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Mortality in a Long-term Open Cohort of Prostitute Women

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In this study, the authors estimated overall and cause-specific mortality among prostitute women. They recorded information on prostitute women identified by police and health department surveillance in Colorado Springs, Colorado, from 1967 to 1999. The authors assessed cause-specific mortality in this open cohort of 1,969 women using the Social Security Death Index and the National Death Index, augmented by individual investigations. They identified 117 definite or probable deaths and had sufficient information on 100 to calculate a crude mortality rate (CMR) of 391 per 100,000 (95% confidence interval (CI): 314, 471). In comparison with the general population, the standardized mortality ratio (SMR), adjusted for age and race, was 1.9 (95% CI: 1.5, 2.3). For the period of presumed active prostitution only, the CMR was 459 per 100,000 (95% CI: 246, 695) and the SMR was 5.9 (95% CI: 3.2, 9.0). Violence and drug use were the predominant causes of death, both during periods of prostitution and during the whole observation period. The CMR for death by homicide among active prostitutes was 229 per 100,000 (95% CI: 79, 378), and the SMR was 17.7 (95% CI: 6.2, 29.3). Deaths from acquired immunodeficiency syndrome occurred exclusively among prostitutes who admitted to injecting drug use or were inferred to have a history of it.

acquired immunodeficiency syndrome; HIV; homicide; mortality; overdose; prostitution; substance abuse, intravenous; violence

Abbreviations: HIV, human immunodeficiency virus; NDI, National Death Index; SSDI, Social Security Death Index; SSN, Social Security number.

Female prostitution is embedded in a context of felonious activity, illicit drugs, and violence (1–4) and is associated with premature mortality. Two cohort studies have directly assessed mortality in prostitutes during short observation periods (5, 6). No prior research has measured prostitute mortality during a long period or has verified it with vital statistics records. Indeed, Woolston's 1921 observation that "no satisfactory data showing the length of life of prostitutes in America are available, for the simple reason that women are not registered as such when they die" (7, p. 41) has remained accurate.

For three decades, continuous, community-wide surveillance of prostitutes in Colorado Springs, Colorado, has generated information on a large cohort of prostitute women (8, 9). These data and the availability of national mortality databases permitted assessment of cause-specific mortality among these women.

MATERIALS AND METHODS

Background and population characteristics

US Census figures (10) show that in 1970, Colorado Springs had a population of 235,972, of whom 94 percent were White (including an unknown proportion of Hispanics), 5 percent were African-American, and 1 percent were of other races. Thirty years later, the population of Colorado Springs had increased to 516,929 (11), of whom 81

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percent were White (including 14 percent Hispanic), 7 percent were African-American, 4 percent were of Asian/Pacific Islander/American Indian race, and 9 percent were of other or mixed race (percentages do not sum to 100 because of rounding error).

Enhanced monitoring of prostitution in Colorado Springs began in the 1960s in response to a rapidly growing gonorrhea epidemic associated with prostitution (5, 8). In mid-1970, the health department instituted a mechanism for examining arrested prostitutes for sexually transmitted infections, termed the Health Hold Order (8). At about the same time, the police created a vice squad to monitor prostitution. Their activities included arrest and field surveillance (including the recording of personal identifiers) of persons engaged in prostitution. Colorado statutes urged coordination between public health officials and police officers in suppressing sexually transmitted infections and prostitution (5). This relationship was unilateral: Police provided health officers access to prostitution records but not vice versa. Between 1970 and 2000, health department and police prostitution records were periodically compared.

Health department records for prostitute women were also based on women identified independently in our sexually transmitted infection, human immunodeficiency virus (HIV), and drug treatment clinics (through self-report); in observations of prostitutes during public health outreach activities; and through contact tracing for sexually transmitted infections/HIV. In our clinics, we recorded standard information on each woman as part of routine clinical and epidemiologic evaluation. Starting in mid-1985, women visiting the sexually transmitted infection clinic or the HIV testing clinic who provided histories of prostitution were queried about injecting drug use and offered HIV testing; such information was unavailable for prostitutes ascertained solely by means of other sources.

