawijaya serves as a crucible for hypothermia, significantly elevating the risk of accidental deaths. The overwhelming majority (85.9%) of fatalities in the hypothermia group occurred outdoors, a stark contrast to the 52.2% observed in the non-hypothermia group. This pronounced disparity underscores the critical role of environmental exposure in triggering and exacerbating hypothermia, even in the absence of extreme cold. The outdoor environment, with its inherent unpredictability and exposure to the elements, presents a formidable challenge to the human body's thermoregulatory mechanisms. In Jayawijaya, this challenge is amplified by the region's unique geographical and climatic features. The high-altitude terrain, with its thinner air and lower temperatures, creates an environment where heat loss is accelerated. Wind chill, a phenomenon where moving air increases heat loss from the body, further compounds this risk. Moreover, rainfall can saturate clothing and reduce its insulation properties, leading to rapid cooling. Individuals venturing outdoors in Jayawijaya, whether for work, leisure, or necessity, are exposed to a confluence of environmental factors that can conspire to induce hypothermia. Farmers tending their crops, hikers exploring the scenic landscapes, or even individuals simply walking home after a long day may find themselves vulnerable to the insidious effects of

cold exposure. The lack of readily available shelter in remote areas can further exacerbate this risk, leaving individuals with limited options for escaping the elements and rewarming their bodies. Our study also revealed a distinct seasonal pattern in hypothermia-related deaths, with a higher prevalence during the colder months of June through August. This observation underscores the dynamic nature of hypothermia risk in Jayawijaya, where even subtle shifts in temperature can have profound consequences. During these colder months, the combination of lower ambient temperatures, increased wind chill, and potential rainfall creates a perfect storm for hypothermia. This seasonal variation in risk has important implications for public health interventions and safety campaigns. It highlights the need for targeted messaging and preparedness efforts that specifically address the heightened risk of hypothermia during colder periods. Community education programs should emphasize the importance of adapting clothing and behavior to the changing seasons, providing individuals with the knowledge and tools to protect themselves from the cold. While temperature undoubtedly plays a pivotal role in hypothermia, it is essential to recognize the multifaceted nature of environmental risk. Humidity, wind speed, and precipitation can all interact with temperature to influence the rate of heat loss from the body. For example, high humidity can reduce the effectiveness of evaporative cooling, one of the body's primary mechanisms for dissipating heat. Strong winds can accelerate convective heat loss, while rain or snow can saturate clothing and compromise its insulation properties. In Jayawijaya, the interplay of these environmental factors creates a complex and dynamic risk landscape. A seemingly mild temperature can quickly become dangerous in the presence of strong winds or heavy rainfall. Understanding these interactions is crucial for accurately assessing hypothermia risk and developing effective preventive strategies. The findings of our study serve as a powerful reminder that hypothermia is not a risk confined to extreme cold environments. Even in regions like Jayawijaya, where temperatures may seem relatively mild, the combination of high altitude, cool climate, and unpredictable weather patterns can create conditions conducive to hypothermia. This underscores the importance of vigilance and preparedness, both at the individual and community levels. Individuals venturing outdoors should be aware of the signs and symptoms of hypothermia and take appropriate precautions, such as dressing in layers, staying dry, and avoiding prolonged exposure to cold, wind, and rain. Community leaders and healthcare providers should play an active role in educating the public about hypothermia risk and promoting safe practices for outdoor activities, particularly during colder periods.[13,14]

Our investigation into accidental deaths in Jayawijaya has revealed a complex and interconnected web of contributing factors, where hypothermia often acts as a silent partner, amplifying the severity and lethality of other causes. While trauma, drowning, and poisoning emerged as the leading causes of death in both the hypothermia and non-hypothermia groups, the presence of hypothermia appears to cast a long shadow, influencing the trajectory of these events and tipping the scales towards a fatal outcome. Hypothermia, with its subtle onset and progressive impairment of vital bodily functions, can act as an insidious enabler of accidental deaths. The condition's impact on cognitive and physical performance is particularly concerning. As core body temperature drops, individuals may experience impaired judgment, confusion, and a decreased ability to make rational decisions. This can lead to risky behaviors, such as venturing into hazardous terrain or failing to seek shelter in deteriorating weather conditions, ultimately increasing the likelihood of accidents. Furthermore, hypothermia can significantly compromise coordination and motor skills, making even simple tasks challenging and increasing the risk of falls, slips, and other injuries. This impairment can be particularly dangerous in outdoor settings, where uneven terrain, slippery surfaces, and unpredictable weather conditions already pose significant hazards. Individuals experiencing hypothermia may find themselves unable to navigate these challenges safely, leading to accidents that might have been avoided

