



**The Danish Firefighters Cancer Organization**  
BFC

23.10.2017

**Report and analysis of**

**Bio-monitoring study (BIO brand) (BIO fire) and Epidemiological study (EPI brand) (EPI fire)  
For Danish firefighters exposure to harmful particles  
and risk of cancer (9.061 firefighters) and cardiovascular diseases (11.691 firefighters).  
BIO brand (BIO fire) partly closed. EPI brand (EPI fire) closed. October 2017.**

**Findings:**

BIO brand (BIO fire).

Biomonitoring study of 53 young non-smoking firefighter trainees during firefighter training in Beredsskabsstyrelsen (Danish Emergency Management Agency DEMA) where the exposure is being examined for cancers and cardiovascular diseases. Bio-markers collected from the skin, urine and blood. Function of blood vessels and lung function performed.

Cancer:

- Tars (Pyrene and PAH) were found on the skin after smoke diving ended.
- Increased release of tars in the urine.
- Increased amounts of DNA damages rise with increased exposure to tars.
- No increased intake of particles though the breathing found when using correctly placed and use of full self-contained breathing apparatus (SCBA).

Blood vessel function test:

- Smoke diving affects the regulation of heart function in a negative direction. Lowered vessel function, changed heart frequency.
- Increased strain of the heart probably due to increased physical activity, increased body temperature and intake of particles.

Lung function test:

- Not affected from smoke diving exercise.

Material burning:

- No change in the effect of burning pure EU pallets compared to EU pallets, mattress and electric cable was found.

EPI brand (EPI fire):

The three comparison groups are the general population, workers and employees in the Armed Forces (Army, Navy, Air Force and the Danish Home Guard).

- Cardiovascular diseases (comparison groups, workers and Armed Forces):
- Increased occurrences of certain ischemic diseases in the heart as well as cardiac fibrillation/flutter.
- Increased occurrences of transient stroke (brain) <24 hours.
- No critical findings of the rest of the vascular beds.

(Table 1)



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Table 1.

Cardiovascular diseases among 11.961 firefighters in Denmark compared to samples from workers and employees of the Armed Forces (Army, Navy, Air Force and the Danish Home Guard).

Cardiovascular outcomes	No. of occurrences	Workers		The Armed Forces	
		SIR	95% CI	SIR	95% CI
<b>Other blood vessels</b>					
Atherosclerosis	178	1,02	0,88 – 1,18	1,12	0,96 – 1,29
Blood clot in pulmonary artery	30	0,83	0,58 – 1,19	0,85	0,59 – 1,21
<b>The brain</b>					
Stroke	369	0,95	0,86 – 1,05	0,99	0,90 – 1,10
Transient stroke (<24 hours)	188	1,12	0,97 – 1,30	1,10	0,95 – 1,26
<b>The heart</b>					
Angina pectoris	815	1,16	1,08 – 1,24	1,08	0,87 – 1,32
Heart attack	550	1,16	1,06 – 1,26	1,22	1,12 – 1,32
Chronic ischemic heart disease	652	1,15	1,06 – 1,24	1,22	1,13 – 1,31
Cardiac fibrillation/flutter	504	1,25	1,14 – 1,36	1,08	0,99 – 1,18
Heart failure	354	1,01	0,91 – 1,12	1,15	1,04 – 1,28
Cardiac arrest	89	0,98	0,80 – 1,21	1,08	0,87 – 1,32
<b>All cardiovascular diseases in total</b>	1.839	1,10	1,05 – 1,15	1,02	1,00 – 1,07

Cancer diseases:

(Comparison group, the general population):

- Increased occurrences of a number of types of cancer compared to the general population.
- Cancer types under SIR 1,00 are calculated as firefighters' general better health condition and is labeled as Healthy Workers Effect or HWE.

(Table 2)

Table 2

9.061 firefighters in Danish study from 1968 to 2014. Cancer occurrences are in total (excluding common skin cancer) calculated to 1.071 firefighters. There are 51 types of cancer in total in the study. Comparison group: The general population.

