



**Non-Fire Carbon Monoxide Deaths
Associated with the Use of Consumer Products
1998 Annual Estimates**

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Executive Summary

This report provides information about the number of unintentional non-fire deaths attributed to carbon monoxide (CO) poisoning that were associated with the use of consumer products in 1998.

According to the National Center for Health Statistics (NCHS) totals, between 1994 and 1998, the total number of unintentional non-fire CO poisoning deaths, including those associated with consumer products under the jurisdiction of the U.S. Consumer Product Safety Commission (CPSC) and those associated with motor vehicle exhaust, averaged 516 annually (compared to the 1993 - 1997 average of 534). During this period, the estimated yearly average number of CO poisoning deaths attributed to motor vehicle exhaust was 316 or about 61 percent of all unintentional non-fire CO poisoning deaths (no change from 1993 - 1997). The remaining estimated 200 (39%) deaths were associated with consumer products and considered to be under the jurisdiction of the CPSC.

The 1998 annual estimate of consumer product-related CO poisoning deaths was 180, identical to the previous year's estimate. No significant increase or decrease is detectable for the most recent five years of data (1994 - 1998) as a result of the 1998 estimate. However, the 1998 estimate does contribute to the continuing significant downward trend in estimated CO deaths relative to 1980.

Seventy-one percent of the estimated 180 CO deaths were associated with the use of heating systems, with natural gas heating accounting for 45 percent and liquefied petroleum (LP) gas heating accounting for 38 percent of heating deaths. Nine percent of CO deaths were associated with charcoal grills, six percent were associated with camp stoves and lanterns, and four percent were associated with gas water heaters. The remaining ten percent involved gas ranges and ovens and other appliances.

According to 1998 data, some form of venting problem was noted in about 30 percent of the fatal incidents. Adults 45 years of age and older represented over 50 percent of CO deaths, the result of a steady increase since 1994. Sixty-nine percent of CO deaths occurred in the home in 1998, while deaths in tents and other camping shelters accounted for 26 percent of deaths. Deaths in these temporary types of shelters were mostly associated with LP gas camping heaters. A large percentage (68%) of the fatal 1998 incidents continued to claim only one fatality, although the percentage of fatal incidents involving multiple CO deaths increased by about 15 percent compared to 1994. Although it was not uncommon for non-fatal injuries to accompany fatalities in the fatal CO incidents, they were not quantified for analysis in this report.

Introduction

Carbon monoxide (CO) is a colorless, odorless, and poisonous gas that results from the incomplete combustion of fuels such as natural or liquefied petroleum (LP) gas, oil, wood, coal, and other fuels. The health effects related to CO depend upon its concentration in blood, which in turn depends on its concentration in air, the duration of exposure, and each individual's general health. Carbon monoxide combines with hemoglobin (Hb) with an affinity about 250 times that of oxygen, forming carboxyhemoglobin (COHb) and interfering with oxygen transport, delivery, and utilization. Generally, there are no perceptible health effects or symptoms in healthy individuals at COHb levels below 10 percent. Symptoms associated with blood levels at or above 10 percent COHb include headache, fatigue, nausea, and cognitive impairment. Loss of consciousness, coma, and death can occur at COHb levels greater than 20 percent. At around 3 percent COHb, a decrease in time to onset of angina in exercising individuals with ischemic heart disease, electrocardiographic changes, and neurobehavioral effects in healthy individuals have been recorded (Long & Saltzman, 1995; Burton, 1996).

Some symptoms of CO poisoning may mimic common illnesses, such as influenza or colds; thus, there likely is a high incidence of initial misdiagnosis by physicians and victims (Long & Saltzman, 1995). Patients are frequently unaware of exposures, and health care providers may not always consider CO poisoning as a cause of such non-specific symptoms. COHb formation is reversible, as are some clinical symptoms of CO poisoning. However, some delayed neurological effects that develop following severe poisonings, especially those involving prolonged unconsciousness, may not be reversible. Prompt medical attention is important to reduce the risk of permanent damage.

