Drug Overdose Deaths in Halifax, Nova Scotia from 1996 to 2010:

A Descriptive and Comparative Study

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Abstract

Drug overdose death is an increasing concern in many areas of the world and many prevention programs exist to control these deaths. These include prescription monitoring programs, Naloxone treatment, safer injection facilities and methadone treatment. It is prescription drug overdose deaths which are becoming more prevalent and therefore these prevention programs must be adjusted to fit the on going problems. This can be done by examining trends in overdose deaths. The purpose of this study is to examine drug overdose deaths in Halifax, Nova Scotia, between 1996 and 2010 with respect to death rate, drug prevalence and manner of death. This data is compared to a previous study in Halifax from 1993 to 1995. It was found that death rates (per 100,000 persons) due to drug overdose have increased since 1993. Narcotic analgesics and benzodiazepine were the most prevalent drug categories found in toxicology reports and also increased significantly between the two studies. Cocaine usage also increased. In manner of death comparison a significant decrease in undetermined deaths was seen with a simultaneous increase in accidents. Based on this drug overdose death data, focus can be directed to the areas which are increasing the most, i.e. prescription drug use, as well as be able to adjust prevention programs to help with these areas.

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1. Introduction and Literature Review

1.1 Drug Overdose Deaths

A drug overdose is characterized as the use of a drug or medicine in a greater quantity than is recommended or that is safe (Patel et al., 2008). An overdose can cause harmful symptoms, which can vary depending on the person and amount of drug taken. Variation occurs due to pharmacokinetic properties; how the body absorbs, distributes, metabolizes and excretes the drug, and pharmacodynamic properties; how the drug affects the body based on receptor interaction. Each one of these processes can vary greatly between people and the drug that is being taken. Tolerance, which is the decrease in susceptibility to the effects of a drug through prolonged use, also affects drug reactions. It is because of these processes that not all doses of the same drug cause the same effect. Death may result from a combination of these processes or from a single or combination of drugs as well as the interactions between drugs (Golan et al., 2008).

Deaths caused by drug overdose have increased over the past few years and are a major issue in many parts of the world including Canada and the United States. For example, in New York City (NYC), drug overdose surpassed homicide as the number one cause of accidental death between 1990 and 1998 (Kerr et al., 2006). It became the number one cause of accidental death in the United States (US) in 2009, killing more people than motor vehicle accidents (Brandeis University, 2011). Although there is not as much data collected for Canada, drug overdose death is thought to be a significant problem. From 1992 to 2004, it was estimated that 500 to 1000 drug-related overdose deaths were reported annually in Canada (Fischer et al., 2006 a). From 1993 to 1995, there were approximately 14 deaths per year due to drug overdose in Halifax, which is a

rate of 4.1 deaths per 100,000 persons per year (Poulin et al., 1998).

Not only are the number of overdose deaths alarming but they are increasing at a significant rate. From 1990, death rate due to drug overdose in the US has increased by 300%, resulting in a total of 37,000 deaths in 2009 (Centers for Disease Control and Prevention, 2012 b). In Utah the number of drug poisonings (not limited to deaths) between 1991 and 2003 increased by a factor of five (Centers for Disease Control and Prevention, 2005), while in Florida the death rate of drug overdose increased 47.5% in a six year period (2003-2009) (Centers for Disease Control and Prevention, 2011a). Immediate attention is drawn to the issue of drug overdose death in communities based on these findings.

Several different drugs are responsible for deaths caused by overdose, as well as many different combinations of these drugs (Coffin et al., 2003). Opioids are one of the major drug categories which cause accidental overdose deaths (Coffin et al., 2003; Fisher et al., 2006b). In NYC, opioids were found in toxicology results of 71.1% of those who died of accidental drug overdose (Coffin et al., 2003). In the United States the rate of prescription opioid abuse surpassed that of heroin from 2002 to 2006 (Fischer et al., 2006 b). Alcohol is also found in the toxicology reports of a large number of drug overdose deaths. From 1990 to 1998, 40.4% of persons that died due to drug overdose in NYC had alcohol in the toxicology reports (Coffin et al., 2003) and in Wales 29% of deaths in 2002 were alcohol-related (Webb et al., 2003). Another drug which causes a significant number of unintentional drug overdose deaths is cocaine. In NYC, deaths attributed to cocaine peaked from 1993 to 1995 (10.35, 9.64 and 10.17 drug overdose deaths per 100,000 persons per year, respectively) with a minimum of 7.92 deaths per 100,000 in 1998.

Between 1990 and 1998, 69.5% of overdose deaths were attributed to cocaine (Coffin et al., 2003). In New Mexico, cocaine was implicated in 37.6% of unintentional drug overdose deaths between 1990 and 2005 (Shah et al., 2007) while in Wales it was implicated in only 4% of all drug overdose deaths in 2000 (Webb et al., 2003).

