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Review on AirQ models and air pollutants

Abstract

Air pollution modeling can describe air pollution, including an analysis of emission sources, physical and chemical changes, meteorological processes, and forecast human outcomes. This review presents a short review about Air Quality Softwares (AirQ 2.2.3 and AirQ+ models) which assess the health risks (such as mortality and morbidity) caused by exposure to ambient air pollutants and household air pollutants.

Keywords: air pollution, airq models, health impacts, epidemiology

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Introduction

Air contamination is the main ecological danger factor to health.[5,19,43] In any case, air contamination keeps on representing a huge wellbeing danger in developed and developing nations the same. Checking and demonstrating of exemplary and arising pollutants are essential as far as anyone is concerned of health results in presented subjects and to our capacity to anticipate them. This paper gives a short survey of the Air Quality models (AirQ models) concerning the prediction of health impacts. The World Health Organization (WHO), Local Office for Europe, has created AirQ+ inside its exercises on air quality and health.[47]

Studies show that particulate matter can be related with expanded emergency clinic confirmations, physiological changes in the body, and various illnesses, particularly of the respiratory[36] and cardiovascular[6] framework, asthma, and lung cancer mortality.[2,25]

The WHO assesses that some 80% of unexpected losses are because of ischemic coronary illness and stroke brought about by outside air contamination, 14% are because of persistent obstructive aspiratory sickness or intense lower respiratory lot diseases, and 6% are because of cellular breakdown in the lungs. Kids are especially susceptible because of their fast metabolism.[13, 9,37] As indicated by the WHO, a decrease in particulate matter (PM10) contamination from 70 to 20 µg/m3 can lessen air contamination related deaths by 15%.[44]

The rules apply in all WHO locales and regard particulate matter (PM), ozone (O_3), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2) (Table 1).[7] Ideal policymaking to secure human wellbeing includes a decrease of openness to ecological dangers at all phases of the interaction (Ha 2014). Exemplary and arising pollutants are $PM_{2.5}$, PM_{10}, SO_2, NO_2, O_3, CO, and volatile organic compounds (VOCs), which are produced by natural and/or anthropogenic processes.[1, 13, 30]

Table 1 Air quality guidelines in some emerging and developed countries

Pollutant		WHO	NAAQS	CAFE	China	Brazil
PM2.5	Annual mean	10 µg/m³	12 µg/m³	20 µg/m³	15 µg/m³	–
	24 h mean	25 µg/m³	–	35 µg/m³	–	–
PM10	Annual mean	20 µg/m³	150 µg/m³	40 µg/m³	40 µg/m³	–
	24 h mean	50 µg/m³	–	50 µg/m³	50 µg/m³	–
O3	8 h mean	100 µg/m³	0.075 ppm	120 µg/m³	100 µg/m³	
	1 h mean	–	–	–	160 µg/m³	160 µg/m³
NO2	Annual mean	40 µg/m³	53 ppb	40 µg/m³	40 µg/m³	100 µg/m³
	1 h mean	200 µg/m³	100 ppb	200 µg/m³	200 µg/m³	320 µg/m³
SO2	Annual mean	–	–			80 µg/m³
	24 h mean	20 µg/m³	–	125 µg/m³	50 µg/m³	365 µg/m³
	3 h mean	–	0.5 ppm			–
	1 h mean	–	75 ppb	350 µg/m³	150 µg/m³	–
	10 min mean	500 µg/m³		–	–	–
CO	Not to be exceeded	–	–	10,000 µg/m³	–	–

Table Continued

Pollutant		WHO	NAAQS	CAFE	China	Brazil
	24 h mean	–	–		4000 μg/m^3	–
	8 h mean	–	–	–	–	10,000 μg/m^3
	1 h mean	30 μg/m^3	–	–	10,000 μg/m^3	40,000 μg/m^3
	15 min mean	100 μg/m^3	–	–	–	–

