Evidence-Based Practice Group Answers to Clinical Questions

"Noise-Induced Hearing Loss among Fire Captains or Fire Chiefs"

A Rapid Systematic Review

By

WorkSafeBC Evidence-Based Practice Group

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Clinical Services – Worker and Employer Services

About this report

Noise-Induced Hearing Loss among Fire Captains or Fire Chiefs

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About the Evidence-Based Practice Group

The Evidence-Based Practice Group was established to address the many medical and policy issues that WorkSafeBC officers deal with on a regular basis. Members apply established techniques of critical appraisal and evidence-based review of topics solicited from both WorkSafeBC staff and other interested parties such as surgeons, medical specialists, and rehabilitation providers.

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Objective

To determine whether there is any evidence to indicate that Fire Chiefs or Fire Captains are exposed to hazardous noise levels while on the job, and whether there is any evidence to indicate that Fire Chiefs or Fire Captains suffer from higher level of noise-induced hearing loss compared to the general population.

Methods

- Comprehensive systematic literature searches were conducted on May 16 and May 22, 2018.
- These searches were conducted on several commercial literature databases by employing combinations of keywords, as follows:
  1. Medical literature databases: BIOSIS Previews® (1969 to 2008), Embase® (1974 to 2018 May 15), Medline Epub Ahead of Print®, Medline In-Process & Other Non-Indexed Citations®, Medline Daily Update®, Medline® 1946 to May 09, 2018) that are available through the Ovid® interface.

     Keywords:
     a. ((noise **ADJ** exposure) **OR** (noise **ADJ** dosimetry) **OR** (hazardous **ADJ** noise **ADJ** level$) **OR** (occupational **ADJ** noise **ADJ** induced **ADJ** hearing **ADJ** loss)) **AND** ((fire **ADJ** chief$) **OR** (fire **ADJ** captain$)) (0)
     b. ((fire **ADJ** chief$) **OR** (fire **ADJ** captain$)) (34) (1-34)
     c. ((noise **ADJ** exposure) **OR** (noise **ADJ** dosimetry) **OR** (hazardous **ADJ** noise **ADJ** level$) **OR** (occupational **ADJ** noise **ADJ** induced **ADJ** hearing **ADJ** loss)) **AND** firefighter$ (24) (35-58)
  2. Canadian Centre for Occupational Health and Safety databases (CCOHS): MSDS, CANManage, CHEMINFO, CHEMpendium, RTECS®, OSH References, Canadian enviroOSH Legislation plus Standards, OSH Answers, INCHEM, ILO Encyclopaedia, CHEMINDEX and WHMIS Classifications. Within these CCOHS databases, the one most relevant to this systematic review is the OSH References, which include OSHLINE®, NIOSHTIC®, NIOSHTIC-2, HSELINE, CISILO, Canadiana, PubMed and INRS Bibliographie.

     Keywords:
     a. Firechief*
     b. (Fire captain*)
  3. Graduate thesis related database: ProQuest Dissertations and Theses Global

Keywords:

a. Firefighter* **AND** (hearing loss)
b. Firefighter* **AND** audiometry
    - Firefighter* **AND** (noise exposure*)

- No limitations, such as on date and language of publication, were implemented in any of these searches.
- Manual searches based on the references of the fully retrieved articles were also conducted.
- A recent textbook on health risks in the fire service[86] was also consulted.

Results

- According to the United States Bureau of Labor Statistics, and the U.S. Department of Labor, in their Occupational Outlook Handbook, Firefighters, the ranking and promotion of firefighters within the fire service is as follows: a firefighter may be promoted to engineer, then to lieutenant, captain, battalion chief, assistant chief, deputy chief, and, finally, fire chief (https://www.bls.gov/ooh/protective-service/firefighters.htm#tab-4).
- In a more detailed description of job duties, the position of Fire Chief is described as primarily administrative. Fire Chief job duties include the scheduling and assigning of duties to firefighters, overseeing training and drills in firefighting and rescue techniques, and the evaluation of firefighters' performance and oversees their advancement. Fire Chiefs also monitor the care and maintenance of the fire station and all equipment, submit requests for new acquisitions and work with fire department budgets. Additionally, Fire Chiefs ensure firefighters follow established policies and procedures by keeping records and reports of all fire response actions (from CareerOneStop, an online source for career exploration, training & jobs sponsored by the US Department of Labor. https://www.careeronestop.org/Toolkit/Careers/Occupations/occupation-profile.aspx?keyword=Municipal Fire Fighting and Prevention Supervisors&onetcode=33102101&location=CALIFORNIA).
- Literature search results:
    1. No published study was identified through search 1-a, and 34[1-34] published studies were identified through search 1-b. Examination of the titles and abstracts of these 34[1-34] published studies did not reveal any article that may be relevant to the objectives of this systematic review. A further 24[35-58] published studies were identified through search 1-c. Upon examination of the titles and abstracts of these 24[35-58] studies, 15[35,36,38,39,43,44,45,46,47,50,51,52,53,54,55] studies were thought to be relevant and were retrieved in full for further appraisals.