Medical examiners and coroners generally categorize drug overdose deaths into accidental, suicide and undetermined manners of death. Correct classification is important for many reasons, including for insurance and public health policies. There is considerable variation in the assessment of manner of death. Suicides differ from accidents because they are purposely committed by the deceased and are generally underreported (Lindqvist and Gustafsson, 2002). Suicides have many biological and psychological (i.e. depression) factors which affect the investigation (Shields et al., 2005) making a positive determination of suicide highly variable among medical examiners (Shah et al., 2007). Medical examiners only categorize a death as undetermined if they have little evidence to discriminate between an accident or suicide (Lindqvist and Gustafsson, 2002). Unintentional overdose deaths (accidental deaths) have been increasing in many areas, including New Mexico from 1990-2005 (Shah et al., 2007) and New York City from 1990-1993 (Coffin et al., 2003). They are also the primary cause of death in illicit drug users throughout the world (Shah et al., 2007).

1.2 Overdose Prevention

There are many different preventative techniques in place which attempt to decrease the number of overdose deaths (Kerr et al., 2006). One approach is that of harm reduction which focuses on the problems of the user rather than their specific drug use. Harm reduction differs from rehab centers in one way by not making the addict quit their

drug usage immediately. Harm reduction includes using outreach programs to educate users on the harms and potential deadly outcomes of drug use by attempting to limit the users' need for drugs (Cheung, 2000). The problem with this type of program is that once users are no longer in treatment, they can resort back to their old habits, which increases their risk of death due to overdose (Hickman et al., 2007). There are also prescription monitoring programs which attempt to regulate the intentional overuse of prescription drugs by monitoring the amount of drugs given to patients by pharmacists and doctors (Nova Scotia Prescription Monitoring Program). These efforts help prevent the purposeful misuse of a prescription drug (Canadian Center on Substance Abuse, 2012), but have no effect on their accidental misuse.

Differing from substance abuse and rehab programs which aid in the prevention of harm from all drugs, there are new programs focusing on harm reduction of specific types of drugs, like opioids and injection drugs. In 2003, North America's first ever supervised safer injection facility was established in Vancouver (Kerr et al., 2006). This program has been shown to reduce the number of overdose deaths caused by the injection of drugs (Fischer et al., 2006 a; Kerr et al., 2006; Milloy et al., 2008). Supervised safer injection facilities are areas in which drug users can inject drugs (licit and illicit), which they procure under the supervision of medically trained personnel (Kerr et al., 2006; Milloy et al., 2008). By having medically trained personnel available, overdoses can be treated before they become fatal.

Many areas of the world are also using the distribution of Naloxone to prevent overdose deaths (Centers for Disease Control and Prevention, 2012a; Fischer et al., 2006a; Piper et al., 2007). Naloxone is an opioid antagonist which when administered,

reverses the respiratory depression caused by overdose of any opioid drug (Centers for Disease Control and Prevention, 2012a; Fischer et al., 2006a). Through training sessions and the distribution of prescriptions for Naloxone to opioid drug users, many overdose deaths can be prevented (Piper et al., 2007).

Another form of drug harm reduction is the use of methadone maintenance programs (Cheung, 2000). Methadone is a treatment for opioid addiction, especially heroin, and is given to users on a strict schedule (Drucker et al., 1998). This program prevents the symptoms caused by withdrawal, which leads users to continue heroin use to avoid the negative affects, and it is also used for detoxification (Drucker et al., 1998; Langendam et al., 2001). Although this program does help, methadone is still a potentially addictive drug and can cause overdose deaths on its own if not monitored strictly by pharmacists (Williamson et al., 1997).

Though all these programs are helpful, the large majority of them focus mainly on the use of illegally obtained drugs. For example, the studies done on Naloxone and supervised safer injection facilities focus mainly on opioid injection drugs such as heroin (e.g. Milloy et al., 2008; Piper et al., 2007). These illegally obtained drugs, which include heroin, cocaine, hallucinogens and stimulants, cause a considerable number of overdose deaths (e.g. in the US there are 2.8 overdose deaths per 100,000 persons due to illegally obtained drugs) (Centers for Disease Control, 2011b), but they are not the most concerning cause of drug overdoses. In British Columbia, there has been a downward trend in overdose deaths caused by the use of illegally obtained drugs since 1998 (British Columbia Coroner's Service, 2011). According to the Canadian Center on Substance Abuse (2012), prescription drug abuse is an increasing concern for Canadians. From 1998

to 2002, there was an increase in the amount of prescription drugs in Canada (Morgan, 2004). This is also true in the United States where the death rate for prescription drug overdose is 6.5 deaths per 100,000 persons per year (Centers for Disease Control and Prevention, 2011 b). In Florida, the death rate involving prescription drugs was four times that of illegally obtained drugs (e.g. heroin and cocaine). Deaths due to prescription drugs, in Florida, increased between 2003 and 2009 by 84.2% and accounted for 76.1% of all overdose deaths (Centers for Disease Control and Prevention, 2011 a). This trend was also seen in Kentucky (Centers for Disease Control and Prevention, 2011 a). In Hamilton Ontario, prescription drug overdose deaths accounted for 72% of all overdose deaths in 1967 (Sims et al., 1973).

