Lung cancer risk for diesel exhaust: meta-analysis of 3 cohorts (2 truck drivers, 1 underground miners, pre-2007)

Exposure setting	Average EC exposure ($\mu g/m^3$)	Excess lifetime risk through age 80 years (per 10,000)
Worker exposed, age 20–65 years	25	689
Worker exposed, age 20–65 years	10	200
Worker exposed, age 20–65 years	1	17
General public, age 5–80 years	0.8	21

Based on linear risk function, lnRR = 0.00098 × exposure, assuming a 5-year lag, using age-specific (5-year categories) all cause and lung cancer mortality rates from the United States in 2009 as referent.

Exposure-Response Estimates for Diesel Engine Exhaust and Lung Cancer Mortality Based on Data from Three Occupational Cohorts https://ehp.niehs.nih.gov/1306880/

Non-cancer effects of diesel exhaust (particulate and NO2)

Table 1. Key Experimental Data on Health Effects and Dose–Responses of Diesel Exhaust (Adapted From Taxell and Santonen, 2016)

Endpoint and Type of Study	New Technology Diesel Engines	Older Technology Diesel Engines	
	With Exhaust After Treatment[a]	With Particle Filter/Trap	Without Exhaust After Treatment
Human inhalation studies (1–2 h)			
Inflammatory changes in BAL/BW, increased airway resistance	No data identified	No data identified	LOAEL: 100 μg DEP/m^3 (0.2–0.4 ppm NO_2)
Sensory irritation	No data identified	No data identified	LOAEL: 100–300 μg DEP/m^3 (0.2–1.3 ppm NO_2)
Reduced response to vasodilators	No data identified	NOAEL: 3.4 ppm NO_2 (7 μg DEP/m^3)	LOAEL: 250–350 μg DEP/m^3 (0.2–1.6 ppm NO_2)
Increased ischemic burden	No data identified	No data identified	LOAEL: 300 μg DEP/m^3 (1.0 ppm NO_2)[b]
Animal inhalation studies			
Histopathological changes in lungs (104–130 week, rat)	NOAEL: 0.9 ppm NO_2 (5 μg DEP/m^3); LOAEL: 4.2 ppm NO_2 (12 μg DEP/m^3)	LOAEL: 1.1 ppm NO_2 (10 μg DEP/m^3)	LOAEL: 210 μg DEP/m^3 (0.2 ppm NO_2)
Mild decrease in pulmonary function (104–130 week, rat)	NOAEL: 0.9 ppm NO_2 (5 μg DEP/m^3); LOAEL: 4.2 ppm NO_2 (12 μg DEP/m^3)	No data identified	NOAEL: 2 000 μg DEP/m^3 (1.5 ppm NO_2) LOAEL: 3 500 μg DEP/m^3 (0.3 ppm NO_2)
Lung tumors (104–130 week, rat)	NOAEL: 4.2 ppm NO_2 (12 μg DEP/m^3)	No lung tumors (original conc. 6 600 μg DEP/m^3, no data on final exposure levels)	NOAEL: 800–1 000 μg DEP/m^3 (0.3 ppm NO_2) LOAEL: 2 200 μg DEP/m^3 (approximately 1 ppm NO_2)
DNA damage in lungs	Negative (comet)	No data identified	Positive (induction of 8-OHdG, *gpt*, and *lacI* point mutations, DNA strand breaks and adducts)
Systemic genotoxicity	Negative (8-OHdG, micronuclei)	No data identified	Mostly negative
In vitro studies			
Genotoxicity	No data identified	Mutagenic to bacteria (limited data)	Mutagenic to bacteria and mammalian cells (DEP extracts)

NIOSH, 2009: Occupational exposure measurements to diesel exhaust from on-road vehicles: elemental carbon (EC, µg/m³), submicron and respiratory particulate matter (PM_S and PM_R, µg/m³), and CO, NO and NO_2 (ppm)

