



## A story of **Impact**

### *NIOSH Research Improves Equipment Design to Protect Firefighters*

In the United States, approximately 1.1 million firefighters risk their lives to put out fires and rescue people from burning buildings and other dangerous situations.<sup>1</sup> On average, 90 to 100 firefighters die in the line of duty each year.<sup>1</sup> In 2010, firefighters suffered approximately 72,000 injuries. The average rate of fatal workplace injuries in firefighters was 16.6 per 100,000 employed, which was 4 times higher than the rate for all workers in 2006.<sup>2</sup> Firefighters rely heavily on their equipment and gear to help protect them from being injured or killed in crashes, rollover incidents, and excessive thermal and chemical exposures. They can also benefit from ergonomically designed fire apparatus to enhance safe operation and reduce other risks, such as falls from vehicles. However, poor fit of personal protective equipment (PPE), gear, and fire apparatus can compromise performance and safety. For example, if seat belts cannot be buckled by larger firefighters wearing their gear, the firefighters will not be protected by these lifesaving devices.

In 2006, the National Fallen Firefighters Foundation reported the need to consider firefighter anthropometry (body size and shape information) when designing fire

▲ A fire chief demonstrates the challenges in accessing an aerial ladder and truck steps. Photo by Hongwei Hsiao.

#### Relevant Information

**NIOSH collected anthropometry** data from 951 firefighters in four US regions (Rockville, MD; Philadelphia, PA; Phoenix, AZ; and Fort Worth, TX).<sup>2</sup>

**On average, male firefighters** were 22 lbs heavier and female firefighters were 1.1 inches taller than their counterparts in the general U.S. population. They also have larger upper-body builds than the general U.S. population.<sup>2</sup>

**The data obtained** in this study provide the first available U.S. national firefighter anthropometric information for fire apparatus and firefighter PPE designs.



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apparatus (i.e., vehicle) and equipment (i.e., body restraint, bunker gear, cab, mask, seat). A group of firefighter associations and fire apparatus manufacturers proposed a survey of U.S. firefighters to address fire-apparatus design issues and to update the NFPA standards for apparatus and PPE.\* In response, NIOSH collaborated with the firefighter community, firefighter apparatus manufacturers, and the NFPA standards committee to plan and conduct a national survey on firefighter anthropometry during 2008-2012 and transferred data and knowledge into product design processes.

### Impact

NIOSH produced a database that was shared with 17 firefighter associations and firefighter apparatus manufacturers to begin updating their designs of seat belts, fire truck cabs, gloves, boots, seats, self-contained breathing apparatus carrying straps, and protective clothing. NIOSH also developed a series of advanced theories in measuring human body size and shape and its effect on fire apparatus operation to assist the fire apparatus and equipment industry in fire apparatus arrangement and PPE sizing determinations. The NIOSH research team worked with professional associations and fire apparatus and PPE companies on using the data and theories to inform design processes for improved engineering innovations. For example, a fire department in a very large metropolitan area retrofitted older fire apparatus with new seatbelt systems based on the NIOSH data. The NIOSH national firefighter anthropometry data, along with the robust partnerships established throughout this effort, contributed to an NFPA standards update on seatbelt specifications, which resulted in science-based modifications to seatbelt length, configuration, and retracting systems.<sup>3</sup> This standard guides manufacturers in their design process and fire departments in their purchase requirements. The improved fire apparatus and PPE designs will better fit future firefighters and help protect them against injuries and hazardous exposures. This study sets a model for conducting similar studies of other special groups (e.g., law enforcement officers and emergency medical service workers) for effective equipment design.

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Visit the NIOSH Web site ([www.cdc.gov/niosh](http://www.cdc.gov/niosh)) for more information about firefighter safety. The study, **Sizing firefighters: methods and implications**, was authored by Hongwei Hsiao, Jennifer Whitestone, Tsui-Ying Kau, Richard Whisler, J. Gordon Routley, and Michael Wilbur, and was published in *Human Factors* 56(5): 873-910 (2014). This study received the 2014 Bullard-Sherwood Award in the Knowledge category.

<sup>1-3</sup> For a complete list of references, see [www.cdc.gov/niosh/docs/2015-183/](http://www.cdc.gov/niosh/docs/2015-183/).

\* National Fallen Firefighters Foundation, National Fire Protection Association, International Association of Women in Fire and Emergency Services, International Association of Fire Chiefs, International Association of Fire Fighters, National Fire Protection Association, and Fire Apparatus Manufacturers' Association

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