PREMATURE DEATHS AND INCIDENCE OF CARDIO-VASCULAR DISEASES RESULTS OF THE EP-PARTICLES STUDY

POLISH SMOG
EP-PARTICLES STUDY

ŁUKASZ KUŹMA
Department od Invasive Cardiology
Medical University of Bialystok
Bialystok, Poland

NCT: #05198492
www.polishsmog.com

CONFLICT OF INTEREST
None declared

MEDICAL UNIVERSITY OF BIALYSTOK
1950

FOUNDING
National Science Center, Poland
Grant number UMO-2021/41/B/ NZ7/03716
Medical University of Bialystok, Poland
Grant number UMB-B.SUB.23.509/290/102

23-11-2023

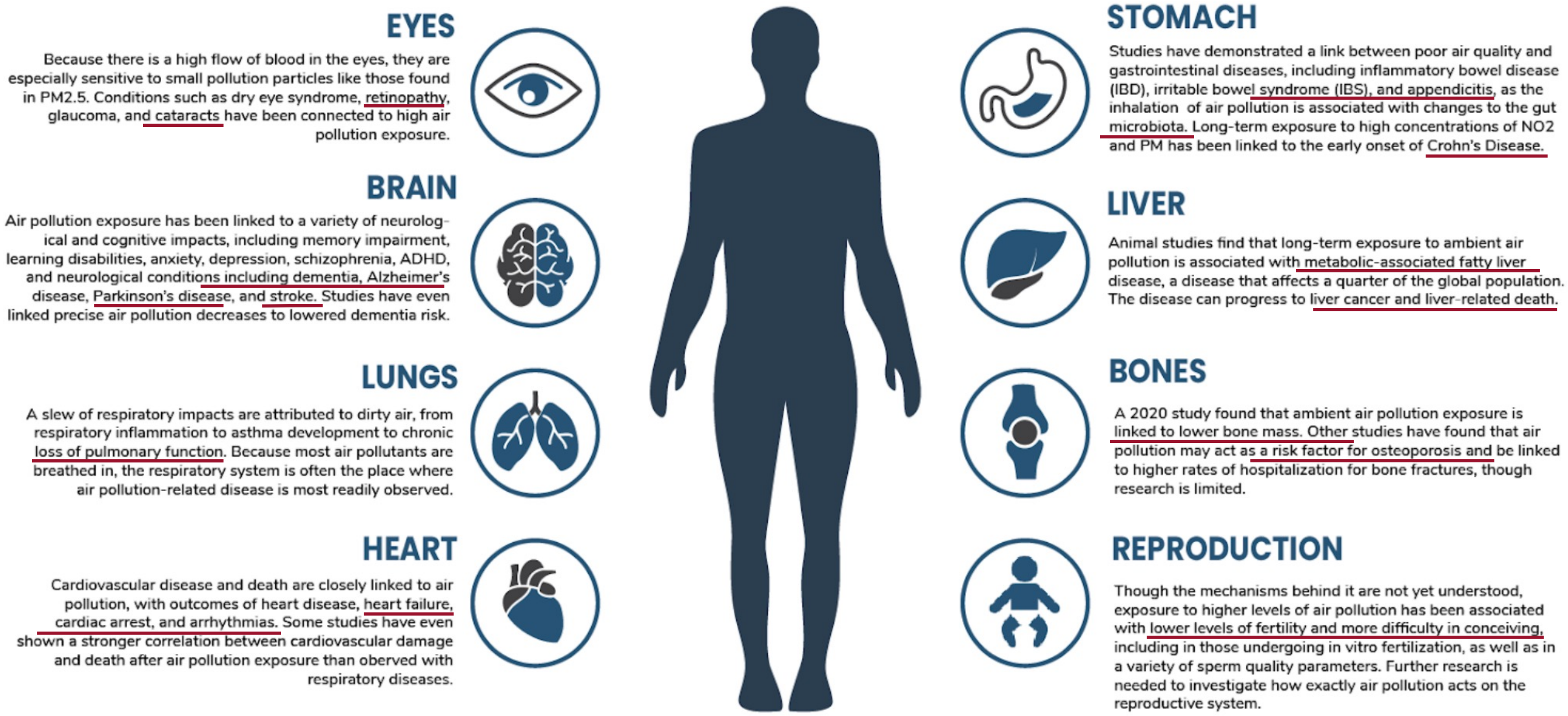
The Ella Roberta Foundation

"A life cut short. On 15th February 2013, just three weeks after her ninth birthday, Ella died of a fatal asthma attack contributed to by exposure to excessive air pollution."

CORONER'S RECOMMENDATIONS

1. National air pollution limits should be in line with WHO guidelines.
2. Raise awareness of the dangers of air pollution amongst the general public.
3. Ensure health professionals are aware of the dangers of air pollution, and that they tell their patients about it.

POLISH SMOG
EP-PARTICLES STUDY

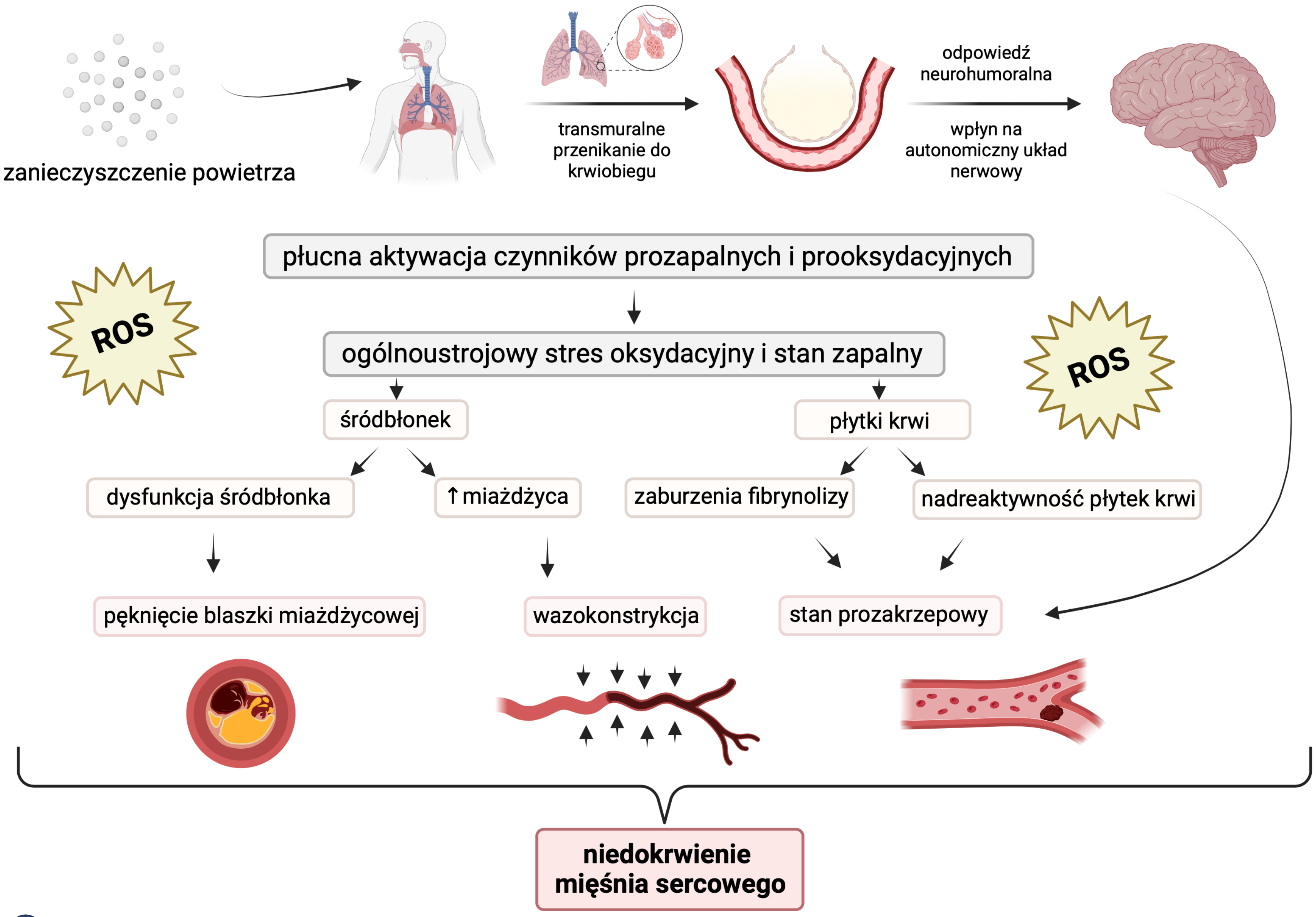


Zanieczyszczenie powietrza powoduje:

ponad **8 milionów** dodatkowych **zgonów rocznie** na całym świecie

globalną średnią utratę **oczekiwanej długości życia** wynoszącą **2,9 roku**

Źródło: https://www.clarity.io/blog/deep-dive-health-impacts-of-air-pollution



Grafika 1. Potencjalne patomechanizmy wpływu zanieczyszczeń powietrza

International Journal of Hygiene and Environmental Health

Exposure to air pollution—a trigger for myocardial infarction? A nine-year study in Bialystok—the capital of the Green Lungs of Poland (BIA-ACS registry)

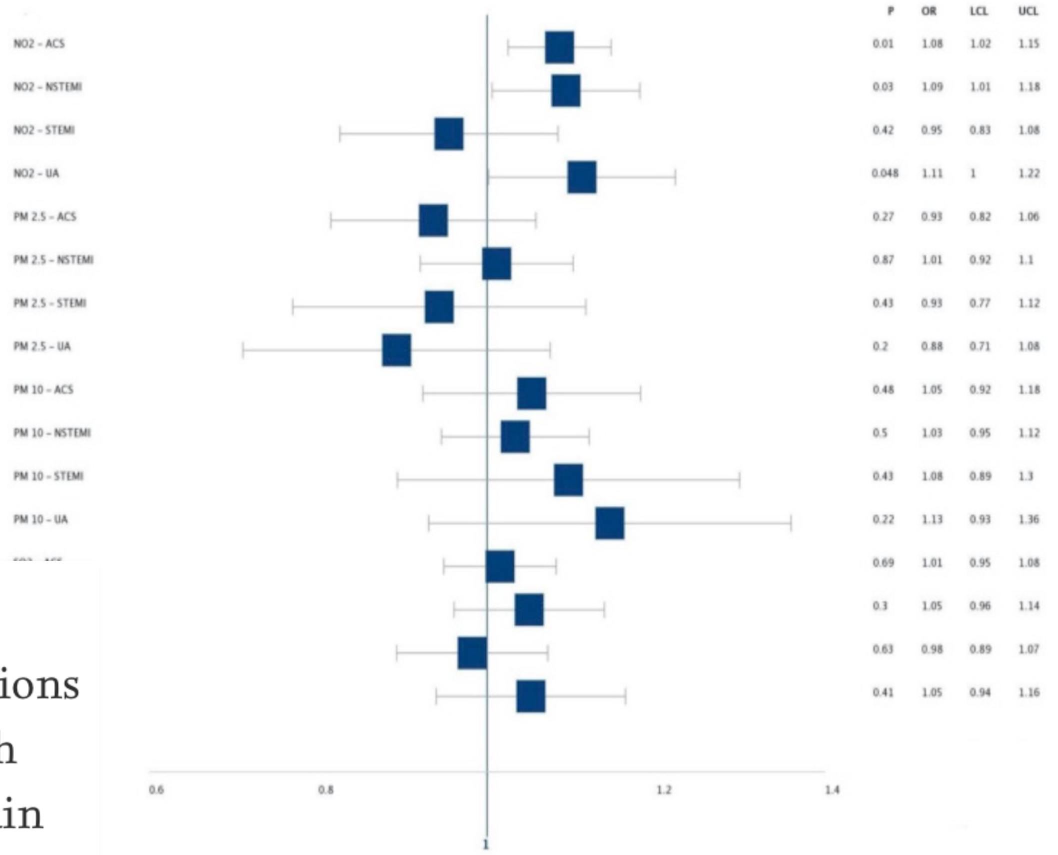
Łukasz Kuźma [a], Szymon Pogorzelski [a], Krzysztof Struniawski [a], Hanna Bachórzewska-Gajewska [a, b], Sławomir Dobrzycki [a]

[a] Department of Invasive Cardiology, Medical University of Bialystok, The Medical University of Bialystok Clinical Hospital, ul. M. Skłodowskiej-Curie 24 A, 15-276, Bialystok, Poland

[b] Department of Clinical Medicine, Medical University of Bialystok, ul. Szpitalna 37, 15-254, Bialystok, Poland

Conclusion

The study showed that the effects of air pollution and weather conditions on the number of ACS hospitalizations are also observed in cities with moderately polluted or good air quality. NO_2 was identified as the main air pollutant affecting the incidence of ACS.



Article

Gender Differences in Association between Air Pollution and Daily Mortality in the Capital of the Green Lungs of Poland–Population-Based Study with 2,953,000 Person-Years of Follow-Up

Journal of Clinical Medicine

Łukasz Kuźma [1,*], Krzysztof Struniawski [1], Szymon Pogorzelski [1], Hanna Bachórzewska-Gajewska [1,2] and Sławomir Dobrzycki [1]

1 Department of Invasive Cardiology, Medical University of Bialystok, 15-276 Bialystok, Poland; kstruniawski@gmail.com (K.S.); szymonpogo@gmail.com (S.P.); hgajewska@op.pl (H.B.-G.); kki@umb.edu.pl (S.D.)