The study cohort included women in Colorado Springs identified by police or health department surveillance as prostitutes, that is, as women who exchanged sex for money or drugs. These women were known to have engaged in prostitution between approximately 1967 and 1999. Most women ultimately appeared in multiple data sources during their prostitution careers (9). Both the prevalence and number of sexual partners of prostitute women in Colorado Springs appear to be representative of prostitutes in the United States (9, 12).

Mortality data sources

As a first step, we searched the Social Security Death Index (SSDI) in mid-1999 regarding people who had died between 1967 and 1999. The SSDI records information on decedents with Social Security numbers (SSNs) for whom survivor claims have been processed (13, 14). It lists the decedent's first name (at least first initial), surname, birth date, date of death, postal codes of last residence and last Social Security benefit, and SSN; it does not record information on sex, race, birth name (for women), death location, or cause of death. The staff of the sexually transmitted infection clinic requested the SSN as an optional item; 79 percent (981/1,245) of the women seen at the clinic provided it. Many (565/1,969) records of women in our cohort contained multiple names. Thus, we queried the SSDI systematically, beginning with SSN only and then using combinations of surname, first name/initial, and birth date to identify likely matches.

The National Death Index (NDI) registers deaths that have occurred in the United States since 1979. It is maintained by the Centers for Disease Control and Prevention. Source documentation consists of death certificate information provided by state and territorial registries. Minimum data required for searches include first name and surname and either SSN or month/year of birth. Provision of middle initial, day of birth, father's surname, age at death, sex, race, marital status, state of residence, and/or state of birth improves search accuracy. NDI algorithms identify possible matches; the quality of matches depends on the completeness of submitted data.

Initial criteria for gauging the probability of a correct match are based on data concordance: 1) either first name or surname and SSN; 2) SSN and surname (for men) or SSN and surname or father's surname (for women); or 3) first name and surname and month and year of birth. The NDI program compensates for spelling subtleties by using phonetic codes. Possible matches include state of death and certificate number. The NDI search algorithm generates many potential matches, especially if the submitted information is incomplete, as well as a score (0–100). For all searches, we classified matches as *definite* (concordance of four of the following: SSN (within one digit), name, birth date, race, and sex); *probable* (among data items other than SSN, no more than two items slightly discordant (e.g., birth date one digit off or name slightly different)); and *possible* (manual review aiming for a preponderance of evidence using data from the NDI, the death certificate, and our records). We considered definite and probable deaths to be confirmed. Most NDI matches were eliminated using logic (e.g., males were automatically excluded) and a conservative NDI score cutoff point (less than 45 out of a possible 100 in the absence of an SSN).

Our list was searched at the NDI in late 1999 and compared with decedent records for 1979–1997. We sought death certificates from relevant registries in the United States for confirmed, probable, and possible matches emanating from the SSDI or NDI searches. Our NDI search was approved by the Colorado Health Sciences Center Institutional Review Board; in addition, death certificate requests were subject, in some states, to local institutional review. The Colorado Springs Police Department supplied a list of homicides that occurred in Colorado Springs between 1968 and 1999. We also requested information about death circumstances from other US jurisdictions for other murdered women in our cohort.

Statistical analyses

Mortality rates were based on the 1,633 women for whom year of first observation of local prostitution was available. Nearly all of the missing data on year of first local prostitution were attributable to women who did not have dated records in police files during the early part of the observation

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period, women identified only through visits to the HIV testing clinic or the drug treatment clinic (where dates of first local prostitution were not systematically collected), women who engaged in prostitution elsewhere, and women for whom the locale of prostitution could not be determined. Our calculations of person-years of observation took into account the fact that actual dates of first observation and death (when dates precise to the day and month were available) were uniformly distributed across a given year (resulting in 0.5 of a person-year, on average, for the first year a woman was observed or the year of her death) and that the final SSDI search occurred in mid-1999 (also resulting in 0.5 of a person-year for a woman censored by that endpoint).