Type of cancer	SIR	No. of occurrences	95% CI SIR	Excess risk including HWE in %
<b>Birthmark</b>	1,24	70	0,98 – 1,57	39
<b>Prostate</b>	1,10	202	0,95 – 1,26	25
<b>Testicle</b>	1,30	47	0,97 – 1,73	45
<b>Non-Hodgkin's lymphoma</b>	0,96	37	0,69 – 1,32	11
<b>Head and neck cancer:</b>				
Nasal cavity	1,38	4	0,52 – 3,67	53
Tongue	1,52	12	0,86 – 2,68	67
Oral cavity	0,60	7	0,28 – 1,25	
Salivary glands	1,79	4	0,67 – 4,77	94
Pharynx	0,91	20	0,59 – 1,41	6
Larynx	0,92	16	0,56 – 1,50	7
<b>Cancer in lower respiratory tract and chest:</b>				
Louge	0,91	132	0,76 – 1,07	6
Mesothelioma (asbestos)	0,65	4	0,24 – 1,73	
Heart and other chest	4,27	3	1,38 – 13,23	442
<b>Colorectal cancer:</b>				
Esophagus	0,99	21	0,65 – 1,53	14
Stomach	1,09	27	0,74 – 1,59	24
Colon	0,73	57	0,57 – 0,95	
Rectum	1,22	64	0,95 – 1,55	37
Liver	0,97	14	0,58 – 1,64	12
Gallbladder and gallbladder passages	0,99	5	0,41 – 2,37	14
Pancreas	1,20	34	0,86 – 1,68	35
Anus	1,31	4	0,49 – 3,49	46
<b>Cancer in urinary tract and genitals:</b>				
Kidney	1,04	32	0,74 – 1,47	19
Renal pelvis og urine leader	1,46	10	0,79 – 2,72	61
Urine bladder	1,09	88	0,89 – 1,35	34
<b>Cancer in the central nervous system:</b>				
Eye	0,88	3	0,28 – 2,74	3
Heart membrane	1,22	9	0,64 – 2,35	37
Brain	0,94	33	0,67 – 1,33	11
Other parts of CNS	1,39	12	0,79 – 2,45	54
<b>Blood and lymphatic system cancer:</b>				
Hodgkin's lymphoma	1,64	13	0,95 – 2,82	79
Bone marrow (myelomatosis)	0,62	8	0,31 – 1,24	
Lymphocytic leukemia	0,91	15	0,55 – 1,46	6
Myeloid leukemia	0,76	9	0,40 – 1,46	
<b>Average under SIR 1.00:</b>	0,85			
Average Healthy Workers Effect in %	15			



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(Comparison group, workers):

- Increased occurrences of types of cancer compared to samples of workers.

(Table 3)

(Comparison group, the Armed Forces):

- Increased occurrences of types of cancer compared to samples of the armed Forces.

(Table 4)

Table 3

9.061 firefighters in Danish study from 1968 to 2014.  
Cancer occurrences are in total (excluding common skin cancer) calculated to 1.071 firefighters.  
There are 51 types of cancer in total in the study.  
Comparison group: Samples of workers.

Type of cancer	SIR	No. of occurrences	95% CI SIR	Excess risk including HWE in %
Birthmark	1,28	70	1,01 – 1,61	28
Prostate	1,15	202	1,00 – 1,32	15
Testicle	1,04	47	0,79 – 1,39	4
Non-Hodgkin's lymphoma	0,97	37	0,70 – 1,33	
<b>Head and neck cancer:</b>				
Nasal cavity	1,27	4	0,48 – 3,39	27
Tounge	1,62	12	0,92 – 2,85	62
Oral cavity	0,57	7	0,27 – 1,19	
Salivary glands	1,90	4	0,71 – 5,07	90
Pharynx	0,94	20	0,60 – 1,45	
Larynx	0,92	16	0,57 – 1,51	
<b>Cancer in lower respiratory tract and chest:</b>				
Lounge	0,95	132	0,80 – 1,13	
Mesothelioma (asbestosis)	0,68	4	0,26 – 1,82	
Heart and other chest	3,61	3	1,17 – 11,20	361
<b>Colorectal cancer:</b>				
Esophagus	1,05	21	0,68 – 1,61	5
Stomach	1,12	27	0,77 – 1,63	12
Colon	0,77	57	0,59 – 0,99	
Rectum	1,24	64	0,97 – 1,58	24
Liver	0,98	14	0,58 – 1,65	
Gallbladder and gallbladder passages	1,04	5	0,43 – 2,50	4
Pancreas	1,27	34	0,91 – 1,78	27
Anus	1,13	4	0,42 – 3,01	13
<b>Cancer in urinary tract and genitals:</b>				
Kidney	1,02	32	0,72 – 1,44	2
Renal pelvis og urine leader	1,59	10	0,85 – 2,95	59
Urine bladder	1,11	88	0,90 – 1,37	11
<b>Cancer in the central nervous system:</b>				
Eye	0,82	3	0,27 – 2,55	
Heart membrane	1,07	9	0,56 – 2,05	7
Brain	0,87	33	0,62 – 1,23	
Other parts of CNS	1,47	12	0,83 – 2,58	47
<b>Blood and lymphatic system cancer:</b>				
Hodgkin's lymphoma	1,35	13	0,78 – 2,32	35
Bone marrow (myelomatosis)	0,66	8	0,33 – 1,33	
Lymphocytic leukemia	0,97	15	0,59 – 1,61	
Myeloid leukemia	0,73	9	0,38 – 1,40	
<b>Average under SIR 1.00:</b>	<b>0,76</b>			