Any fuel-burning appliance can be a potential source of fatal or hazardous CO levels. Fuels, such as natural and LP gas, kerosene, oil, gasoline, coal, and wood can produce large amounts of CO when there is insufficient oxygen available for combustion. Consumer products that burn kerosene, oil, gasoline, coal or wood (such as wood stoves, oil boilers, and kerosene heaters) produce an irritating smoke that can alert the victim to a potentially hazardous situation. Other products, such as charcoal briquettes and pressed wood-chip logs, produce relatively smokeless fires, even at times of inefficient combustion. Victims receive no obvious sensory warning that high CO levels are present. A different hazard scenario is present when gas appliances are not vented properly or are malfunctioning. Natural and LP gas burn more efficiently and cleanly compared with other forms of fuel. In circumstances of poor maintenance, inadequate ventilation, or defective exhaust pathways, natural and LP gas appliances may emit potentially lethal amounts of CO without any irritating fumes. Again, many victims may be unaware of a potential problem.

National Estimates of Non-Fire CO Poisoning Deaths Associated with Consumer Products

During 1998, the most recent year for which complete death certificate data are available, there were an estimated 180 non-fire carbon monoxide (CO) poisoning deaths associated with the use of consumer products, excluding motor vehicles. In addition to the death certificate data, deaths reported in CPSC's Injury and Potential Injury Incident (IPII) File that were not duplicated in the Death Certificate (DCRT) File were used as supplementary data. In-depth reports from CPSC's In-Depth Investigation (IDI) File were used to confirm the identified consumer products, incident location, and number of victims per incident, as well as additional information concerning the fatal scenarios. Carbon monoxide poisonings referred to in this report do not include those where the CO gas resulted from a fire.

Although there can be multiple factors contributing to a CO poisoning fatality, the source of CO is virtually always a fuel-burning product. As mentioned earlier, poor product maintenance by professionals or consumers, inadequate ventilation, defective exhaust pathways, and user judgment in operating these products can result in fatal scenarios, even in incidents where the fuel-burning products are not inherently defective. It should be noted that CPSC staff produces the CO estimates by associated consumer products in order to identify product groups involved in fatal CO scenarios and to monitor this distribution over time. It is within the individual, product-specific CPSC projects that further analysis is done to consider whether improvements are warranted in the areas of product design, ventilation safeguards, or user information and education.

Table 1 presents the consumer product distribution of CO poisoning deaths. The estimate for Heating Systems, historically a large majority of the consumer product estimate, is further distributed among the various fuel types. The consumer product estimate and product distributions were derived using the methodology described in Appendix A. Of the 180 estimated deaths, heating systems were associated with 128 fatalities, 71 percent of the consumer product estimate. Among heating systems, natural gas heating was associated with 57 deaths (45% of heating deaths) and LP gas heating was associated with 49 deaths (38% of heating deaths). Gas heating where the type of gas could not be determined, coal/wood heating, and kerosene/oil heating each were associated with five deaths (4% of heating deaths), respectively. Heating systems where the fuel used could not be determined were associated with eight deaths (6% of heating deaths).

Beginning with 1997 data, CPSC staff increased the percentage of follow-up investigations performed on fatal CO poisonings. Additional information collected from these follow-ups has resulted in smaller estimates associated with the general categories of Unspecified Gas Heating Systems and Heating Systems, Not Specified. Conversely, estimates associated with Natural Gas Heating Systems have increased compared with previous years. The degree to which staff can obtain fuel type information about each CO death varies from year-to-year; therefore, caution should be used when comparing fuel-specific estimates over time.

An estimated 16 CO deaths (9%) were associated with charcoal grills, eight deaths (4%) were associated with gas water heaters, ten deaths (6%) were associated with camp stoves and lanterns, and three deaths (2%) were associated with gas ranges and ovens. An estimated fifteen CO poisoning deaths (8%) were associated with other appliances, including LP gas refrigerators

and grills using unspecified fuel, as well as multiple fuel-burning products used simultaneously, such that a single source of the CO could not be determined. Products that were simultaneously used and associated with CO deaths were, respectively, a kerosene heater and a gasoline generator, a kerosene heater and a propane heater, an LP gas wall heater and a cook stove, a natural gas water heater and a furnace, and a natural gas wall heater and a range.