2. Search 2-a identified 91 articles (of which 73 were available from the OSH References database) while search 2-b identified 21 articles (all available from the OSH References database). Examination of the titles of these 94 articles did not identify any article that may be relevant to the objectives of this systematic review. It should be noted that articles identified from the CCOHS databases will not be included in the references of this paper, since these articles are not available in a downloadable format, but reference information for them are available upon request.
3. Five[59-63], none and six[59-64] theses were identified through searches 3-a, 3-b and 3-c, respectively. Upon examination of the titles and abstracts of these six[59-64] theses, three[60-62] were thought to be relevant and were retrieved in full for further appraisals.
4. A further twenty-one[65-85] studies were retrieved in full, resulting from manual searches.

- Appraisal of the retrieved studies:

Within the 39 [35,36,38,39,43,44,45,46,47,50,51,52,53,54,55,60-62,65-85] articles retrieved in full and the textbook on health risks in the fire service[86], no study provided data on occupationally-related noise exposure specific to the position of Fire Chief and no study investigated the potential excess risk of occupationally-related, noise-induced hearing loss among Fire Chiefs.

Among these 40[35,36,38,39,43,44,45,46,47,50,51,52,53,54,55,60-62,65-86] articles that were retrieved in full, 28[35,36,38,39,45,47,51,53,54,60,61,65,67,68,71,72,75,73,74,75,78,79,81,82,83,84,85,86] were not relevant or did not provide any data on the noise exposure and the potential hearing loss associated with the noise exposure. As such, these 28[35,36,38,39,45,47,51,53,54,60,61,65,67,68,71,72,75,73,74,75,78,79,81,82,83,84,85,86] studies will not be discussed further.

Of the 12[43,44,46,50,52,55,62,66,69,70,77,80] studies that were thought to be relevant, only one[55] compared hearing levels of firefighters to national standards while the rest of the studies measured occupational noise exposures.

- Clark and Bohl[55] evaluated the results of hearing tests completed by firefighters from two cities and compared it with age-matched, non-occupationally exposed groups of individuals. Records from 12,609 hearing tests conducted over an 11-year period were evaluated in a longitudinal cohort-like data analysis (level of evidence 3. Appendix 1) comparing the rate of hearing loss to levels expected due to presbycusis, as well as to hearing loss rates found in an age-matched case-control like study (level of evidence 3.

Appendix 1), and also comparing it with control populations from an American national standard. The authors found that, compared to the age-matched, non–occupationally exposed control from the national standard, firefighters did not exhibit excessive loss of hearing. The longitudinal study examining the regression of firefighters' hearing with age compared with the expected presbycusic regression function indicated that the hearing of firefighters in the study declined over the 7-year period at a rate that was less than that expected due to age alone. The authors concluded that firefighters were not at risk for occupational noise-induced hearing loss. *It should be noted that no other potential risk factors for hearing loss were explored in this study, and as such the potential effect of confounders were not explored. Further, the findings were not adjusted to multiple testings.*

- Four[66,69,70,80] health hazard evaluation reports in relation to noise exposures among firefighters in different cities were conducted by the US National Institute for Occupational Safety and Health (NIOSH), covering a range of different time measures. In general, 8-hour noise dosimetry measurements reported in these studies showed time-weighted average (TWA) noise exposures that were below either the recommended US NIOSH or US OSHA standard limits regarding 8-hour TWA exposures (≤ 85 dBA per 8 hours). It should be noted that exposure data reported in these hazard evaluations were from firefighters "fighting fires" as opposed to conducting administrative types of work.
- In 1979, Reischl et. al.[77] reported on noise exposure to firefighters during Code-3 operations (i.e. relatively high speed fire truck operation, while sounding siren and air-horn warning signals). One hundred-seventy dosimetry measurements (level of evidence 5. Appendix 1) from eight firefighter positions (engine captain, engine engineering, engine firemen right and left, truck captain, truck engineering, truck tillerman and paramedics) were obtained. The authors found that under current operational conditions, firefighters experienced short-duration, high intensity noise exposure, with the engine captain and truck captain each being recorded as having received an average sound pressure of >114 dBA. It should be noted that the position of engine and truck captains in this study is not equivalent to the position of Fire Chief being investigated in this systematic review.

