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Determination of the cause and the manner of death in post-mortem cases in the West Bank in the years 2011-2021

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ABSTRACT

A post-mortem examination is a reliable method to reveal possible hidden causes of death. However, due to the stigma associated with drug use, mortality data related to drug use is a neglected topic in local health in Palestine. Therefore, we aimed to describe post-mortem examination cases' mortality data and investigate the occurrence of death-related drug use in the West Bank in a retrospective study, 2011-2021. Homicide was more prevalent among males (32.9%) than females (20.9%), with increased risk in young adults (OR=2.8) and the summer season (OR=1.9). Moreover, Palestinian refugees were three times more likely to commit homicide than urban (OR=30.3). Most suicide cases were males and with increased risk in children (OR=4.9) and young adults (OR=8.7) than age group>40 years (p-value<0.05). In mortality data related to intoxication, organophosphates were the leading cause of death in suicidal cases and multidrug misuse in unintentional death. Amphetamines were the most drugs found in combination with other drugs. Most of the deaths related to drug use were male prominent and from villages. In conclusion, age-related increases in homicide and suicide rates highlighted the vital role of raising national health awareness and improving the health care system in rural areas and refugee camps. Moreover, the increased percentages of suicide and accidental death related to drug use, the age of victims, and the polydrug tested in these cases indicate a hidden population of multidrug users in young Palestinian adults and children, which designates drug use in Palestine has reached an alarming situation.

Keywords: Toxicity; Post-Mortem Examination; Drug Intoxication; Suicide; Homicide; Palestinian Refugees; Autopsy.

INTRODUCTION

Drug-related deaths are deaths in which at least one drug or poison is found in post-mortem samples and assigned to death (1-3). The drug could be a causative agent, or poisoning with that drug contributes to death (2). It is known that drug abusers suffer from higher mortality than the general population of the same age (3). Like most societies, drug use is criminalized, hidden, and stigmatized in Palestine (4-9). However, illicit drugs have seen an upswing among children and young adults during the last decade in the West Bank(4-11). In 2017, it was estimated that 1.8% of the male population aged 15 and above were high-risk drug users (HRDU) (12). Cannabis and synthetic cannabis are the most commonly used illicit drugs in the West Bank (4, 8, 12). The side effects of synthetic cannabis are not similar to those caused by natural cannabinoids. They may indicate the presence of potential artificial additives and toxicants that cause these symptoms (13). The use of synthetic cannabinoids in the West Bank is magnified because synthetic cannabinoids are substandard and counterfeited with other more toxic compounds such as insecticides like carbamate, rodenticides, and acetone (4).

Moreover, the use of amphetamine-type stimulants (ATS) involving amphetamine (AMA), methamphetamine, and 3,4-Methyl enedioxy methamphetamine (MDMA) or (Ecstasy) is a growing phenomenon in the West Bank (13). The majority of MDMA users also take cannabis or synthetic cannabis. The United Nations Office on Drugs and Crime (UNODC) studied drug users in Palestine who used drugs daily, and 28.1% of the cases used two or more illicit drugs(14). Data are lacking on high-risk drug use (HRDU) in both the West Bank and Gaza Strip (12). Stigmatizing attitudes may keep individuals with substance use disorders (SUDs) from seeking the help they need and limit the overall quality of their healthcare and treatment outcomes (15), increasing their death rate. Mortality data related to drug use is rarely absent in the West Bank. The absence of mortality data is an important limitation in developing and implementing policies to prevent drug use. Mortality data are one of the best sources of information about the health of living communities (16). They provide a snapshot of current health problems and suggest persistent patterns.

In Palestine, many deaths occur outside hospitals and without medical attention (17). A substantial fraction of deaths occurring at home is registered with ill-defined causes of death. Therefore, the reliability of causes of death at registration remains uncertain (17), especially for stigmatized cases such as drug use. Diagnostic pathological autopsies have long been considered the gold standard for the cause of death determination (18). It has been shown in numerous studies that autopsy and post-mortem histopathological examination are the only ones that can diagnose wholly and correctly (19). Although drug use is widely distributed across the West Bank and Gaza Strip, mortality related to drug use is a neglected topic in local health. Palestinian society's discussion of illicit drug use is filled with emotions and inaccuracies(4). The extent of mortality related to drug use in the West Bank is difficult to estimate due to the limited availability of research and the stigma associated with their use (4, 11). In Palestinian culture, death by overdose is loaded with social and moral stigma and intense feelings of anger, guilt, and shame. This might lead to underreporting of death cases due to overdose and calls for other sources of data to ascertain the cause of death, and here comes the role of autopsy as one of these sources. Establishing the manner and cause of death is one of the most critical endeavors in forensic pathology (18). Data obtained from the autopsy is a prerequisite to informing policy-making, which may have substantial implications for prevention. To the authors ' best knowledge, no studies have described mortality related to drug use in the West Bank. Studying mortality associated with drug use can provide insight into the extent of illicit substance use and assess the risk of these drugs to raise awareness about them.