Description	Agent	Duration	n	AM (SD)	GM (GSD)	Location	Year	Reference
Drivers								
Truck – local	EC_S	>4	56	5 (0.9)	0.9 (4.0)	US	1980s	(Zaebst et al. 1991)
Truck - local	EC_S	>4	576 (a)	2 (2.3)	1 (2.8)	US	2001–2005	(Davis et al. 2007)
Truck – local	EC_R	>4	5	7[c]	6 (1.6)	US	1999	(Garshick et al. 2002)
Truck – local	EC_{NI}	>4	4 (a)	5 (0.1)	5 (1.0)	US	1985	(NIOSH 1986)
Truck - long haul	EC_S	>4	72	5 (0.4)	0.4 (3.8)	US	1980s	(Zaebst et al. 1991)
Truck - long haul	EC_S	>4	349 (a)	1 (0.8)	1 (2.3)	US	2001–2005	(Davis et al. 2007)
Truck - long haul	EC_R	>4	5	5[c]	4 (2.0)	US	1999	(Garshick et al. 2002)
Truck - long haul	EC_{NI}	>4	4 (a)	22 (13.2)	19 (2.0)	US	1985	(NIOSH 1986)
Truck	EC_I	1->4	3	10 (6.0)	9 (1.8)	US	1992	(NIOSH 1993)
Bus	EC_R	>4	5	10[c]	9 (1.3)	Estonia	2002 (p)	(Boffetta et al. 2002)
Bus	EC_R	>4	39	2.0 (1.3)	1.4 (3.3)	US	2002 (p)	(Ramachandran et al. 2005)
Bus	EC_I	>4	4	2>LOD: 11–20		US	1998	(NIOSH 1998)
Bus and truck[x]	EC_I	>4	20	11[c]	6 (2.9)	Sweden	2002–2004	(Lewne et al. 2007)
Taxi[x]	EC_I	>4	8	8[c]	7 (1.6)	Sweden	2002–2004	(Lewne et al. 2007)
Mechanics								
Truck	EC_S	>4	80	27 (4.1)	4 (12.1)	US	1980s	(Zaebst et al. 1991)
Truck	EC_R	>4	10	4[c]	4 (1.6)	US	1999	(Garshick et al. 2002)
Ambulance depot	EC_R	>4	3	31	29 (1.6)	UK	2000(p)	(Groves et al. 2000)
Bus	EC_R	>4	53	39	31 (2.1)	UK	2000(p)	(Groves et al. 2000)
Bus	EC_R	>4	15	39[c]	38 (1.3)	Estonia	2002 (p)	(Boffetta et al. 2002)
Truck/bus (+inspection)	EC_I	>4	40	21[c]	11 (3.2)	Sweden	2002–2004	(Lewne et al. 2007)
Others								
Firefighter	EC_I	>4	27	24 (max)		US	2002(p)	(Roegner et al. 2002)
Firefighter	EC_I	>4	18	40 (20.3)	35 (1.7)	US	1995(p)	(Echt et al. 1995)
Firefighter	EC_I	>4	12	10 (max)		US	1997	(NIOSH 1998)
Firefighter	EC_I	<1	8	ND	ND	US	1998	(NIOSH 1998)
Service worker bus	EC_I	>4	4	2>LOD: 0.3–15		US	1998	(NIOSH 1998)
Vehicle testing	EC_R	>4	11	11	11 (1.8)	UK	2000(p)	(Groves et al. 2000)
Parking attendant (booth)	EC_R	>4	34 (a)	1.1 (0.6)	1.1 (1.8)	US	2002 (p)	(Ramachandran et al. 2005)
Drivers								
Taxi[x]	PM_S	>4	8	12[c]	11 (1.3)	Sweden	2002–2004	(Lewne et al. 2007)
Bus and truck[x]	PM_S	>4	20	15[c]	14 (1.6)	Sweden	2002–2004	(Lewne et al. 2007)
Truck – local	PM_R	>4	5	129[c]	120 (1.5)	US	1999	(Garshick et al. 2002)
Truck – local	PM_R	>4	545 (a)	28 (39)	20 (2.1)	US	2001–2005	(Davis et al. 2007)
Truck - long haul	PM_R	>4	4	56[c]	55 (1.2)	US	1999	(Garshick et al. 2002)
Truck - long haul	PM_R	>4	334 (a)	53 (328)	23 (2.5)	US	2001–2005	(Davis et al. 2007)
Bus	PM_R	>4	5	600[c]	580 (1.5)	Estonia	2002 (p)	(Boffetta et al. 2002)
Mechanics								
Truck/bus (+inspection)	PM_S	>4	40	28[c]	23 (1.9)	Sweden	2002–2004	(Lewne et al. 2007)
Truck	PM_R	>4	10	203[c]	152 (2.1)	US	1999	(Garshick et al. 2002)
Bus	PM_R	>4	15	1100[c]	1020 (1.6)	Estonia	2002 (p)	(Boffetta et al. 2002)
Bus	PM_R	NI	232	240 (260)		US	1987 (p)	(Gamble et al. 1987)
Bus	PM_R	>4	41	267	224 (1.8)	UK	2000(p)	(Groves et al. 2000)
Ambulance depot	PM_R	>4	3	127	118 (1.6)	UK	2000(p)	(Groves et al. 2000)