Rates were computed for two sets of women: the cumulative cohort (which grew steadily from 1967 to 1999) and a subcohort classified as active prostitutes. The latter consisted of a shifting set of women. We created this "moving cohort" by including, for a given year, only women who were within 3 years of first being observed engaging in prostitution. Among prostitute women in our cohort known to reside in Colorado Springs for several years or more at some point prior to 1995 (n = 449), 50 percent had a time span between first and last observation of local prostitution (based on police surveillance, observation in the field or health department clinics, and/or reports from other active prostitute women) of 3 or more years. Fifteen percent had a span of prostitution of 2 years, and 35 percent had a span of less than 2 years. Thus, we inferred that the majority of living women in the cohort continued to work as prostitutes while in the moving cohort.

We calculated the expected number of deaths (using the "prospective model" (15)) in the cumulative and active cohorts using sex-, age-, and race-specific mortality tables for all causes of death (16) and homicide (17–19). We computed standardized mortality ratios by dividing the observed number of deaths by the expected number of deaths. In addition, we estimated the average annual number of murdered prostitutes in the United States between 1981 and 1990 by multiplying the homicide rate we observed by the estimated number of prostitute women in the United States (23 per 100,000 population, derived from our local capture-recapture study (9)). Then we divided this product by the mean number of females, overall and between ages 15 and 44 years, murdered annually during this period (17–19) to estimate the percentage of female murder victims in the United States who were prostitutes. We estimated the typical prostitute's risk of murder during her prostitution career by means of the formula $1 - (1 - \text{active prostitutes' crude homicide rate})^5$, because prostitutes in Colorado Springs worked for 5 years, on average (9).

RESULTS

Cohort characteristics

From 1967 through 1999, 1,969 women were identified as prostitutes in Colorado Springs. Nearly two thirds (n = 1,245; 63.2 percent) were initially identified in the sexually transmitted infection clinic, 134 (6.8 percent) were identified in the HIV testing center, 56 (2.8 percent) were identified in the substance abuse clinic, and 88 (4.5 percent) were identified during routine outreach. The remaining 446 women (22.7 percent) were initially identified by police; nearly three quarters (326/446) were observed by undercover officers, and the remainder were observed by uniformed officers patrolling solicitation areas. Four fifths (1,579/1,969) were known to have received care in one of our health department clinics. The overwhelming majority of the women worked as street prostitutes; only 126 worked in massage parlors, and most of these women also worked on the streets (9).

We classified the majority of prostitute women (1,795/1,969; 91 percent) as evanescent, short-term, or long-term residents. Evanescent prostitutes (n = 1,012; 56 percent) resided and solicited locally for a few days or weeks in any given year. Short-termers (n = 315; 18 percent) solicited for many weeks to months in any given year, and long-termers (n = 468; 26 percent) solicited for years even if they did not solicit continuously (9). Ninety-one percent were known to have engaged in prostitution locally, 4 percent reported histories of prostitution elsewhere only, and for 5 percent, locale was not recorded. The mean age at first observation of working locally was 24 years for those for whom we had data on date of first observation (n = 1,633; median, 23; standard deviation, 6.0; interquartile range, 20–27; range, 11–54).

Search results

The NDI search of 1,969 women used 2,883 names (mean = 1.47 per person; range, 1–9), yielding 9,926 potential matches, of which 1,223 met our initial matching criteria. Using the more rigorous matching criteria, we made 301 requests for death certificates for 165 women from 38 state registries. For the 33-year study interval, 117 women (6 percent) were classified as confirmed dead and 26 (1.3 percent) were classified as possibly dead (table 1). The 117 confirmed deaths were distributed in 26 states. Health department records and death certificates showed perfect concordance on SSN for 49 (86 percent) of the 57 confirmed-dead women who had an SSN in both sources. The NDI identified 100 confirmed deaths, with the SSDI corroborating only 57 of these; all deaths recorded by the SSDI appeared in the NDI. In reviewing the 43 deaths "missed" by the SSDI, at least 36 should have been listed, because a matching name or SSN was available. Predictably (7), none of the death certificates recorded any history or evidence of prostitution.

Comparative mortality

Observed dates of first prostitution were available for 1,633 women. Figures 1, 2, and 3 show for each year the number of women observed for the first time, the number in the cumulative cohort, and the number in the active cohort, respectively. Women who had dates of first prostitution were more likely to be African-American (33 percent) than women lacking such information (17 percent).