2 Department of Clinical Medicine, Medical University of Bialystok, 15-276 Bialystok, Polan

* Correspondence: kuzma.lukasz@gmail.com; Tel.: +48-85-746-8496; Fax: +48-85-746-8828

Received: 7 June 2020; Accepted: 21 July 2020; Published: 23 July 2020

Variables	RR	Lower 95% CI for RR	Upper 95% CI for RR	*p*
NO_2 µg/m^3 * + Meteorological parameters	0.99	0.96	1.04	0.96
SO_2 µg/m^3 * + Meteorological parameters	1.10	1.04	1.17	0.002
PM2.5 µg/m^3 ** + Meteorological parameters	1.03	0.99	1.06	0.13
PM10 µg/m^3 ** + Meteorological parameters	0.99	0.96	1.03	0.99
Temp. °C ***	1.01	0.99	1.04	0.29
Variables	**RR**	**Lower 95% CI for RR**	**Upper 95% CI for RR**	***p***
NO_2 µg/m^3 * + Meteorological parameters	1.02	0.97	1.07	0.40
SO_2 µg/m^3 * + Meteorological parameters	1.02	1.00	1.04	0.08
PM2.5 µg/m^3 ** + Meteorological parameters	1.07	1.02	1.12	0.01
PM10 µg/m^3 ** + Meteorological parameters	0.95	0.90	1.01	0.60
Temp. °C ***	1.02	0.98	1.07	0.25

Variables	RR	Lower 95% CI for RR	Upper 95% CI for RR	*p*
NO_2 µg/m^3 * + Meteorological parameters	0.98	0.94	1.03	0.31
SO_2 µg/m^3 * + Meteorological parameters	1.05	1.01	1.10	0.009
PM2.5 µg/m^3 ** + Meteorological parameters	0.99	0.96	1.03	0.73
PM10 µg/m^3 ** + Meteorological parameters	1.03	0.98	1.07	0.17
Temp. °C ***	1.04	1.02	1.07	0.003
Variables	**RR**	**Lower 95% CI for RR**	**Upper 95% CI for RR**	***p***
NO_2 µg/m^3 * + Meteorological parameters	0.99	0.93	1.05	0.69
SO_2 µg/m^3 * + Meteorological parameters	1.02	0.99	1.05	0.19
PM2.5 µg/m^3 ** + Meteorological parameters	1.00	0.95	1.05	0.86
PM10 µg/m^3 ** + Meteorological parameters	1.03	0.97	1.09	0.36
Temp. °C ***	1.08	1.04	1.13	<0.001

Conclusions

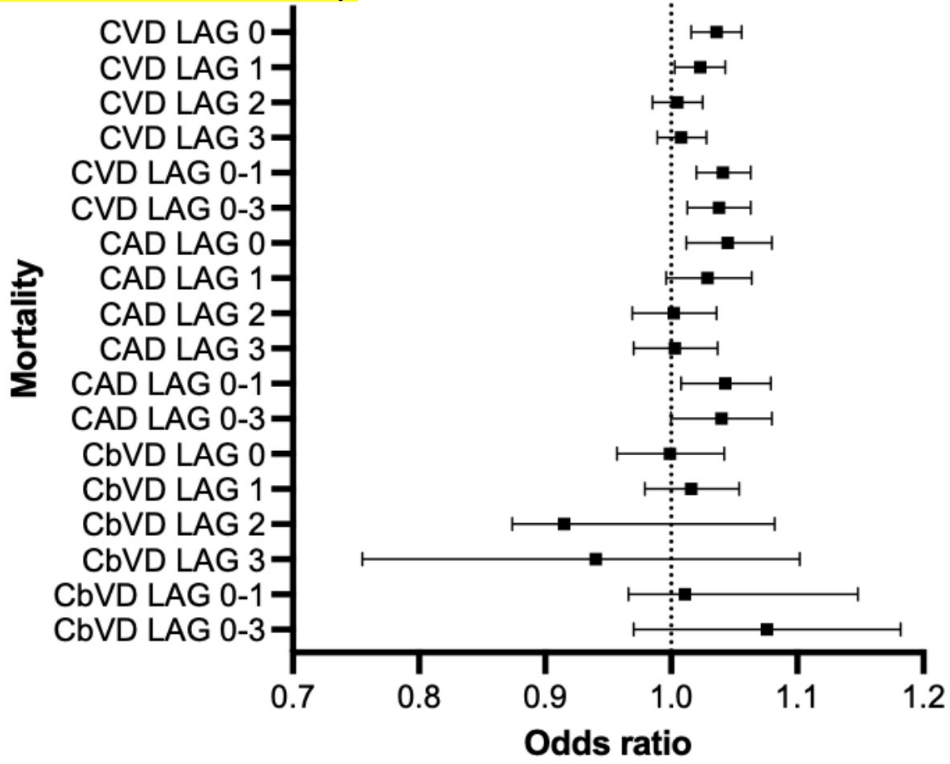
1. Air quality and atmospheric conditions had an impact on the mortality of Bialystok residents.
2. The main air pollutant that influenced the mortality rate was SO_2, and there were no gender differences in the impact of this pollutant. In the male population, an increased exposure to PM2.5 concentration was associated with significantly higher cardiovascular mortality.

Association between air pollution and case-specific mortality in north-eastern part of Poland. Case-crossover study with 4,500,000 person-years of follow-up (PL-PARTICLES study)

Objectives: To assess the short-term impact of air pollution on cardiovascular (CVD)-, coronary artery-related (CAD)-, and cerebrovascular-related (CbVD) mortality.

Patients and methods: The analysis with 4,500,000 person-years of follow-up with a time-stratified case-crossover design was performed.

Results: The interquartile range (IQR) increase in $PM_{2.5}$ (OR 1.036, 95%CI 1.016–1.056,P<0.001) and PM_{10} concentration (OR 1.034, 95%CI 1.015–1.053,P<0.001) was associated with increased CVD mortality on lag 0 and this effect persisted on following days. The effects of PMs were more expressed in association with CAD-related mortality (OR for $PM_{2.5}$=1.045, 95%CI 1.012–1.080,P=0.008), (OR for PM_{10}=1.044, 95%CI 1.010–1.078,P=0.011). Additionally, IQR increase in NO_2 concentration was associated with increased CAD-related mortality at lag 0-1 (OR=1.055, 95%CI .1.004–1.108,P=0.032).



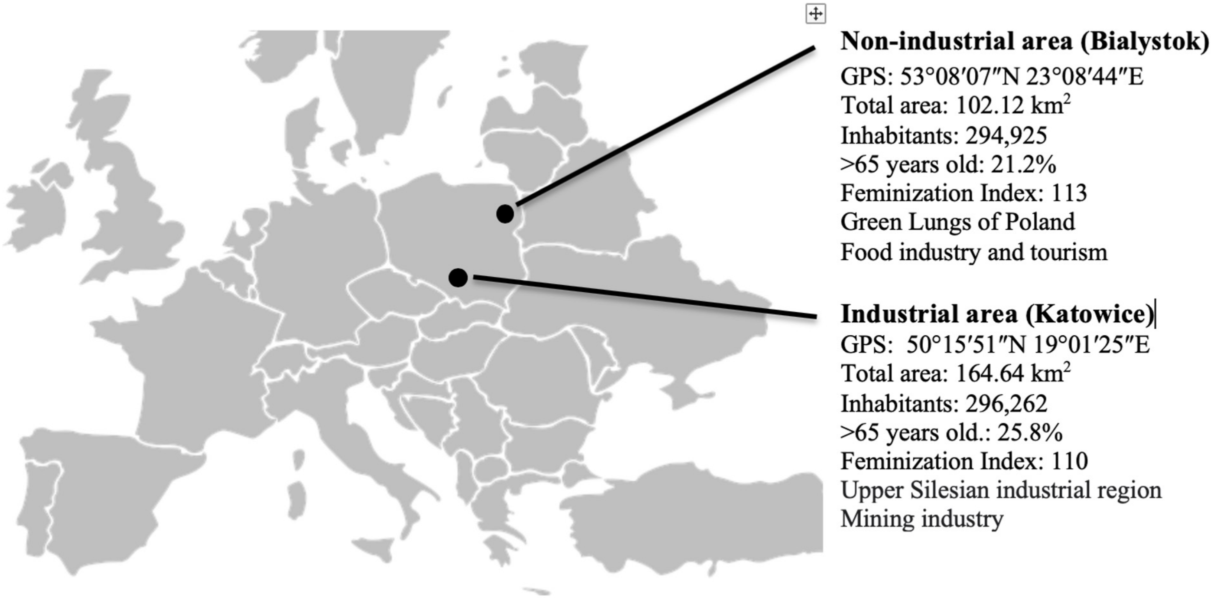
Conclusions: The impact of PMs on CVD mortality is also observed in moderately polluted areas. This adverse health effect was more apparent in CAD mortality. Differences in effect size and seasonality may depend on the source of air pollution.

ELSEVIER

Environmental Research
Volume 197, June 2021, 111154

Impact of short-term air pollution exposure on acute coronary syndrome in two cohorts of industrial and non-industrial areas: A time series regression with 6,000,000 person-years of follow-up (ACS - Air Pollution Study)

Łukasz Kuźma [a], Wojciech Wańha [b], Paweł Kralisz [a], Maciej Kazmierski [b], Hanna Bachórzewska-Gajewska [a], Wojciech Wojakowski [b], Sławomir Dobrzycki [a]



6,000,000 person - years

Data on hospitalization for ACS from 2008 to 2017 was obtained and extracted from the National Health Fund reports. We used data from patients registered as residents in the city of Bialystok – non industrial area and Katowice city - industrial area. The limit of the daily mean value for $PM_{2.5}$ according to the WHO guidelines was exceeded on 45.2% days in industrial area and on 24.9% days in non-industrial area. The daily WHO upper limit for PM_{10} was exceeded on 27.6% days in industrial area and on 9.1% days in non-industrial area. The WHO limit for SO_2 was exceeded sporadically in non-industrial area (0.4%) and on 18.4% days in industrial area.

NATURE

scientific reports

Exposure to Air Pollution and Renal Function - An Underestimated Threat?

Łukasz Kuźma (kuzma.lukasz@gmail.com)

Department of Invasive Cardiology, Medical University of Bialystok, ul. M. Skłodowskiej-Curie 24 A, 15-276 Białystok

Jolanta Małyszko

Medical University of Warsaw

Hanna Bachórzewska- Gajewska

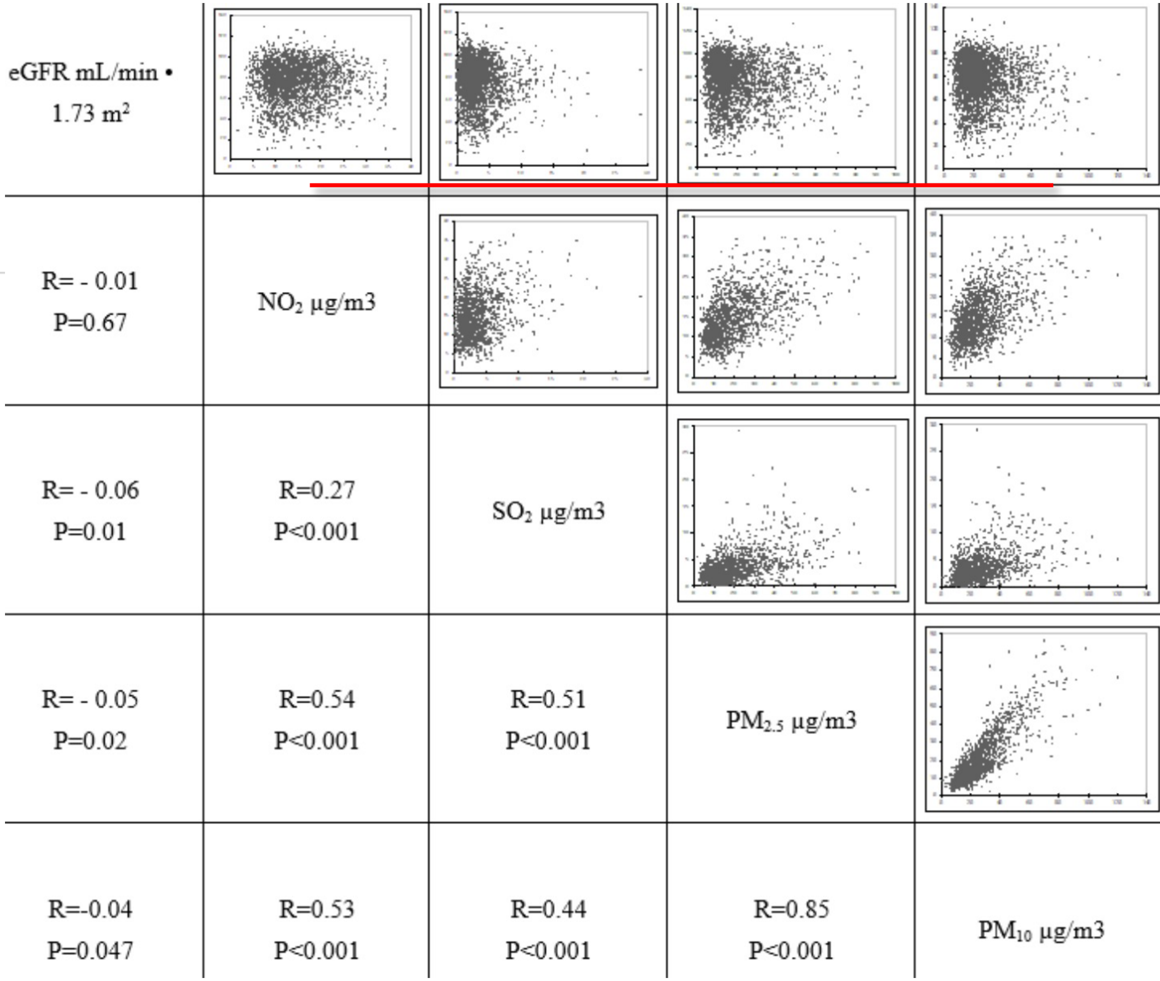
Medical University of Białystok

Sławomir Dobrzycki

Medical University of Białystok

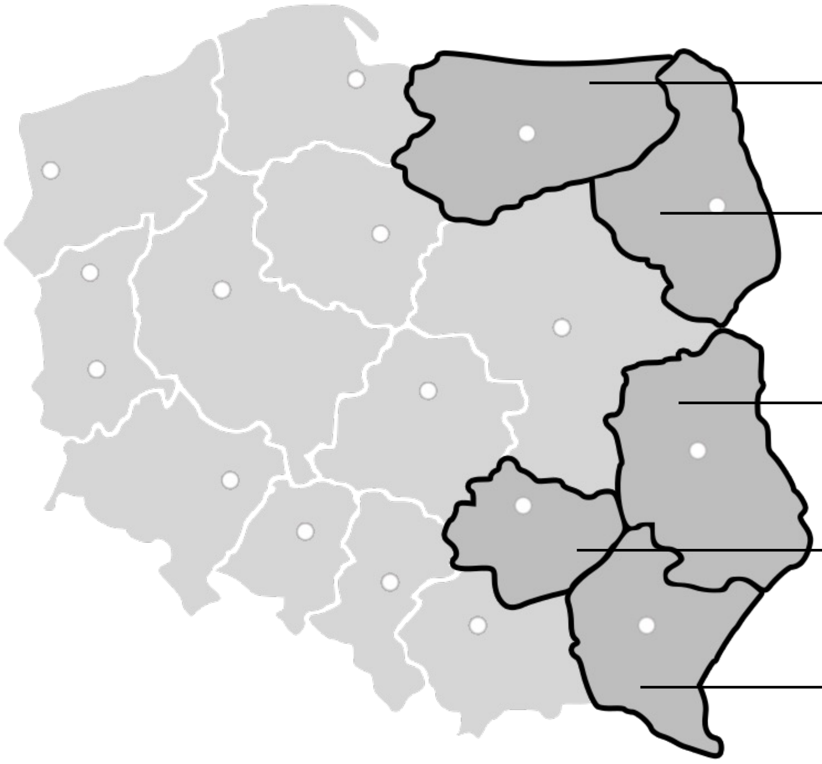
Results: 3,554 patients were included into the final analysis. The median age was 66 (IQR 15) and men were in the majority (53.2%, N=1891). Chronic kidney disease (CKD) was diagnosed in 21.5% (N=764). The long-term increase in annual average concertation of $PM_{2.5}$ (OR for IQR increase=1.07; 95% CI 1.01 – 1.15, P=0.037) and NO_2 (OR for IQR increase=1.05;95% CI 1.01 – 1.10, P=0.047) resulted in an increased number of patients with CKD. In short-term observation the IQR increase in weekly $PM_{2.5}$ concentration was associated with a 2% reduction in eGFR (OR=0.98, 95%CI 0.97 – 0.99, P=0.03)