This study aimed to characterize post-mortem examination cases' mortality data and precisely investigate deaths due to drug use in the West Bank in post-mortem cases referred to the Forensic Medicine Institute An-Najah National University, Palestine, from 2011to 2021.

METHODS

Study design and setting

A retrospective study was conducted in the north of the West Bank in the Forensic Medicine Institute, An-Najah National University, Palestine, in 2021. All medical records of autopsied cases (N=673) were reviewed from September 2011 to May 2021. Autopsies were carried out by forensic pathologists and consisted

of a review of history from relatives and, or from medical records (where available), external examination, internal examination of all major organ systems (dissection), and additional studies (histology, microbiology, toxicology) in selected cases as determined by the forensic pathologist. Age, gender, place of residency, cause, manner of death, signs, and symptoms of any pre-mortem illness and its duration, health care seeking, medications used, and admission to a health facility were taken from final autopsy reports in the forensic medicine institute's database. Age was divided into infants < 1 year, children 1-17 years, young adults 18-40 years, late adults 41-65 years, and elderly >65 years. Manner of death is classified into intentional (homicide or suicide), unintentional (accidental), natural and undetermined, while the cause of death is the actual mechanism that produces death (20). The locality was divided into city, village, and refugee camps.

Data analysis

Statistical Product and Service Solutions (SPSS), Version 22, (IBM Corp., Armonk, NY: IBM Corp.) was used for data analysis; Data was described using means, medians, and percentages. In addition, Pearson Chi-square and Fisher's Exact tests compared categorical variables and t-tests for continuous variables. Finally, multivariate logistic regression analysis evaluated the relative risk by generating the odds ratios (OR) and 95% confidence intervals (CI) for risk factors. A p-value of less than 0.05 was considered statistically significant.

Ethics approval and consent to participate

The Ethics Committee of the Institutional Review Board "IRB" at An-Najah National University (ANNU) approved the study protocol (Ref. Med. June 2021/7, approved on June 22, 2021). All procedures followed were by the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, revised in 2000. Ethical safeguards were employed. Data were collected and treated confidentially, kept safe, and available for the researchers only. Codes were used instead of names.

RESULTS

General characteristics of the post-mortem cases

Males constituted most of the study cases (n=529; 78.6%) throughout the study period. The median age and (25%, 75%) were 31 (20, 44) years; [31(20,40) years for males, and 27(18,39) years for females]. For age categories, 50.2% were young adults, 23.5% were late adults, 5.34% were infants, 13.97% were children, and 6.84% were elderly. The majority were from villages (61.37%). For the manner of death, natural death was the most prevalent (40%), followed by homicide (30%), accident (17.4%), and suicide (12.0%) (Table 1).

Table (1): General characteristics of the post-mortem cases referred to the north of the West Bank in 2011-2021.

	Category	**n(%)**
Gender	Males	529(78.6)
	Females	144(21.4)
Age	Infants (<1)	36(5.34)
	Children (1-17)	94(13.97)
	Young adults (18-40)	338(50.22)
	Late adults (41-65)	158(23.48)

	Category	n(%)
	Elderly (>65)	46(6.84)
Location	City	197(29.27)
	Village	413(61.37)
	Refugee Camp	63(9.36)
Season	Winter	160(23.77)
	Spring	160(23.77)
	Summer	192(28.53)
	Autumn	158(23.48)
Manner of Death	Natural	272(40.04)
	Homicide	202(30.0)
	Accident	117(17.4)
	Suicide	81(12.0)
	Undetermined	1(0.1)

The epidemiology of manner of death

Table 2 describes the epidemiology of the manner of death from 2011to 1-in 2021. All forms of death were male prominent (p-value<0.001). Based on age categories, the least number of deaths were in extremes of age (infants and elderly) and were attributed mainly to natural causes of death (77.8% and 63.0%in infants and elderly, respectively). Moreover, natural death was the most prevalent manner of death in late adults (51,.3%), while homicide in young adults (37.6%) and accidents in children (30.9%). Most suicidal cases (70.4%) were young adults, and 21% were in children. Based on location, most homicide cases were from villages (58.2%). However, the most prominent death in refugee camps were homicides (54.0%) and natural death in cities (45.7%) and villages (39.6%). Homicide-related to political conflict consists of 16.5% of homicide cases. For the distribution of manner of death based on season, natural death was the most prominent manner of death in winter (44.4%). In comparison, homicidal death was the most prominent manner of death in summer (38.9%) (Table 2).