1.3 Uses for Drug Overdose Data

Reducing drug overdose deaths must involve a more intensive public health approach, paying attention to both illegally obtained and prescription drugs (Shah et al., 2007). The prevention programs and interventions should be tailored to specific trends in overdose death rates and different drug combinations in a given area (Coffin et al., 2003; Fischer et al., 2004; Shah et al., 2007). Drug-related mortality studies provide important information on drug use and practices which can then be used to monitor drug policy, prescription practices and the effectiveness of treatment programs (Webb et al., 2003) as well as future overdose death rates (Coffin et al., 2003).

1.4 Drug Overdose data collection in Canada

There are very few estimates of mortality due to drug overdose in Canada (Single et al., 2000), with the majority of information derived from Ontario and British Columbia. These few studies mainly examine illegally obtained drug trends, making it difficult to

determine patterns of drug overdose. From 1993 to 1995 there was an in-depth study done by Poulin et al. (1998) which examined drug overdose deaths in Halifax, Nova Scotia. The authors report 48 deaths caused by drug overdose during the three year period, which represents approximately 14 deaths per year and a rate of 4.1 deaths per 100,000 persons per year. Of these 48 deaths, only five had illicit drugs in their toxicology reports and of these, only three contained cocaine (7.1% of all overdose deaths). The most commonly observed drug category in the toxicology results of victims of drug overdose was ethanol (47.6%). Psychotropic medications (antidepressants, benzodiazepines, antipsychotics, and hypnotics and sedatives) were found in 62% of drug overdose deaths. Poulin et al. (1998) also found that suicide was the most common manner of death, attributing to 47.6% of all drug overdose deaths. The majority of suicides were committed by females (65%). Undetermined manner of death was the second most common, comprising 45.2% of all drug overdose deaths.

1.5 Objectives

The objectives of this study were to:

1) Examine the trends in drug overdose death rates between 1996 and 2010 and to determine if these trends changed significantly within this study period.
2) Determine which types of drugs were the most prevalent in the toxicology results between 1996 and 2010.
3) Examine the trends in cocaine prevalence in toxicology reports of people dying of drug overdose between 1996 and 2010.
4) Examine any the trends in the manner of death (accidental vs. suicide vs. undetermined) for 1996-2010.

These data will be compared to those of Poulin et al. (1998) to determine whether drug usage and death rates have increased since 1995.

2. Methods

The study was aligned in design with that done by Poulin et al. (1998) to permit comparison over two sampling periods. All data were collected from the Nova Scotia Medical Examiner Service (NSMES) in Halifax, Nova Scotia, Canada (44.6°N, 63.6°W) using compiled spreadsheets and case files for mortality data collected between 1996 and 2006. Data collected from 2007 to 2010 were compiled in a spreadsheet by the information technology department of the NSMES. Cause of death was noted. If death was due to drug overdose, the case number, date of death, age, manner of death, cause of death, sex, toxicology results, place of residence (where they are living) at death and place of death (where they were found deceased) were recorded. This study was focused on people who lived and died in Halifax, Nova Scotia.

Dr. Matt Bowes, Chief Medical Examiner, checked the data to insure that all recorded deaths were caused by a drug overdose. Any deaths that he did not believe to be a direct result of drug overdose were not included in this analysis.

2.1 Death Rates

Halifax's population size was regressed against year between 1981 and 2010 (Statistics Canada). Population size for a given year was interpolated from the generated equation (Appendix A). Death rates due to drug overdose per 100,000 persons were calculated by dividing the total number of drug overdose deaths (D) (Appendix B) by the population of Halifax for that year (P) and then multiplying by 100,000 [i.e. (D/P)*100,000]. This death rate was calculated for each year from 1996 to 2010 (Figure 1).

2.2 Prevalence of Drugs

The types of drugs found in toxicology reports were split into fifteen different categories. Twelve of these categories were based on the previous study done by Poulin et al. (1998) to enable comparison. Categories included are listed in Table 1. The other three categories (stimulants, carbon monoxide and hallucinogens) were added based on the drugs that were found in the more recent toxicology reports that had not been included in the results of Poulin et al. (1998). To provide an in depth look at cocaine as well as to ensure comparison, cocaine was left as its own category and added to the stimulants category. Classifications were constructed according to Berardi et al. (2009) and Lacy et al. (2010), and were examined by the Chief Medical Examiner of Nova Scotia, Dr. Matt Bowes (list of drugs along with their metabolites can be found in Appendix C).

The toxicology results from each case were examined and a category of drug was considered present if one or more drugs from that category were found in the results. The totals were then calculated for each year, and added together for an overall total over all 15 years. The percentage of cases which contained each drug category were then calculated ([prevalence/total overdoses]*100).

2.3 Manner of Death

The trends in manner of death (suicide, accident or undetermined) were graphed as to the percent of deaths caused by each manner of death for each year between 1996 and 2010. Percent of deaths was calculated by dividing the number of drug overdose deaths deemed with the manner of death by the total of overdose deaths (Appendix B) and multiplied by 100.