Conclusions: The effects of air pollution on renal function were observed. Long- and short–term exposure to elevated air pollution levels was associated with a decrease in eGFR. The main pollutant affecting the kidneys was $PM_{2.5}$.



Projekt badania

POLISH SMOG
EP-PARTICLES STUDY



Zgony N=831 246
Zgony **CVD** N=**377 344** (45,5%)

Hospitalizacje CVD N=2 141 213
139 697 przypadków ACS (45,2% STEMI)

Analiza statystyczna
na poziomie gmin dla wzrostu o 10 μg/m^3 stężeń zanieczyszczeń

analiza czasowo-przestrzenna

I etap
Oszacowanie wpływu zanieczyszenia powietrza w poszczególnych powiatów przy użyciu uogólnionych modeli addytywnych z regresją Poissona. W analize uwzględniono wpływ dnia tygodnia, świąt państwowych, okresów epidemii grypy i SARS-CoV-2 oraz naturalne splajny z 6 stopniami swobody (df) dla 0-1-dniowej średniej ruchomej temperatury i 0-6 średnich ruchomych i 3 df dla wilgotności względnej i ciśnienia atmosferycznego, tendencje sezonowe, naturalny splajn z 6 df na rok),

II etap
Metaanaliza z zastosowaniem efektów losowych
Heterogeniczność między gminami określono ilościowo za pomocą statystyki I2.

Projekt został sfinansowany ze środków **Narodowego Centrum Nauki** przyznanych na podstawie umowy nr UMO-2021/41/B/NZ7/03716.

EP-PARTICLES COHORT

POLISH SMOG
EP-PARTICLES STUDY

Observation years: 2011- 2020

Main outcomes

3,141,213 hospitalizations due to CVD

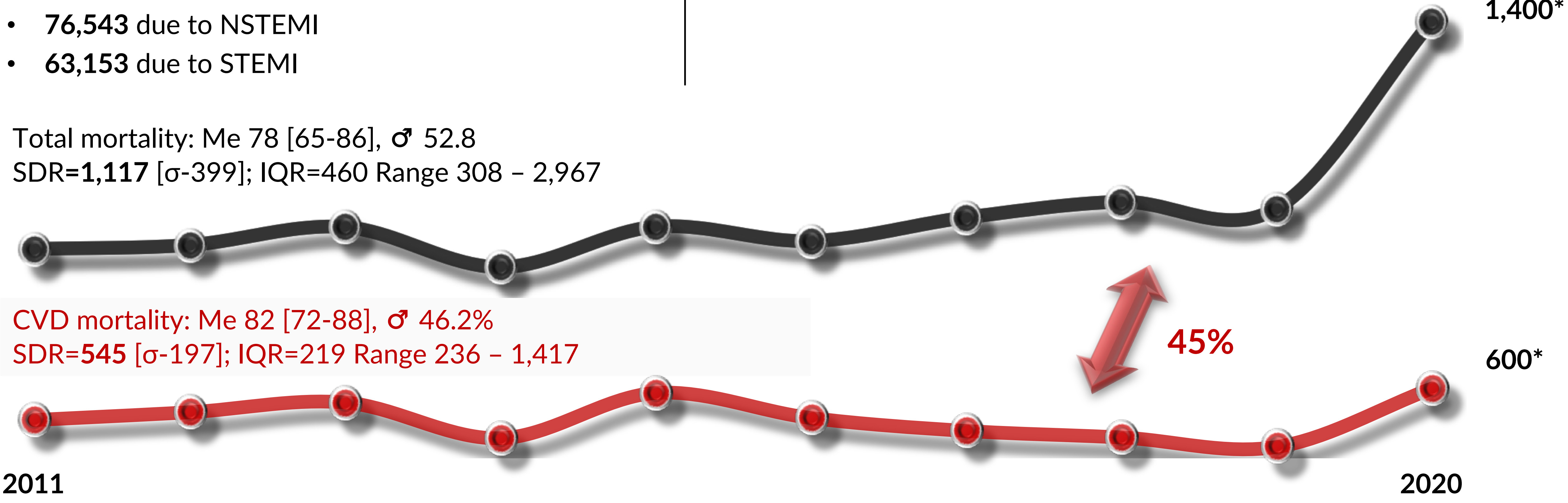
- **822,144** due to HF
- **252,566** due to AF
- **146,262** due to IS
- **76,543** due to NSTEMI
- **63,153** due to STEMI

831,246 recorded deaths

- **377,344** due to CVD
- **83,031** due to ACS
- **61,166** due to CVbD

Total mortality: Me 78 [65-86], ♂ 52.8
SDR=**1,117** [σ-399]; IQR=460 Range 308 – 2,967

CVD mortality: Me 82 [72-88], ♂ 46.2%
SDR=**545** [σ-197]; IQR=219 Range 236 – 1,417



*Age standardized death rate /100,000 population/year – based on European Standard Population (ESP) structure

EP-PARTICLES COHORT

POLISH SMOG
EP-PARTICLES STUDY

Observation years: 2011- 2020

Aggregated at NUTS3

	GDP	Mean age	Fem index	BMI >25	Tobacco use	Alcohol use*	HT**	DM**	ESRD**
Poland	**50,050**	**42.1**	**108**	**53%**	**29.1%**	**74.7%**	**315**	**86.4**	**74.1**
Lubelskie	31,000	39.8	107	45.9%	27%	71%	**342**	**87.2**	74.2
Podkarpackie	33,417	41.6	104	52%	23.7%	71.4%	314	82.5	73.1
Podlaskie	32,547	42.3	110	44.%	**31%**	**77%**	291	89	82.4
Świętokrzyskie	33,229	42.5	105	**54.8%**	25%	71%	323	90.6	**83.3**
Warmińsko-mazurskie	29,312	41.8	104.2	46.2%	28%	74%	296	78.9	57.5
	P=0.48	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001

* more than one time per week
**per /1,000 population

Combined data from National Health Found Reports/Central Statistical Office

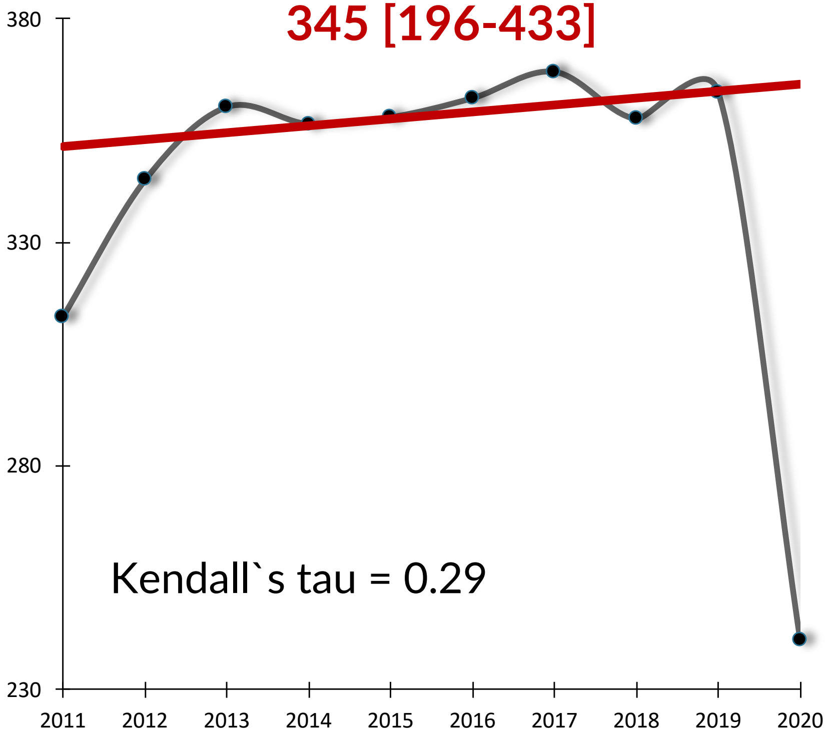
Abbreviations: ESRD, end-stage renal disease; DM, diabetes mellitus; HT, hypertension

EP-PARTICLES COHORT

Time trends (aggregated at LAU 2)

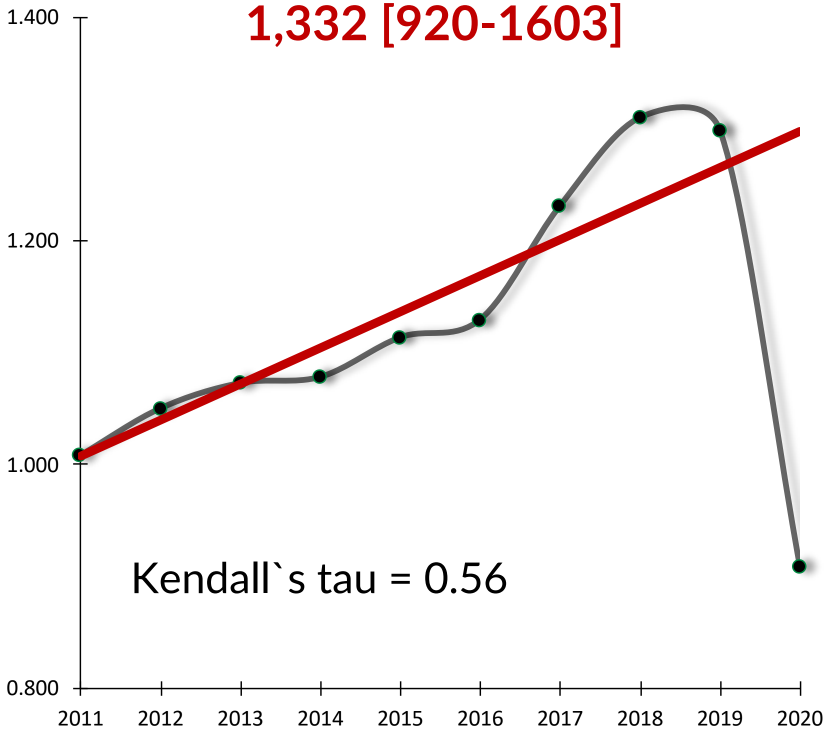
POLISH SMOG
EP-PARTICLES STUDY

Atrial fibrillation
345 [196-433]



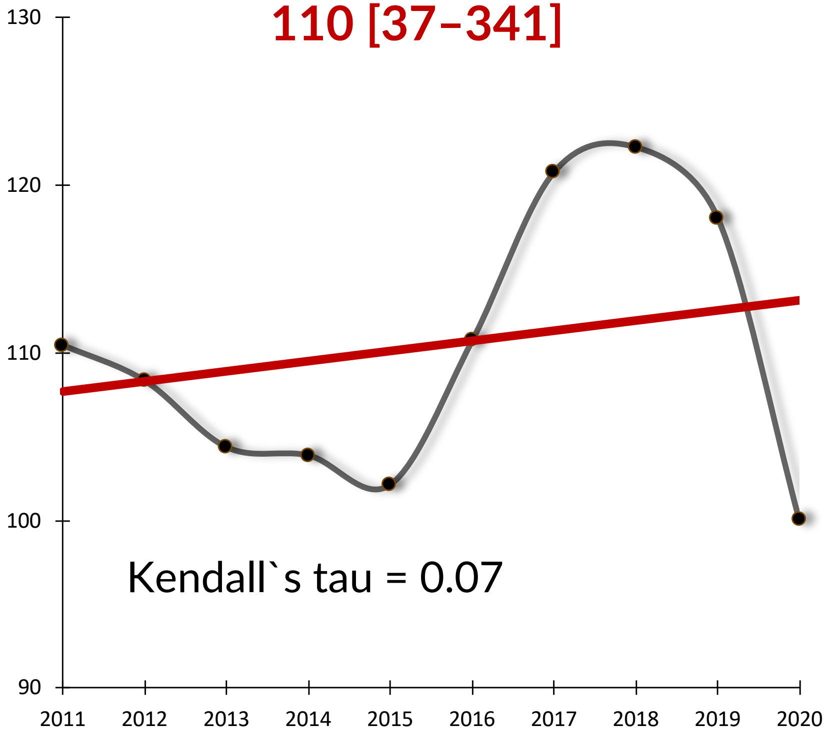
Sen`s slope:
1.54 (-2.33 – 5.07)
P=0.29

Heart Failure
1,332 [920-1603]