Table (2): The epidemiology of manner of death in 2011-2021**.**

		Natural n(%)	Accidental n(%)	Suicide n(%)	Homicide n(%)
Gender	Male	203(38.4)	87(16.5)	64(12.1)	174(32.9)
	Female	69(47.9)	28(19.4)	17(11.8)	30(20.9)
Age in years	Infants (<1)	28(77.8)	7(19.4)	0(0)	1(2.8)
	Children (1-4)	4(33.3)	3((25)	0(0)	5(41.7)
	Children (5-17)	22(27.2)	25(30.9)	17(21.1)	17(21.1)
	Young adults (18-40)	108(32.0)	46(13.6)	57(16.9)	127(37.6)
	Late adults (41-65)	81(51.3)	24(15.2)	6(3.8)	47(29.7)
	Elderly (>65)	29(63.0)	11(23.0)	1(2.2)	5(10.9)

		Natural n(%)	Accidental n(%)	Suicide n(%)	Homicide n(%)
Location	City	90(45.7)	34(17.3)	23(11.7)	50(25.4)
	Village	163(39.6)	78(18.9)	53(12.9)	118(28.6)
	Refugee Camp	19(30.2)	5(7.9)	5(7.9)	34(54.0)
Season	Winter	71(44.4)	22(13.8)	23(14.4)	44(27.5)
	Spring	59(36.9)	38(23.8)	17(10.6)	46(28.8)
	Summer	71(36.8)	28(14.5)	18(9.3)	75(38.9)
	Autumn	69(43.7)	29(18.3)	23(14.6)	37(23.4)

The specific cause of death for each manner is based on gender

Table 3 describes the highest prevalence (prevalence >1%) of the specific causes of death for each manner based on gender. Cardiovascular related diseases were the leading cause of natural death (29.0%) followed by gunshot (18.3%), hanging (9.2%), trauma (7.2%), stabbing wound (5.8%), intoxication (4.6%), drowning (3.1%), and burns (2.5%). All causes of death were male predominant except for intoxication cases (3.7% in males vs. 6.9% in females) (Table 3).

Table (3): Specific cause of death for each manner based on gender.

Cause of Death	Males n(%)	Females n(%)	Total n(%)
Cardiac disease	155(29.3)	40 (27.8)	195(29.0)
Gunshot	110(20.8)	13(9.0)	123(18.3)
Hanging	51(9.6)	11(7.6)	62(9.2)
Trauma	41(7.6)	7(4.9)	48(7.2)
Stabbing	34(6.4)	5(3.5)	39(5.8)
Intoxication	20(3.7)	11(6.9)	31(4.6)
Drowning	17(3.2)	4(2.8)	21(3.1)
Electrical shock	9(1.8)	2(1.4)	11(1.6)
Asphyxia	9(1.8)	2(1.4)	11(1.6)
Falling down	7(1.4)	2(1.4)	9(1.3)
Strangulation	8(1.6)	0(0)	8(1.2)
Burns	7(1.4)	10(6.9)	17(2.5)
Haemorrhage	10(2.0)	4(2.8)	14(2.1)
Epilepsy	4(0.8)	5(3.5)	9(1.3)

Adjusted multivariate logistic regression for the association between the manner of death and other factors

Table 4 describes the adjusted multinomial regression for the manner of death and different risk factors. In comparison with natural death, homicide is more significantly prevalent among males than females (OR=2.24, p-value=0.002), and among refugees than in urban (OR=3.027, p-value=0.002), in summer than in autumn (OR=1.910, p-value=0.018), and in young adults than age late adults and elderly (OR=2.797, p-value=<0.001). On the other

hand, suicide is more prevalent in children (age group <18) (OR=4.928, p-value=0.001) and young adults (OR=8.66, p-value=<0.001) than in the age group >40 years old (Table 4).

Table (4): Adjusted multivariate logistic regression for the association between the manner of death and other risk factors.

Manner of death*	Category	Reference	OR	95%CI	P-value
Accident					
Gender	Female	Male	0.989	0.594-1.645	0.989
Location	Village	City	1.226	0.753-1.996	0.412
	Camp		0.712	0.244-2.075	0.533
Season	Winter	Autumn	0.712	0.317-1.368	0.308
	Spring		1.558	0.853-2.843	0.149
	Summer		1.021	0.547-1.905	0.949
Age in years	0-17	>41	2.105	1.177-3.763	0.012
	18-40		1.390	0.825-2.343	0.216
Homicide					
Gender	Female	Male	0.446	0.270-0.739	0.002
Location	Village	City	1.358	0.878-2.10	0.170
	Camp		3.027	1.521-6.022	0.002
Season	Winter	Autumn	1.133	0.640-2.007	0.669
	Spring		1.476	0.830-2.25	0.186
	Summer		1.910	1.116-3.269	0.018
Age in years	0-17	>40	1.099	0.599-2.018	0.761
	18-40		2.797	1.810-4.322	<0.001
Suicide					
Gender	Female	Male	0.659	0.355-1.223	0.186
Location	Village	City	1.251	0.705-2.220	0.445
	Camp		1.071	0.350-3.273	0.904
Season	Winter	Autumn	0.946	0.474-1.886	0.874
	Spring		0.946	0.451-1.981	0.882
	Summer		0.796	0.385-1.643	0.537
Age in years	0-17	>40	4.928	1.911-12.705	0.001
	18-40		8.662	3.764-19.931	<0.001

*The reference category is Natural Death. OR: Odds Ratio, CI: Confidence Interval.