Table 1
Estimated Non-Fire Carbon Monoxide Poisoning Deaths
by Associated Fuel-Burning Consumer Product, 1994 - 1998

Consumer Product	Average Percent	Average Estimate	1994	1995	1996	1997	1998
Total Deaths	100%	200	223	201	217	180	180
Heating Systems	76%	152	177	159	163	135	128
Unspecified Gas Heating	12%	25	59	26	22	12	5
LP Gas Heating	23%	46	35	51	54	41	49
Natural Gas Heating	18%	35	24	31	19	46	57
Coal/Wood Heating	3%	6	6	6	7	5	5
Kerosene/Oil Heating	4%	9	9	5	15	10	5
Heating Systems, Not Specified	15%	32	44	40	47	20	8
Charcoal Grills, Charcoal	9%	17	15	14	19	23	16
Gas Water Heaters	4%	7	7	5	8	8	8
Camp Stoves, Lanterns	5%	9	12	15	3	5	10
Gas Ranges/ Ovens	4%	7	9	5	15	5	3
Other/Multiple Appliances	3%	6	3	3	8	3	15

Source: U.S. Consumer Product Safety Commission / EPA.

CPSC Death Certificate File, CPSC Injury or Potential Injury Incident File, CPSC In-Depth Investigation File, National Center for Health Statistics Mortality File, 1994 - 1998.

Note 1: Detail may not add to total due to rounding.

Note 2: The p-value for the regression analysis F-test statistic was 0.07. A significant p-value is a value less than 0.05 for a 95% confidence test.

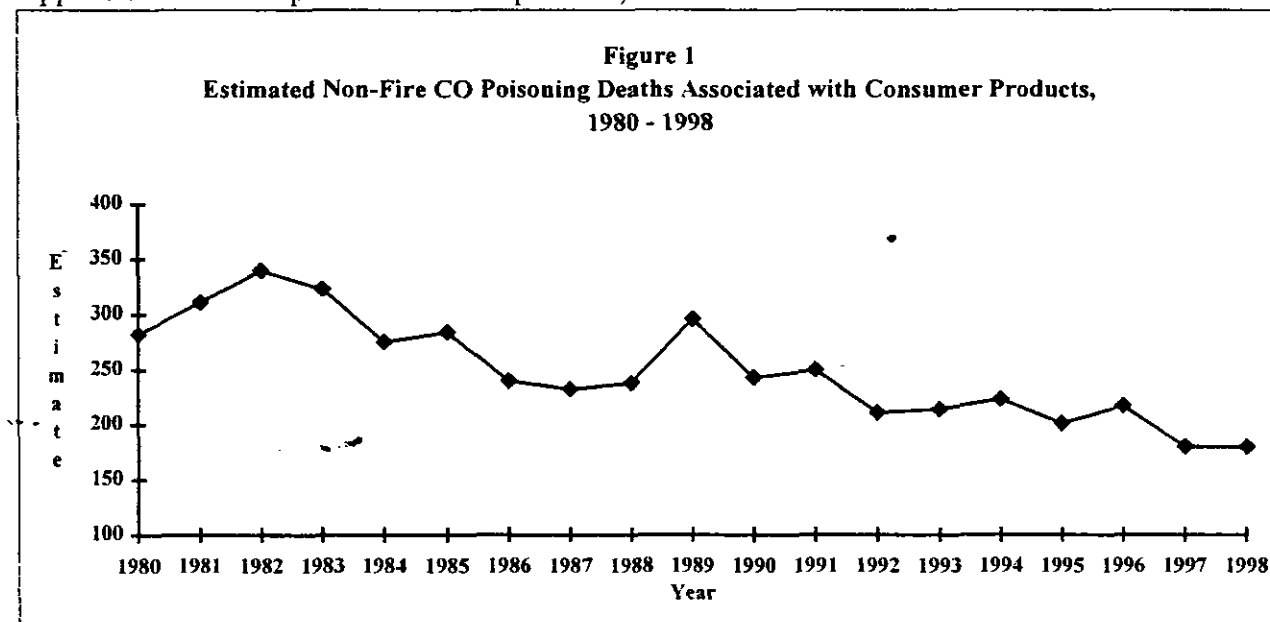
Detailed information regarding the conditions of products associated with fatalities could not be routinely collected, and the availability of such information in the CPSC files varied widely. Compromised vent systems for furnaces, boilers, vented natural and LP gas heaters, and water heaters were mentioned as contributing to CO deaths in about 30 percent of the fatal incidents. Disconnected vents were sometimes found after repairs had been made to the product, or after structural repairs in the home (e.g., roof) had been performed nearby, but unrelated to, the product. Some vented products had vents that became detached or that apparently were not installed with the product. Blocked vent conditions sometimes occurred when outdoor debris, birds' nests, or small animals worked their way into the chimney or flue pipe. These conditions could develop during the warmer months of the year when the heating products were not in use. In some cases, these conditions were not detected by the time the heating season began and contributed to the resulting fatal scenarios. Vents were also sometimes blocked by soot caused

by inefficient combustion, which in turn may have been caused by several factors, such as leaky or clogged burners, an over-firing condition, or inadequate combustion air.