AirQ models

Air contamination checking gives significant quantitative data about air pollutants concentrations and their deposition; however it can just depict air quality without giving clear ID of reasons for contamination. Air pollution modeling can depict contamination, including an investigation of outflow sources, physical fand substance changes, meteorological cycles, and forecast the human outcomes.[8,14] Air Quality Softwares (AirQ models) is a valuable tool for evaluating the health impacts related with air pollutants. Measuring the impacts on general soundness of openness to air contamination has turned into a basic part in strategy conversation. Air Q has two primary parts: the short-term impacts of changes in air contamination (in view of hazard gauges from time-series considers) are assessed; the second part, the long-term impacts of exposure (utilizing life-tables approach and in light of hazard gauges from partner examines) are assessed.[26,20] AirQ models are helped out through four phases: data input, dispersion computations, derivation of concentrations, and analysis.[29,42]

The WHO European Center for Environment and Health (WHO, 2014) has proposed AirQ programming model 2.2 as a substantial and dependable tools to gauge the potential health impacts of air pollutants. AirQ programming is windows programming that gathers, manages, and shows results from air quality data information. It is intended to ascertain the extent of the effects of air contamination on health in a given populace.

AirQ programming 2.2.3 and the new form AirQ+ 1.0 programming can be applied for any city, nation, or locale of the world to answer to significant epidemiological questions such as the following: What amount of a specific health result is inferable from air contaminations? Or on the other hand Contrasted with the current situation, what might be the adjustment of health impacts of air contamination levels changed in the future? [46]

Methodology

The software was utilized to assess the effect of short-term exposure to Air contaminations on mortality and morbidity, impacts on health brought about by long-term exposure, assuming that the contamination level remaining steady during the simulation years to six exemplary air pollutants (SO_x, NO_x, O_3, CO, $PM_{2.5}$, and PM_{10}) on the health of inhabitants living in a specific period and region.[12] Figure 1 was showed the Flowchart of the utilization of Air Q programming. The evaluation depends on the attributable proportion (AP), characterized as the portion of the health result in a certain population an attributable to exposure to a given air pollutant.

The AP is calculated by the following equation:[18,16,33,7]

$$AP = \sum\{(RR(C)-1\}\,x\,P(C)\}\,/\sum(RR\,(C)x\,P(C)) \quad \textbf{Eq. 1A}$$

Where: AP is the attributable proportion of the health result, RR is the relative risk for a given health result, and P(c) is the amount of the population in category of exposure. If the baseline frequency of the health result in the population being researched is known, the rate attributable to the exposure can be determined by the following equation:

$$IE = I \; x \; AP \quad \textbf{Eq. 1B}$$

Where: IE is the rate of the health result attributable to the exposure and I is the baseline frequency of the health result in the population under researched. At long last, when the size of the populace is known, the quantity of cases attributable to the exposure can be assessed by the following equation:

$$NE = IE \; x \; N \quad \textbf{Eq. 1C}$$

Where: NE is the number of cases attributable to the exposure and N is the size of the population considered.

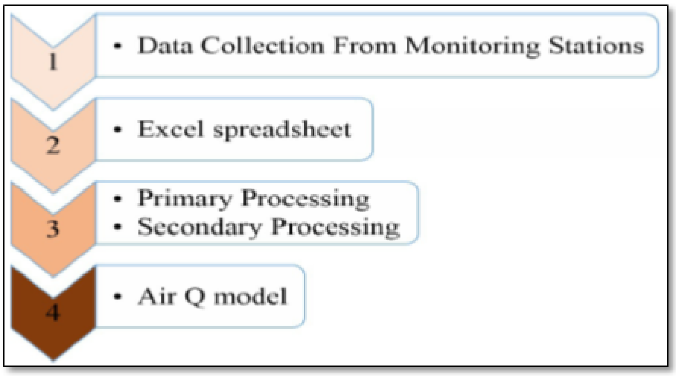

Figure 1 Flowchart of use of Air Q software (Source: Kamarehie etal., 2017).