General characteristics of death cases caused by drugs and other toxicants

Table 5 describes the general characteristics of death cases caused by poisoning. 31 cases (20 males and 11 females) were caused by intoxication; 41.9% were drug toxicity, 35.5% were pesticide toxicity, and 12.9% were carbon monoxide toxicity, and 9.7% were medication toxicity. The median age was 28 years (30 for males and 22 for females). Multidrug involved in toxicity was found in 19.4% of cases (25% in males and 9.1% in females).

Drugs detected in both genders in post-mortem cases were methadone, MDMA, Tetrahydrocannabinol (THC), and a benzodiazepine. Methamphetamine, AMA, morphine, alcohol,

and propofol were detected only in male cases. The drugs were mainly MDMA, AMP, THC, methamphetamine, and alcohol. Death caused by intoxication (59.2%) occurred in villages. The majority of death-related to intoxication in general (n= 28, 90.3%) and death-related to drug intoxication (n=11, 84.6%) located in villages. Most death-related to drug toxicity were by accident (53.5%) (Table 5).

Table (5): General characteristics of death cases caused by drugs and other toxicants.

	Males n=20	**Females n=11**	**Total N=31**
Death caused by drug use n (%)	10(50.0)	3(27.3)	13(41.9)
Death caused by multidrug use n (%)	5(25.0)	1(9.1)	6(19.4)
Death caused by pesticides n (%)	7(35.0)	4(36.4)	11(35.5)
Death caused by medications n (%)	0(0)	3(2.7)	3(9.7)
Death caused by carbon monoxide n (%)	3(15)	1(9.1)	4(12.9)
Median age in years (25^{th}, 75^{th}) percentile	30(26, 42)	22(18, 32)	28(22-38)
Age in years (Minimum-Maximum)	14-77	17-44	14-77
Age for drug users in years (Minimum-Maximum)	24-55	25-44	24-55
Location			
Villages n(%)	18(90.0)	10(90.9)	28(90.3)
Camp n(%)	1(5.0)	0	1(3.2)
City n(%)	1(5.0))	1(9.1)	2(6.5)
Manner of death			
Accident (pesticides, medication, CO) n (%)	5(25.0)	5(45.5)	10(32.3)
Accident (drugs) n (%)	10(50.0)	1(9.1)	11(53.5)
Suicide (pesticide, medication) n (%)	4(20.0)	3(27.3)	7(33.3)
Suicide(drugs) n (%)	1(5.0)	1(9.1)	2(6.5)
Homicide (pesticides, medication) n (%)	1(5.0)	1(9.1)	2(6.5)

DISCUSSION

Mortality data in Palestine is limited. Like many developing countries, autopsy in Palestine is rare unless conducted in the medicolegal arena (21). In addition, drug use in Palestine is hidden, stigmatized, and associated with social disapproval (4-8, 12, 22). Stigmatizing attitudes may keep individuals with substance use disorders from seeking help, putting them at higher risk of death (15). Therefore, mortality data related to drug misuse is scarce. This study aimed to investigate mortality associated with drug use in post-mortem cases in the West Bank from 2011-to 2021.

Natural death was the leading cause of death, followed by homicide. In agreement with other studies, males constituted the bulk of the post-mortem cases referred to the Institute of Forensic Science in ANNU in 2011-2021 (23, 24). This could be because most deaths (70%) were by natural causes and homicides. More Palestinian males than females die due to chronic diseases (23). Homicidal death was ranked second in this study, with firearm shooting the leading cause of death, followed by

stab wounds. We cannot ascertain why homicidal death preceded accidental death in the frequency of cases. However, homicidal death was predominant in the summer season, with increased risk in young adults aged 18-40, and most cases located in villages and refugee camps.

Refugees were three times more likely to commit homicide than Palestinians living in West Bank cities. Refugee camps in the West Bank are characterized by violent conflict, weak state control, and social turmoil. Palestinian refugees suffer from ordinary daily life stressors such as high unemployment, low income, high poverty, poor infrastructure, and high population density(7), which makes them at increased risk of violence, abuse, exploitation, and neglect across the region (7, 22). Palestinians believe that the lack of awareness and addiction to alcohol and drugs is one reason for domestic violence(8). They also believe Israel promotes drug trafficking and consumption, especially in areas B and C (villages and refugee camps), where weak governmental control and surveillance are noticed (4, 7, 8). Palestinians who live in towns and camps gain more access to alcohol and illicit drugs from their locality than others. In this study, 90.3% of post-mortem cases caused by drugs and other toxicants were from villages. According to the International Classification of Diseases (ICD), deaths caused by drug abuse were classified as drug dependence or drug intoxication (unintentional or intentional) (25).