- A small (n=34) cross sectional study (level of evidence 5. Appendix 1), investigating the noise exposure level, duration of exposure and the hearing level of firefighters, was reported by Rackl and Decker in 1979[50]. The authors found that the mean emergency response time was 23 minutes, with a mean noise exposure of 110 dBA during Code-3 responses. The authors also found that 8 to 11 years of fire truck noise exposure did not significantly change the hearing sensitivity of these firefighters since they found that the mean daily noise exposure was 90dBA lower than the standard the OSHA imposed upon 8-hour noise exposure periods.
- In 2011, Kirkham et. al.[44] reported their findings on exposures to noise and carbon monoxide (CO) among firefighters in three municipalities in Vancouver, British Columbia. With regard to noise exposure, the authors reported 113 noise samples from 45 male firefighters aged 41.0 ± 7.2 years with 14.2 ± 9.0 years of experience. Mean L_{eq} (equivalent continuous sound level) and peak noise levels were 81.1 ± 4.8 dBA and 137.1 ± 5.2 dB, respectively, with 45% of samples exceeding occupational limits. This small (n=45) cross sectional study (level of evidence 5. Appendix 1) further found that noise levels were significantly greater on day shifts, among firefighters in non-supervisory jobs (mean exposure of 79.2 dBA among captain + lieutenant vs. mean exposure of 81.5dBA among firefighters + probationary firefighters), and for those working on engine and rescue trucks. Noise levels were also significantly greater as per number of emergency calls they attended and in particular, for motor vehicle accident and building alarms calls, if subjects worked near or used fire equipment, or if they participated in active firefighting training activities. The authors cautiously concluded that firefighters may be at an increased risk of exposure to high noise levels.
- In her Master of Science thesis, Schwennker measured the noise levels of the equipment and emergency vehicles at ten Poudre Fire Authority stations and then estimated the potential 24-hour cumulative noise exposures among Poudre firefighters based on their regular activities and the associated noise levels measured from the equipment used. The author found that Poudre firefighters were potentially exposed to relatively loud equipment noise (i.e. > 85 dBA) which contributed to their daily noise doses; however, based on the estimated, average time-of-use for each piece of equipment used during a 24-hour shift, overall, the estimated

noise dose during equipment usage in this study did not exceed 100% of the NIOSH daily exposure limit.

- In 2013, Root et. al.[52] investigated the noise levels of typical fire station equipment and emergency response equipment used by firefighters as well as on the average noise exposure of firefighters while using emergency response equipment during routine training activities that simulated small house fires, as sampled from 10 fire stations in Colorado, USA. This small cross sectional study (level of evidence 5. Appendix 1) reported noise dosimetry samples taken from 93 firefighters during 10 training activities. The authors found that the average noise exposure was 78 dBA during the training activities, which lasted 70 minutes on average. The authors concluded that, although Colorado firefighters routinely used equipment and emergency response vehicles that could produce hazardous levels of noise, this study showed that the average noise levels experienced by firefighters was below generally accepted guidelines.
- Neitzel et. al.[46], in 2013, measured task-based noise exposures within firefighting operations and used noise level data based on 21 tasks (totaling 100 measurements) to create 8- and 24-hour noise exposure estimates, to simulate experiences which Southern Michigan and Northern California firefighters may encounter. Assuming an average of 5.7 hours of time spent in the fire station, the authors estimated the mean 8 hours of noise exposures ranged from 82.4 to 98.2 dBA in the rural Michigan fire department and 81.4 to 88.8 dBA in the suburban Northern California fire station. The authors estimated that the mean 24-hour equivalent continuous sound level was 84.5 dBA which was about 3 dBA higher than the allowable 24-hour NIOSH noise exposure limit of 80.25 dBA. The authors concluded that there was a potential for overexposure to noise from a variety of firefighting tasks and equipment.
- In 2013, Kang et. al.[43] evaluated the noise exposure levels of several job categories for 24-hour periods over 7 days to determine the contribution of each microenvironment to total noise exposure. The authors measured noise exposure levels of 47 individuals, of whom seven were firefighters, via continuous use of personal noise dosimeters in metropolitan Seoul, Korea. The seven firefighters included in this study ranged from 28 to 50 years old and of whom six were males. The authors found the 24-hour mean equivalent continuous sound level for these firefighters were 75 ± 5 dBA in total,

with a mean of 74 ± 5 dBA during weekdays and 76 ± 6 dBA during weekends. It should be noted that the level of exposure is below the current WorkSafeBC limit of 85 dBA (https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-07-noise-vibration-radiation-and-temperature?origin=s&returnurl=https%3A%2F%2Fwww.worksafebc.com%2Fen%2Fsearch%23q%3Dnoise%26sort%3D%2540fcomputedohsorderfield343%2520ascending%26f%3Acontent-type-facet%3D%5BOHS%2520regulation%2520%2526%2520related%2520materials%5D%26f%3Alanguage-facet%3D%5BEnglish%5D#C8ABC670F01240B0A01980755A17C8F6)

Summary

- At present, there is no study to prove that Fire Chiefs were exposed to hazardous noise levels in their job or any data to show that Fire Chiefs had higher incidences of occupational noise induced hearing loss.
- At present, the majority of studies investigating the average 8-hour or 24-hour noise exposure periods among firefighters showed that the average noise exposures were below limit set by WorkSafeBC at 85 dBA. At best, current data showed conflicting evidence on the mean level of noise exposures faced by firefighters.

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Appendix 1

WorkSafeBC - Evidence-Based Practice Group Levels of Evidence

(adapted from 1,2,3,4)

1	Evidence from at least 1 properly randomized controlled trial (RCT) or systematic review of RCTs.
2	Evidence from well-designed controlled trials without randomization or systematic reviews of observational studies.
3	Evidence from well-designed cohort or case-control analytic studies, preferably from more than 1 centre or research group.
4	Evidence from comparisons between times or places with or without the intervention. Dramatic results in uncontrolled
5	Opinions of respected authorities, based on clinical experience, descriptive studies or reports of expert committees.

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