2.4 Statistical Analysis

Data was tested for normality using D'Agostino & Pearson omnibus normality test (GraphPad software, Inc, 2013). To assess change in death rate between the first half of the study (1996-2002) and the second half (2003-2010), a Mann Whitney test was performed. Prevalence of drug categories in this study was determined using a goodness of fit test calculated by hand and comparison between the two studies was done through chi-squared testing (numbers were moved one place to avoid decimals). Chi-squared testing was also done to view changes in manner of death. All tests (except the goodness of fit test) were done using graphPad (GraphPad software, Inc, 2013) and all results were considered significant if $P \leq 0.05$.

3. Results

3.1 Death Rates due to Drug Overdose

The death rate per 100, 000 persons due to drug overdose in Halifax were significantly higher in the last eight years of the study compared to the first seven years (8.95 deaths per 100,000 ± 0.75, n= 8 vs. 6.46 deaths per 100,000 ± 0.49, n=7 respectively; Mann-Whitney U= 9.00, p= 0.03). The death rates due to drug overdose began with an increase from 6.73 to 8.32 drug overdose deaths per 100, 000 persons in 1998. The rate then decreased to a low of 4.78 in 2000. There has been an increase in death rate since then with a major spike in 2007 with 11.61 deaths per 100, 000 persons (Figure 1). In 2007 a decrease began and has continued to decrease to 8.99 drug overdose deaths per 100,000 people at the end of the study (2010) (Figure 1).

The average death rate also increased in comparison with the previous study from 1993 to 1995 by Poulin et al. (1998). There were 4.1 deaths/100,000 (ranged from 3.50 - 4.67) in that study and 7.79 deaths/100,000 (ranged from 4.78 - 11.61) from 1996 to 2010.

3.2 Prevalence of Drug Categories

There was a significant difference in prevalence between drug categories (χ^2=689.35, df= 14, P< 0.0001). Toxicology reports show that narcotic analgesics were the most frequent category of drugs used while hallucinogens were the least (Table 1).

There was a significant change in drug prevalence between Poulin et al.'s study (1998) and this study (χ^2=495, df=14, P<0.0001). Prevalence was typically higher in this study than Poulin et al.'s (1998) with nine of the fifteen categories showing an increase in prevalence. Benzodiazepines and cocaine had increased the most. There were also three categories which were not in toxicology results of the previous study (stimulants, which

include cocaine, carbon monoxide and hallucinogens); therefore, drugs from these categories have increased from zero usage (Table 2).

3.3 Prevalence of Cocaine

The prevalence of cocaine in toxicology reports of drug overdose deaths fluctuated between 1996 and 2010 with major peaks in 1998, 2002 and 2007 (34%, 33.3% and 31.8% of drug overdose deaths, respectively) (Figure 2). Despite these fluctuations, there has been a general increase in cocaine found in toxicology reports of drug overdose death (4.3 % in 1996 to 20% in 2010) (Figure 2).

Poulin et al. (1998) found that 7.1% of persons that died from drug overdose had cocaine in their toxicology reports (range was not provided). This study found that 20.2% of persons that died of drug overdose had cocaine in their toxicology reports (range 3.7 to 34%).

3.4 Manner of Death

Manner of death for drug overdose deaths varied over the 15 year period (Figure 3). Suicides fluctuated throughout the study with a high in 1999 and a low in 2005. Suicides were on a decreasing trend for the last five years (48.7% in 2006 to 25.7% in 2010). Undetermined drug overdose deaths have decreased resulting in a minimum of zero in 2005, 2006, 2007 and 2008, while accidental drug overdose deaths have increased with a maximum of 84% in 2005.

A significant difference in the mean number of accidental, suicidal and undetermined deaths between the two studies was found (χ^2=417.7, df=2, P<0.0001) (Table 3).

