U.S. Fire Service Fatalities in Structure Fires, 1977-2000

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Since 1977, the number of U.S. firefighter deaths annually at structure fires has dropped 59 percent, a finding that often has been credited to improvements in protective clothing and equipment, fire ground procedures and training, but little attention has been paid to the drop in the number of structure fires themselves.[1] Over the same period (up until 2000, the most recent year for which structure fire statistics are available), the annual number of structure fires declined by 54 percent.[2] (Figure 1) To what degree then has the decrease in firefighter deaths been driven by the drop in the number of fires?

A comparison of the decline in the number of structure fires and the decrease in the number of firefighter deaths at structure fires shows that the trends track fairly closely, indicating that the drop in deaths may have been, to a great degree, a result of the reduction in the number of fires. This leads to an important second question: how has the *rate* of deaths at structure fires trended over the same period? In other words, are firefighters just as likely to die today as they were 25 years ago?

In order to smooth out the year-to-year fluctuations in the number of deaths, Figure 2 displays a comparison of the number of structure fires and the *rate* of firefighter deaths at structure fires using a rolling three-year average. The mid-point of each three-year range is shown at the bottom of the graph. The rate of firefighter deaths at structure fires in the late 1990s was roughly the same as the rate in the late 1970s. In the late 1970s, the death rate for firefighters at structure fires was approximately 5.8 deaths per 100,000 structure fires. That rate dropped to approximately 4.8 deaths per 100,000 structure fires around 1987, but rose again to 5.8 in 1991. After falling to 4.8 deaths per 100,000 structure fires in 1994, it rose steadily to 5.7 deaths per 100,000 in the late 1990s.

Given the improvements in personal protective clothing and equipment, training and operating procedures over the past two decades, what is the cause of these deaths, and in what areas might deaths be increasing? A review of the data shows that the rate of heart attack deaths at structure fires (inside and outside) has been dropping since the early 1980s, as has the rate of non-heart-attack deaths outside at structure fires. Heart attack deaths at structure fires occurred at the rate of 2.6 deaths per 100,000 fires in the late 1970s and dropped to 1.9 deaths per 100,000 fires in the late 1990s. The rate of non-heart-attack deaths *outside* of structures dropped over the same

time interval from 1.4 to 0.5 deaths per 100,000 structure fires, after reaching a peak of 1.7 in the mid-1980s. (Figure 3)

The one area that is showing marked increases over the period is the rate of deaths due to traumatic injuries while operating inside structures. In the late 1970s, traumatic deaths inside structures occurred at a rate of 1.8 deaths per 100,000 structure fires and by the late 1990s had risen to almost 3 deaths per 100,000 structure fires. (Figure 4) Almost all of these non-heart attack deaths inside at structure fires were the result of smoke inhalation (63.0 percent), burns (18.5 percent) and crushing or internal trauma (16.1 percent). The rate at which these deaths have occurred per 100,000 structure fires is shown in Figure 5. The major causes of these traumatic injuries inside structures were lost inside, structural collapse and fire progress (including backdraft and flashover). Although individually there were no consistent trends when looking at cause of injury, together there was a clear upward trend. (Figure 6)

In order to reduce the number of deaths of firefighters operating inside structure fires, it is crucially important to understand how they are happening and why they are increasing. A detailed look at each incident is beyond the scope of this analysis, but the National Institute for Occupational Safety and Health (NIOSH) has a program of on-site data collection and investigation of on-duty firefighter fatalities that is providing a valuable database. Reports on many of the most recent fatalities can be found on their website: www.cdc.gov/niosh/firehome.html. However, we can give some general findings.

For the 87 firefighters killed since 1990 who died of smoke inhalation while operating inside structures, the major causes of injury were became lost inside the structure and ran out of air (29 deaths); caught by the progress of the fire, backdraft or flashover (23 deaths); and caught in structural collapses (18 deaths, 10 of which were in floor collapses). All but one of these 70 victims were wearing self-contained breathing apparatus. (The one exception was a firefighter rescuing family members from a fire in his own home.)