There are various versions like I) Air Q programming, version 2.2.3 that measures air contamination data. The data inputted included exposed population, coordinates (latitude and longitude), uncovered populace, number of stations utilized for monitoring, statistical data of air pollutants concentrations (i.e. mean, maximum, and minimum values of annual, winter, and summer), baseline incidence (BI) per 100 000 per year, relative risk (RR) (mean, lower, and upper), and annual 98th percentile. For the predefined health results, two choices were given while calculating the health impact: to utilize WHO default esteems for BI and RR (95% CI), the degree of logical assurance of which is given by the accessible epidemiological proof, or to supplant the WHO default esteems with gauges for BI and RR acquired from neighborhood epidemiological investigations. In instances of the second choice, the scientific uncertainty will be set to unknown by the program. In this research, the RR and BI values were chosen dependent on similar investigations.[15,33,25] ii) AirQ+ is the WHO update version of AirQ programming created in May 2016. Both long and short-term exposure to ambient air contamination from several pollutants can be contemplated. All computations performed via

AirQ+ programming depend on approaches and response functions grounded by epidemiological examinations. Furthermore, AirQ+ can appraise likewise the impacts of household air contamination related to solid fuel use (SFU).[7] AirQ+ isn't intended to compute hazard evaluation gauges identified with a mishap (for instance a blast). While AirQ+ estimates the following evaluations: 1) attributable number of cases; 2) the attributable number of cases per 100000 population at risk; 3) proportion of cases in every classification of air pollutant ; 4) cumulative distribution by air contamination; 5) ; 6) Years of Life Lost (YLL).[47,48] AirQ+ evaluates: I) the impacts of short-term exposure in air contamination (based on hazard gauges from time-series examines); ii) the impacts of long-term exposures (utilizing life-tables approach and based on risk gauges from epidemiology studies).[48]

Input data for ambient air pollution:[47]

Air quality data:

I. Average concentration, for long-term exposure impacts.

II. Detailed concentration (frequency of days with particular pollutant concentration values), for short-term exposure impacts.

I. Data for population at risk (for instance: the total number of adults aged ≥ 30 years).

II. Health data, such as baseline rates of health results in the population studied.

III. A cut-off value for consideration (for instance 10 μg/m^3 for $PM_{2.5}$).

IV. Relative Risk (RRs) values if not the same as the default ones given by WHO.

V. Population and mortality data, both defined by age, when using the life table analysis. Examples for calculations, including life table calculations are provided in the AirQ+ tutorial.

Input data for household air pollution:[47]

I. Data for population at risk (for example: the total number of children < 5 years of age).

II. % total population using solid fuel for cooking, lighting, and heating.

III. Health data, such as baseline rates of health results in the population investigated.

IV. Relative Risk (RRs) values if not the same as the default ones given by WHO.

Results and Discussions

A few reports have raised worries over the health impacts of outdoor air contamination. Classic air pollutants are related with chronic obstructive pulmonary disease (COPD)[21,17,31] acute bronchitis,[34] heart arrhythmia and cardiovascular diseases,[51,23,31] increased limb defects,[27] pre-eclampsia in pregnancy,[50] low-term birth weight,[36] autism spectrum disorders,[24] and hypertension and expanded circulatory strain.[10] For sure, every 10 μg/m^3 expansion in SO_2 and PM_{10} was related with an increment of around 1.021 (95% CI 1.002, 1.040) and 1.012 (95% CI 1.002, 1.022) in ischemic heart disease and mortality, respectively.[40,27,28]

[3] have measured the public health effect of long-term exposure to $PM_{2.5}$ in terms of the attributable number of deaths and the likely addition in future in 23 European urban areas. Results show 16,926 unexpected deaths from all causes, including 11,612 and 1901 for cardiopulmonary deaths and lung-cancer deaths, respectively. These deaths would have been forestalled every year if long haul openness to $PM_{2.5}$ levels were diminished to 15 μg/m^3 in every city. Along these lines, this increase life expectancy at age 30 by a reach between multi month and over 2 years in the APHEIS cities.[39] concentrated on the adverse health impact related with PM_{10} exposure in certain areas in Poland, and they showed chronic sickness endpoints in contaminated industrial regions in the southern piece of Poland.