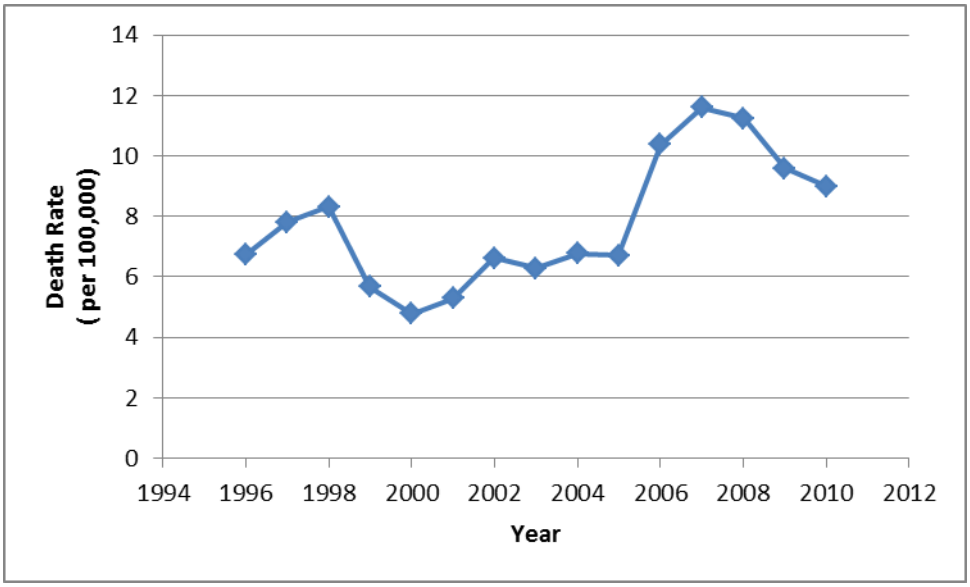

Figure 1: The trend in death rate (per 100,000 persons) of individuals, in Halifax N.S., who died of drug overdose for the years between 1996 and 2010.

Table 1: Prevalence of drug categories, total number and percent of total deaths, in the toxicology reports of overdose deaths between 1996 and 2010.

Drug Class	Number of Overdoses	Percent of Total overdoses*
Narcotic analgesics	196	45.6
Benzodiazepines	182	42.3
Ethanol	171	39.8
Antidepressants	164	38.1
Medications available without prescription	119	27.7
Stimulants (including cocaine)	100	23.3
Cocaine	87	20.2
Other prescription medications	79	18.4
Miscellaneous	56	13.0
Cannabis	43	10.0
Carbon Monoxide	39	9.1
Hypnotics and sedatives	38	8.8
Drugs for major psychiatric or neurologic disorders	37	8.6
Other Alchohol	15	3.5
Hallucinogens	2	0.5

*Percentages do not add up to 100 as multiple drugs were often simultaneously found in toxicology results

Table 2: Comparison of prevalence of drug categories in the toxicology reports of overdose deaths in the previous study by Poulin et al. (1998) and this study.

Drug Class	Percent of Total from Poulin et al.(1998)*	Percent of Total from 1996-2010*
Narcotic analgesics	23.8	45.6
Benzodiazepines	19	42.3
Ethanol	47.6	39.8
Antidepressants	38.1	38.1
Medications available without prescription	28.6	27.7
Stimulants (including cocaine)	N/A	23.3
Cocaine	7.1	20.2
Other prescription medications	9.5	18.4
Miscellaneous	7.1	13.0
Cannabis	4.8	10.0
Carbon Monoxide	N/A	9.1
Hypnotics and sedatives	11.9	8.8
Drugs for major psychiatric or neurologic disorders	11.9	8.6
Other Alchohol	7.1	3.5
Hallucinogens	N/A	0.5

*Percentages do not add up to 100 as multiple drugs were often simultaneously found in toxicology results

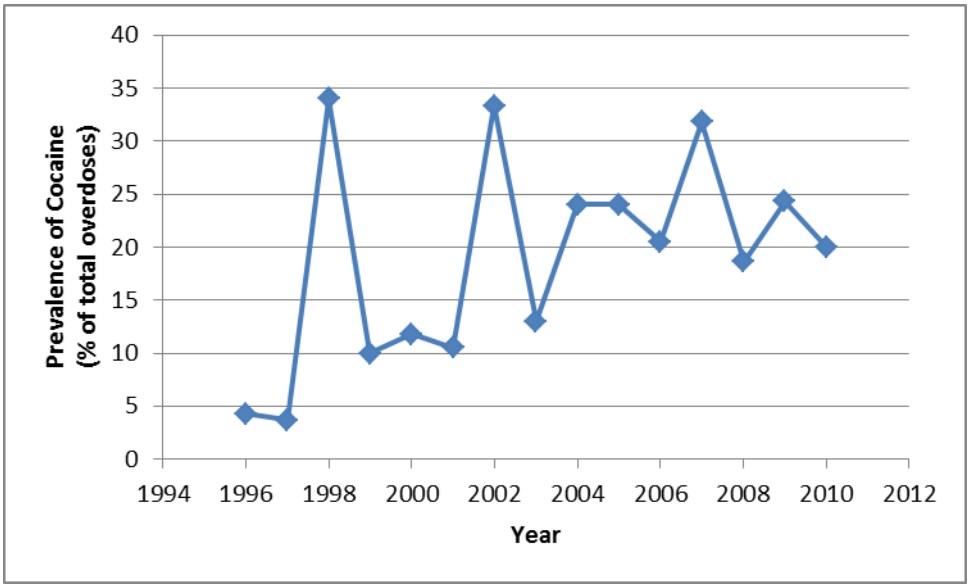

Figure 2: The prevalence of cocaine found in the toxicology reports of overdose deaths in Halifax N.S. (percentage of total overdose deaths per year)

Table 3: Comparison of manner of death between a study by Poulin et al. (1998) (1993-1995) and this study (1996-2010).