Table 4

9.061 firefighters in Danish study from 1968 to 2014.  
Cancer occurrences are in total (excluding common skin cancer) calculated to 1.071 firefighters.  
There are 51 types of cancer in total in the study.  
Comparison group: Employees of the Armed Forces (Army, Navy, Air Force and the Danish Home Guard).

Type of cancer	SIR	No. of occurrences	95% CI SIR	Excess risk including HWE in %
Birthmark	1,05	70	0,82 – 1,33	5
Prostate	1,02	202	0,88 – 1,17	2
Testicle	0,98	47	0,73 – 1,3-	
Non-Hodgkin's lymphoma	0,97	37	0,70 – 1,--	
<b>Head and neck cancer:</b>				
Nasal cavity	1,42	4	0,53 – 3,76	42
Tounge	1,46	12	0,83 – 2,57	46
Oral cavity	0,61	7	0,29 – 1,37	
Salivary glands	1,59	4	0,60 – 4,2-	59
Pharynx	0,87	20	0,56 – 1,5-	
Larynx	1,01	16	0,62 – 1,6-	1
<b>Cancer in lower respiratory tract and chest:</b>				
Lounge	1,06	132	0,90 – 1,26	6
Mesothelioma (asbestosis)	0,71	4	0,27 – 1,89	
Heart and other chest	4,30	3	1,39 – 13,32	430
<b>Colorectal cancer:</b>				
Esophagus	1,18	21	0,77 – 1,81	18
Stomach	1,26	27	0,87 – 1,84	26
Colon	0,70	57	0,54 – 0,90	
Rectum	1,20	64	0,94 – 1,53	20
Liver	1,17	14	0,69 – 1,98	17
Gallbladder and gallbladder passages	1,02	5	0,42 – 2,44	2
Pancreas	1,28	34	0,92 – 1,80	28
Anus	1,12	4	0,42 – 2,99	12
<b>Cancer in urinary tract and genitals:</b>				
Kidney	1,04	32	0,74 – 1,46	4
Renal pelvis og urine leader	1,35	10	0,73 – 2,51	35
Urine bladder	1,05	88	0,86 – 1,30	5
<b>Cancer in the central nervous system:</b>				
Eye	0,90	3	0,29 – 2,78	
Heart membrane	1,23	9	0,64 – 2,37	23
Brain	0,90	33	0,64 – 1,26	
Other parts of CNS	1,31	12	0,74 – 2,30	31
<b>Blood and lymphatic system cancer:</b>				
Hodgkin's lymphoma	1,42	13	0,82 – 2,??	42
Bone marrow (myelomatosis)	0,65	8	0,33 – 1,??	
Lymphocytic leukemia	0,88	15	0,53 – 1,??	
Myeloid leukemia	0,83	9	0,43 – 1,??	
<b>Average under SIR 1.00:</b>	<b>0,82</b>			

SIR= Standardized Incidence Ratio is a measure for a disease's occurrence within citizens in relation to another group of citizens like for example firefighters.

95% CI= Confidence interval which in principal means that there are 95% certainty for correct numbers, or to put in another way, a maximum of 5% risk of being wrong.



### **Conclusion:**

There are connections between the profession of being a firefighter and developing certain cardiovascular diseases and several types of cancer.