Sen`s slope:
0.03 (0.01 – 0..04)
P=0.03

NSTEMI
110 [37–341]

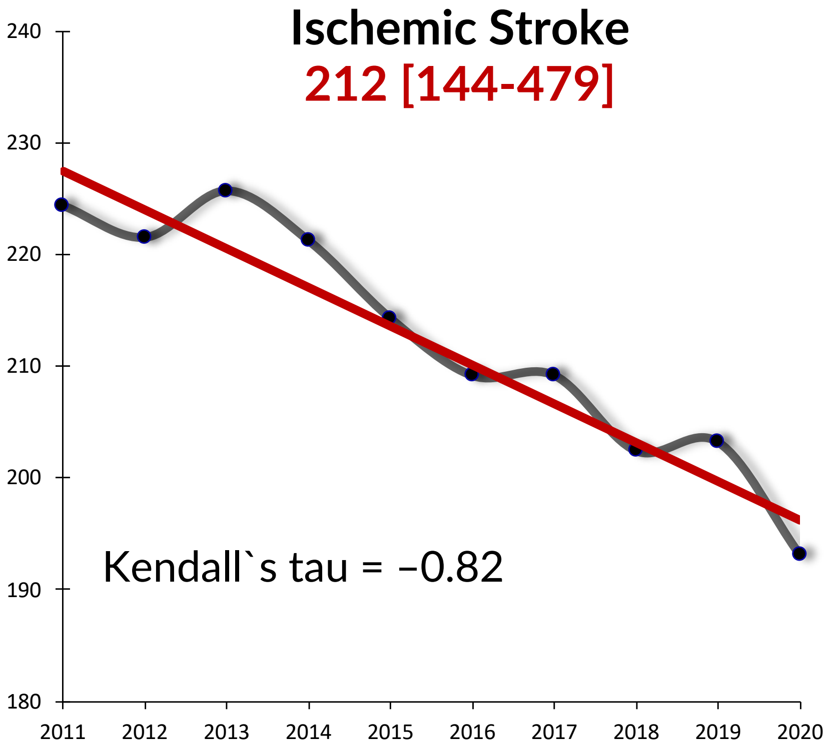


Sen`s slope:
0.6 (-2.06 – 2.49)
P=0.86

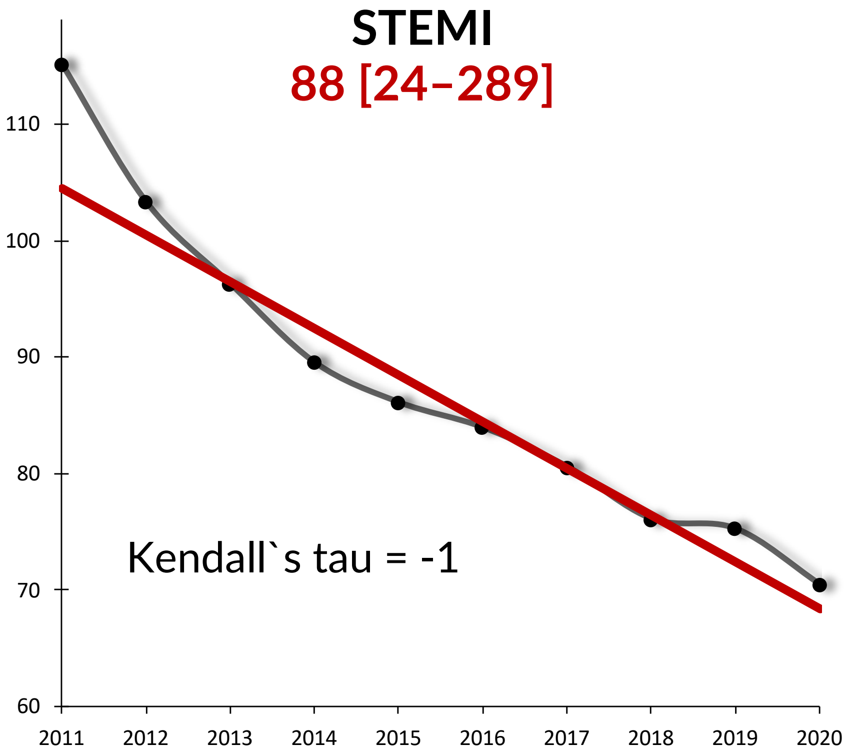
*Age standardized rate /100,000 population/year – based on European Standard Population (ESP) structure

EP-PARTICLES COHORT

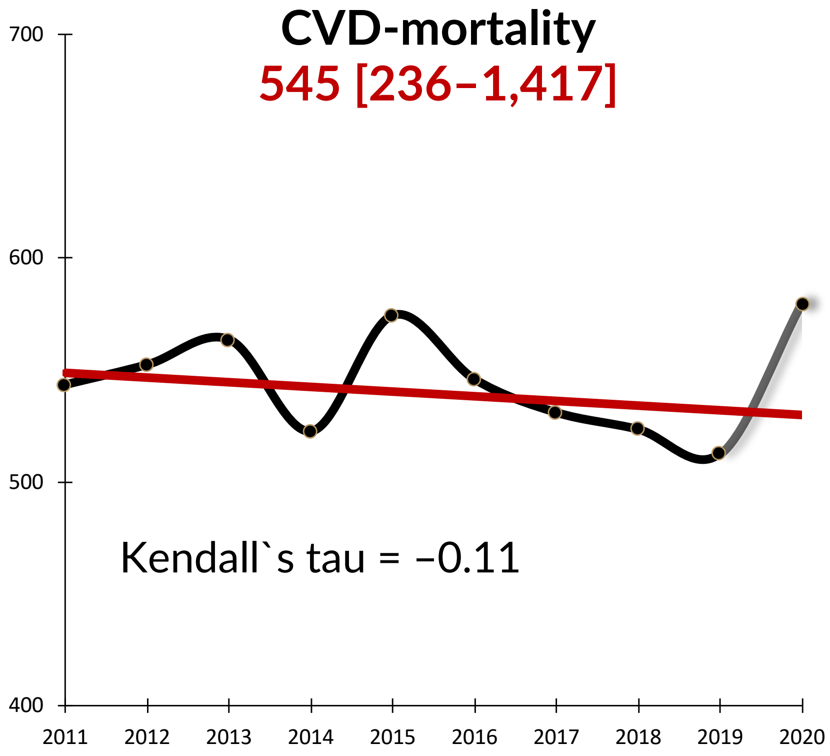
Time trends (aggregated at LAU 2)



Sen`s slope:
-3.47 (-4.65 – -2.62)
P<0.001



Sen`s slope:
-4.01 (-5.08 – -3.33)
P<0.001



Sen`s slope:
-2.09 (-8.46 – 5.45)
P=0.73

*Age standardized rate /100,000 population/year – based on European Standard Population (ESP) structure

EP-PARTICLES COHORT

POLISH SMOG
EP-PARTICLES STUDY

Geographical variation (aggregated at LAU 1)

	Heart Failure*		Atrial Fibrillation		Ischemic Stroke	
Max	3,326	bieszczadzki	1,184	parczewski	340	skarżyski
	3,114	włodawski	932	zamojski	320	krasnostawski
	2,748	parczewski	928	Zamość	305	zamojski
						R=0.45 (0.32-0.62)
Me	Age 75 [63-82] ♂ **51.4%** Skewness 1.24 Kurtosis 3.54		Age 70 [63-79] ♂ **47.2%** Skewness 1.42 Kurtosis 2.43		Age 76 [66-83] ♂ 48% Skewness 0.96 Kurtosis 1.98	
Min	478	rycki	108	bieszczadzki	123	Suwałki
	439	ostrowiecki	63	kolbuszowski	105	leski
	404	piski	60	kazimierski	65	kazimierski

*Age standardized rate /100,000 population/year – based on European Standard Population (ESP) structure

EP-PARTICLES COHORT

POLISH SMOG
EP-PARTICLES STUDY

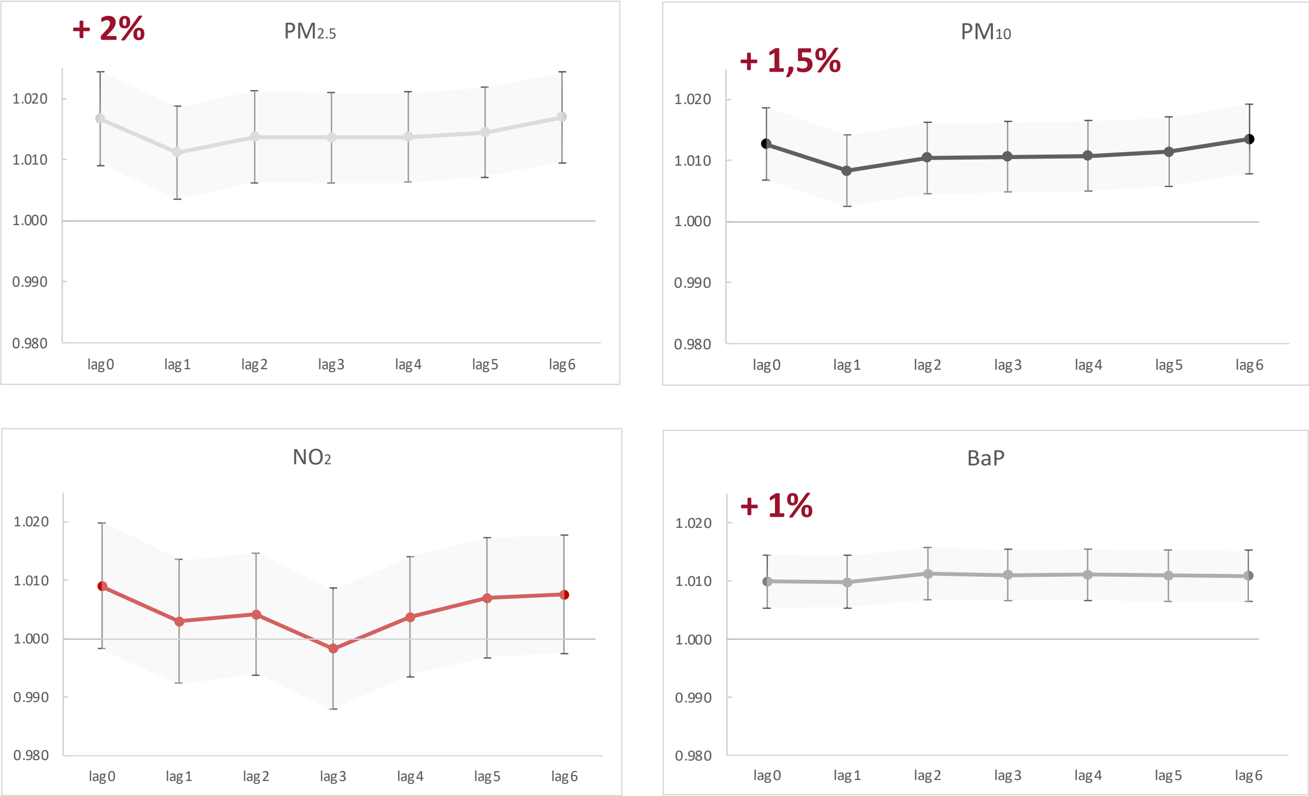
Geographical dispersion (aggregated at LAU 1)

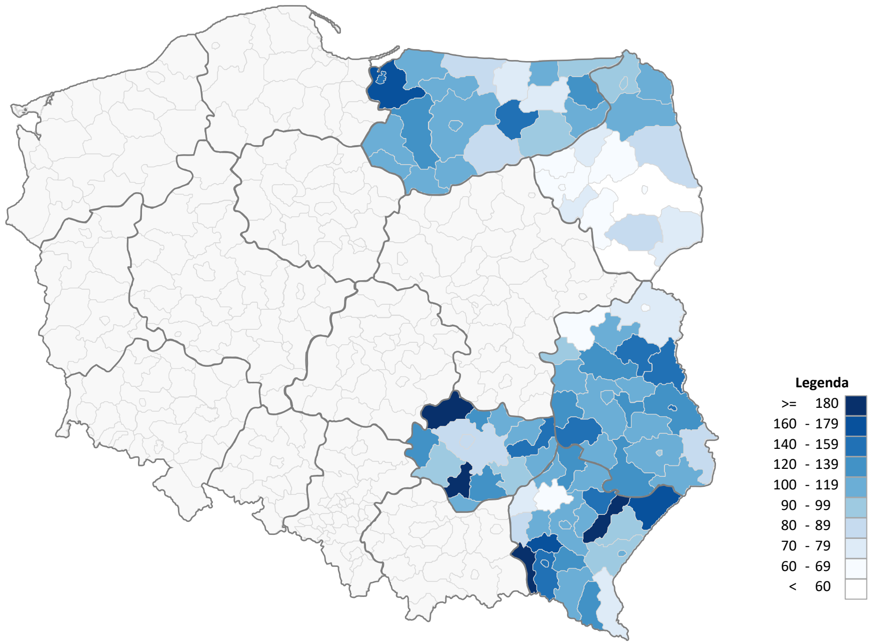
R=0.35 (0.15-0.52)

	STEMI*		NSTEMI		CVD mortality	
Max	174	sandomierski	209	pińczowski	1,148	Chełm
	154	skarżyski	200	jasielski	1,141	Zamość
	153	jędrzejowski	191	konecki	1,121	Krosno
Me	Age 67 [59-77] ♂ 64% Skewness 1.43 Kurtosis 4.58		Age 70 [62-80] ♂ 60% Skewness 0.98 Kurtosis 2.39		Age 82 [72-88] ♂ 46.2% Skewness 0.96 Kurtosis 1.98	
Min	58	łukowski	60	białostocki	188	suwalski
	52	dębicki	53	Białystok	178	przemyski
	37	grajewski	50	siemiatycki	174	chełmski

*Age standardized rate /100,000 population/year – based on European Standard Population (ESP) structure