Specifically,[11] evaluated the results of $PM_{2.5}$ exposure and found that short-term exposure was the main health effects on 24,000 peoples of two Italian urban cities. That result showed that NO_2 and O_3 each caused excess three over cases of total mortality.[38] have anticipated hospital admissions respiratory diseases (HARD) cases because of exposure to particulate matter (PM) in Greater Cairo-Egypt during (2008-2009). The results referenced that the respiratory hospitalizations was 3.7% (95% CI 3.5 - 3.8%) at site-1, 4.0% (95% CI 4.0 - 4.1) at site-2, 4.0% (95% CI 4.1%) at site-3 and 4.1% (95% CI 4.1–4.2%) per 10 μg/m3 increment of PM. Thunis et al (2011) assessed, in Trieste city, the conceivable medical advantages by decrease exposure to PM10 to values not more than 10 , 20, 30, 40, 50, and 60 μg/m^3, utilizing PM10 data of the year 2002. They mentioned that rates were 1.8% (CI 95% 0.6%; 2.9%), 2.2% (CI 95% 0.6%; 3.7%), 2.5% (CI 95% 0; 7.3%), 1.5% (CI 95% 0.6; 2.4%), and 1.6% (CI 95% 0; 3.3%) for normal deaths, cardiovascular deaths, respiratory deaths, cardiovascular admissions, and respiratory admissions, respectively. Which were attributable to PM_{10} levels more than 20 μg/m^3.

Naddafi and colleagues in Tehran was analyzed NO_2, SO_2, O_3, and PM_{10} levels to evaluate exposure openness and health impacts in terms of attributable proportion of the health result, the annual number of excess mortality cases for all causes, and respiratory and cardiovascular diseases. The annual average levels of NO_2, SO_2, O_3, and PM_{10} were 85, 89.16, 68.82, and 90.58 μg/m^3, respectively. The short-term impacts of PM10 affected the 8,700,000 people, causing an excess of total mortality of 2194 out of 47,284 in a year. In contrast, NO_2, O_3, and SO_2 levels caused roughly 1050, 819, and 1458 excess cases of total mortality, respectively.[33,16] have mentioned that ambient PM exposure and health effects in two urban and industrial regions in Tabriz. The deaths related with $PM_{2.5}$, PM_{10}, and TSP levels were 360, 363, and 327, respectively; mortality because of respiratory disease was 67 (PM10) and 99 (TSP); and cardiovascular mortality for PM_{10} and TSP was 227 and 202, respectively.