There is a severe strain of the heart is seen during smoke diving/firefighting.

There is a connection is seen between the exposure of tar substances (Pyrene and PAHs) and smoke diving/firefighting with damages on the DNA.

During controlled training at Beredsskabstyrelsen (DEMA) it appears that when using full respiratory protection properly, the user is protected against the ingestion of particles through the breath. At the time where the respiratory protection is removed after the end of smoke diving/firefighting and in areas considered safe zones the intake rises considerably.

An increased occurrence of certain heart diseases and an increase of certain types of cancers must be ascribed to the very hard work environment during smoke diving/firefighting in the form of increased body heat, changed heart rate and intake of carcinogens primarily through the skin but also via mouth and nose to the respiratory system and digestion, respectively.

### **Argumentation:**

There should no longer be any doubt that there is a correlation between Danish firefighters' work/working conditions and the long term development of types of cancer and cardiovascular diseases which calls for a presumptive legislation.

Out of 17 types of cancer a varied overrepresentation at firefighters is seen compared to the general population from 4 to 427%, 15 of them are on 10% or above. Adding a 15% HWE the numbers grow to 27 different types of cancer from 3 to 442% whereof 22 are over 10%.

It is worth noticing that common skin cancer is not included in the study but earlier numbers show 531 cases.

Internationally it is assessed that HWE is in a place from 10 to 25% and is an expression of firefighters' expected better health in relation to the general health. This, basically, better health may be due to the fact that firefighters are going through a thorough health check already before the employment and that they throughout the employment must be in a relatively good shape.

There can be variations of cancer cases through the decades as it can be seen that it may be when looking at the form of employment, full time, part time and volunteer, but it is not a parameter that should be a decisive factor in a legislation made of presumptive legislation but more likely the function as a firefighter. The same should be applicable when it comes to cardiovascular diseases.

Other general causal links:

There are probably also other occupational health reasons that are contributing to an increased occurrence of the above diseases.

Physical stress load.

A weight measure of firefighters gear shows how much firefighters are loaded with already before they are doing the actual firefighting efforts (psychical stress and strain).

(Table 5)



Table 5

Physical stress loads on firefighters calculated in relation to the function onboard the fire engine.

Basic turn out gear for all firefighters	13,2 Kilo
Firefighter seat number 1	41,9 Kilo
Firefighter number 1 all together	55,1 Kilo
Firefighter seat number 2	50,4 Kilo
Firefighter seat number 4 all together	63,6 Kilo
Firefighter seat number 3	56,8 Kilo
Firefighter seat number 3 all together	70,0 Kilo
Firefighter seat number 4	64,3 Kilo
Firefighter seat number 4 all together	77,5 Kilo

Interrupted circadian rhythm.

Firefighters must be standing by during 24 hours of the day and must respond to an alarm/call during the night even if the whole day and evening have been filled with tasks, work, fire incidents etc. What is special about this is that the firefighters as the nature of things do not have the ability to wake up in a calm manner when the alarm sounds which is a heavy strain for the body and the circadian rhythm of the individual is disturbed.

This interruption and strain is suspected of increasing load on the cardiovascular and for having a relation to certain types of cancer.

Gear, PPE, arrangement and procedures.

It is a known problem that gear that has been used in a firefighting incident for the most part are put back on the vehicle and thus over time is contributing to a contamination of the vehicle and the fire station which in almost all cases in Denmark are designed in an unsuitable way in relation to clean and dirty areas/zones as well as in many places there is a lack of, or insufficient, cleaning facilities both for gear, PPE, vehicles and facilities (shower, sauna and locker room) for the crew. In many places there is insufficient vent of the vehicles' diesel exhaust and some places vent does not exist apart from the natural ventilation when the gates are opened.

These circumstances will in total be contributing to an extra exposure.

Science and logic.

Three studies point in the same direction, an excess risk of cancer and cardiovascular diseases among firefighters.

The first study from 1988 by Eva Støttrup Hansen et al. studies 885 firefighters and compared them to 48.000 civil servants and officials shows types of cancer (0,87 – 2,20) and for cardiovascular (1,12 – 2,95). The second study from Pukkala et al. 2014 the so-called Nordic study where an excess risk of cancer among Nordic firefighters, yet highest among Danish firefighters.