Moreover, 32.3% of these cases were deaths related to intentional intoxication, suicide, and homicide, and 41.9% were death-related drug toxicity (n=13). The majority of death-related drug toxicity (n=11, 84.6%) were accidental death in which multidrug was found in 38.5 %, indicating that multidrug and overdose toxicity could play significant roles in mortality data related to intoxication in the West Bank. This also emphasizes that the lack of governmental control and surveillance on drugs could further increase the increased risk of mortality caused by drugs in rural areas on the West Bank.

The majority of overdose deaths involve combinations of drugs (26). Using two or more illicit drugs is of great significance due to the potentially harmful effects of some drug combinations that can lead to hazardous and sometimes deadliest results (26). MDMA is most commonly taken with alcohol and other drugs, and mono-intoxication is less common (27). Similar to global results, most illicit drug-related deaths occur in males, with the median age of death 30 years (28). Amphetamine-type stimulants were involved in most death-related drugs.

Moreover, ATS use is a growing global phenomenon (14, 29). It tends to occur most frequently in groups engaged in risky behaviors. Most cases indicated that this study involved multidrug toxicity as the cause of death. This involves AMA, methamphetamine, MDMA, and methadone. Alcohol and THC were also found in samples either alone or in combination. Concomitant alcohol use also increases the toxicity of other drugs (28), while alcohol and benzodiazepine dependence increase the risk of suicide(28). This is the case for both victims in this study who committed suicide with a benzodiazepine. It was expected to find MDMA in most drug intoxication cases; MDMA pills are the most seized pills in the West Bank (4), and the majority of HRDU had benzodiazepines (74%) and amphetamines (67%) in their system (12).

Moreover, MDMA was used to prepare a new homemade liquid drug called GG that

emerged in the West Bank in 2013 (4). The toxicological testing of users' urine for this substance was positive for methamphetamine compared to none users. Laboratory tests also confirmed that the substance is liquid methamphetamine. This homemade amphetamine was associated with risky behaviors (4).

Methadone alone was found in three cases; one by injection and two were engaged in polydrug use, including MDMA, morphine, and AMA. Methadone maintenance therapy is used to treat opioid addiction to decrease the withdrawal symptoms of opioid temperance (2, 30). However, it takes longer for new opiate users to clean their bodies from methadone, placing them at higher risk of overdose(30). Moreover, it may also cause fatal intoxications if used outside the maintenance therapy program (31). In polydrug use victims, the methadone itself may not be enough to carry severe risk and cause death (4). There is a high risk of developing dependence. The use of other drugs, particularly respiratory depressants, will have an additive effect and increase the risk of death due to depressed ventilation (32). The medical and psychosocial follow-up for drug users in the West Bank is absent due to the absence of cost-free rehabilitation centers. Establishing rehabilitation centers in the West Bank that provide the psychological, social, and medical care of drug addicts is strongly needed. Since most of the victims were in their middle age and not enrolled in a drug treatment program, an increased risk of premature mortality is estimated among Palestinians.

The World Health Organization (WHO) and the Centres of Disease Control and Prevention (CDC) stated that accidental or unintentional injury is the leading cause of death in children aged one through 18 years(33, 34). In this study, and agreement with other studies, the minor numbers of death were in extreme ages, elderly >65 years and children, and were attributed mainly to natural causes of death (34). However, most cases that committed suicide (70.4%) were young adults,18-40 years old, and 21% were in the age group 5-17. Children were five times more likely to commit suicide, while young adults were nine times more likely to commit suicide than victims aged >40 years. These results agree with the CDC results, stating that more teens die from suicide than the combined other disease causes (33). In agreement with further studies, most suicides were males aged ≤40 years, and asphyxiation by hanging was the predominant cause (35, 36). In all mortality data related to intoxication, organophosphates were the leading cause of death in suicidal cases, while multidrug misuse was the leading cause of unintentional death. Due to the limitations in testing drugs in forensic labs in the West Bank, not all suicide cases are tested for drugs. Only those who are suspected of drug use are examined. This could underestimate death-related drug use in Palestinians.

Physicians have a higher rate of psychoactive substance use when compared to the population in general (37). Anesthesiology is one of the most affected medicine specialties, mainly due to overwork and easier drug access (38). The most widely used drugs are opioids (fentanyl and sufentanil), propofol, and inhalational anesthetics. Young professionals are the most affected. Among the consequences of drug abuse are workplace absence and even death (39). Although healthcare providers have access to a wide array of potent narcotics, injectable propofol has become a drug of choice, and the most common reason for this is the ease of access(40). This is the case in this study, with

propofol overdose causing death. Anesthesia and pharmacy information management systems may allow earlier detection and be adopted in Palestinian hospitals(41).

