2021 WHO AQGs: from Evidence to Guidelines

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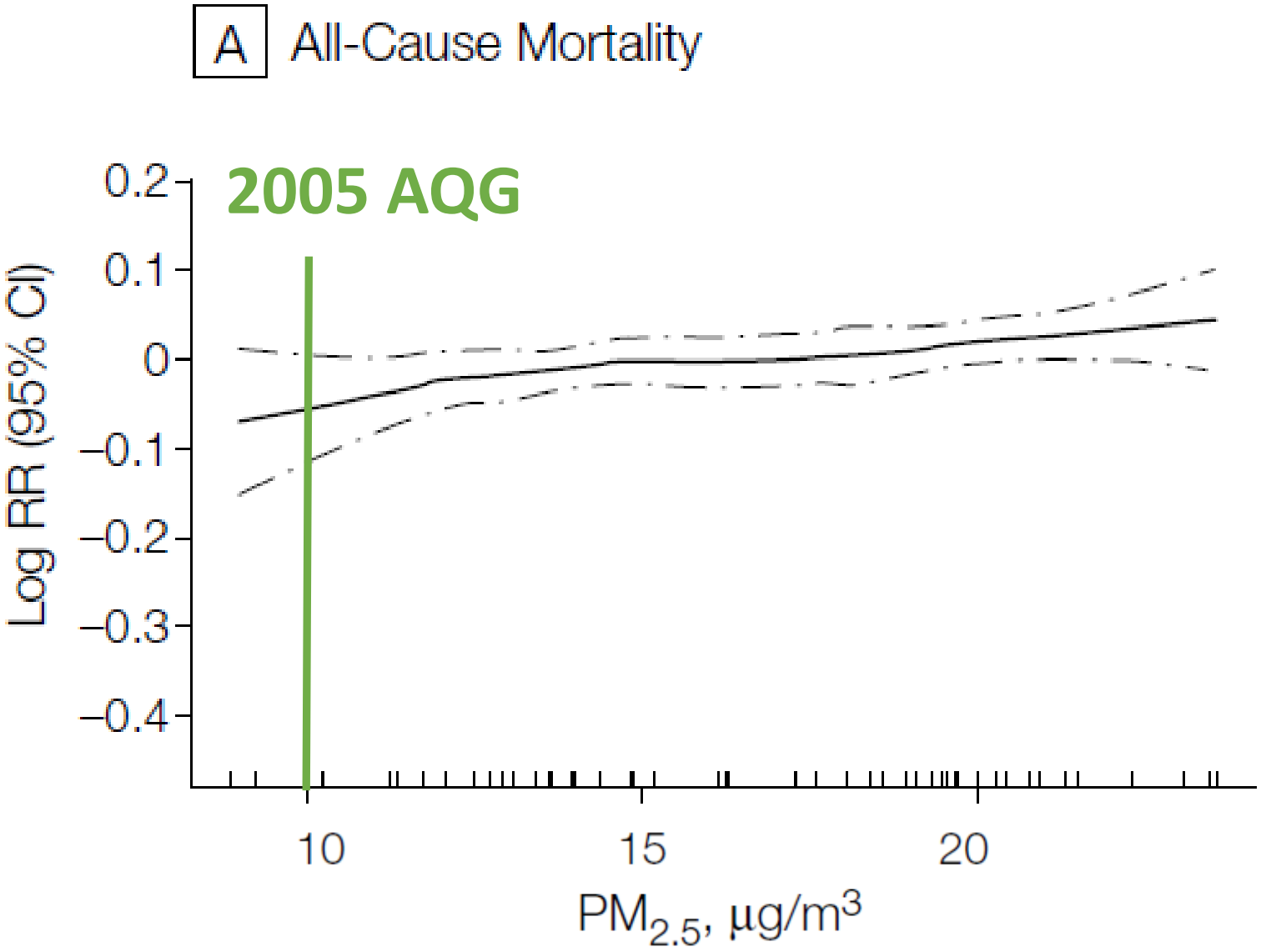
Summary

- Long term AQGs: mean of lowest 5th percentiles of study population distributions
- Short term AQGs: 99th percentiles of distributions of 24 hour mean concentrations matching the long term AQGs
- Analogy approach when there is no long-term AQG (CO, SO2)

Pope JAMA 2002



8 steps

1. CRFs from systematic reviews
2. Lowest level of exposure = 5th %
3. Size of health effect = 0 for mortality
4. AQG = 5th %
5. Compare across critical outcomes
6. Certainty of evidence: systematic reviews
7. New evidence since systematic reviews?
8. New insights in causality?