In Iran,[18] have analyzed the relationship between SO_2, NO_2, and O_3 levels and hospitalizations for COPD among the inhabitant of Tabriz. They mentioned that for each 10 μg/m^3 increase in their levels, the risk of hospitalization increased by around 0.440, 0.38, and 0.58%, respectively.[31] have evaluate the impact of (hospitalization, chronic obstructive pulmonary disease, acute myocardial infarction, cardiovascular and respiratory mortality, and total mortality) caused by exposure to $PM_{2.5}$, PM_{10}, SO_2, NO_2, and O_3 contaminations on people's health of Mashhad city. Miri etal. found that for every 10 μg/m^3, a general risk rate of pollutant level for total mortality because of $PM_{2.5}$, PM_{10}, SO_2, NO_2, and O_3 was expanded by 1.5, 0.6, 0.4, 0.3, and 0.46%, respectively, and the attributable proportion of total mortality ascribed to these pollutants was 4.57, 4.24, 0.99, 2.21, 2.08, and 1.61% (CI 95%), respectively, of the total mortality (for the non-accident) that happened in the year of study[32] have predicted the hospital admissions respiratory diseases (HARD) cases due to exposure to SO_2 and NO_2 in two areas of Egypt during December 2015 - November 2016 by utilizing AirQ 2.2.3 model. Concentrations at the Ain Sokhna area were 19, 22 µg/m³ and at Shoubra El-Khaima area were 92, 78 µg/m3 for SO_2 and NO_2, respectively. These concentrations were less than the Egyptian guidelines (125 µg/m³ in urban and 150 µg/m³ in industrial for SO_2, 150 µg/m³ in urban and industrial for NO_2). Results mentioned that relative risks were 1.0330 (1.0246 - 1.0414) and 1.0229 (1.0171 - 1.0287) at the Ain Sokhna area while they were 1.0261 (1.0195 - 1.0327) and 1.0226 (1.0169 - 1.0283) at Shoubra El-Khaima area for SO_2 and NO_2, respectively. The highest cases of HARD were found in the Shoubra El-Khaima area; 234 cases at levels 120 - 129 µg/m³ of NO_2 and 311 cases at levels 120 - 129 µg/m³ of SO_2. While, in Ain Sokhna, HARD were 15 cases at levels 60 - 69 µg/m³ of NO_2 and18 cases at levels 50 - 59 µg/m3 of SO_2. Different studies utilizing Air Q models (softwares) have shown that predicted long-term and short term exposures caused by air contaminations ($PM_{2.5}$, PM_{10}, O_3, and NO_2) were recorded in tables 2, 3, 4, and 5.[25, 4, 22, 49]

Table 2 Studies on long-term PM2.5 exposure (Chen & Hoek (2020))

Exposure	Study	Me(di)an (µg/m³)	HR (95% CI)a
All non-accidental mortality	McDonnell et al. (2000)	59.2	1.09 (0.98–1.21)
	Enstrom (2005)	23.4	1.01 (0.99–1.03)
	Beelen et al. (2008)	28.3	1.06 (0.97–1.16)
	Hart et al. (2011)	14.1	1.10 (1.02–1.18)
	Puett et al. (2011)	17.8	0.86 (0.72–1.02)
	Lepeule et al. (2012)	15.9	1.14 (1.07–1.22)
	Carey et al. (2013)	12.9	1.11 (0.98–1.26)
	Beelen et al. (2014)	13.4	1.14 (1.03–1.27)
	Weichenthal et al. (2014)	9.5	0.95 (0.76–1.19)
	Bentayeb et al. (2015)	17	1.16 (0.98–1.36)
	Hart et al. (2015)	12	1.13 (1.05–1.22)
	Ostro et al. (2015)	17.9	1.01 (0.97–1.05)
	Tseng et al. (2015)	29.6	0.92 (0.72–1.17)
	Villeneuve et al. (2015)	9.5	1.12 (1.05–1.20)
	Pinault et al. (2016)	5.9	1.26 (1.19–1.34)
	Thurston et al. (2016a)	13.6	1.03 (1.01–1.06)
	Turner et al. (2016)	12.6	1.07 (1.06–1.09)
	Badaloni et al. (2017)	19.6	1.05 (1.02–1.08)
	Di et al. (2017a)	11.5	1.08 (1.08–1.09)
	Pinault et al. (2017)	7.1	1.18 (1.15–1.21)
	Yin et al. (2017)	40.7	1.09 (1.08–1.10)
	Bowe et al. (2018)	11.8	1.08 (1.03–1.13)
	Cakmak et al. (2018)	6.5	1.16 (1.08–1.25)
	Parker, Kravets & Vaidyanathan (2018)	11.8	1.03 (0.99–1.08)
	Yang et al.5	42.2	1.06 (1.01–1.10)
Circulatory mortality	Laden et al. (2006)	–	1.08 (0.79–1.48)
	Beelen et al. (2008)	28.3	1.07 (0.75–1.52)
	Hart et al. (2011)	14.1	1.05 (0.93–1.19)
	Carey et al. (2013)	12.9	1.00 (0.85–1.17)
	Vedal et al. (2013)	12.9	1.31 (0.94–1.83)
	Beelen et al. (2014)	13.4	0.98 (0.83–1.16)
	Weichenthal et al. (2014)	9.5	1.15 (0.76–1.73)
	Bentayeb et al. (2015)	17	1.21 (0.72–2.04)
	Crouse et al. (2015)	8.9	1.06 (1.04–1.08)
	Ostro et al. (2015)	17.9	1.05 (0.99–1.12)