under normal circumstances. The impact of hypothermia on self-rescue efforts is another critical consideration. Even in the event of a minor accident or injury, the ability to self-rescue or seek help can be severely compromised by hypothermia. The combination of impaired judgment, decreased coordination, and fatigue can make it difficult for individuals to extricate themselves from dangerous situations or communicate their distress to others. This delay in seeking help can be fatal, especially in remote areas where access to emergency services is limited. Beyond its impact on cognitive and physical performance, hypothermia triggers a cascade of physiological changes that can exacerbate the severity of other injuries and accelerate the progression toward death. As core body temperature drops, the heart rate slows, blood pressure decreases, and blood flow to vital organs is reduced. This can lead to organ dysfunction, tissue damage, and ultimately if left untreated, cardiac arrest and death. In the context of accidental deaths, the presence of hypothermia can significantly complicate the clinical picture. For example, in cases of trauma, hypothermia can mask the severity of internal injuries, making it difficult for healthcare providers to assess the full extent of the damage and initiate appropriate treatment. In drowning cases, hypothermia can prolong the time an individual can survive without oxygen, potentially leading to delayed resuscitation attempts and decreased chances of successful recovery. The role of alcohol in accidental deaths, while not statistically significant in our study, warrants further exploration. Alcohol is a potent vasodilator, causing blood vessels near the skin to widen and increasing heat loss from the body. This effect can be particularly dangerous in cold environments, where the body is already struggling to maintain core temperature. Moreover, alcohol can impair judgment and coordination, increasing the risk of accidents and hindering self-rescue efforts, as discussed earlier. While our study did not find a statistically significant association between alcohol consumption and hypothermia-related deaths, the slightly higher prevalence of alcohol detection in the hypothermia group suggests a potential link. It is possible that the relatively small sample size of our study limited our ability to detect a statistically significant effect. Future research with larger cohorts and more detailed toxicological analysis may shed further light on the complex relationship between alcohol and hypothermia in accidental deaths. The intricate interplay of contributing factors in accidental deaths underscores the challenges faced by healthcare providers, forensic investigators, and public health officials in understanding and preventing these tragedies. It is crucial to recognize that hypothermia is rarely the sole cause of death but rather a contributing factor that can significantly influence the severity and outcome of other injuries or exposures.[15,16]

The significantly lower core body temperatures we observed in the hypothermia group serve as a chilling reminder of the profound physiological impact of this condition. However, amidst this clarity lies a complex challenge: accurately diagnosing hypothermia in deceased individuals. The intricacies of postmortem changes, particularly the phenomenon of postmortem cooling, can obscure the true nature of death, making it difficult to distinguish between cases where hypothermia was a contributing factor and those where it was merely an artifact of the postmortem interval. This diagnostic challenge underscores the critical importance of meticulous and comprehensive forensic investigations in cases of suspected hypothermia-related deaths. A holistic approach, encompassing a thorough scene investigation, detailed autopsy findings, and careful consideration of the circumstances surrounding the death, is essential to unraveling the true cause of death and accurately attributing the role of hypothermia. Postmortem cooling, also known as algor mortis, is the natural process by which a body loses heat after death. The rate of cooling is influenced by various factors, including ambient temperature, body size, clothing, and the presence of any underlying medical conditions. In some cases, the postmortem core body temperature can drop to levels that mimic those seen in antemortem hypothermia, creating a diagnostic dilemma for forensic pathologists. Distinguishing between true hypothermia and postmortem cooling requires a nuanced understanding of the physiological

and environmental factors at play. While a low core body temperature is a hallmark of hypothermia, it is not sufficient on its own for a definitive diagnosis. Other postmortem findings, such as the presence of Wischnewski ulcers in the stomach lining, can provide additional clues, but these are not always present or specific to hypothermia. The limitations of current diagnostic methods highlight the urgent need for reliable biomarkers that can definitively identify antemortem hypothermia. Such biomarkers could provide objective evidence of the physiological changes associated with hypothermia, helping to differentiate it from postmortem cooling and other conditions that may present similar findings. Several potential biomarkers have been investigated, including changes in gene expression, protein levels, and metabolic markers. However, further research is needed to validate these biomarkers and establish their sensitivity and specificity in the context of forensic investigations. The ideal biomarker would be easily detectable in postmortem samples, resistant to degradation, and specific to antemortem hypothermia. The accurate diagnosis of hypothermia in death investigations has far-reaching implications beyond the individual case. Misdiagnosis or underreporting of hypothermia-related deaths can distort public health data, leading to an underestimation of the true burden of this condition. This can hinder the development of effective prevention strategies and resource allocation for addressing hypothermia risk. Furthermore, accurate death certification is crucial for legal and insurance purposes, ensuring that families receive appropriate compensation and support. Misdiagnosis of hypothermia can have significant financial and emotional consequences for bereaved families, denying them rightful benefits and closure. Addressing the challenge of accurate hypothermia diagnosis requires a multidisciplinary approach that brings together forensic pathologists, clinicians, researchers, and public health officials. Collaboration and knowledge-sharing are essential to advance our understanding of hypothermia and its impact on mortality. Forensic pathologists play a crucial role in recognizing the potential for hypothermia in death investigations and conducting thorough autopsies that consider a wide range of factors. Clinicians can contribute by improving the recognition and management of hypothermia in living patients, potentially preventing fatalities and providing valuable insights into the clinical presentation of the condition. Researchers can focus on identifying and validating reliable biomarkers for antemortem hypothermia diagnosis, while public health officials can use this knowledge to develop and implement effective prevention strategies.[17,18]