Many factors could contribute to underestimating mortality related to drug use in post-mortem cases. First, forensic science is new in the West Bank and was established in 1994. It suffers from a shortage of staff, components, and laboratories. Autopsy results were unreliable until 2010, and forensic laboratories have started working since 2016. However, they still lack the capability of testing body tissues and fluids. Post-mortem drug concentrations in body fluids and tissues are of forensic value. Usually, drug abuse testing involves an initial screening test followed by a second test identifying the exact substance. Only commercially available tests developed and optimized to screen urine for the major drugs of abuse are used in the West Bank. Examination of stomach contents might provide evidence of the method of administration (32). Some samples for body fluids were sent to the Forensic Science Lab in Jordan, a neighboring country, to confirm the results with sensitive and precise test methods. The lack of such practices in the West Bank might underestimate the actual size of the problem.

Secondly, one of the limitations of this study is that victims of road traffic accidents are not routinely referred to the post-mortem examination, which may underestimate the mortality of drug use rate in the West Bank. The significant causes of death amongst illicit drug users are drug overdose, disease, suicide, and trauma (28). Cannabis has no risk of overdose or infection by sharing injecting equipment. Its related mortality is primarily due to the long-term effects of administration on the respiratory system or traumatic motor vehicle accidents (28). Cannabis has been the most widely used and seized illicit drug in the West Bank in the last decade (4). Road traffic accidents, drowning, and falls were this study's leading causes of fatal unintentional injuries.

Moreover, official statistics on the prevalence of illicit drug use and illicit drug-related mortality vary enormously from country to country. Environmental, cultural, and behavioral factors vary between countries and affect estimates made for those countries(28). Palestinian society rejects autopsy as they believe it contradicts religion and the sanctity of the human body (21). Therefore, the autopsy is rare in Palestine unless conducted in the medicolegal arena.

Thirdly, hospitalized death and death witnessed by medical providers usually do not undergo post-mortem examination, contributing to underestimating premature mortality related to drug use in the West Bank. Illicit drug use is responsible for over 585,000 premature deaths worldwide (42). Deaths from illegal drug use can be differentiated as an indirect risk factor for premature death from disease or injury and direct death from drug dependency and overdoses(42). In this study, two cases with congenital malformation had premature death and heart failure following drug use. Benzazepine was found in the system of a 24 years old male attempting suicide, and THC was found in the system of a 23 years old male who was positive for the THC test. Several studies conclude that amphetamine abuse is strongly associated with coronary artery disease and subarachnoid hemorrhages. It can also cause tachycardia and hypertension, and cause significant cerebral blood flow(43). This could lead to premature death, which could be misclassified as natural. In the light of the increased drug use in the West Bank, this

emphasizes the need to increase the awareness of premature death related to drugs.

CONCLUSION

This study indicated that natural death was the leading cause, followed by homicide. Homicidal death was predominant in the summer, with increased risk in young adults from villages and refugee camps. Most suicide cases were males aged ≤40 years, and asphyxiation by hanging was the predominant cause. Therefore, age-related increases in homicide rates highlight the vital role of raising national health awareness and improving the health care system in rural areas and refugee camps. In all mortality data related to intoxication, organophosphates were the leading cause of death in suicidal cases; during multidrug misuse in unintentional death. ATS was the primary combined drug. The type of combined drugs estimated the potential danger caused by these drugs in the West Bank. Death-related drug use was prevalent in males and rural areas. Overall, mortality data related to drug use could be underestimated in post-mortem cases. The increased rate of suicide and accidental death related to drug use, the age of victims, and the polydrug tested in these cases indicate a hidden population of multidrug users in young Palestinian adults and children, which designates drug use in Palestine has reached an alarming situation. Prevention programs are recommended to decrease the homicide, suicide, and accidental mortality rates related to drug use. Law enforcement and prevention programs for drug abuse are requested.

List of abbreviations

- AMA: Amphetamine.
- ANNU: An-Najah National University.
- ATS: Amphetamine-Type Stimulants.
- CDC: Center for Disease Control and Prevention.
- CI: Confidence Intervals.
- HRDU: High-Risk Drug Users.
- ICD: International Classification of Diseases.
- IRB: Institutional Review Board.
- MDMA: 3,4-Methyl enedioxy methamphetamine
- OR: Odds Ratio.
- SPSS: Statistical Product and Service Solutions.
- SUDs: Substance Use Disorders.
- THC: Tetrahydrocannabinol.
- UNODC: United Nations Office on Drugs and Crime.
- WHO**:** World Health Organization

Ethics approval and consent to participate

The Ethics Committee of the Institutional Review Board "IRB" at An-Najah National University (ANNU) approved the study protocol (Ref. Med. June 2021/7, approved on June 22, 2021). All procedures followed were by the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, revised in 2000. Ethical safeguards were employed. Data were collected and treated confidentially, kept safe, and available for the researchers only. Codes were used instead of names.

Consent for publication

Not applicable.