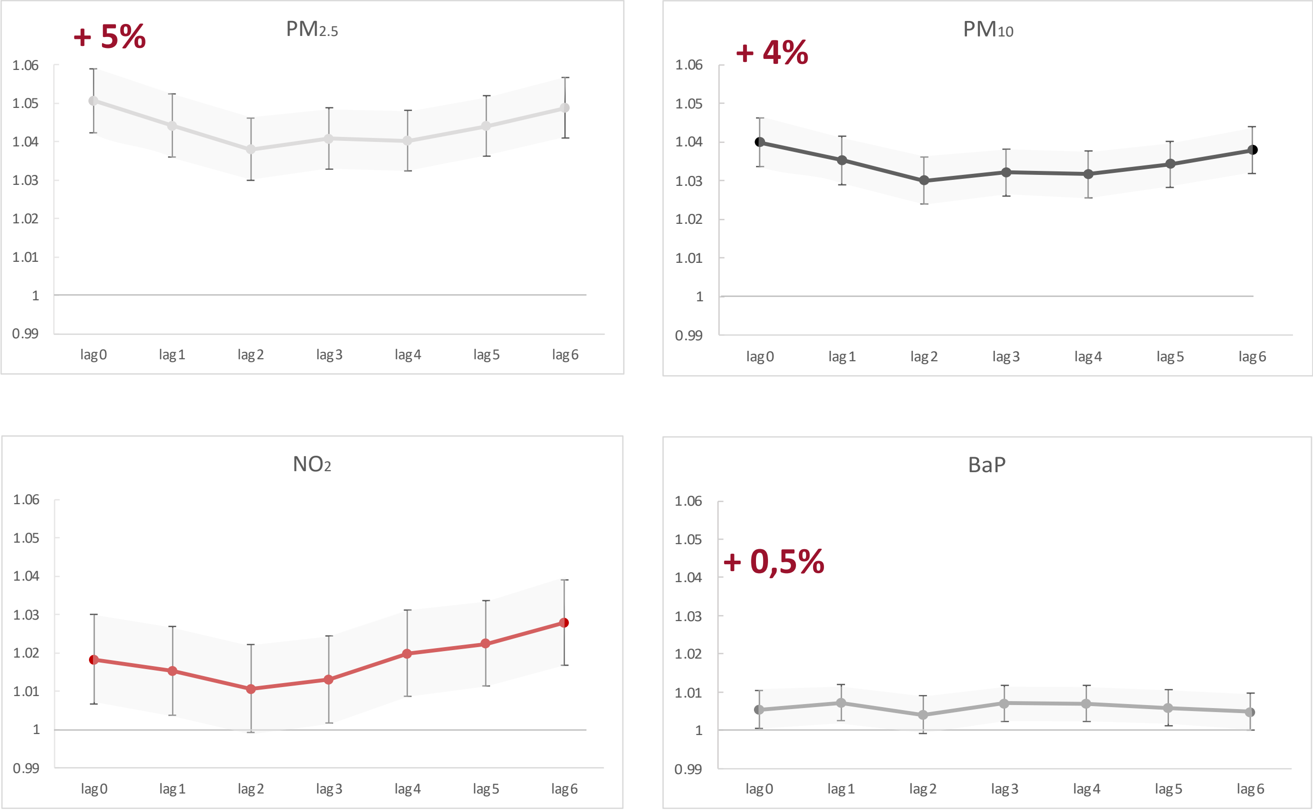
Chorobowość hospitalizowana NSTEMI



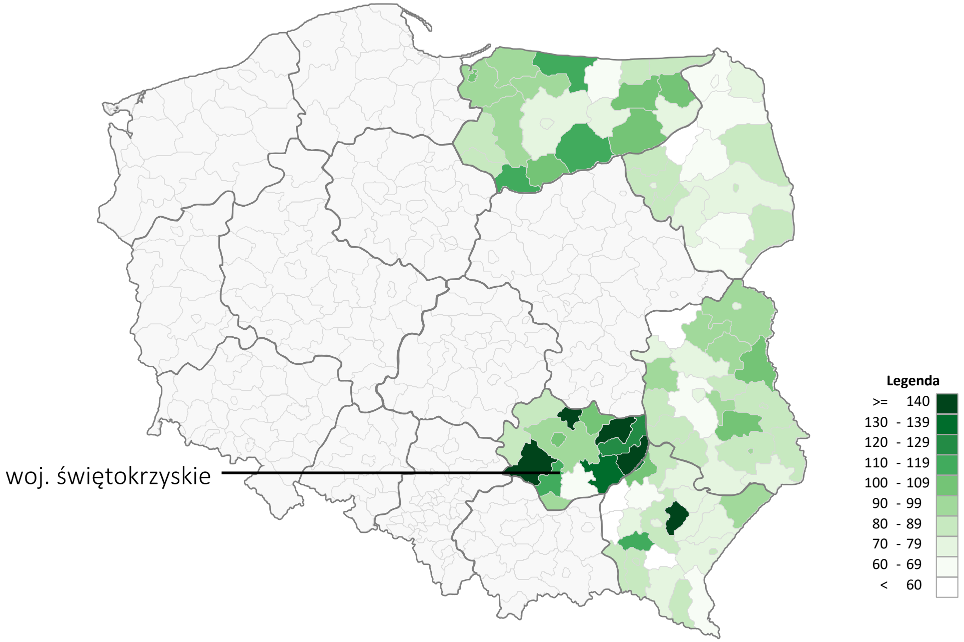


Standaryzowana wg wieku i płci liczba przypadków/100 tyś/rok
(Standardowe populacje europejska – EP27)

Rycina 1. Zwiększone hospitalizacje NSTEMI związane ze wzrostem o 10 µg/m^3 stężeń zanieczyszczeń



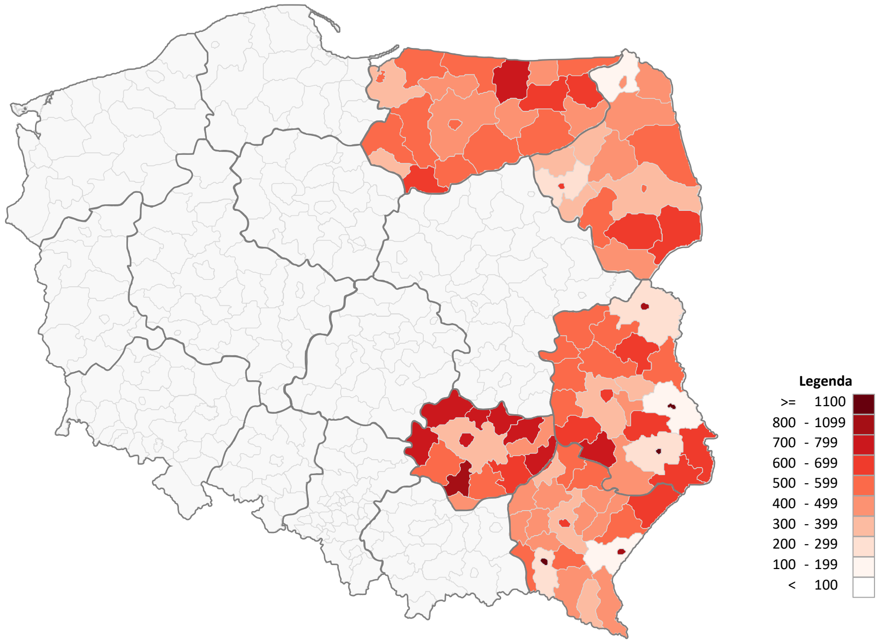
Chorobowość hospitalizowana STEMI



Standaryzowana wg wieku i płci liczba przypadków/100 tyś/rok
(Standardowe populacje europejska – EP27)

Rycina 2. Zwiększone hospitalizacje STEMI związane ze wzrostem o 10 µg/m^3 stężeń zanieczyszczeń

Śmiertelność sercowo-naczyniowa



Standaryzowana wg wieku i płci liczba zgonów/100 tyś/rok
(Standardowe populacje europejska – EP27)

Rycina 3. Zwiększona śmiertelność CVD związana ze wzrostem o 10 µg/m^3 stężeń zanieczyszczeń

Zmiany występowania incydentów sercowo-naczyniowych związanych z miesięcznym wzrostem stężenia:

STEMI (RR=**1.214**, 95%CI 1.002 - 1.009), P=0.005

NSTEMI (OR=**1.017**, 95%CI 1.009 - 1.026), P<0.001

CVD mortality (OR=**1.057** 95%CI 1.048 - 1.067), P<0.001

Overall (OR=**1.036**, 95%CI 1.028 - 1.053), P<0.001

na wzrost o IQR $PM_{2.5}$ µg/m^3

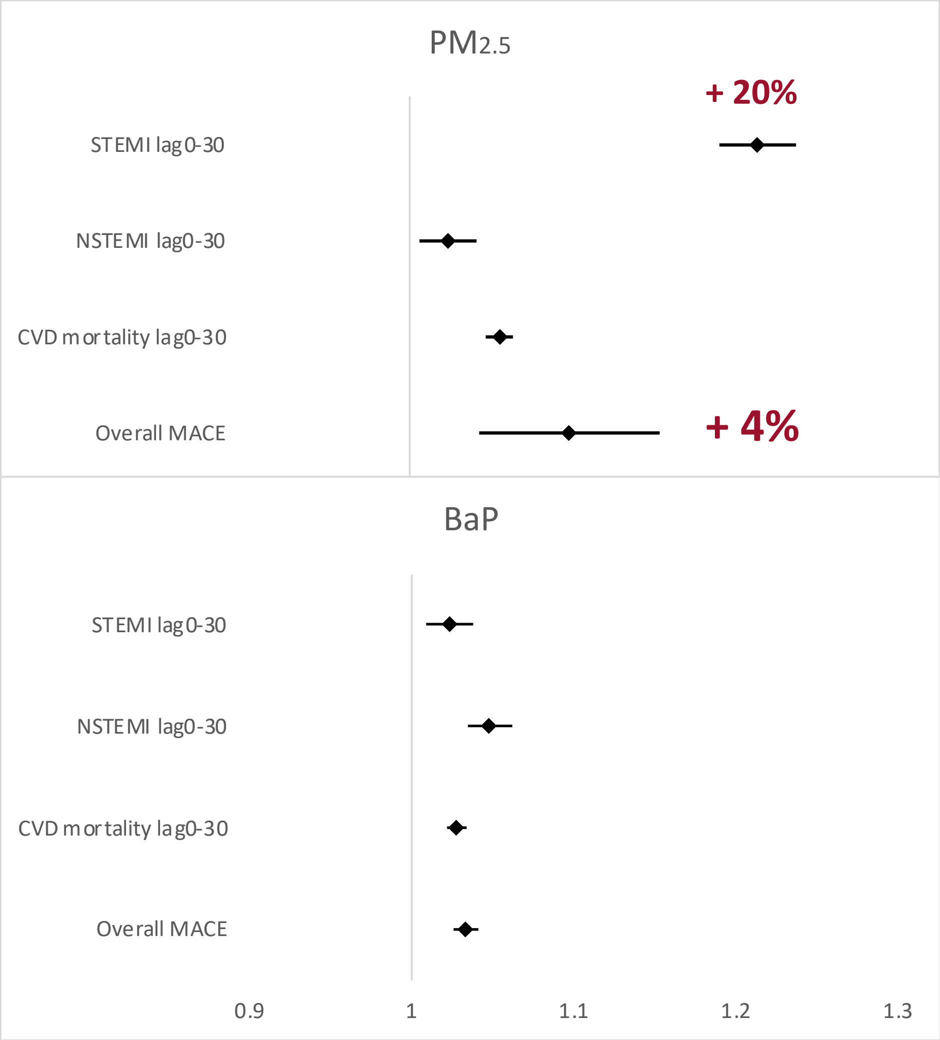
STEMI (RR=**1.024**, 95%CI 1.009 - 1.038), P=0.005