Less frequently, other conditions related to furnaces included compromised heat exchangers, filter covers/doors that were not sealed or were removed, and dirty filters. Cooking stoves and ovens used as heating devices were involved in at least one fatal incident, as were homemade grills and heaters. A few products were over 20 years old and apparently were poorly maintained such that there were several factors involved in generating and exacerbating the amount of CO produced. Isolated incidents mentioned a backdraft condition, use of a product despite its being "red-tagged" by the utility company, and use of a natural gas heater with an LP gas supply.

CPSC staff is also aware of 14 CO poisoning deaths associated with consumer products with gasoline motors and engines. One death was associated with a power lawnmower, while the other 13 deaths were associated with generators. However, national estimates for these products, comparable with those in Table 1, are not available. For further explanation, see Appendix B.

Table 1 shows the estimated number of CO deaths associated with consumer products for years 1994 - 1998. The average yearly total of CO deaths for this five-year period was 200 (with a standard error of approximately 9.0). The 95 percent confidence interval* for this estimated average ranged from 175 to 225 deaths. A linear regression analysis did not show a significant increase or decrease in the estimated annual death totals during this period (see note below Table 1). However, as in recent years, a linear regression analysis did show a significant decrease in estimated annual CO deaths since 1980. A significant decrease was in evidence as early as 1994, with the highest annual estimate occurring in 1982 (340) and the lowest occurring in 1997 and 1998 (both 180). Figure 1 below graphs the annual estimates from 1980 through 1998. (See Appendix C for data point values and p-value.)



Source: U.S. Consumer Product Safety Commission / EPHA.
National Center for Health Statistics Mortality File, 1980 - 1998.

* Confidence interval based on a t-distribution with four degrees of freedom.

Table 1 also lists the average percentage of CO deaths associated with each group of consumer products over the years 1994 - 1998. For this period, 76 percent of deaths involved heating systems and 9 percent involved charcoal grills. These percentages were 76 and 10, respectively, for the previous five-year period (1993 - 1997). Each of the other product groups was associated with an average of 5% or less of the estimated CO deaths in 1994 - 1998, similar to previous years.

Table 2 shows that for the most recent five years of data, adults age 25 years and older continued to account for an average of over 75 percent of CO poisoning deaths. Adults age 65 years and older accounted for 25 percent of total deaths, while children under 15 years of age accounted for 7 percent of deaths. Between 1994 and 1998, the annual percentage of deaths represented by adults 45 and older increased from 45 percent to 54 percent, while the annual percentage of deaths to victims 24 years and younger fell from 30 percent to 16 percent.

Adults in the higher age groups were more frequently reported to have pre-existing health conditions affecting the heart, lungs, and circulatory system. The presence of one or more of these conditions lower a victim's tolerance of COHb in the bloodstream, increasing the risk of a fatal CO exposure. Eighteen percent (32) of the estimated 180 CO victims were noted as having secondary health conditions not related to CO poisoning at the time of death. Seventy percent of these 32 victims were 45 years of age or older. Consumers in the higher age groups also tend to own older products, especially installed appliances, which are not affected by recent improvements in voluntary standards. Lack of routine product maintenance, especially in older products, further increases the potential for a fatal scenario.

Table 2
Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Age of Victim, 1994 - 1998

Age	Average	1994	1995	1996	1997	1998
Total	100%	223	201	217	180	180
Under 5	3%	10	7	8	5	3
5 - 14	4%	7	15	12	4	6
15 - 24	15%	50	40	23	20	19
25 - 44	27%	55	51	66	49	49
45 - 64	24%	50	51	45	45	49
65 and over	25%	51	37	62	54	49
Unknown	1%	0	0	0	1	5

Source: U.S. Consumer Product Safety Commission / EPA.