Of these 1,633 women, 100 died during the study period. The crude mortality rate was 391 per 100,000 person-years, and the standardized mortality ratio was 1.9 (table 2). The

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TABLE 1. Vital status of 1,969 women who worked as prostitutes in Colorado Springs, Colorado, by race, 1967–1999

Race	Definite death*		Probable death*		Possible death*		Not dead		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Black	42	37.8	3	50.0	15	57.7	536	29.4	596	30.3
Hispanic	10	9.0	0	0	0	0	128	7.0	138	7.0
White	56	50.5	3	50.0	8	30.8	1,054	57.7	1,121	56.9
AI/A/PI†	3	2.7	0	0	1	3.8	68	3.7	72	3.7
Other/unknown	0	0	0	0	2	7.7	40	2.2	42	2.1
Total	111	100	6	100	26	100	1,826	100	1,969	100

* See Materials and Methods section for details on classification of deaths.
† AI/A/PI, American Indian/Asian/Pacific Islander.

overall crude mortality rate and standardized mortality ratio for the presumed-active prostitutes—the women whose period of observation included only that time during which they were most likely to have been engaged in prostitution—were 459 per 100,000 person-years and 5.9, respectively.

Causes of death

Few of the women died of natural causes, as would be expected for persons whose average age at death was 34 years. Rather, based on proportional mortality, the leading causes of death were homicide (19 percent), drug ingestion (18 percent), accidents (12 percent), and alcohol-related causes (9 percent) (table 3).

For nine women (8 percent), the underlying cause of death was HIV infection or acquired immunodeficiency syndrome; all had either admitted to a history of injecting drug use or were inferred (from having track marks, being named an injecting drug user by others, or associating only with other injecting drug users) to have a history of injecting drug use. Thus, deaths from acquired immunodeficiency syndrome occurred only among injecting drug users. Seven hundred seventy-four (98 percent) of the 786 women who had visited any of our health department clinics since mid-1985 had been tested for HIV, and 29 (3.7 percent) were HIV-positive. Twenty-seven of the 29 HIV-positive women admitted to injecting drug use. Among the 117 women who died, injecting drug use status was known for 59; 45 admitted to injecting drug use. Though incomplete, the data suggest that the nexus of injecting drug use, drug overdose, and acquisition of HIV was the most important nonviolent contributor to heightened mortality.

Violent death

Of 21 murders, nine occurred within 3 years of the first observed prostitution. All of these nine women were active prostitutes at the time of death, and eight were killed while soliciting. The crude mortality rate for homicide in the cumulative cohort was 82.0 per 100,000 person-years; for the cohort of active prostitutes, it was 229 per 100,000 person-years (table 2). On the basis of this latter estimate, these women faced, on average, a 1 percent (0.0114) chance

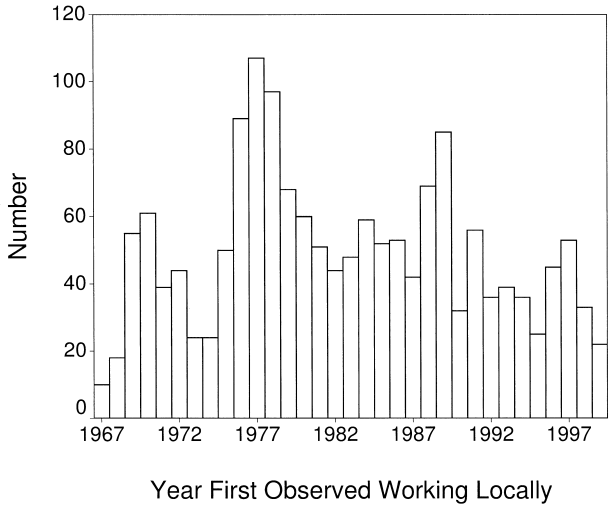


FIGURE 1. Number of women observed for the first time working as prostitutes in Colorado Springs, Colorado, by year, 1967–1999.