NSTEMI (OR=**1.048**, 95%CI 1.035 - 1.062), P<0.001

CVD mortality (OR=**1.028** 95%CI 1.022 - 1.034), P<0.001

Overall (OR=**1.033**, 95%CI 1.026 - 1.041), P<0.001

na wzrost o IQR BaP ng/m^3

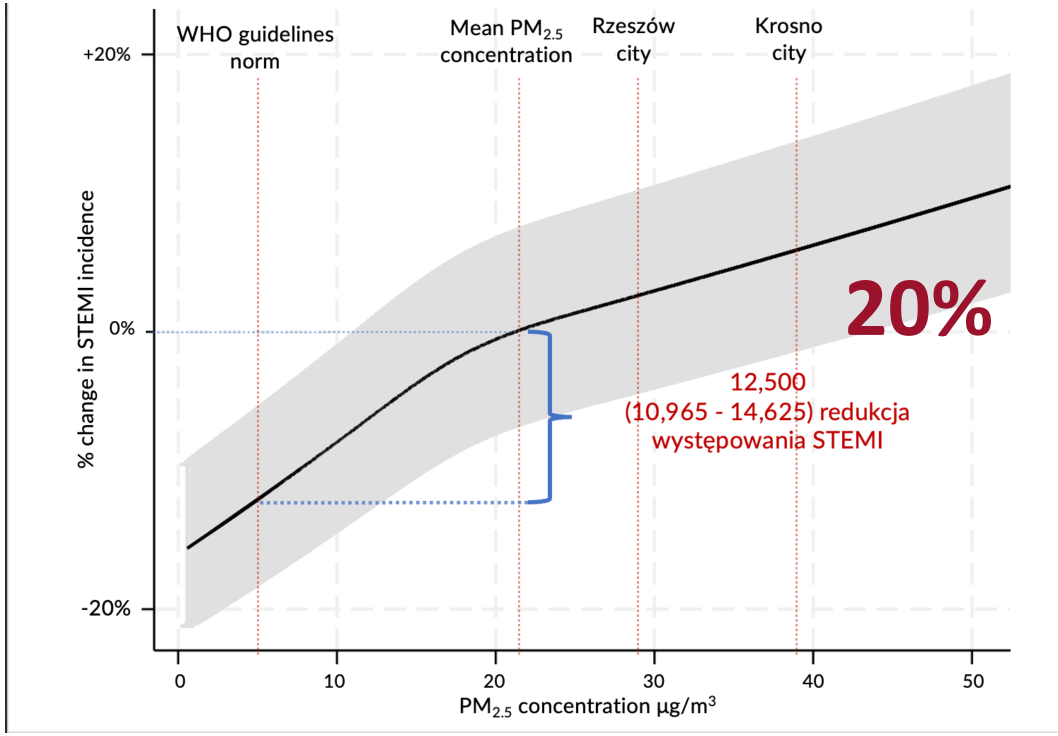


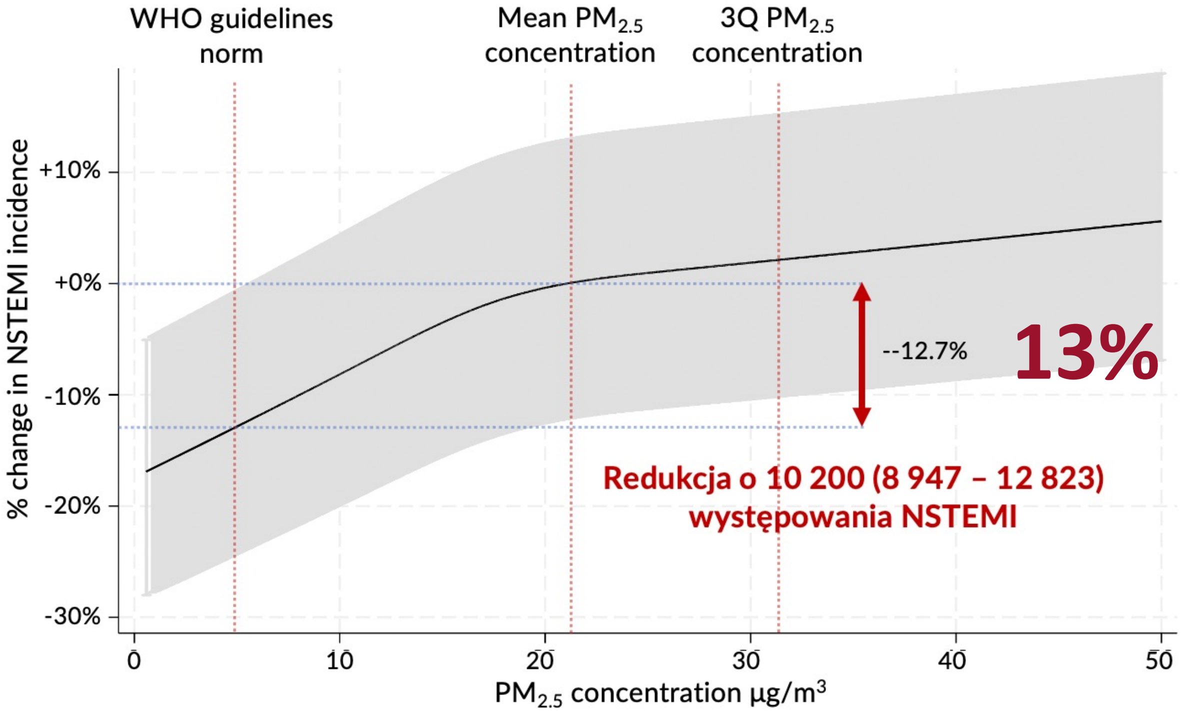
Kobiety/mężczyźni	65-/65+
+1,2%	+4.9%
+5.7%	+12.6%
+3.4%	+5.7%
+4.8%	+8.7%

Kobiety/mężczyźni	65-/65+
-0,01%	+0.2%
+1.2%	+0.5%
+1.5%	+1.7%
+0,9%	+0,7%

Gdyby, w analizowanym okresie, dzienne stężenia **$PM_{2.5}$** nie przekraczały dopuszczalnej normy WHO:

POLISH SMOG
EP-PARTICLES STUDY





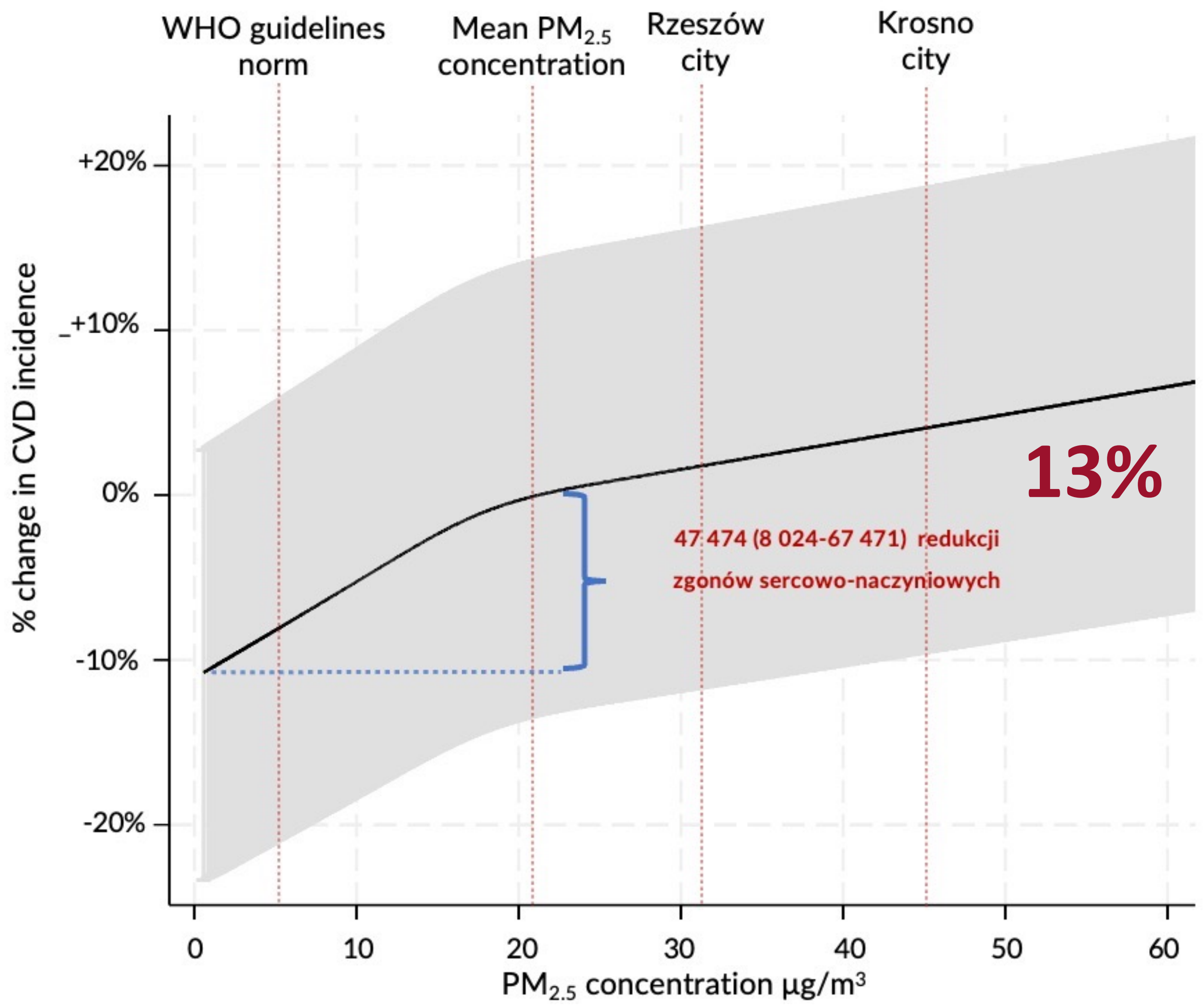
Funkcje narażenie-odpowiedź: % wzrost przyjęć do STEMI i NSTEMNI na rosnące poziomy $PM_{2.5}$, modele specyficzne dla prowincji skorygowane o trend, temperatura powietrza: naturalne splajny dla opóźnienia 0-1 (df=6), opóźnienie 0-6 (df=3), wilgotność względna (df=3) ciśnienie atmosferyczne (df=3) i zmienne wskaźnikowe dla gminy, dnia tygodnia, świąt państwowych oraz okresów epidemii grypy.i SARS-CoV-2

Zero na osi Y reprezentuje średni efekt, a część krzywej poniżej/powyżej zera oznacza mniejsze/większe oszacowanie niż średni efekt.

Gdyby, w analizowanym okresie, dzienne stężenia **$PM_{2.5}$** nie przekraczały dopuszczalnej normy WHO:

POLISH SMOG

EP-PARTICLES STUDY



Funkcje narażenie-odpowiedź: % wzrost zgonów CVD na rosnące poziomy $PM_{2.5}$ (Lag 0), modele specyficzne dla prowincji skorygowane o trend, temperatura powietrza: naturalne splajny dla opóźnienia 0-1 (df=6), opóźnienie 0-6 (df=3), wilgotność względna (df=3) ciśnienie atmosferyczne (df=3) i zmienne wskaźnikowe dla gminy, dnia tygodnia, świąt państwowych oraz okresów epidemii grypy i SARS-Ciov-2

Zero na osi y reprezentuje średni efekt, a część krzywej poniżej/powyżej zera oznacza mniejsze/większe oszacowanie niż średni efekt.

YLL= 893 lat

(395 lat – 1,086 lat)/100,000 mieszkańców

↓

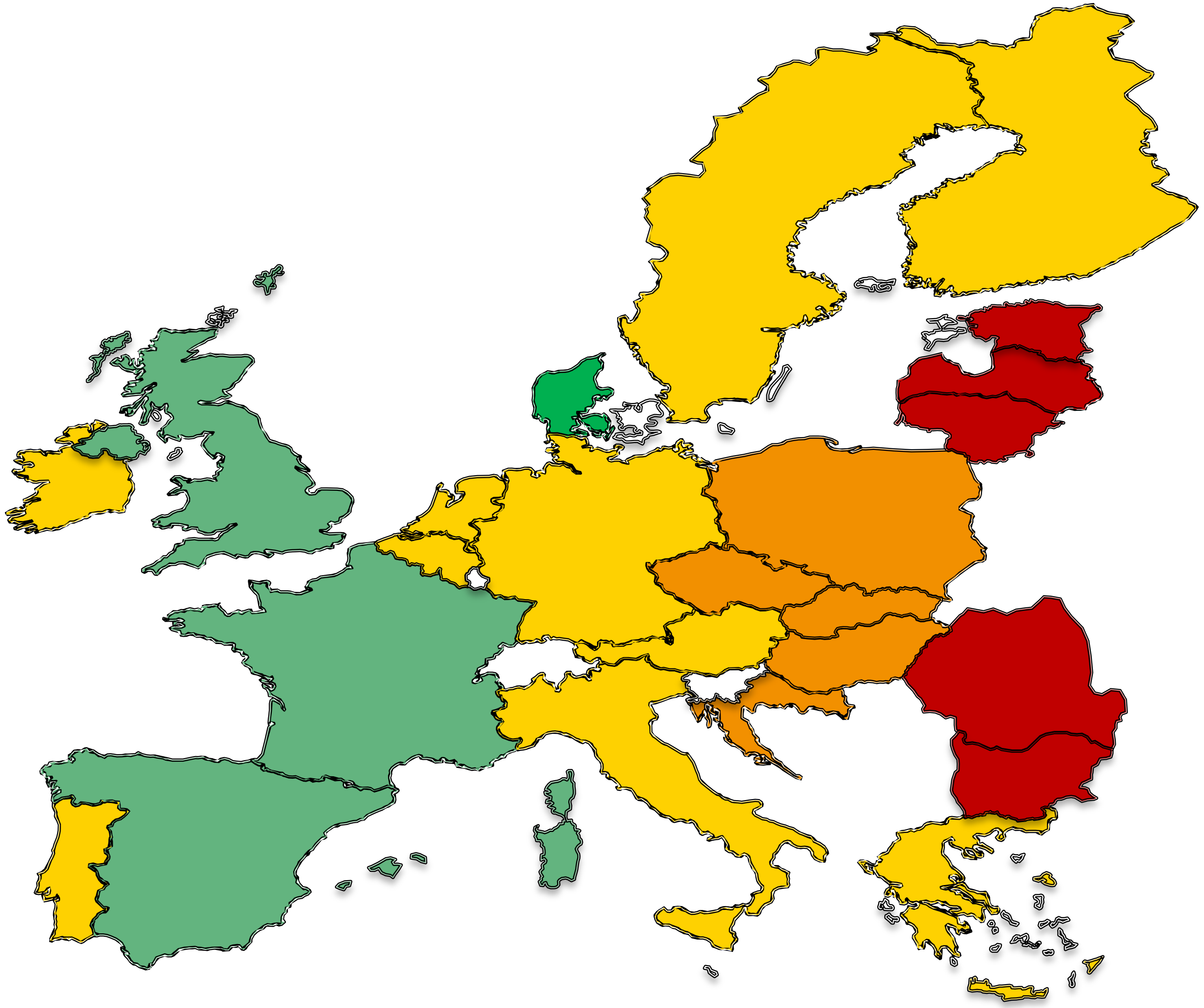
71,440 lat

w całej analizowanej populacji

Why do we need a new indicator?