CPSC Death Certificate File, CPSC Injury or Potential Injury Incident File, CPSC In-Depth Investigation File, National Center for Health Statistics Mortality File, 1994 - 1998.

Note: Detail may not add to total due to rounding.

In 1998, 69 percent of CO victims were males and 31 percent were females, virtually unchanged compared to 1997. About one-third (62) of the deaths occurred in January and December. Twenty-seven percent (49) of deaths occurred in March and April, with another 13 percent (23) occurring in October.

Table 3 shows that from 1994 - 1998, an average of 77 percent of fatal CO incidents reported to CPSC involved a single death. The yearly percentage of fatal incidents involving only one fatality steadily decreased from 83 percent of incidents in 1994 to 68 percent of incidents in 1998. It should be noted that Table 3 accounts for only the fatally injured victims in each CO poisoning incident. It is not uncommon for CO incidents involving one or more

fatalities to also result in one or more non-fatal CO poisoning injuries.

Table 3
Number of Carbon Monoxide Poisoning Incidents reported to CPSC
By Number of Deaths Per Incident, 1994 - 1998

Number of Deaths Reported in Incident	Average Percent	1994	1995	1996	1997	1998
Total Incidents	100%	123	104	122	104	78
1	77%	102	84	93	80	53
2	19%	17	17	24	20	19
3	3%	2	1	3	4	5
4	1%	1	1	2	0	0
5 or more	1%	1	1	0	0	1

Source: U.S. Consumer Product Safety Commission / EPHA.

CPSC Death Certificate File, CPSC Injury or Potential Injury Incident File, CPSC In-Depth Investigation File, 1994 - 1998.

Note 1: Detail may not add to total due to rounding.

Note 2: Data in Table 3 do not add to totals presented in Table 1. Data presented in Table 3 are not national estimates derived from the NCHS totals, but reported deaths contained in the CPSC files. NCHS data do not contain enough detail to identify multiple victims of the same CO poisoning incident.

Table 4 shows that an average of over two-thirds of CO deaths occurred in homes, including manufactured and mobile homes, from 1994 – 1998. An average of 18 percent of deaths took place in temporary shelters, such as tents, recreational vehicles, campers, and trailers. In 1998, 26 percent of CO deaths, the highest percentage for the five-year period, took place in such temporary shelters. LP gas camping heaters were the products most frequently associated with these deaths, followed by charcoal grills. LP gas lanterns, LP and natural gas wall heaters, LP gas cook stoves, and LP gas refrigerators were also associated with these scenarios. A consistently small percentage of deaths occurred in vans, trucks, or automobiles in which victims were spending the night. In 1998, the products used in these settings were LP gas camping heaters and LP gas camp stoves. “Other” locations for fatal incidents included a college dormitory and a cave.

Table 4
Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Location of Death 1994 - 1998

Location of Death	Average Percent	1994	1995	1996	1997	1998
Total	100%	223	201	217	180	180
Home	68%	161	119	159	118	125
Temporary Shelter	18%	22	40	38	30	47
Auto	5%	15	11	7	16	5
Other	6%	12	23	11	8	3
Unknown	3%	13	8	1	7	0

Source: U.S. Consumer Product Safety Commission / EPHA.

CPSC Death Certificate File, CPSC Injury or Potential Injury Incident File, CPSC In-Depth Investigation File, National Center for Health Statistics Mortality File, 1994 - 1998.

Note: Detail may not add to total due to rounding.

Appendix A: Methodology

The following data sources and methodology were used to compute the national estimate of non-fire CO poisoning deaths associated with the use of consumer products and the estimates by product, victim age, and incident location.

All death certificates filed in the U.S. are compiled by the National Center for Health Statistics (NCHS) into multiple cause of mortality data files. The mortality data files contain demographic and geographic information, as well as the International Classification of Diseases codes for the underlying cause of death and up to 20 contributing conditions. The data are compiled in accordance with the World Health Organization instructions, which request that member nations classify causes of death by the current Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death. The International Classification of Diseases, Ninth Revision was implemented in 1979 and was in effect through 1998, the latest year of data presented in this report. Although the NCHS data contain cause of death codes that are helpful in identifying deaths due to CO poisoning, the data do not contain any narrative information that might indicate the involvement of a consumer product.