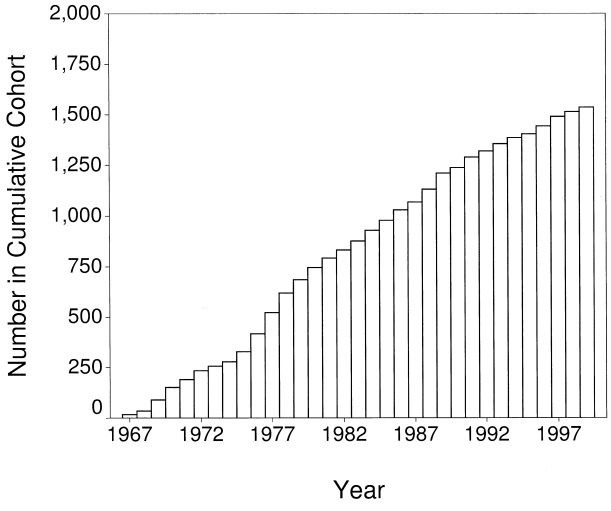


FIGURE 2. Number of prostitute women in the cumulative cohort, by year, Colorado Springs, Colorado, 1967–1999.

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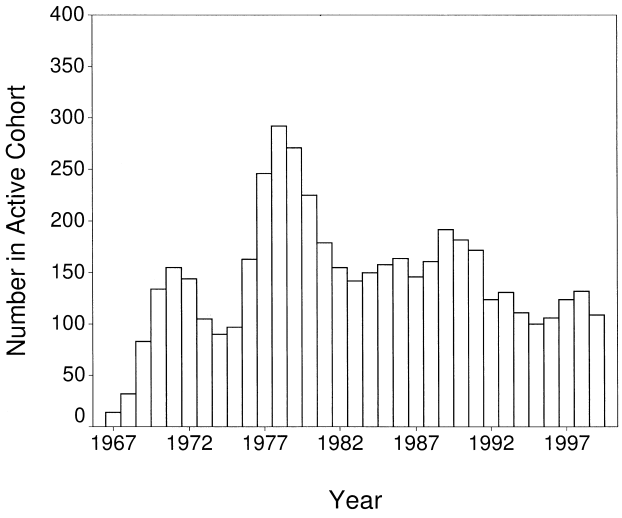


FIGURE 3. Number of prostitute women in the active cohort, by year, Colorado Springs, Colorado, 1967–1999.

of being murdered during their prostitution careers. By extrapolation, this rate implies that between 1981 and 1990, approximately 124 prostitute women were murdered annually in the United States, accounting for 2.5 percent of female murder victims (3.7 percent of female murder victims aged 15–44 years). The workplace homicide rate for prostitutes in the moving cohort (eight murdered on the job) was 204 per 100,000 person-years. The standardized mortality ratio for homicide in the cumulative cohort was 7.9, and in the moving cohort it was 17.7. Thus, active prostitutes were almost 18 times more likely to be murdered than women of similar age and race during the study interval. The nine deaths occurring among active prostitutes that were not deemed to be homicides included five drug overdoses, two suicides, and two deaths due to unknown causes.

Although murder accounted for 19 percent of all confirmed deaths, it accounted for half of the 18 deaths in the active subcohort. Of the 12 women murdered more than 3 years after the first observation of prostitution, eight died while still actively working as prostitutes (six were slain while soliciting and another was killed by a boyfriend who was jealous of her prostitution activity). One victim was not actively engaged in prostitution; death circumstances suggested that two were killed by clients while soliciting; and no information on prostitution status was available for the other. Thus, the vast majority of murdered women in our sample were killed as a direct consequence of prostitution.

DISCUSSION

We collected data on 1,969 prostitute women in Colorado Springs. This large cohort, assembled over 30 years as part of routine sexually transmitted infection control efforts, afforded us the opportunity to generate approximate population-based mortality data on women who spent some time in "the life." Our analysis indicated that their high mortality was attributable primarily to violence and drug use. Notably, despite prostitutes' very high number of sexual partners (12), the only women in our cohort who died of acquired immunodeficiency syndrome had a history of injecting drug use. This latter result is consistent with the very strong association between injecting drug use and HIV infection among prostitute women in Israel, Vietnam, and elsewhere in the United States (20–22).