POLISH SMOG
EP-PARTICLES STUDY

- Clinical risk stratification focuses on patient-centric risk factors, without consideration of environmental pollution
- 14% people with fatal ACS and 50% patients with ACS have none or only one classical risk factor
- Risk scores are not validated for air pollution so they may under- or overestimate the true risk
- Environmental cardiology offers opportunities for primary prevention and can help address health disparities



ePM-years Index

POLISH SMOG
EP-PARTICLES STUDY

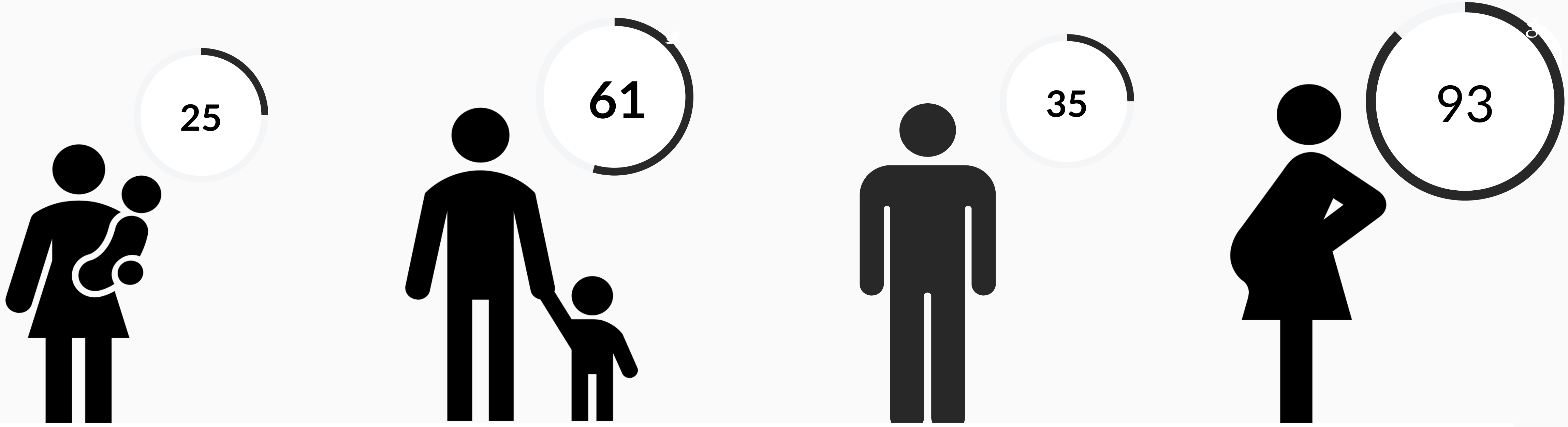
$$\Sigma = \max\left[\frac{c^1 + c^2 + c^3 \ldots + c^N}{C_w} - t;\ 0\right]$$

C^1 - mean yearly concentration in the first year of observation

C^N - mean yearly concentration in the last year of observation

C_w – World Health Organization annual norm form $PM_{2.5}$

t – time of observation (years)



32 y.o Białystok city | 52 y.o Katowice city | 51 y.o Białystok city | 31 y.o Kraków city

ePM-years Index

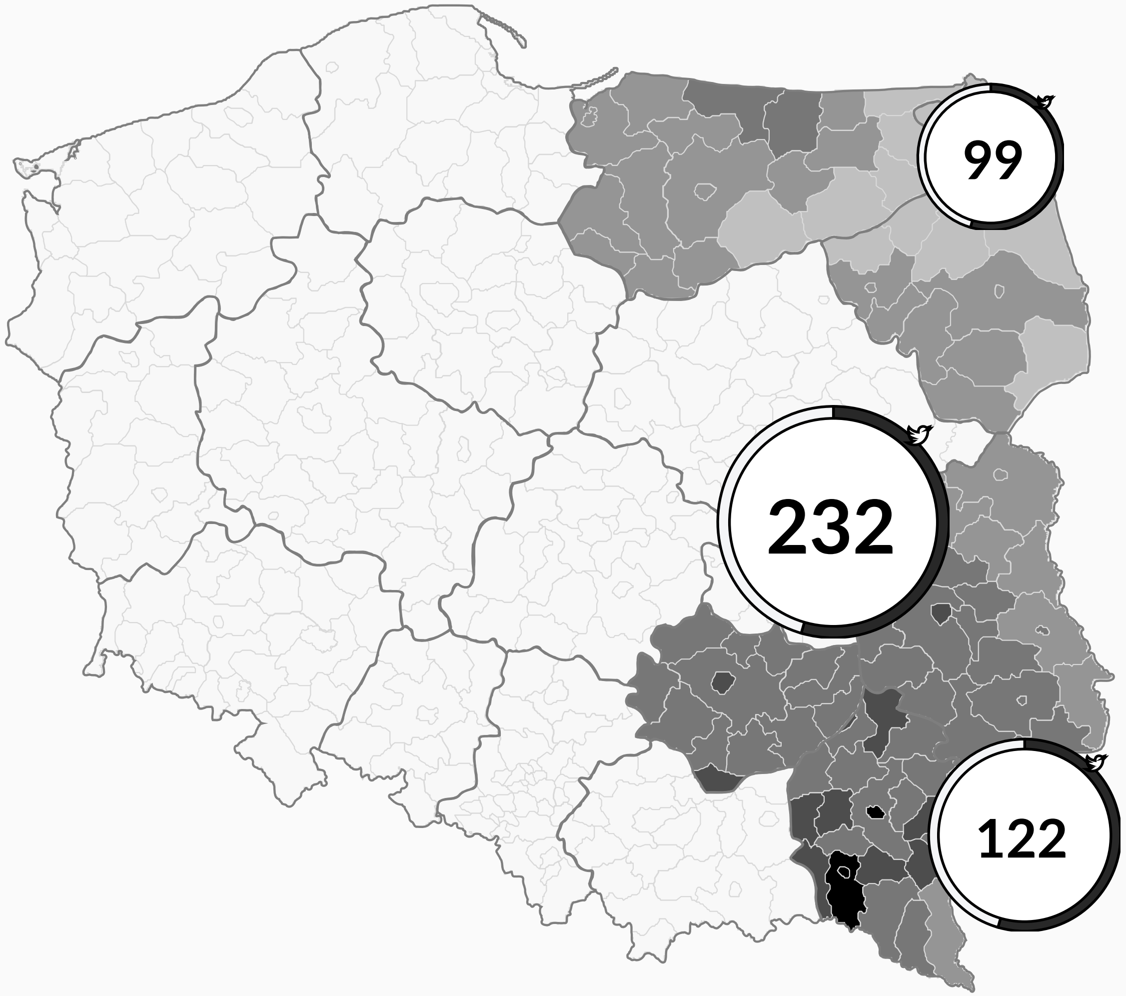
$$\Sigma = \max \left[\frac{c^1 + c^2 + c^3 \ldots + c^N}{C_w} - t; 0 \right]$$

C^1 - mean yearly concentration in the first year of observation

C^N - mean yearly concentration in the last year of observation

C_w – World Health Organization annual norm form $PM_{2.5}$

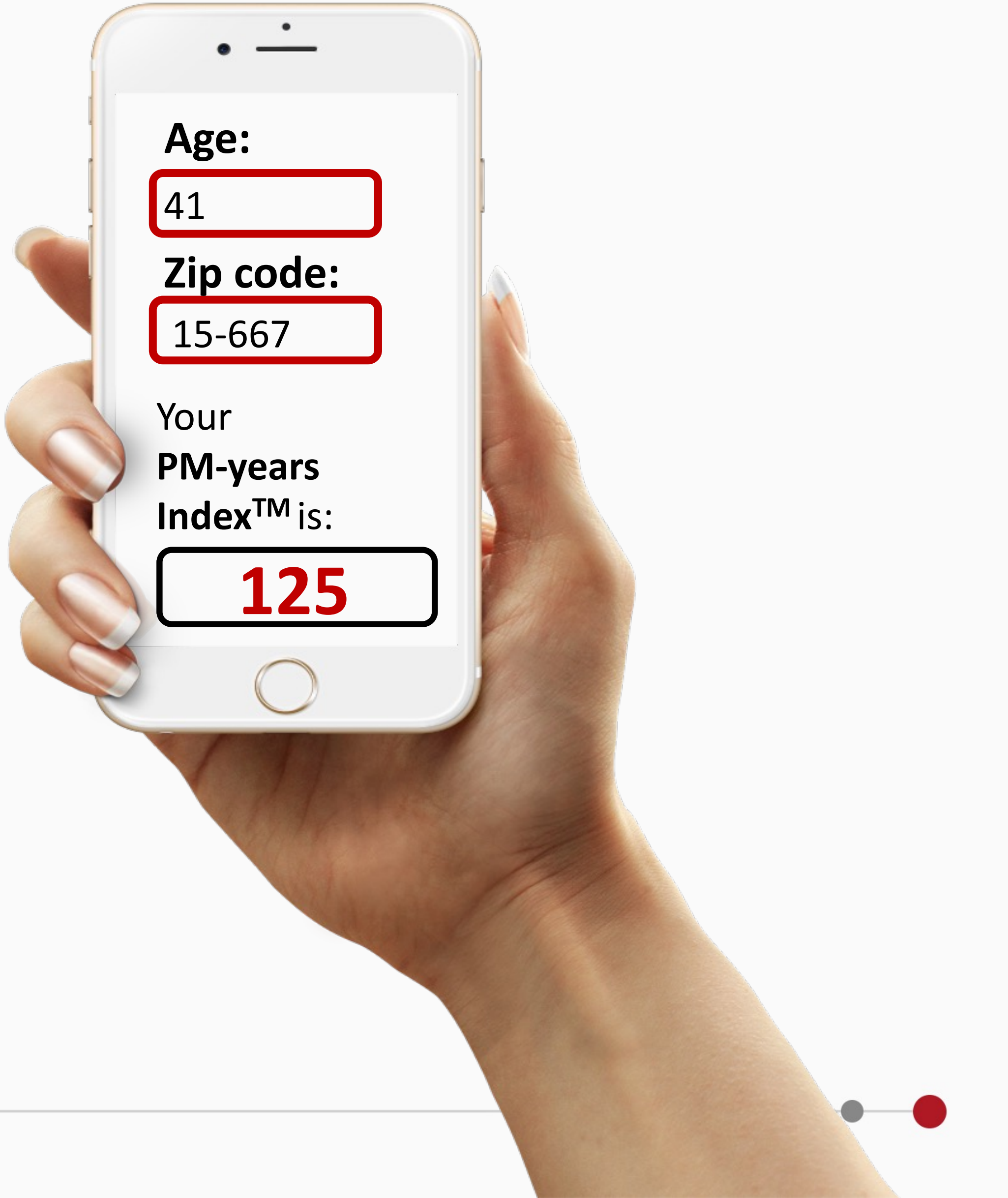
t – time of observation (years)



ePM-years Index

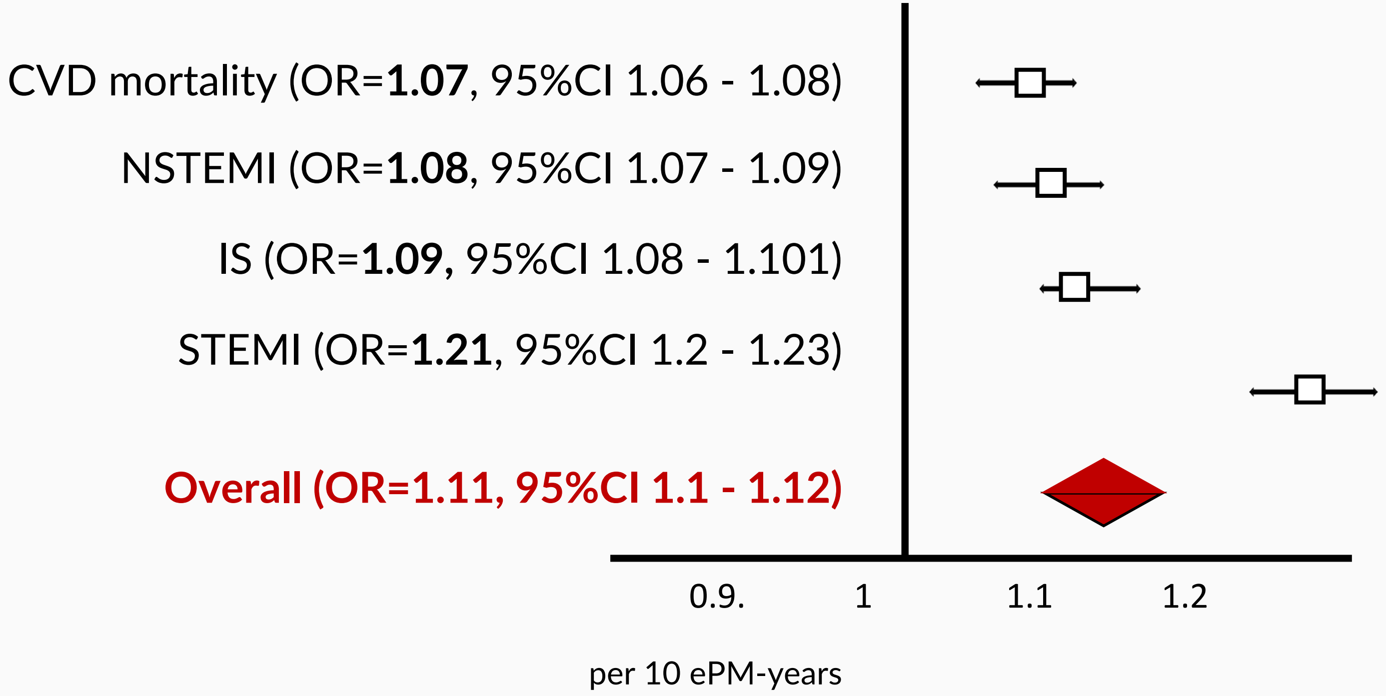
What it delivers:

- CVD risk reclassification
- identifies the cohorts at high risk
- more personal information and role in decision-making for those at „intermediate" risk
- allows for modification of intensity of monitoring or early preventive strategies
- support decisions making regarding the location of the public health as well as personal investments
- Informs insurance companies about patients risks