Of the 31 firefighters who died of burns inside structure fires since 1990, 14 were caught or trapped by fire progress, backdraft or flashover and 12 were caught in structural collapses. Of the 17 firefighters who died as a result of crushing injuries or internal trauma, eight were killed in structural collapses.

The major question these statistics raise is: are firefighters putting themselves at greater risk while operating at fires inside structures? Do firefighters think modern protective equipment provides a higher level of protection but do not realize the limitations of that equipment or are ignoring those limitations? Have some aspects of modern building construction or changes in the burning properties of today's contents and furnishings changed the way fires develop? This area of the firefighter fatality problem requires closer analysis and NIOSH's investigation program will provide some important answers. In the meantime, there is a lot that can be done to reduce these deaths.

Personnel accountability programs must be in place to ensure that incident managers know where their firefighters are. Firefighters must stay with their partners while operating inside structures. If firefighters encounter difficulties, Rapid Intervention Teams can be crucial in saving lives, but will only work when the locations of firefighters are well tracked.

During fire suppression operations, firefighters must remain highly aware of their surroundings -- conditions can change rapidly and firefighters who have moved too far into a building may find their escape route cut off or too long to traverse. Firefighters must recognize the danger signs -- fires burning in basements and attics, indications of potential collapse, flashover, and backdraft, etc. -- and respect them.

Low air alarms must be heeded. PASS devices must be turned on whenever firefighters enter a structure.

All these safety recommendations are covered in NFPA's series of standards for the fire service. But one additional point may not have been stressed sufficiently. The various safety recommendations work together as a system, and to a large degree, they rely on each other for their success. Compliance with half of the recommendations, for example, may not produce half of the safety benefit, because so much of the benefit depends on the interaction of the safety provisions. More than ever, it is clear that fire department safety officers need to guide their departments to *full* compliance with all safety requirements.

Anecdotally, there is a growing concern in the fire service related to whether firefighters and fire officers receive the degree of training and experience necessary to properly assess the risks on

the fire ground. If the number of structure fires is decreasing, how in fact do firefighters and fire officers gain the experience to understand fire progression, fire behavior, and what happens to the structural integrity of a building under fire conditions?

Training is an integral component to allow firefighters and fire officers alike the opportunity to learn the intricate and un-exact science of firefighting. Computer and other types of simulations, where trainees are "put in the hot seat" of making decisions using incident command and fighting fires in different types of building construction, can help. The components of the command system, and its risk management decision-making process, can all be learned in the classroom simulation environment. A careful critique of fire ground procedures following each major fire, including an analysis of what went right and what went wrong, is a great opportunity not only for the people involved but for those firefighters and officers who were not at the incident to learn and improve their understanding of fire behavior. NFPA has standards for training, professional qualifications, and incident management. It is incumbent upon today's fire service leaders to provide the training as well as the proper promotional assessment processes to ensure company and chief officers understand the environment their firefighters are exposed to and the proper operational procedures to deal with that environment so the safety of everyone on the fireground is improved. The fireground is a very unforgiving learning environment!