Our estimates of the all-cause crude mortality rate (459 per 100,000) and standardized mortality ratio (5.9) for presumed-active prostitutes are similar to earlier estimates from smaller groups of prostitute women followed in Colorado Springs in 1976–1977 (standardized mortality ratio = 3.3) (5), in Nairobi, Kenya, in 1998–2002 (n = 466; crude mortality rate = 310 per 100,000 (Stephen Moses, University of Manitoba, personal communication, 2003)), and in London, United Kingdom, in 1985–1994 (n = 402; crude mortality rate = 401 per 100,000; standardized mortality ratio = 12.2) (6). The London study was based on comparatively few (675) person-years, deaths were measured by incidental reports from other prostitutes, and the observation period for living women was the interval between the first and last clinic visits, truncating the observation period relative to women who died.

TABLE 2. Overall mortality and homicide rates among 1,969 prostitutes in Colorado Springs, Colorado, 1967–1999

Type of mortality and cohort*	No. of deaths	Person-years of observation	Crude mortality rate (per 100,000 person-years)	95% confidence interval†	Standardized mortality ratio	95% confidence interval†
Overall mortality						
Cumulative	100	25,599	391	314, 471	1.9	1.5, 2.3
Active	18	3,925	459	246, 695	5.9	3.2, 9.0
Homicide mortality						
Cumulative	21	25,599	82	47, 117	7.9	4.5, 11.3
Active	9	3,925	229	79, 378	17.7	6.2, 29.3

* "Cumulative" refers to the whole cohort throughout the entire observation period. "Active" refers to persons in the moving cohort of women presumed to be actively engaged in prostitution (see text).

† Confidence intervals were calculated treating the numerator for each calculation as a Poisson variable.

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TABLE 3. Causes of death for confirmed deaths among 1,969 prostitutes in Colorado Springs, Colorado, 1967–1999

Underlying cause of death*	No. of deaths†	Specific cause of death
Homicide	21	Gunshot wound (8)‡
		Knife wound (3)
		Strangulation (4)
		Other (6)
Suicide	5	Gunshot wound (2)
		Drowning (1)
		Drug intoxication (1)
		Hanging (1)
Accident	13	Motor vehicle accident (7)
		Pedestrian struck by vehicle (2)
		Drowning (1)
		Exsanguination (1)
		Smoke inhalation (2)
HIV§/AIDS§	9	*Pneumocystis carinii* pneumonia (2)
		Other opportunistic infections (3)
		Other complications (4)
Drug-related death	20	Chronic drug use (3)
		Cocaine (6)
		Heroin (3)
		Multiple drugs (4)
		Other (4)
Alcohol-related death	10	Acute intoxication (2)
		Chronic alcoholic cirrhosis (8)
Cancer	9	Breast cancer (3)
		Cervical cancer (1)
		Vulvar cancer (1)
		Uterine cancer (1)
		Pancreatic cancer (1)
		Carcinoid growth (1)
		Unknown primary cause (1)
Leukemia	3	Lymphocytic leukemia (2)
		Acute myelocytic leukemia (1)
Coronary artery disease	4	Acute myocardial infarction (2)
		Complications of diabetes (2)
Cerebrovascular disease	6	Cerebral hemorrhage (3)
		Not specified (3)
Other causes	11	Morbid obesity (1)
		Pancreatitis (1)
		Pneumonia (1)
		Pulmonary edema (1)
		Pulmonary embolus (1)
		Renal failure (2)
		Seizure disorder (1)
		Aspiration pneumonia (1)
		Adult respiratory distress syndrome (1)
		Acute liver failure (1)

* To better convey the type of death, we use common terms rather than the formal nomenclature from the *International Classification of Diseases*.

† We were unable to obtain death certificates for six of the 117 confirmed deaths.

‡ Numbers in parentheses, number of deaths.

§ HIV, human immunodeficiency virus; AIDS, acquired immunodeficiency syndrome.