To complement the NCHS mortality data, CPSC purchases death certificates from the 50 states, the District of Columbia, and New York City. Specifically, CPSC purchases death certificates for certain cause of death codes for which there is a high probability that consumer products are involved. In addition to the cause of death codes and demographic and geographic information, the death certificates contain information on the location and brief narratives describing the events of death. Any references to consumer products are usually found in these narratives. The CPSC Death Certificate (DCRT) File for 1998 represented about 80 percent of deaths found in the NCHS mortality data for those cause of death codes purchased by CPSC. CPSC staff conducts follow-up in-depth investigations on selected deaths to confirm and expand upon the involvement of consumer products as resources allow.

The first step in the estimation process is computing the total estimate of CO deaths associated with consumer products. This step relies only on the NCHS data, which is initially searched for the external cause of death codes (Ecodes) that correspond to all unintentional CO poisoning deaths. These Ecodes and their shorthand definitions are listed below:

<u>Ecode</u>	<u>Definition</u>
867.0	Accidental poisoning by gas distributed by pipeline
868.0	Accidental poisoning by liquefied petroleum distributed in mobile containers
868.1	Accidental poisoning by other and unspecified utility gas
868.3	CO from incomplete combustion of other domestic fuels
868.2	Accidental poisoning by motor vehicle exhaust gas
868.8	CO from other sources
868.9	Unspecified CO

The first four Ecodes listed (867.0, 868.0, 868.1, 868.3) are assumed to contain CO deaths associated with consumer products. Although the complete definition for Ecode 868.2 encompasses gas engines and motors, which can be found in consumer products such as generators and power mowers and tools, this Ecode is generally used to classify CO deaths from auto exhaust and other motor vehicles -- products outside the jurisdiction of CPSC. Ecodes 868.8 and 868.9 are considered to contain CO deaths where the source of CO is unknown. Deaths in these "unknown" Ecodes were allocated between the consumer product Ecodes and the motor vehicle Ecode in the following way:

1. The CO death counts in the consumer product Ecodes (867.0, 868.0, 868.1, 868.3) were summed (n_1).
2. The CO death count in the motor vehicle Ecode (868.2) was identified (n_3).
3. The CO death counts in the unknown Ecodes (868.8, 868.9) were summed (n_2).
4. The unknown CO deaths (n_2) were proportionally allocated to the consumer product total (n_1) and the motor vehicle total (n_3). The results were an adjusted consumer product total (n^*_1) and an adjusted motor vehicle total (n^*_3), where:

$$n^*_1 = n_1 + n_2 \times [n_1 / (n_1 + n_3)]$$

and

$$n^*_3 = n_3 + n_2 \times [n_3 / (n_1 + n_3)]$$

The following table contains the 1998 NCHS CO death counts used to compute the adjusted consumer product total and the adjusted motor vehicle total.

Type of CO Deaths	Totals
Consumer Product CO (n_1)	123
Motor Vehicle CO (n_3)	191
Unknown CO (n_2)	146
Total Unintentional CO	460
Adjusted Consumer Product CO (n^*_1)	180
Adjusted Motor Vehicle CO (n^*_3)	280
Total Unintentional CO	460

As computed above, the adjusted consumer product CO death total (n^*_1) is the national estimate of CO poisoning deaths associated with the use of consumer products. The table below shows the adjusted totals / national estimates for consumer product CO deaths and motor vehicle

CO deaths for the most recent five years of NCHS data.

Estimates	1994	1995	1996	1997	1998
Consumer Product CO	223	201	217	180	180
Motor Vehicle CO	359	333	316	294	280
Total Unintentional CO Deaths	582	533	531	474	460

Source: National Center for Health Statistics Mortality File, 1994 - 1998.

Note: Detail may not add to total due to rounding.

The next step in the process was to search CPSC's Death Certificate File for death certificates where the cause of death was non-fire CO and a consumer product was mentioned in the narrative. Since 1979, CPSC has purchased all death certificates in Ecodes 867.0, 868.0, 868.1, 868.3, 868.8, and 868.9 since they are assumed to involve, or potentially involve, consumer products. Since Ecode 868.2 is generally used to classify CO deaths from products that are outside the jurisdiction of CPSC, death certificates with this Ecode were not purchased. Although virtually all CO deaths reported to CPSC were found in the DCRT file, a small number of additional CO deaths associated with consumer products were identified from CPSC's Injury or Potential Injury Incident (IPII) File. The IPII File contains voluntarily submitted incident reports, and includes newsclips, medical examiner's reports, and coroner's reports. Any follow-up reports found in CPSC's In-Depth Investigation (IDI) File that were based on a CO death were also reviewed to obtain more detailed product, fuel type, location, and victim information. Each CO death found in the CPSC files was then manually reviewed to exclude out-of-scope and highly questionable cases and to remove duplicates.