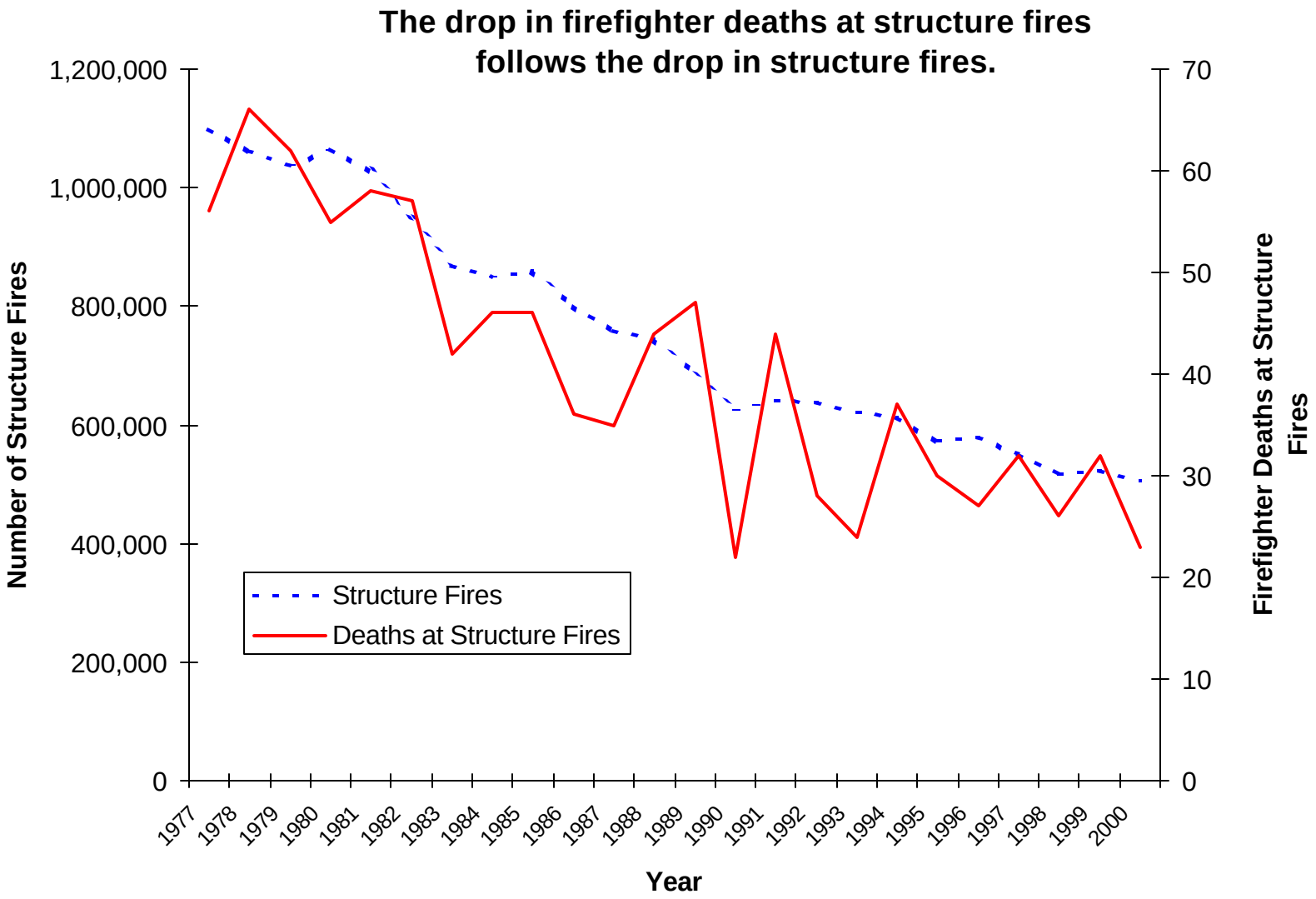
A review of recent non-heart-attack, firefighter deaths while operating inside structure fires is underway and the results will be available by December 2002.

REFERENCES

1. Fahy, R.F. and LeBlanc, P.R., "Firefighter Fatalities in 2000," *NFPA Journal*, Vol. 95, No. 4, pp. 66-79 (2001).

2. Karter, M.J., "2000 United States Fire Loss Report," *NFPA Journal*, Vol. 95, No. 5, pp. 81-87 (2001).

Figure 1


The drop in firefighter deaths at structure fires follows the drop in structure fires.
Number of Structure Fires
Firefighter Deaths at Structure Fires
Year
Structure Fires
Deaths at Structure Fires
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
70
60
50
40
30
20
10
0
1977
1978
1979
1980
1981
1982
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1998
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2000