	1993-1995	1996-2010
Accidental	7.1%	42.8%
Suicide	47.6%	42.3%
Undetermined	45.2%	14.4%

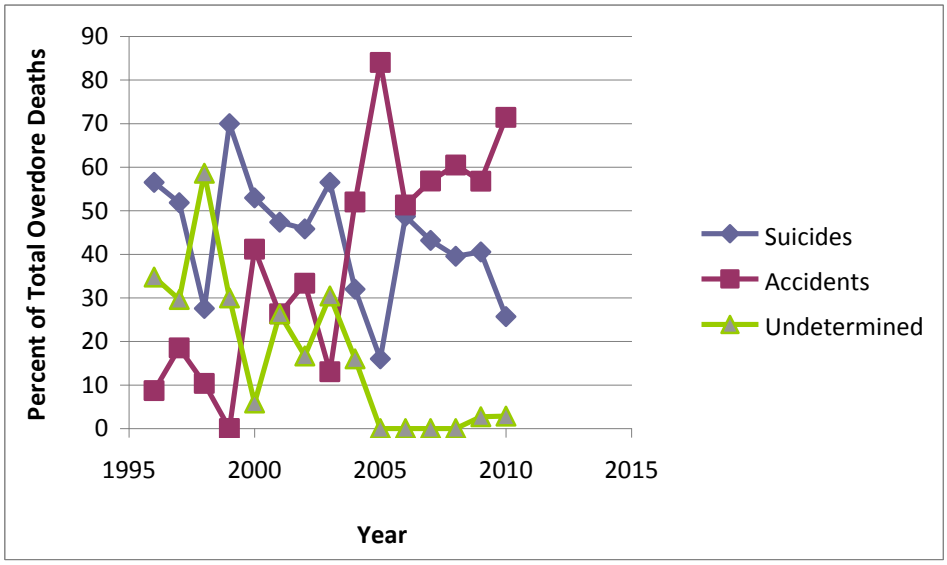

Figure 3: The trends in manner of death, suicide, accidental, undetermined, by percentage of total overdose deaths between the years of 1996 and 2010 in Halifax N.S.

4. Discussion

The death rate due to drug overdose increased significantly from 1993 to 2010 in Halifax, N.S. This is shown through the comparison between the study done by Poulin et al. (1998) with a mortality rate of 4.1 drug-overdose deaths per 100, 000 persons per year (1993-1995) compared to the average drug overdose death rate of 7.79 deaths per 100,00 per year in this study (1996-2010). Although statistical analysis could not be done between these two studies, there was an increase in death rate, almost doubling, with no overlap between the ranges. This increase in death rate continued throughout the current study until 2007 where it began to decrease (Figure 1) but it did not affect the increase of drug overdose death rate that was observed in the second half of the study. This general increase in drug overdose death rate during these years is consistent with other areas such as New York City and the rest of the United States from 1990 to 2009 (Brandeis University, 2011; Kerr et al., 2006). A full comparison of my study to many of the other studies conducted on drug overdoses is difficult due to different areas of study and variations in drug categories. Many studies on drug overdose typically only include data of accidental manner of death, such as the ones for the US (Brandeis University, 2011). By limiting their investigation into drug overdose deaths they are not able to view general trends which allow focus on specific and important areas of interest. Because an increase in drug overdose deaths is observed in many different areas, it is a concern that must be addressed when dealing with health issues.

Four categories of drugs were more prevalent in toxicology results than expected (Table 1). The most prevalent category was that of narcotic analgesics, which include opioid drugs such as morphine and codeine as well as heroin. In general, these drugs all

relieve the sensation of pain (Golan et al., 2008). Benzodiazepines were also a prevalent category. This category includes a wide variety of drugs that are prescribed for anxiety (Golan et al., 2008). Ethanol and antidepressants were also prevalent. Many different types of antidepressants are used to treat depression. Classifying the drugs into only one drug category is difficult because many of them are used to medicate more than one condition. For example, many benzodiazepines are prescribed as sedatives (which is another category of drugs in this study), muscle relaxants and anti-convulsion medication (Golan et al., 2008). In many studies of accidental overdose, deaths due to opioids (narcotic analgesic category) and alcohol were among the most frequent causes of death (Coffin et al., 2003; Fischer et al., 2006 b; Webb et al., 2003), this is also consistent with my findings. Most of the drugs found in these categories are either legal to purchase (e.g. alcohol) or are available by prescription. My findings indicate that prescription and other legal drugs have surpassed illegally obtained drugs in overdose deaths.

Narcotic analgesics and benzodiazepines increased significantly between the two studies situating them in the top two most prevalent drug categories (Table 2). This rise in popularity may be for many reasons such as an increase or decrease in the availability of other drugs. Two other categories of drugs which also gained popularity were cocaine, which is generally obtained illegally, and other prescription medications that do not fit in the other categories (Table 2).

Cocaine was present in the toxicology reports of three of the 42 deaths (7.1%) that were investigated by Poulin et al. (1998), which is low for a popular recreational drug (Siegel, 1977). Between the two studies there was an increase in the prevalence of cocaine (20.2%; Table 2) involved in overdose deaths. This significant increase is similar

to trends for deaths in New York during their peak of 69.5% from 1993 to 1995 (Coffin et al., 2003) and New Mexico with 37.6% from 1990 to 2005 (Shah et al., 2007). These results only portray accidental overdose deaths. In Wales in 2000, only 4% of all drug overdose deaths involved cocaine. These results vary widely in different populations, though they do show a general increase throughout this variation (Figure 2).