Others								
Vehicle testing	PM_R	>4	10	156	149 (1.4)	UK	2000(p)	(Groves et al. 2000)
Driver								
Truck – local	NO	>4	4 (a)	0.23 (0.05)	0.22 (1.3)	US	1985	(NIOSH 1986)
Truck - long haul	NO	>4	4 (a)	0.27 (0.10)	0.25 (1.5)	US	1985	(NIOSH 1986)
Driver								
Taxi[20]	NO_2	>4	12	0.03[2]	0.02 (0.7)	Sweden	2002–2004	(Lewne et al. 2007)
Bus and truck[21]	NO_2	>4	30	0.03[2]	0.03 (0.7)	Sweden	2002–2004	(Lewne et al. 2007)
Truck	NO_2	>4	40	0.04 (0.02)		Sweden	1997–1999	(Lewne et al. 2006)
Taxi	NO_2	>4	20	0.03 (0.01)		Sweden	1997–1999	(Lewne et al. 2006)
Bus	NO_2	>4	42	0.03 (0.01)		Sweden	1997–1999	(Lewne et al. 2006)
Mechanics								
Truck bus (–inspection)	NO_2	>4	60	0.05[2]	0.05 (0.9)	Sweden	2002–2004	(Lewne et al. 2007)
Bus	NO_2	NI	232	0.24 (0.26)		US	1987 (p)	(Gamble et al. 1987)

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3073453/

NISOH, 2012: Measurement of Area and Personal Breathing Zone Concentrations of Diesel Particulate Matter (DPM) during Oil and Gas Extraction Operations, including Hydraulic Fracturing

Personal Breathing Zone Measurements of Diesel Particulte Matter (DPM as µg/m^3 Elemental Carbon) by Operation Arithmetic (AM) and Geometric (GM) Means as Time Weighted Averages

Job Title*	Total # of samples	AM ±SD*	GM±SE**	Range	95% CI (lower/upper)
Completions	33	11.9±11.3	8.4±.1.1	1.4-52	6.2/11
Drilling Operations	10	7.4±5.3	5.7±1.4	2.0-18	3.3/10
Servicing Operations	6	5.4±3.8	3.0±2.1	0.1-11	0.5/18
Total	49	10±9.9	6.8±0.9	0.1-52	5.2/9.0

Area Measurement Diesel Particulate Matter (DPM as µg/m^3 Elemental Carbon) by Operation, Arithmetic (AM) and Geometric (GM) Means as Time Weighted Average (TWA)

Operation	Total # of samples	AM ±SD*	GM±SE**	*Range*	95% CI (lower/upper)
Completions	30	18.5±16.6	9.5±.2.7	*0.1-68*	5.3/17
Drilling Operations	21	16.2±15.0	11.0±2.2	*3.0-51*	7.2/17
Servicing Operations	4	8.4±8.4	4.4±3.2	*0.8-18*	0.4/47
Total	55	16.9 ±15.5	9.5±1.7	0.1-68	6.6/13.6

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5957075/