Figure 2

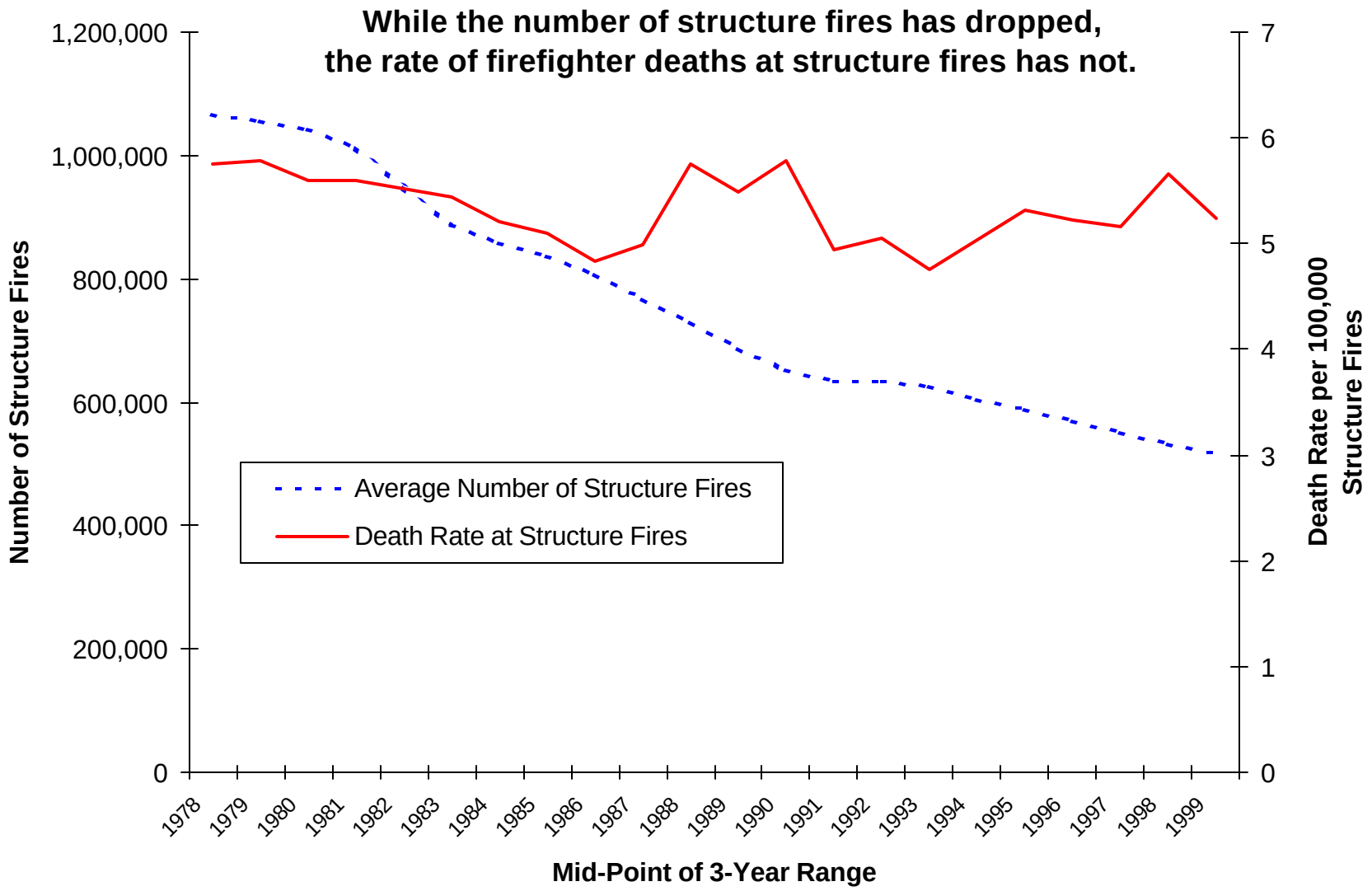
While the number of structure fires has dropped,
the rate of firefighter deaths at structure fires has not.
Number of Structure Fires
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Death Rate per 100,000 Structure Fires
7
6
5
4
3
2
1
0
Average Number of Structure Fires
Death Rate at Structure Fires
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Mid-Point of 3-Year Range

Figure 3

The rate of heart attack deaths at structure fires and of non-heart attack deaths outside structure fires have been dropping.