Table Contined

Exposure	Study	Me(di)an (μg/m³)	HR (95% CI)a
	Tseng et al. (2015)	29.6	0.80 (0.43–1.49)
	Villeneuve et al. (2015)	9.5	1.32 (1.14–1.52)
	Pinault et al. (2016)	5.9	1.19 (1.07–1.31)
	Thurston et al. (2016a)	13.6	1.05 (0.98–1.13)
	Turner et al. (2016)	12.6	1.12 (1.09–1.15)
	Badaloni et al. (2017)	19.6	1.08 (1.03–1.12)
	Dehbi et al. (2017)	9.9	1.30 (0.39–4.34)
	Pinault et al. (2017)	7.1	1.25 (1.19–1.30)
	Yin et al. (2017)	40.7	1.09 (1.08–1.10)
	Parker, Kravets & Vaidyanathan (2018)	11.8	1.16 (1.08–1.25)
	Yang et al. (2018)	42.2	1.02 (0.93–1.11)
Non-malignant respiratory mortality	McDonnell et al. (2000)	59.2	1.23 (0.97–1.55)
	Laden et al. (2006)	14.8	1.08 (0.79–1.48)
	Beelen et al. (2008)	28.3	1.04 (0.90–1.21)
	Hart et al. (2011)	14.1	1.18 (0.91–1.53)
	Katanoda et al. (2011)	30.5	1.16 (1.04–1.30)
	Carey et al. (2013)	12.9	1.57 (1.30–1.91)
	Cesaroni et al. (2013)	23	1.03 (0.98–1.08)
	Dimakopoulou et al. (2014)	13.4	0.79 (0.47–1.34)
	Bentayeb et al. (2015)	17	0.88 (0.57–1.36)
	Crouse et al. (2015)	8.9	0.95 (0.91–0.98)
	Ostro et al. (2015)	17.9	0.99 (0.90–1.09)
	Villeneuve et al. (2015)	9.5	0.82 (0.61–1.11)
	Pinault et al. (2016)	5.9	1.52 (1.26–1.84)
	Thurston et al. (2016a)	13.6	1.10 (1.05–1.15)
	Turner et al. (2016)	12.6	1.16 (1.10–1.22)
	Pinault et al. (2017)	7.1	1.22 (1.12–1.32)
	Yang et al. (2018)	42.2	1.11 (1.04–1.19)
Lung cancer mortality	McDonnell et al. (2000)	59.2	1.39 (0.79–2.46)
	Beelen et al. (2008)	28.3	1.06 (0.82–1.38)
	Hart et al. (2011)	14.1	1.05 (0.88–1.26)
	Katanoda et al. (2011)	30.5	1.24 (1.12–1.37)
	Lipsett et al. (2011)	–	0.95 (0.70–1.28)
	Lepeule et al. (2012)	15.9	1.37 (1.07–1.75)
	Carey et al. (2013)	12.9	1.11 (0.86–1.44)
	Cesaroni et al. (2013)	23	1.05 (1.01–1.10)
	Weichenthal et al. (2014)	9.5	0.75 (0.34–1.65)
	Villeneuve et al. (2015)	9.5	0.97 (0.80–1.18)
	Pinault et al. (2016)	5.9	1.17 (0.98–1.40)
	Turner et al. (2016)	12.6	1.09 (1.03–1.16)
	Pinault et al. (2017)	7.1	1.16 (1.07–1.25)
	Yin et al. (2017)	40.7	1.12 (1.09–1.16)
	Cakmak et al. (2018)	6.5	1.29 (1.06–1.59)

[a]Per 10 μg/m³.