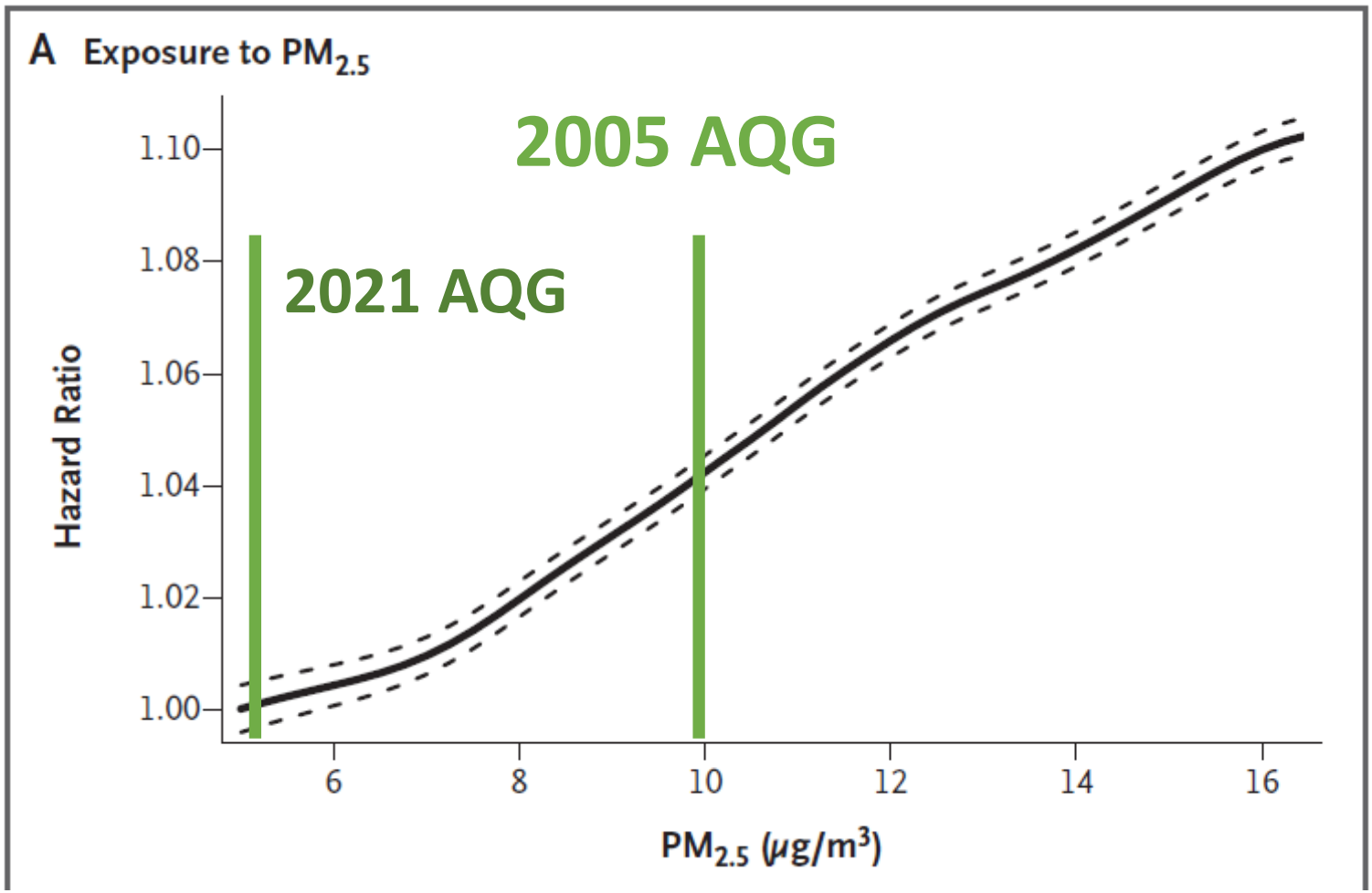
Low-level PM2.5 studies

PM2.5 REFERENCE	MEAN	SD	M-1.645*SD	P5	HR	LCL	UCL
(Pinault 16)	5.9			3	1.26	1.19	1.34
(Cakmak)	6.5	2	3.2	3.2	1.16	1.08	1.25
(Pinault 17)	7.1			3.5	1.18	1.15	1.21
(Weich.)	9.5	1.7	6.7	6.7	0.95	0.76	1.19
(Villeneuve)	9.5	3.5	3.7	4.8	1.12	1.05	1.2
(Di)	11.5	2.9	6.7	7.1	1.08	1.08	1.09
(Hart)	12.0	2.8		7.8	1.13	1.05	1.22

Result: an annual PM2.5 AQG of 5 µg/m³

Interim Target	$PM_{2.5}$ (µg/m³)
IT1	35
IT2	25
IT3	15
IT4	10 (= 2005 AQG)
AQG	**5**

Di et al., NEJM 2017



SHORT-TERM AQG PM2.5

- Ratio of 99th percentiles of distributions of 24-hour averages to mean of distribution
- Mean equal to long-term AQG
- Ratio from MCC study (Liu, NEJM 2019)
- 3.05 for PM2.5, Rounded to 3.00
- Excess mortality at short-term AQG day, relative to day at the long-term AQG = 0.65% (PM2.5)

Produces a 24 hr PM2.5 AQG of 15 µg/m³

Interim Target	$PM_{2.5}$ (µg/m³)
IT1	75
IT2	50
IT3	37.5
IT4	25 (= 2005 AQG)
AQG	**15**

AQGs for NO2 & O3

LONG-TERM AQGs NO2, O3

- Mean of 5th percentiles of lowest exposure studies on non-accidental and respiratory mortality
- **NEW**: annual AQG for O3; 24-hour AQG for NO2
- Database for NO2 larger than for O3
- Influential recent studies on O3
- **NEW** Interim Targets for both NO2 & O3