Data and material availability

Most data generated or analyzed during this study are included in this manuscript. Other data that supported the findings of this study and analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' Contributions

BD and RA conceptualization and project administration, BD, RA, RZ, AT, ST, and OS designed the methodology, BD formal analysis, and data curation, BD, ST, OS, and MJ prepared the draft version of the manuscript, and all authors have read and agreed to the published version of the manuscript and have agreed to the submission to the journal.

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REFERENCES

1) Pardo Cabello AJ, Del Pozo Gavilán E, Gómez Jiménez FJ, Mota Rodríguez C, Luna Del Castillo Jde D, Puche Cañas E. Drug-related mortality among inpatients: a retrospective observational study. European journal of clinical pharmacology. 2016; 72(6): 731-6.

2) Drummer OH, Opeskin K, Syrjanen M, Cordner SM. Methadone Toxicity Causing Death in Ten Subjects Starting on a Methadone Maintenance Program. The American Journal of Forensic Medicine and Pathology. 1992; 13(4): 346-50.

3) Vaduganathan M, Machado S, DeFilippis E, Bajaj N, Stehlik J, Mossialos E, et al. Organ Donation and Drug Intoxication–Related Deaths in the United States. The New England Journal of Medicine. 2019; 380(6): 597-9.

4) Damiri B, Sayeh W, Odeh M, Musmar H. Drug use and possession, emerging of new psychoactive substances in the West Bank, Palestine. Egyptian Journal of Forensic Sciences. 2018; 8(1): 42.

5) Van Hout MC, Al-Afifi MF, Abushams L, Kewley S, Quigg Z, Whitfield M, et al. Palestinian Children's Experiences of Drug Abuse in the home in the Occupied Territories of Palestine: a Scoping Review of Extant Literature. International Journal of Mental Health and Addiction. 2020; 18(6): 1572-85.

6) Al-Afifi M, Abushams L, Sakka M, Shehada M, Afifi R, Alloush M, et al. Perspectives of Frontline Professionals on Palestinian Children Living with Sibling and Parental Drug Use in the West Bank and Gaza Strip. International Journal of Mental Health and Addiction. 2020; 18(4): 1097-112.

7) Damiri B. The Use of Psychoactive Substances in a Conflict Area in the West Bank: Drug Use Risk Factors and Practices in Palestinian Refugee Camps. International Journal of Mental Health and Addiction. 2020; 18(6): 1507-20.

8) Massad S, Shaheen M, Karam R, Brown R, Glick P, Linnemay S, et al. Substance use among Palestinian youth in the West Bank, Palestine: a qualitative investigation. BMC Public Health. 2016; 16(1): 800.

9) Damiri B, Sandouka H, Janini E, Yaish O. Prevalence and associated factors of psychoactive substance use among university students in the West Bank, Palestine. Drugs: Education, Prevention and Policy. 2020; 27(2): 173-82.

10) Damiri B, Salahat I, Aghbar M. Pattern of substance use among schoolchildren in Palestine: a cross-sectional study. Egyptian Journal of Forensic Sciences. 2018; 8(1): 59.

11) United Nations Office on Drugs and Crime U. World Drug Report 2015. United Nations publication, Sales No. E.15.XI.6; 2015.

12) United Nations Office on Drugs and Crime U. Estimating the Extent of Illicit Drug Use in Palestine. 2017.

13) Willey J. JMS Letter. Journal of Mass Spectrometry. 2009.

14) United National International Drug Control Programme U. World Drug Report. . New York, Oxford University Press; 2000.

15) Witte TH, Wright A, Stinson EA. Factors Influencing Stigma Toward Individuals Who Have Substance Use Disorders. Substance Use and Misuse. 2019; 54(7): 1115-24.

16) Baker R, Sullivan E, Camosso-Stefinovic J, Rashid A, Farooqi A, Blackledge H, et al. Making use of mortality data to improve quality and safety in general practice: a review of current approaches. Qual Saf Health Care. 2007; 16(2): 84-9.

17) Qaddumi JAS, Nazzal Z, Yacoup ARS, Mansour M. Quality of death notification forms in North West Bank/Palestine: a descriptive study. BMC Res Notes. 2017; 10(1): 154-.

18) Madea B, Rothschild M. The Post Mortem External Examination: Determination of the Cause and Manner of Death. Deutsches Ärzteblatt International. 2010; 107(33): 575-88.

19) Fligner C, Murray J, Roberts D. Synergism of verbal autopsy and diagnostic pathology autopsy for improved accuracy of mortality data. Population Health Metrics. 2011; 9:25-.

20) Martinez B, Botella G, Aznar B, Sanchez N, Barcelo C, Gomez L. The role of clinical autopsy in monitoring the quality of the clinical diagnosis in an emergency department]. Anales de medicina interna (Madrid, Spain : 1984). 1998; 15(4): 179-82.