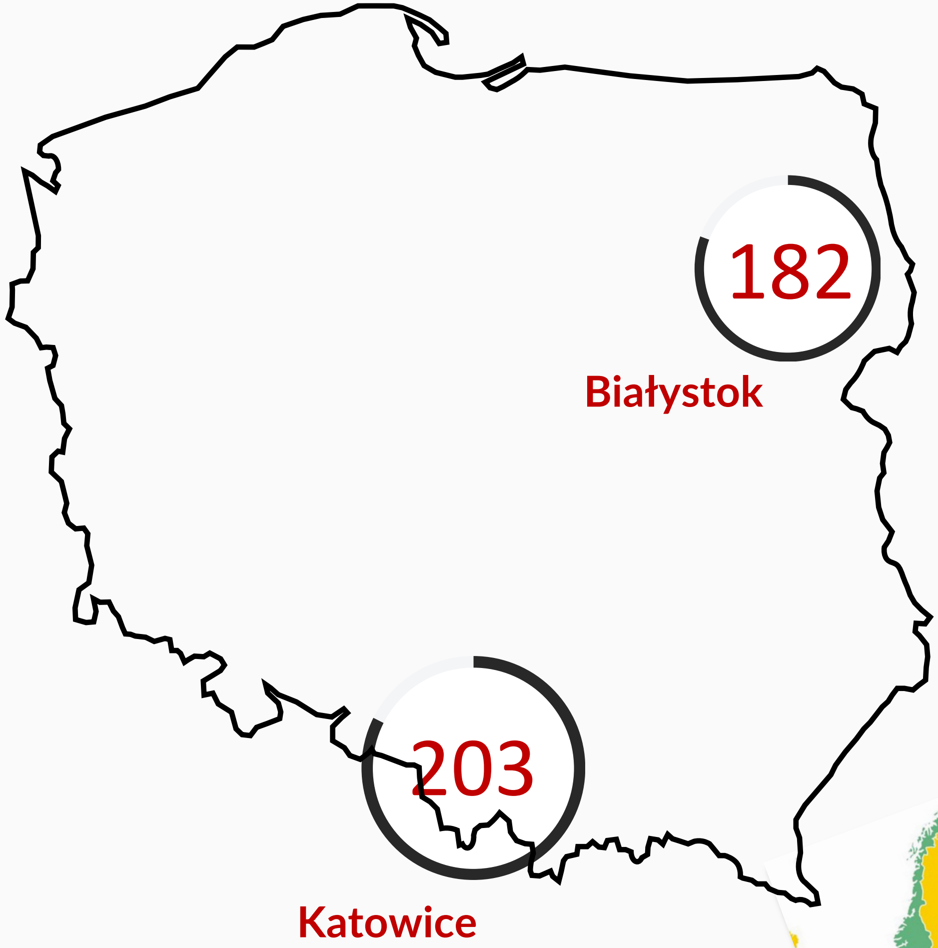
ePM-years Index

- ✓ is an independent predictor of major cardiovascular events
- ✓ may be used as a simple index for risk stratification
- ✓ should be incorporated into prediction models



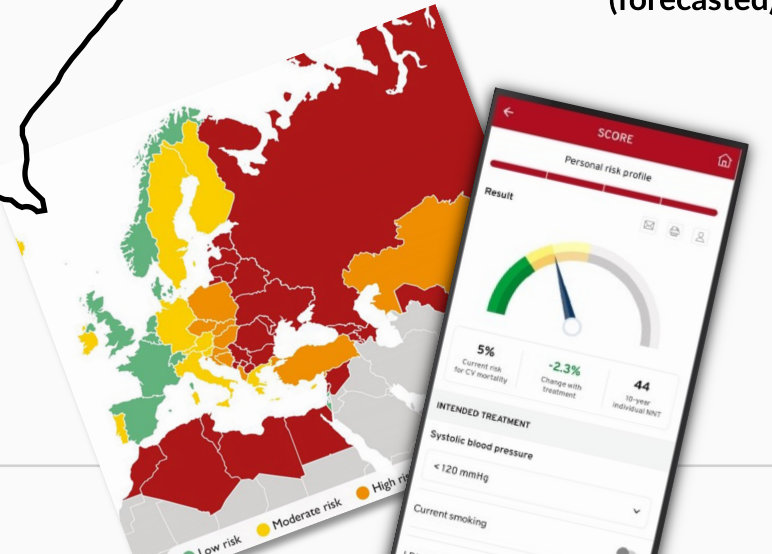
EP-PARTICLES COHORT

POLISH SMOG
EP-PARTICLES STUDY



2020 → 2030

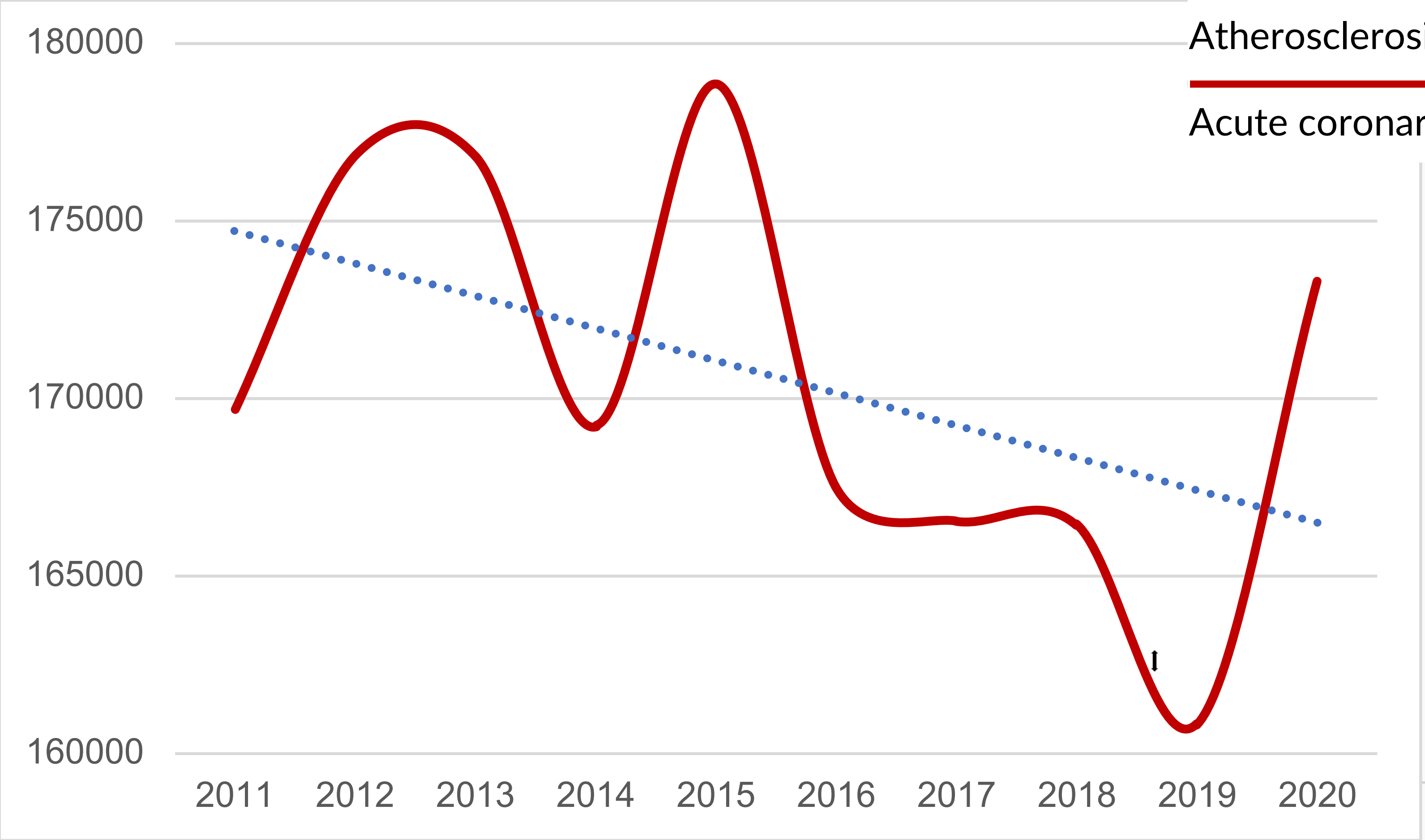
	Białystok	Katowice
41 y.o. healthy man, non-smoker (2020)		
SCORE2	**<1%**	**<1%**
ePM-years Index	**159**	**173**
51 y.o. healthy man, non-smoker (2030)		
SCORE2	<1.5%	<1.5%
ePM-years Index (forecasted)	**182**	**203**



EUROsmog COHORT

CVD-mortality (N= 1,706,111)
Me 81 [71-87], ♂ 47%

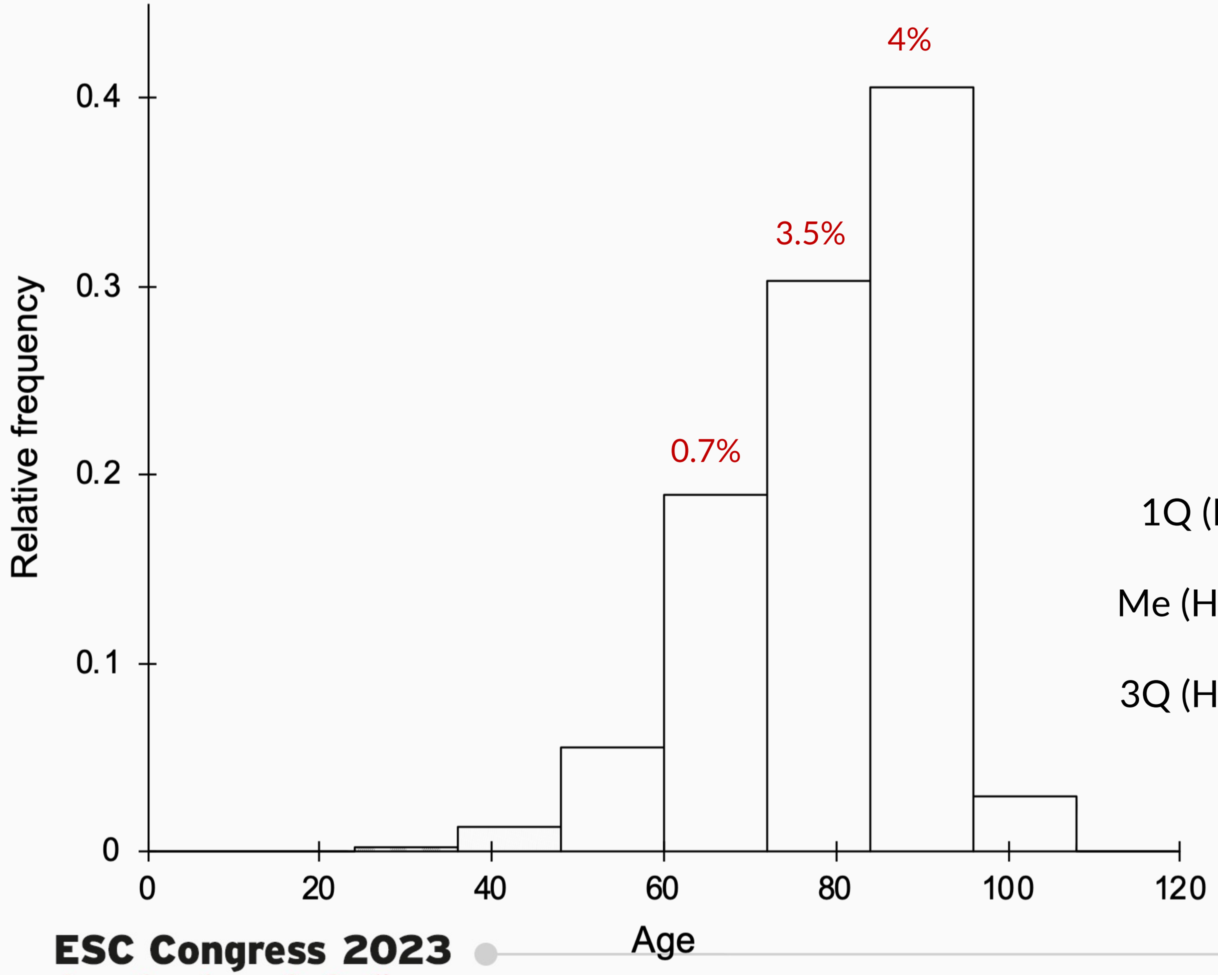
Heart failure	22.56%
Ischemic stroke	7.57%
Atherosclerosis	18.84%
Acute coronary syndromes	24.27%



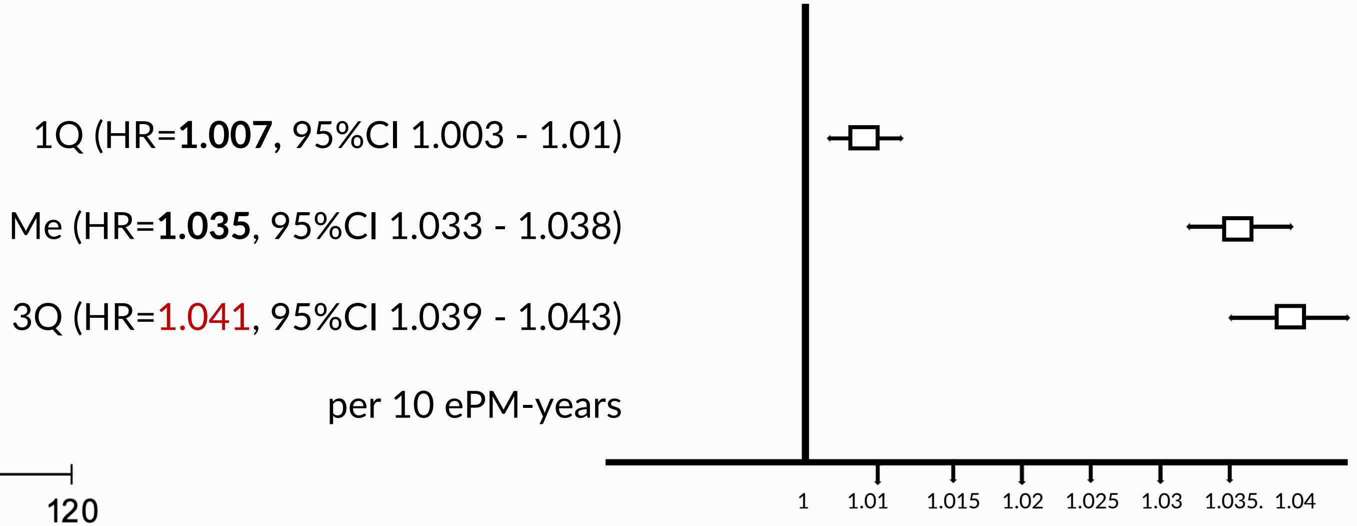
EUROsmog COHORT

POLISH SMOG
EP-PARTICLES STUDY

CVD-mortality (N= 1,706,111). Me 81 [71-87], ♂ 47%



What we are doing at the moment is NOT effective



Łukasz Kuźma
Department of Invasive Cardiology
Medical University of Bialystok
lukasz.kuzma@umb.edu.pl
𝕏 @KuzmaLukasz
𝕏 @PolishSmog