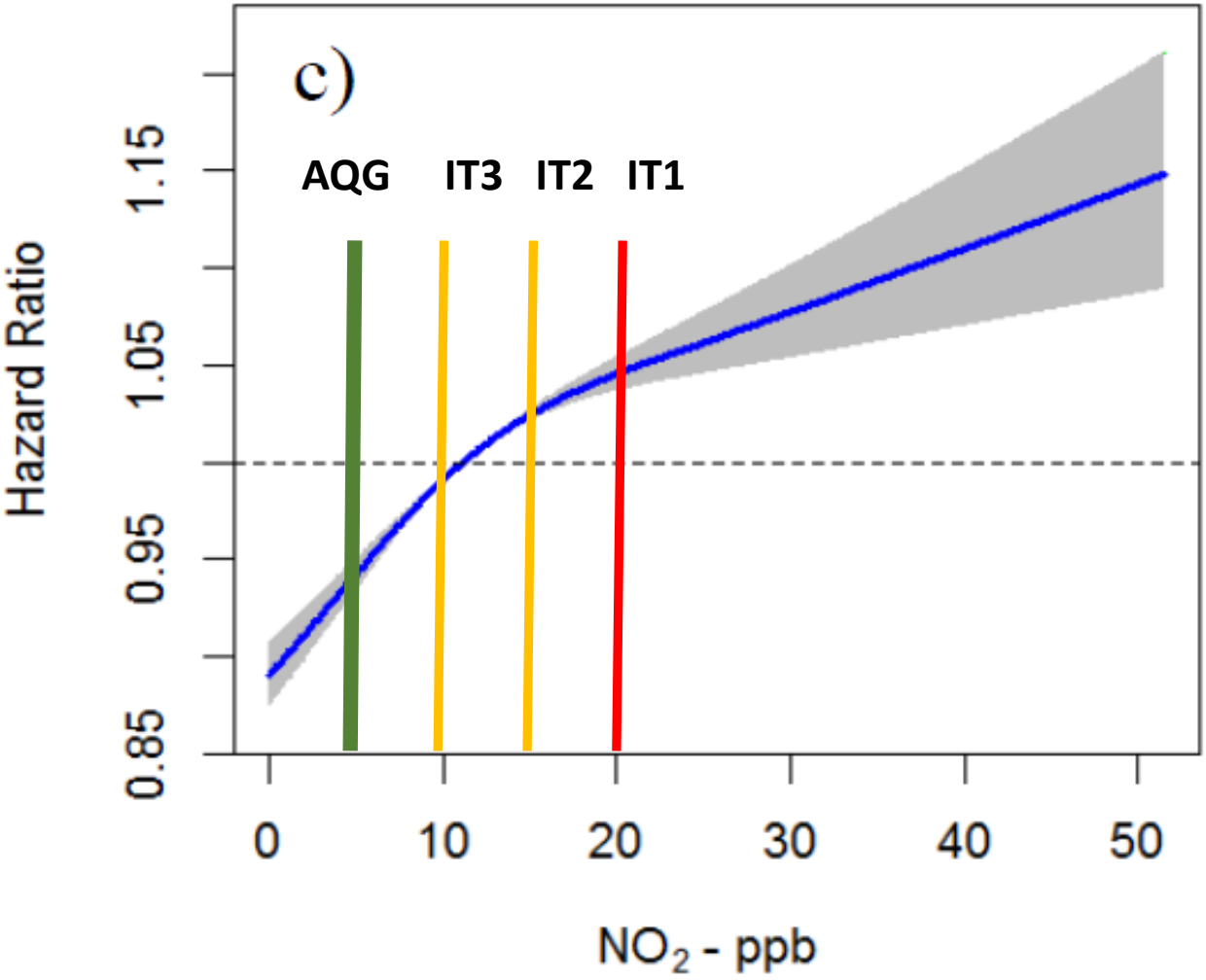
Low-level NO2 studies

NO2 Reference	Me(di)an	SD	M-1.645*SD	P25	P5	HR	LCL	UCL
(Tonne)	18,5	6,8	7,3		7,3	1,01	0,98	1,04
(Weich.)	21,6			12,1	6,3	1,04	1,03	1,04
(Crouse)	21,8			11,3		1,03	1,03	1,04
(Turner)	21,8	9,6	6,0		9,6	1,02	1,01	1,03
(Yorifuji)	22	15	-2,7		-2,7	1,12	1,07	1,18
(Carey)	22,5	7,4	10,3		10,3	1,02	1	1,05
(Beelen)	22,2			19,9	15,3	1,01	0,99	1,03
(Hart 2013)	26,1			19	8,3	1,01	1	1,03
(Hart 2011)	26,7	13,3	4,8		8,3	1,05	1,02	1,08

Produces an annual NO2 AQG of 10 µg/m³

Interim Target	NO2 (µg/m³)
IT1	40 = 2005 AQG
IT2	30
IT3	20
AQG	10

CROUSE 2015 Note: 1 ppb = 2 µg/m^3



Ratio of MCC 99th %/mean ~ 2.5 Produces a 24 hr NO2 AQG of 25 µg/m^3

Interim Target	NO2 (µg/m^3)
IT1	100
IT2	50
GEL	25

FINAL REMARKS

- AQGs for ***long-term*** concentrations developed ***following a common logic*** to move from evidence to guidelines (PM2.5, PM10, NO2, O3)
- AQGs for ***short-term*** concentrations based on ***99th percentiles of 'AQG' distributions*** for same, using MCC database
- AQGs for ***short-term*** concentrations for SO2 and CO ***by analogy with*** short-term AQGs for other pollutants

The 2021 WHO Air Quality Guidelines

Pollutant	Averaging time	AQG level
$PM_{2.5}$	Annual	5 µg/m^3
$PM_{2.5}$	24-hour	15 µg/m^3
PM_{10}	Annual	15 µg/m^3
PM_{10}	24-hour	45 µg/m^3
O_3	Peak season	60 µg/m^3
O_3	8-hour	100 µg/m^3
NO_2	Annual	10 µg/m^3
NO_2	24-hour	25 µg/m^3
SO_2	24-hour	40 µg/m^3
CO	24-hour	4 mg/m^3