21) Daher-Nashif S. Historical and Present-Day Practices of Forensic Medicine in Palestine: Body, Society, and Science Jerudalem: palestine-studies.org 2017 [Available from: http://www.palestine-studies.org/sites/default/files/jq-articles/Pages%20from%20JQ%2070%20-%20Daher-Nashif.pdf.

22) Van Hout MC, Aaraj E, Maalouf W. Public health imperatives in countering drug related health threats and vulnerabilities in contemporary Palestinian refugee camps. Int J Drug Policy. 2020; 85: 102931-.

23) MoH MoH. Palestine Health Status Annual Report 2011. Palestinian Health Information Center: MOH; 2012. Contract No.: 11/22/2012.

24) Borges G, Nock MK, Haro Abad JM, Hwang I, Sampson NA, Alonso J, et al. Twelve-month prevalence of and risk factors for suicide attempts in the World Health Organization World Mental Health Surveys. Jornal of Clinical Psychiatry. 2010; 71(12): 1617-28.

25) Stenbacka M, Leifman A, Romelsjo A. Mortality and cause of death among 1705 illicit drug users: A 37 year follow up. Drug and Alcohol Review. 2010; 29(1): 21-7.

26) Darke S, Degenhardt L, Mattick R. Mortality and drug overdose. In: Degenhardt L, Mattick R, Darke S, editors. Mortality amongst Illicit Drug Users: Epidemiology, Causes and Intervention. International Research Monographs in the Addictions. Cambridge: Cambridge University Press; 2006. p. 42-66.

27) Milroy CM. "Ecstasy" associated deaths: what is a fatal concentration ? Analysis of a case series. Forensic Science, Medicine, and Pathology. 2011; 7(3): 248-52.

28) Darke SaD, Louisa and Mattick, Richard Mortality amongst illicit drug users. In: Degenhardt L, Mattick R, Darke S, editors. Mortality amongst Illicit Drug Users: Epidemiology, Causes and Intervention. International Research Monographs in the Addictions. Cambridge: Cambridge University Press; 2006. p. 20-41.

29) World Health Organization W. Management of substance abuse, Amphetamine-type stimulants. 2018 [cited 2018 11/6/2018]. Available from: http://www.who.int/substance_abuse/activities/amphetamine/en/.

30) Karch SB, Stephens BG. Toxicology and pathology of deaths related to methadone: retrospective review. West J Med. 2000; 172(1): 11-4.

31) Fugelstad A, Stenbacka M, Leifman A, Nylander M, Thiblin I. Methadone maintenance treatment: the balance between life-saving treatment and fatal poisonings. Addiction (Abingdon, England). 2007; 102(3): 406-12.

32) Milroy CM, Forrest ARW. Methadone deaths: a toxicological analysis. Journal of Clinical Pathology. 2000; 53(4): 277-81.

33) Gaynes BN, West SL, Ford CA, Frame P, Klein J, Lohr KN, *et al*. Screening for suicide risk in adults: a summary of the evidence for the US Preventive Services Task Force. Annals of internal medicine. 2004; 140(10): 822-35.

34) Centers for Disease C, Prevention CDC. Reproductive mortality, infant mortality: CDC; 2011 [Available from: https://www.cdc.gov/reproductivehealth/maternalinfanthealth/infantmortality.htm.

35) Masango SM. Suicide and suicide risk factors: a literature review : CPD. South African Family Practice. 2008; 50(6): 25-9.

36) Dabbagh N. Behind the statistics: the ethnography of suicide in Palestine. Culture, medicine and psychiatry. 2012; 36(2): 286-305.

37) McLellan AT, Skipper GS, Campbell M, DuPont RL. Five year outcomes in a cohort study of physicians treated for substance use disorders in the United States. BMJ British Medical Journal. 2008; 337: a2038.

38) Garcia-Guasch R, Roigé J, Padrós J. Substance abuse in anaesthetists. Current Opinion in Anesthesiology. 2012; 25(2).

39) Jungerman FS, Palhares Alves HN, Carmona MJC, Conti NB, Malbergier A. Anesthetic Drug Abuse by Anesthesiologists. Brazilian Journal of Anesthesiology. 2012; 62(3): 375-86.

40) Lee J. Propofol abuse in professionals. Journal of Korean medical science. 2012; 27(12): 1451.

41) Fitzsimons MG, Baker KH, Lowenstein E, Zapol WM. Random Drug Testing to Reduce the Incidence of Addiction in Anesthesia Residents: Preliminary Results from One Program. Anesthesia and Analgesia. 2008; 107(2): 630-5.

42) Ritchie H, Roser M. Opioids, cocaine, cannabis and illicit drugs 2018 [Available from: https://ourworldindata.org/illicit-drug-use.

43) Masini E, Sgambellone S, Lanzi CJB, Dynamics H. Psychostimulants and Cardiovascular Function. Brain and Heart Dynamics 2020: 829-41.