Table 3 Studies on long-term PM_{10} exposure (Chen & Hoek (2020))

Exposure	Study	Me(di)an (µg/m3)	HR (95% CI)a
All non-accidental mortality	Dockery et al. (1993)	28.9	1.09 (1.03–1.15)
	Abbey et al. (1999)	51.2	1.01 (0.94–1.08)
	Puett et al. (2008)	21.6	1.16 (1.05–1.28)
	Hart et al. (2011)	26.8	1.07 (1.02–1.11)
	Lipsett et al. (2011)	29.2	1.00 (0.97–1.04)
	Puett et al. (2011)	27.9	0.92 (0.84–0.99)
	Ueda et al. (2012)	34.9	0.98 (0.92–1.04)
	Carey et al. (2013)	19.7	1.07 (1.00–1.14)
	Heinrich et al. (2013)	43.7	1.22 (1.06–1.41)
	Beelen et al. (2014)	20.9	1.04 (1.00–1.09)
	Zhou et al. (2014)	104	1.02 (1.01–1.03)
	Bentayeb et al. (2015)	25	1.18 (1.06–1.32)
	Fischer et al. (2015)	29	1.08 (1.07–1.09)
	Chen et al. (2016)	144	1.01 (1.01–1.01)
	Hansell et al. (2016)	20.7	1.24 (1.15–1.32)
	Badaloni et al. (2017)	36.6	1.02 (1.01–1.03)
	Kim, Kim & Kim (2017)	56	1.05 (0.99–1.11)

Table 4 Studies on long-term ozone (O3) exposure (Huangfu & Atkinson (2020))

Exposure	Study	Me(di)an (µg/m3)	HR (95% CI)a
All non-accidental mortality	Lipfert et al. (2006)	173.4	1.0000 (0.990–1.020)
	Lipsett et al. (2011)	96.2	0.9900 (0.990–1.000)
	Bentayeb et al. (2015)	101	0.9800 (0.900–1.060)
	Turner et al. (2016)	94.2	1.0100 (1.010–1.015)
	Di et al. (2017a)	90	1.0115 (1.011–1.012)
	Weichenthal, Pinault & Burnett (2017)	76.6	1.0290 (1.024–1.033)
	Cakmak et al. (2018)	78.4	1.0400 (1.010–1.070)
	Brauer et al. (2019)	72	1.036 (1.034–1.036)
	Lim et al. (2019)	92.4	1.000 (0.995–1.005)
	Lefler et al. (2019)	94.9	1.016 (1.010–1.022)
	Kazemiparkouhi et al. (2020)	110	1.006 (1.006–1.007)
Respiratory mortality	Lipsett et al. (2011)	96.2	1.02 (0.990–1.040)
	Crouse et al. (2015)	78	0.985 (0.975–0.994)
	Turner et al. (2016)	94.2	1.05 (1.035–1.060)
	Weichenthal, Pinault & Burnett (2017)	76.6	1.020 (1.006–1.035)
	Lim et al. (2019)	92.4	1.040 (1.020–1.060)
	Kazemiparkouhi et al. (2020)	110	1.018 (1.016–1.020)

Table 5 Studies on long-term nitrogen dioxide (NO2) exposure (Huangfu & Atkinson (2020))