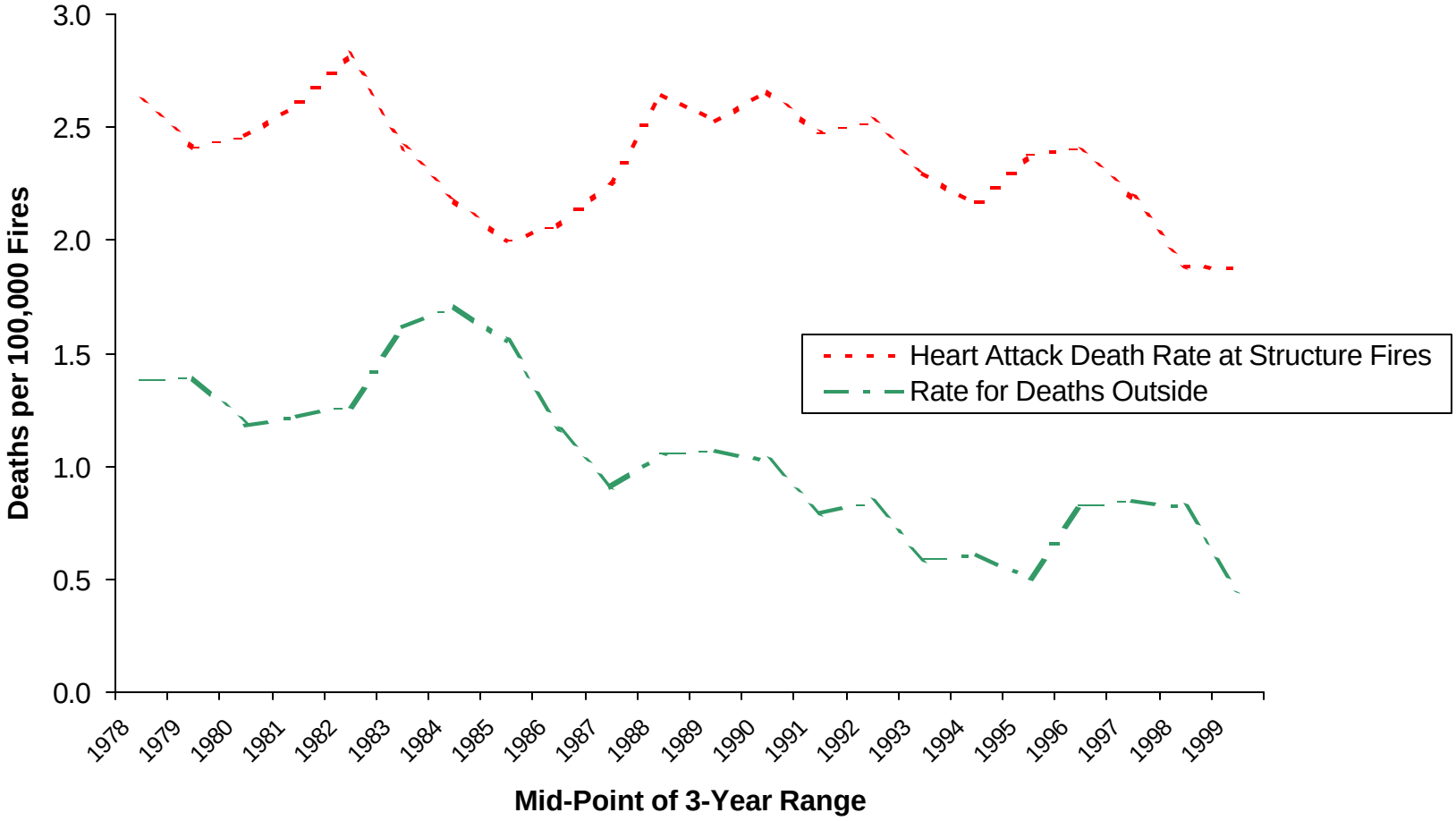

Figure 4

While the rate of non-heart attack deaths outside structure fires has been dropping, the rate for deaths inside has been rising.