Comparing the manners of death (accidental, suicide and undetermined) to the study done by Poulin et al. (1998), a significant difference was found, with a drastic increase in accidental deaths (8.7% in 1996 and 71.4% in 2010). A corresponding decrease in undetermined deaths, dropping to zero in 2005 with only a variation of approximately 3% was also found. This drastic change in manner of death corresponds to the addition of the current Chief Medical Examiner at the NSMES, Dr. Matt Bowes. He joined the NSMES in 2004 and was appointed chief in 2006, where he undertook a more thorough and accurate approach to the determination of manner of death (Bowes). This limited the number of undetermined deaths, which is only used when they cannot determine true manner of death (Lindqvist and Gustafsson, 2002). Although there is no significant change in the percent of suicides between the two studies, there were differences in the criteria which were used to classify deaths as suicides. In the previous study deaths were only classified as suicides if a note was found (Poulin et al., 1998). Dr. Bowes stated that as part of their determination of manner of death investigators take a more thorough approach, looking at multiple aspects, such as information from the families and social media sites that may give an indication of how that person was feeling prior to death (M. Bowes, Pers. Comm.). This more thorough method resulted in a decrease of suicides, 48.7% in 2006 to 25.1% in 2010, indicating that it is possible more

efficient at determining manner of death as a suicide. There were other decreases before this time (from 56% in 2003 to 16 in 2005) which also indicates the possibility of other factors contributing to prevalence of suicides as manner of death in drug overdose (Figure 3).

A major disadvantage when studying and comparing overdose deaths among studies is that death investigations vary among jurisdictions and medical examiners or coroners (Tatsumi et al., 2013).

Prevalence of drugs was calculated based on drugs found in toxicology reports that did not necessarily cause death. Although these data indicate which drugs are highly implicated in drug overdose death, they can skew results by over representing typical medications that are found in low amounts and that are not implicated in the cause of death such as acetaminophen which is a common pain releiver.

Gaining information on the rates of overdose death, the prevalence and changes in drugs found in the toxicology reports of overdose deaths as well as the manner of death provides insight into the drug problem in Halifax, Nova Scotia during a fifteen-year period. Based on these data, it is possible to form more effective prevention programs or alter current ones to better focus the issues of public safety on the area which are causing the most problems. Focusing more effort into the prescription monitoring programs and creating more ways to regulate prescription drugs would be warranted. By warning people of the dosing effects and possible side effects of drugs, accidental overdoses could be avoided. By determining the general trend in drug overdose deaths specific areas can then be concentrated on.

In the future, larger scale studies could be done for the entire province of Nova

Scotia or Canada, which would enable provincial and national laws to be re-evaluated regarding drugs and public health and safety. These could then be models for areas outside of Canada as well. Future studies could be on examining factors which my affect the determination of a death due to overdose such as, decomposition. Examining why some drugs are increasing in prevalence in relation to others would also be important to investigate.

5. Conclusion

Drug overdose deaths have been increasing since 1993 in Halifax, Nova Scotia which is of concern to public health. Along with this increase in overdose death is the increased prevalence of many prescription medications such as narcotic analgesics and benzodiazepines, two of the most prevalent drugs in the toxicology results of overdose deaths. Since 1993 there has been an increase in accidental overdose deaths which also correlated with a decrease in undetermined deaths, resulting from a more thorough system investigation system. By studying these changes of the important aspects in drug overdose death it is possible to form more effective prevention of these deaths. Similar data collection and analysis done provincially or nationally could result in laws being changed and could serve as a model for other areas. A more in depth look at drug categories and overdose death determination would aid in monitoring drug overdose problems as well.

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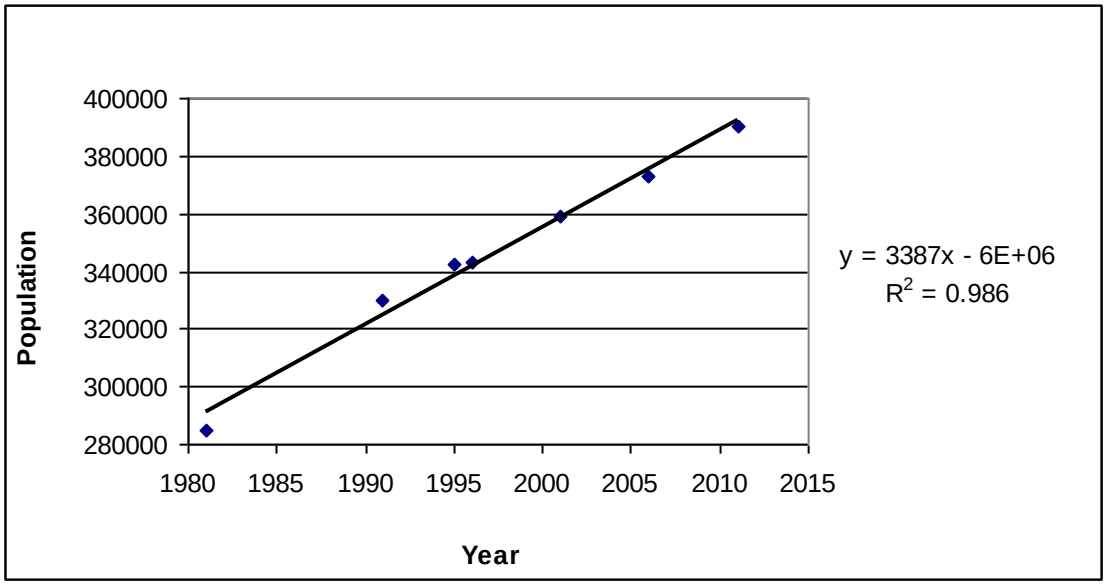
Appendix A- Interpolation of population size data for Halifax, N.S. from 1996-2010