Exposure	**Study**	**Me(di)an (μg/m3)**	**HR (95% CI)a**
All non-accidental mortality	Abbey et al. (1999)	69.2	1.00 (0.99–1.01)
	Krewski et al. (2003)	30.3	1.08 (1.02–1.14)
	Filleul et al. (2005)	36.5	1.14 (1.03–1.26)
	Lipfert et al. (2006)	37.2	1.03 (0.99–1.07)
	Rosenlund et al. (2008)	48.5	0.95 (0.89–1.02)
	Brunekreef et al. (2009)	38	1.03 (1.00–1.05)
	Jerrett et al. (2009)	39.1	1.23 (1.00–1.51)
	Hart et al. (2011)	26.7	1.05 (1.02–1.08)
	Lipsett et al. (2011)	63.1	0.98 (0.95–1.02)
	Carey et al. (2013)	22.5	1.02 (1.00–1.05)
	Cesaroni et al. (2013)	43.6	1.03 (1.02–1.04)
	Hart et al. (2013)	26.1	1.01 (1.00–1.03)
	Tonne & Wilkinson (2013)	18.5	1.01 (0.98–1.04)
	Yorifuji et al. (2013)	22	1.12 (1.07–1.18)
	Beelen et al. (2014)	22.2	1.01 (0.99–1.03)
	Bentayeb et al. (2015)	28	1.07 (1.00–1.15)
	Crouse et al. (2015)	21.8	1.03 (1.03–1.04)
	Fischer et al. (2015)	31	1.03 (1.02–1.04)
	Chen et al. (2016)	40.7	0.92 (0.90–0.95)
	Desikan et al. (2016)	44.6	0.94 (0.76–1.17)
	Hartiala et al. (2016)	35.9	1.00 (0.75–1.34)
	Turner et al. (2016)	21.8	1.02 (1.01–1.03)
	Weichenthal, Pinault & Burnett (2017)	21.6	1.04 (1.03–1.04)
	Yang et al. (2018)	104	1.00 (0.99–1.01)
	Brauer et al. (2019	16.2	1.004 (1.002–1.007)
	Dirgawati et al. (2019)	13.4	1.060 (1.000–1.120)
	Hanigan et al. (2019)	17.8	1.060 (0.960–1.140)
	Hvidtfeldt et al. (2019)	25	1.070 (1.040–1.100)
	Lefler et al. (2019)	20.1	1.010 (1.002–1.017)
	Eum et al. (2019)	26.7	1.027 (1.027–1.029)
	Klompmaker et al. (2020)	23.1	0.990 (0.960–1.010)
Respiratory mortality	Abbey et al. (1999)	69.2	0.99 (0.98–1.01)

Table Continued

Exposure	Study	Me(di)an (μg/m3)	HR (95% CI)a
	Brunekreef et al. (2009)	38	1.11 (1.00–1.23)
	Jerrett et al. (2009)	39.1	1.08 (0.64–1.84)
	Hart et al. (2011)	26.7	1.04 (0.95–1.14)
	Katanoda et al. (2011)	32	1.07 (1.03–1.12)
	Lipsett et al. (2011)	63.1	0.96 (0.86–1.08)
	Carey et al. (2013)	22.5	1.08 (1.04–1.13)
	Cesaroni et al. (2013)	43.6	1.03 (1.00–1.06)
	Yorifuji et al. (2013)	22	1.19 (1.06–1.34)
	Dimakopoulou et al. (2014)	22.2	0.97 (0.89–1.04)
	Crouse et al. (2015)	21.8	1.02 (1.01–1.04)
	Fischer et al. (2015)	31	1.02 (1.01–1.03)
	Turner et al. (2016)	21.8	1.02 (1.00–1.04)
	Weichenthal, Pinault & Burnett (2017)	21.6	1.06 (1.04–1.08)
	Yang et al. (2018)	104	1.00 (0.97–1.02)
	Eum et al. (2019)	26.7	1.027 (1.027–1.029)
	Hvidtfeldt et al. (2019)	25	1.070 (1.040–1.100)
	Klompmaker et al. (2020)	23.1	0.990 (0.960–1.010)

Conclusion

This review highlights that air pollution is still a critical public health issue and that further studies for a better correlation of air quality and population health are required. The AirQ models (software) are intended for exposure assessment, assess the health risks (such as total mortality, cardiovascular mortality, respiratory mortality, respiratory disease morbidity, and cardiovascular disease), and epidemiological.

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Conflicts of interest

The author declares there is no conflict of interest.

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