The findings of our study serve as a clarion call for action, illuminating the urgent need for comprehensive public health interventions and preventive strategies to address the significant burden of hypothermia-related deaths in Jayawijaya. The high prevalence of hypothermia in accidental deaths, particularly in outdoor settings and during colder months, underscores the critical importance of empowering the community with knowledge, resources, and preparedness to mitigate this often-underestimated risk. At the heart of any effective prevention strategy lies awareness. The perception of hypothermia as a risk confined to extremely cold environments may lead to complacency and a failure to recognize the early signs and symptoms of the condition, even in seemingly mild temperatures. This study highlights the critical need to dispel this misconception and educate the community about the insidious nature of hypothermia in Jayawijaya's unique environment. Comprehensive public awareness campaigns, tailored to the specific cultural and linguistic context of the region, should be implemented to disseminate information about hypothermia risk factors, prevention strategies, and early recognition. These campaigns could leverage various channels, including community meetings, schools, healthcare facilities, and local media, to reach a broad audience and ensure that the message resonates with diverse populations. Key messages should emphasize the importance of proper clothing and layering, especially in outdoor settings and during colder months. Individuals should be encouraged to wear warm, insulating clothing that wicks away moisture and protects against wind chill. The use of hats, gloves, and scarves to minimize heat loss from

the head and extremities should also be emphasized. Furthermore, the importance of seeking shelter and avoiding prolonged exposure to cold, wind, and rain should be underscored. Individuals should be advised to plan their outdoor activities carefully, taking into account weather conditions and carrying essential supplies such as food, water, and emergency blankets. While raising general awareness is crucial, targeted interventions are necessary to address the specific needs of high-risk groups within the community. Individuals engaged in outdoor occupations, such as farmers, herders, and construction workers, face a heightened risk of hypothermia due to their prolonged exposure to the elements. Providing these individuals with access to warm clothing, shelter, and education about hypothermia prevention could significantly reduce their vulnerability. Employers should also be encouraged to implement workplace safety protocols that address cold exposure risks and ensure that workers are equipped with the knowledge and resources to protect themselves. The elderly population is another group at increased risk of hypothermia due to age-related physiological changes that impair thermoregulation. Community-based programs that focus on educating seniors about hypothermia prevention, providing them with warm clothing and home heating assistance, and encouraging regular social interaction to combat isolation and neglect could be instrumental in safeguarding their health and well-being. Individuals with underlying health conditions, such as diabetes, hypothyroidism, and cardiovascular disease, are also more susceptible to hypothermia. Healthcare providers should play a proactive role in identifying and educating these individuals about their increased risk, providing them with personalized guidance on managing their health and preventing hypothermia. Prompt recognition and treatment of hypothermia are critical for improving outcomes and reducing mortality. Enhancing emergency response protocols for hypothermia cases is therefore a crucial component of a comprehensive prevention strategy. Healthcare providers, first responders, and community members should be trained in recognizing the signs and symptoms of hypothermia and initiating appropriate first aid measures. This includes moving the individual to a warm, dry environment, removing wet clothing, and providing gentle rewarming with blankets or warm fluids. In severe cases, active rewarming measures, such as warm intravenous fluids or heated humidified oxygen, may be necessary. Establishing clear guidelines for referral and transport to medical facilities is also essential, ensuring that individuals with hypothermia receive timely and appropriate care. Addressing the challenge of hypothermia in Jayawijaya requires a concerted and collaborative effort involving healthcare providers, public health officials, community leaders, and individuals themselves. By working together to raise awareness, implement targeted interventions, and enhance emergency response capabilities, we can strive to create a safer and healthier environment for all. The findings of this study provide a roadmap for action, highlighting the specific areas where interventions are most needed. It is our hope that this research will serve as a catalyst for change, inspiring a community-wide commitment to preventing hypothermia-related deaths and protecting the well-being of the people of Jayawijaya.[19,20]

4. Conclusion

This study has underscored the significant role of incidental systemic hypothermia in accidental deaths within Jayawijaya, Indonesia. Nearly a quarter of accidental deaths were associated with hypothermia, highlighting its insidious nature even in milder climates. Environmental factors, particularly outdoor exposure and colder seasons, emerged as key determinants of hypothermia risk. Trauma, drowning, and poisoning were leading causes of death, often exacerbated by hypothermia's effects. This research emphasizes the urgent need for heightened awareness, targeted prevention strategies, and improved forensic practices to combat this silent killer.

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