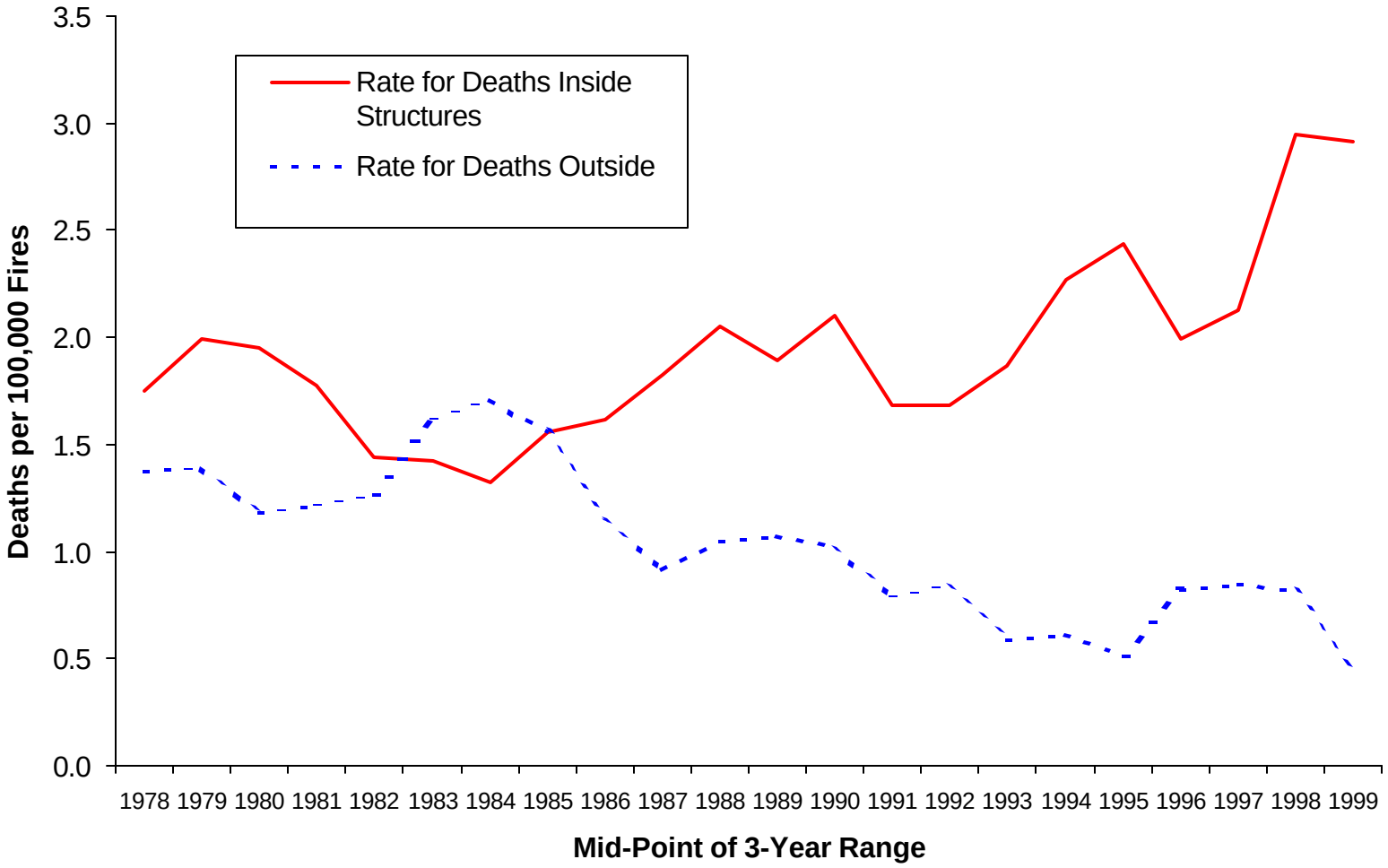

Figure 5

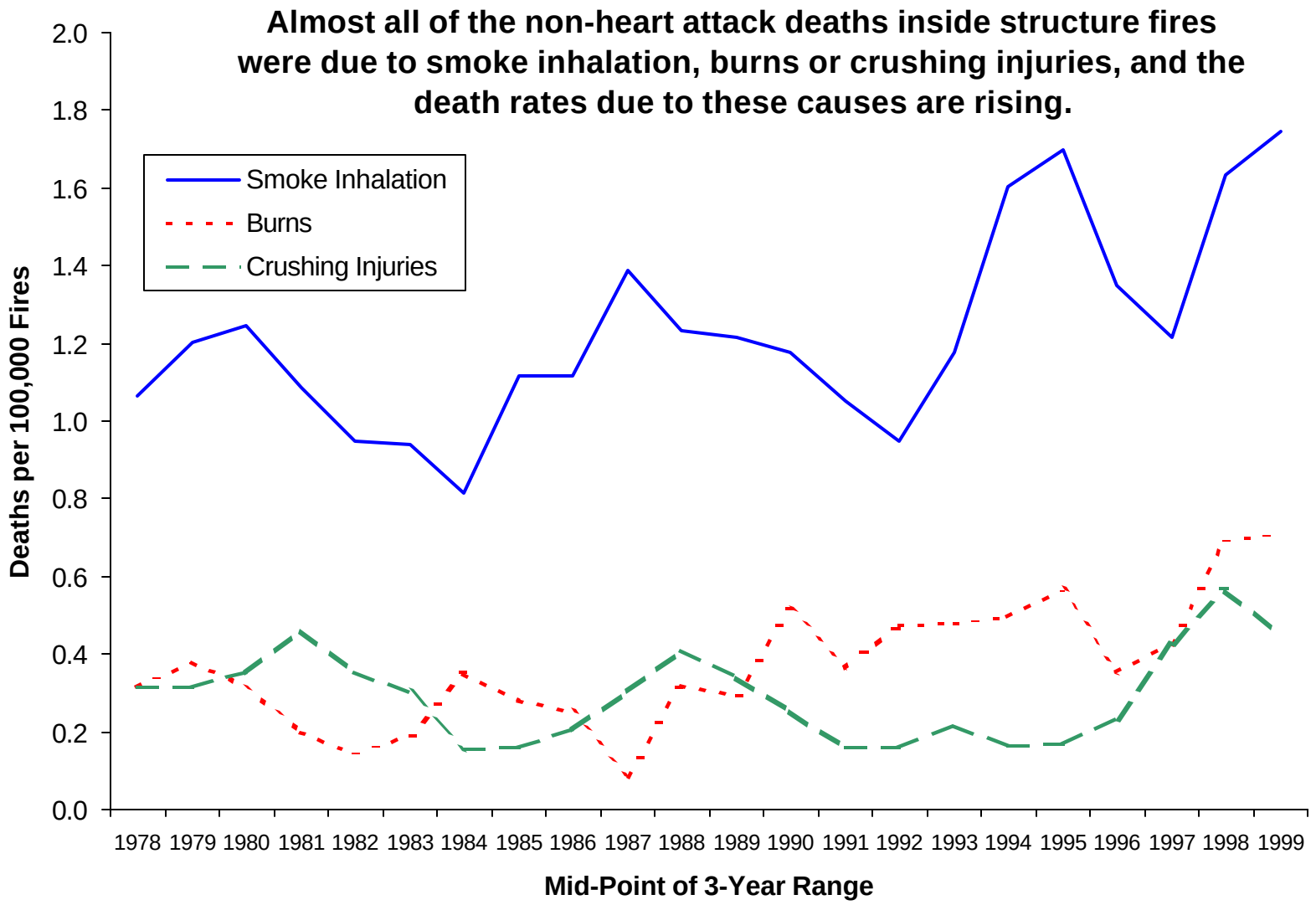
Almost all of the non-heart attack deaths inside structure fires were due to smoke inhalation, burns or crushing injuries, and the death rates due to these causes are rising.
Smoke Inhalation
Burns
Crushing Injuries
Deaths per 100,000 Fires
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
Mid-Point of 3-Year Range

Figure 6

The death rates for the three major causes of fatal injuries to firefighters while operating inside structure fires have been rising. It is essential that we find out why.