The resulting number of CO deaths from the CPSC files was used with the consumer product CO estimate derived from the NCHS mortality data to compute a weighting factor for each CPSC death. The 1998 weighting factor was computed by dividing the national estimate of consumer product CO deaths (180) by the number of CO deaths culled from the CPSC files (111). Since each CO death reported to CPSC (in most cases) is coded to reflect the consumer product(s) involved, the weighting factor allows the computation of national estimates of CO deaths by consumer product and by other characteristics collected by CPSC about each death. The table below shows the weighting factors used for the 1994 - 1998 estimates.

1994 - 1998 Weighting Factors for CPSC Non-Fire Carbon Monoxide Poisoning Deaths

Year	Estimated NCHS Consumer Product Total	Deaths Reported to CPSC (DCRT, IPII)	Weighting Factor
1994	223	151	1.48
1995	201	130	1.55
1996	217	158	1.37
1997	180	132	1.36
1998	180	111	1.62

Source: U.S. Consumer Product Safety Commission / EPHA.

National Center for Health Statistics Mortality File, CPSC Death Certificate File, CPSC Injury or Potential Injury Incident File, CPSC In-Depth Investigation File, 1994 - 1998.

Reports of non-fire CO poisoning deaths were retrieved from the DCRT File based on the following criteria: date of death between 1/1/98 and 12/31/98 and Ecode in 867.0, 868.0, 868.1, 868.3, 868.8, or 868.9. Carbon monoxide deaths were retrieved from the IPII File based on the following criteria: date of incident between 1/1/98 and 12/31/98; injury code = death (8); hazard type = poisoning (6); and narrative contained reference to carbon monoxide, poisoning, or exposure. As mentioned above, the results of these initial queries were manually reviewed to exclude out-of-scope and highly questionable cases and to remove duplicates.

Each CO death was reviewed and coded by the author according to the consumer product and type of fuel involved, incident location, and whether multiple deaths were the result of the same incident, whenever possible. If information about the product's condition, venting system, or installation environment or the victim's health was provided on the DCRT, IPII, or IDI report, this information was coded for anecdotal purposes.

In Table 1, the heating systems category combined furnaces, boilers, vented floor and wall heaters, unvented space heaters, camping heaters, fireplaces, and other miscellaneous heating systems. Deaths associated with charcoal being burned alone and in the absence of an appliance (e.g., in a pail) were presented with charcoal grills, even though this practice was usually done for heating purposes. Portable stoves, whether meant for heating or cooking, were presented under camp stoves. In 1998, deaths where multiple fuel-burning products were used simultaneously such that a single source of the fatal CO could not be determined, were classified under other/multiple appliances.

Appendix B: Consumer Products with Engines / Motors

In the NCHS mortality data, Ecode 868.2 is used for reporting non-fire CO deaths associated with motor vehicle (not in transit) exhaust and CO deaths associated with the use of farm tractors, gas engines, motor pumps, and any other type of combustion engine not in watercraft. CPSC does not routinely purchase death certificates for Ecode 868.2, since most motor vehicles are not within the jurisdiction of CPSC. Therefore, it is not feasible to estimate the proportion of total deaths in this Ecode that are associated with consumer products, as opposed to motor vehicles. As a result, appropriate weighting factors (as discussed in Appendix A) are not available for computing national estimates of CO deaths associated with consumer products, such as generators, which incorporate gas engines and motors. CO deaths related to these products are occasionally reported to CPSC through the DCRT File (usually under the unknown CO Ecodes 868.8 and 868.9) and the IPII File.

The table below shows the unweighted, actual number of CO poisoning deaths in the CPSC files associated with generators and other engine- and motor-driven appliances, such as pumps, power lawnmowers, power washers, and snow blowers.

**Number of Non-Fire CO Poisoning Deaths Reported to CPSC
Associated with Engine- and Motor-Driven Appliances**

Appliance	1994	1995	1996	1997	1998
Total	11	13	20	20	14
Generators	7	12	17	18	13
Other Products	4	1	3	2	1

Source: U.S. Consumer Product Safety Commission / EPHA.