It is likely that we underestimated mortality in our current analysis. While the sensitivity of the SSDI relative to the NDI for the 1979–1997 period was only 57 percent, other research shows that the SSDI ascertained proportionally fewer deaths in the decades prior to 1979 than in the years after 1978 (23). Thus, the sensitivity of the SSDI for the 1967–1978 period in our study was probably lower than the sensitivity we estimated for the 1979–1997 period. Moreover, the NDI displayed only moderately high sensitivity (81–93 percent) for samples of known female decedents (24, 25). Had NDI data been available for the periods 1967–1978 and 1998–1999, for which we relied solely on the SSDI, we estimate that another 10 (9.7) additional confirmed deaths would have been identified. The extent of underestimation is probably even greater than that suggested by these factors, given that we classified deaths conservatively and did not include 26 possible deaths when computing mortality rates.

The relatively low sensitivity of the death indexes for our cohort might have been due to the tendency of women to have multiple surnames, to some women's ineligibility for Social Security benefits (lack of sufficient legal employment), and to the dearth of information on fathers' surnames in our database. Other factors may have prevented ascertainment of death for some women. For example, prostitutes who died in a foreign country or were murdered but never identified as dead (because the body was never found or the remains were not identifiable) (26–28) would be unlikely to appear in death indexes. Some women also might have intentionally misreported identifying information to the health department or police.

To our knowledge, no population of women studied previously has had a crude mortality rate, standardized mortality ratio, or percentage of deaths due to murder even approximating those observed in our cohort. The workplace homicide rate for prostitutes (204 per 100,000) is many times higher than that for women and men in the standard occupations that had the highest workplace homicide rates in the United States during the 1980s (4 per 100,000 for female liquor store workers and 29 per 100,000 for male taxicab drivers) (29).

Our crude homicide mortality rate for presumed-active prostitutes (229 per 100,000) is also similar to the mortality rates extrapolated from passive and informal surveillance of prostitute women in Canada between 1992 and 1998 (30) (181 per 100,000 on the basis of our prostitute prevalence estimate (9) and national population figures (31)) and in the Canadian province of British Columbia between 1985 and 1990 (32) (112–225 per 100,000). Parallel calculations for the 34 known prostitute women who were murdered on the job in Canada between 1992 and 1995 (30) yield a workplace homicide rate of 127 per 100,000. In our study, murder accounted for 50 percent of the deaths among presumed-active prostitutes. Murder accounted for 29–100 percent of prostitute deaths observed in recent decades in Birmingham, United Kingdom (Hilary Kinnell, United Kingdom Network of Sex Work Projects, personal communication, 1999), Nairobi (Stephen Moses, University of Manitoba, personal communication, 2003), Vancouver (32), and London (6). However, prostitutes represented a greater share of all female murder victims in British Columbia between 1981

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and 1990 (8 percent) (32) and in Canada overall between 1991 and 1995 (5 percent) (33) than in the United States between 1981 and 1990, by our estimate (3 percent).

The high homicide and overall mortality rates observed in our cohort probably reflect circumstances for nearly all prostitutes in the United States (where prostitution is illegal, except for a few rural Nevada counties where brothels are permitted (34)) and many other countries. Although these Colorado Springs prostitutes appeared to be representative of all US prostitutes in terms of prevalence and number of sexual partners (9, 12) and although they worked as prostitutes (and died) in many parts of the country, prostitutes elsewhere might have different mortality rates and profiles.

Clients perpetrate a large proportion of the lethal and nonlethal violence experienced by prostitutes (1, 32, 35–41). For instance, clients were suspected perpetrators in 55 (64 percent) of the 86 murders of known prostitute women that took place in Canada between 1992 and 1998 (30). Moreover, clients who are serial murderers may account for a disproportionate fraction of prostitute murders (26–28, 42–44). Surveys also indicate that prostitute women encounter more violence from clients when working on the streets than in off-street contexts (32, 45–47), and 84 percent of known prostitutes murdered in the United Kingdom in the 1990s worked on the streets (39).

Women engaged in prostitution face the most dangerous occupational environment in the United States. Research identifying individual and contextual factors that make prostitutes vulnerable to murder and drug overdose can inform the development of interventions for reducing harm (32, 37, 48, 49).

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