There can be certain problems in comparing these studies in relation to the two Danish studies BIO brand (BIO fire) and EPI brand (EPI fire) from 2017 which are more thoroughly conducted.

Scientific methods and thus results are developed over time and will of course give answers to certain questions but they do of course not show everything and thus further questions arise.

As one of the leading researchers in the area Tee Guidotti says: *"Science cannot answer all questions, at some point assumptions and logic need to get into play and that's exactly why the language of the act (read: legislation that recognizes cancer as an occupational disease for firefighters) say that the benefit of the doubt should be given to the worker (read: firefighters)".*

It is not possible to protect firefighters completely which underlines that certain diseases are indeed occupational and should be recognized as such.

### **Recommendations/needs for prevention and future studies:**

#### Need.

- A law that recognizes overrepresented cancers as occupational disease for firefighters. Internationally called "Presumptive legislation. Fair act for firefighters".
- Introducing better preventive procedures that reduce firefighters' exposure to harmful particles and gases at the site of injury. This is about all used PPE and equipment.
- Introduction of logistics for proper handling of contaminated equipment from the site of injury.
- The introduction of procedures for the correct handling of contaminated PPE and equipment from the site of injury, the arrangement of laundry rooms in clean and unclean areas as well as safe and efficient washing and decontamination machines.
- Correct design of fire stations in clean and unclean areas.
- Introduction of direct point extraction from vehicle exhaust.
- Correct locker room and washing conditions for personal cleaning after insertion.  
Rinse off soot – sauna for sweating – rinse of sweat – regular finishing wash.
- Special appropriations earmarked for improvements to the above measures and equipment where it may be missing.

#### Future studies.

- BFC works on a digital logging system for accurate and personal documentation of all incidents and strains, both physical and mental (easy and simple to use by firefighters and ambulance professionals regardless of location and conditions). This documentation may contribute to future epidemiological and other studies. (BFC would like to receive sponsorship and help for faster development and publishing).
- A study that must identify the general public health of Danish firefighters relative to the population, thus obtaining a more accurate figure for "Healthy Workers Effect" and thus their real starting point for developing certain diseases and disorders. Internationally estimated from 10 to 25%. BFC estimates the general health status of Danish firefighters to be 15% better than the average population.  
Such a study could formally be carried out by the Statens Institut for Folkesundhed (National Institute of Public Health).
- Studies of toxicity from different types of fires in Denmark through the collection of material from fires. Analysis and mapping of causes of fire spread. Measurement and analysis of toxicity from specific materials that are essential for fire and spread.



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Such studies/research may be carried out by the Danmarks Tekniske Universitet (Technical University of Denmark), Institut for Bygge og Anlæg (the Institute of Construction), possibly in cooperation with fire investigators from the national fire and rescue agencies.

Such studies will contribute significantly to the understanding of the most toxic materials included in a modern fire, safety for firefighters and citizens, as well as contribute to increased fire safety.

- Study on group1 agents (read: carcinogenic to humans) and gases, developed from fires, absorbed through human skin and beyond to cells and organs.

Such a study could probably be performed by the research group NoFlame, which consists of researchers from Danish and foreign universities' institutes.

The Danish Firefighters Cancer Association BFC works with the above both nationally and internationally, either in collaboration with sister organizations, researchers, firefighters, various organizations and producers with an interest in improving fire protection and/or improving the working environment, including through work procedures and development of new products.

BFC is a 100% volunteer non-profit association without any special interests and we call on all the country's fire brigade associations and others who are not already part of the work to join.

BFC is still available with our knowledge and advice.

### Relevant links:

<https://www.viking-fire.com/en/en469>

<https://www.decontex.com/en/decontex/deco2fire/12>

<http://safercylinders.dk/trykflasker-brand-redning/>

<https://www.youtube.com/watch?v=IJZLgCQ1PfA>

<https://www.youtube.com/watch?v=CR8R3cySPrM>

[http://www.austlii.edu.au/cgi-bin/viewdoc/au/legis/cth/num\\_act/sracapffa2011757/sch1.html](http://www.austlii.edu.au/cgi-bin/viewdoc/au/legis/cth/num_act/sracapffa2011757/sch1.html)

<http://www.brandcancer.dk/litteratur/>

[https://www.youtube.com/watch?v=gUcPI1\\_a3W4](https://www.youtube.com/watch?v=gUcPI1_a3W4)