Appendix B- Total overdose deaths per year, 1996-2010

Year	Total Overdose Deaths
1996	23
1997	27
1998	29
1999	20
2000	17
2001	19
2002	24
2003	23
2004	25
2005	25
2006	39
2007	44
2008	43
2009	37
2010	35

Appendix C- Drug categories and the list of drugs contained in those categories

Ethanol	methanol and isopropanol	antidepresssants	drugs available without prescri	narcotic analgesics	benzodiazepines
	Methanol	amitriptyline	acetaminophen	codeine	7-aminoclonazepam
	Isopropanol	bupropion HCL	diphenhydramine	dihydrocodeine/hydrocodol	alpha-hydroxyalprazolam
	n-propanol	desmethyldoxepin	ibuprofen	hydromorphone	alprazolam
	formic acid	doxepin	salicylate	levomethophan	bromazepam
	formate	citalopram	dextromethorphan	meperidine	chlordiazepoxide
		clomipramine	dextrorphan	methadone	clonazepam
		cotinine	doxylamine	levorphan	diazepam
		desipramine	meclizine	morphine	hydroxytriazolam
		desmethylclomipramine	methocarbamol	fentanyl	lorazepam
		desmethylsertaline	naproxen	oxymorphone	midalozam
		desmethyltrimipramine	theobromine	oxycodone	nordiazepam
		escitalopram	pheniramine	o-desmethyltramadol	oxazepam
		fluoxetine		normeperidine	temazepam
		fluvoxamine		propoxyphene	triazolam
		imipramine		sufentanil	
		mirtazapine		EDDP	
		nefazodone		desmethylproprocyphen	
		norfluoxetine		Heroin	
		nortriptyline		6-monoacetylmorphine	
		o-desmethylvenlafaxine			
		paroxetine			
		phenelzine			
		sertaline			
		trazodone			
		trimipramine			
		venlafaxine			
		paxil			
		nelafaxine			
		moclobimide			

drugs for major psychological and neurological disorders	hypnotics and sedatives	other prescription me	cocaine	cannabis	miscellaneous
8-hydroxy-loxapine	butalbital	insulin	benzoylecgonine	carboxy-THC	acetaldehyde
buspirone	chloral hydrate	acebutolol	ecgonine ethyl ester	cannabinoids	caffeine
carbamazepine	pentobarbital	amlodipine	methylecgonine	delta-9 carboxy THC	ehtylene glycol
clozapine	phenobarbital	atropine	norcocaine	delta-9 THC	glycolic acid
haloperdiol	propofol	benztropine	cocaethylene	THC	isovaleraldehyde
lithium	secobarbitol	bupivacaine			nicotine
loxapine	trichloroethanol	Coumadin/Warfarin			methyl ethyl ketone
methotrimeprazine	zopiclone	chlorpheniramine			isoamyl alcohol
carbamazepine- 10-11- epoxide	etomidate	cyclobenzaprine			
olanzapine	ketamine	digoxin			
phenytoin	norketamine	diltiazem			
primidone		furosemide			
prochlorperazine		hydroxychloroquine			
quetiapine		hydroxyzine			
gabapentin		levamisole			
lamotrigine		lidocaine			
valproic acid		megx			
chlorpromazine		metformin			
		metoclopramide			
		metoprolol			
		norhydroxyzine			
		verapamil			
		norverapamil			
		piroxicam			
		propranolol			
		theophylline			
		tramadol			
		atomoxetine			
		gabapentine			

Stimulants w/ cocaine	Carbon Monoxide	Hallucinogens
benzoylecgonine	carboxyhemoglobin	anhydro EME- psychedelic
ecgonine ethyl ester		EME- psychedelic
methylecgonine		phencyclidine- hallucinogen
norcocaine		
cocaethylene		
amphetamines		
epinephrine		
methamphetamine		
cinnamoylococaine		
TFMPP		
phenyl propanolamine		
norpseudoephedrine		
pseudoephedrine		
MDMA		
MDA		
BZP		