CPSC Death Certificate File, CPSC Injury or Potential Injury Incident File, CPSC In-Depth Investigation File, 1994 - 1998.

Appendix C: National Estimates of Consumer Product CO Deaths, 1980 - 1998

Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Consumer Products, 1980-1998

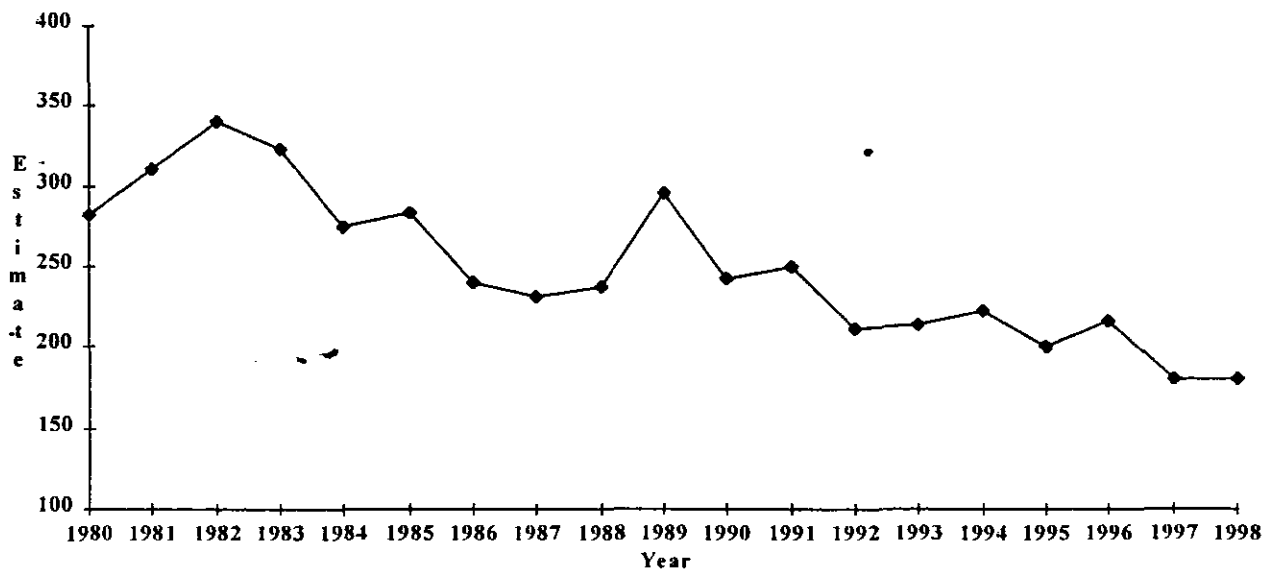
Year	Estimate
1980	282
1981	311
1982	340
1983	323
1984	275
1985	284
1986	240
1987	232
1988	238
1989	296
1990	243
1991	250
1992	211
1993	214
1994	223
1995	201
1996	217
1997	180
1998	180

Source: U.S. Consumer Product Safety Commission / EPHA.

National Center for Health Statistics Mortality File, 1980 - 1998.

Note: The p-value for the regression analysis F-test statistic was less than 0.01. A significant p-value is a value less than 0.05 for a 95% confidence test.

Figure 1
Estimated Non-Fire CO Poisoning Deaths Associated with Consumer Products,
1980 - 1998



Source: U.S. Consumer Product Safety Commission / EPHA.

National Center for Health Statistics Mortality File, 1980 - 1998.

References

Ault, K. (1997). Non-fire Carbon Monoxide Death and Injury Estimates. Washington, D.C.: U.S. Consumer Product Safety Commission.

Ault, K. (2001). A Description and an Evaluation of the Death Certificate Project. Washington, D.C.: U.S. Consumer Product Safety Commission.

Burton, L.E. (1996). Toxicity from Low Level Human Exposure to Carbon Monoxide, Washington, D.C.: U.S. Consumer Product Safety Commission.

Long, K., Saltzman, L. (1995). Non-fire Carbon Monoxide Incidents: Morbidity and Mortality Related to the Use of Household Appliances. Washington, D.C. U.S.: Consumer Product Safety Commission.