



ELISAH

*European Linkage of Initiative
from Science to Action in Health*

DELIVERABLE

3.3

REPORT ON EXPOSURE RISK

VERSION V. 3

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VERSION CONTROL SHEET

• PROJECT SUMMARY

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DISCLAIMER

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ABBREVIATIONS

BC	Breast cancer
EEA	European Environment Agency
EU	European Union
HaDEA	Health and Digital Executive Agency
HR	Hazard ratio
IARC	International Agency for Research on Cancer
ICD-O-3	International Classification of Diseases for Oncology, Third Edition
NO₂	Nitrogen dioxide
PM_{2.5}	Fine particulate matter
PM₁₀	Particulate matter
TNM	Tumour-Node-Metastasis Classification of Malignant Tumours, Sixth Edition
WHO	World Health Organization

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EXECUTIVE SUMMARY

Atmospheric fine particulate matter (PM_{2.5}) and nitrogen dioxide (NO₂) have multiple adverse effects on human health. Several studies in the US and one study in Italy showed an association between these atmospheric pollutants and mortality in women with a breast cancer diagnosis. No study on this subject has ever been performed including more European countries. The ELISAH project conducted a study in Greece, Italy, Spain and Ukraine to assess the exposure of women with a breast cancer diagnosis to PM_{2.5}, PM₁₀ and NO₂, and to evaluate the effect of exposure to these pollutants on women's mortality. The vast majority of women in the ELISAH cohort were found to be exposed to levels of air pollutants above the threshold suggested by the WHO guidelines, and statistically significant mortality risks were identified for exposure to PM_{2.5} and NO₂. The combination of these two main findings highlights the need for urgent intervention limiting PM_{2.5} and NO₂ concentrations to protect women with a breast cancer diagnosis from avoidable deaths.

1. INTRODUCTION

Exposure to atmospheric particulate matter (PM) has been hypothesised as a risk factor for the development and progression of breast cancer (BC). PM may be emitted or formed from natural or anthropogenic sources. In industrial and urban areas, PM is mainly anthropogenic [1]. PM up to 10 μm in diameter (PM_{10}) and fine PM, up to 2.5 μm in diameter ($\text{PM}_{2.5}$), have been documented to have multiple adverse effects on human health and are classified by the World Health Organization (WHO) and the International Agency for Research on Cancer (IARC) as group 1 carcinogens (carcinogenic to humans) [1], [2]. A review by Guo et al. [3] indicated that $\text{PM}_{2.5}$ exposure was related to BC mortality, although further research in this field is needed to validate the conclusion. According to a recent study by Wei et al. conducted using the Surveillance, Epidemiology, and End Results-Medicare database, nitrogen dioxide (NO_2) was associated with an increase in mortality, but the evidence of this association in the scientific literature is not conclusive [4]. According to the ELISAH research group, the association between mortality in women with a BC diagnosis and $\text{PM}_{2.5}$ has reached a sufficient level of evidence to be tested in a public health framework considering the precautionary principle. In this context it would also be useful to evaluate the multi-pollutant exposure effect on women with a BC diagnosis and the possible interaction with neighbourhood characteristics as sources of socioeconomic disparities. Only one study, by the ELISAH coordinator, has been conducted in Europe to assess the association between these factors and mortality in women diagnosed with BC. There have been no studies investigating the link with NO_2 or the interaction with neighbourhood characteristics. Taking into account all these considerations, we planned a study with the following aims:

- a) quantify the exposure to $\text{PM}_{2.5}$, PM_{10} and NO_2 in women with a BC diagnosis in Greece, Italy, Spain and Ukraine
- b) compute the mortality risk in women with a BC diagnosis according to exposure to the atmospheric pollutants under analysis

The results of this study may be useful to plan primary and tertiary prevention interventions, stimulate the application of atmospheric pollutant thresholds as suggested by the WHO, and prompt action to improve living conditions in deprived neighbourhoods.

Because of the public health design of ELISAH, the results of WP3 are linked to the interventions being planned by WP6.

2. CONTENT



Figure 1 Study areas and participating institutions.

Breast cancer cases

We performed a retrospective study on a cohort of women diagnosed with primary BC. The cases were archived by the cancer registries participating in the ELISAH call for data. A search using site code C50 and malignant epithelial morphology codes M8000 to M8575 of the International Classification of Diseases for Oncology, Third Edition (ICD-O-3) [5] retrieved a total of 137 812 primary BC cases diagnosed in the predetermined study period (2010-2021). For the development of task T3.3, aiming to describe both risk factor prevalence and mortality risk in a recent period and giving us the possibility to compute survival at least for three years, we selected cases diagnosed in the interval period from 2017 to 2021. Disease stage was as specified by the TNM Classification of Malignant Tumours (6th edition, 2002) [6]. We collected cases from cancer registries in compliance with privacy legislation, classifying morphology into three broad ICD-O-3 categories:

- ductal BCs, code 8500
- lobular BCs, code 8520
- others in the range not included in the first two

Similarly, we classified age into four age groups: 0-49, 50-59, 60-69 and 70+.

Estimation of $PM_{2.5}$, PM_{10} and NO_2

The procedure for estimating $PM_{2.5}$, PM_{10} and NO_2 exposure involved first retrieving each woman's address at the date of diagnosis (reference date) from the cancer registries and then determining the geographic coordinates (latitude and longitude) of each address. To respect privacy legislation, the participating cancer registries linked geographic coordinates with zip codes and sent the coordinating centre (INT) only the zip codes together with clinical information. INT linked the zip codes with the digital maps (shape files) of the yearly pollutant concentrations provided by the European Environment Agency (EEA) [7] for Italy, Spain and Greece, and by Copernicus [8] for Ukraine. Through this linkage, pollutant exposure was assigned to each BC case. The ground level pollutant estimates were available at a resolution of 1×1 km using EEA data and at a resolution of 10×10 km using Copernicus data. We selected the most recent data from EEA (2019), allowing us to classify pollutant exposure near the data of BC diagnosis. We performed the same selection for Copernicus data.

Assessment of deprivation

Deprivation by neighbourhood was assessed using different databases for Greece, Italy and Spain. For Italy we used the deprivation index set up by Caranci et al. [9]. For Spain we used the national formulation of the deprivation index as proposed by Duque et al, divided into quintiles [10]. Since no national deprivation index was available in Greece, we restricted its application to the region of Attica, making use of the index proposed by the Athens Social Atlas Group [11]. At the beginning of the project, no deprivation index was available in Ukraine, so the ELISAH working group developed a pilot project to evaluate it. The first version of the Ukraine deprivation index was used to classify women from the Ivano-Frankivsk region included in the study described in this document.

Process indicators

The percentage of BC cases successfully geocoded and linked to the atmospheric pollutants under analysis was 99%, excluding data for PM₁₀ in Ukraine because no Copernicus estimates were available. With regard to the deprivation index, we succeeded to link 99% of cases for Italy, Spain and Greece.

Statistical methods

The analyses performed by us are based on the Cox proportional hazards model, which defines the hazard as $\lambda(t) = \lambda_0(t)\exp(\beta X)$, where $\lambda(t)$ is the hazard function for the event in question (death), X is a vector of covariates, and β is a vector of coefficients to be estimated. The hazards for two participants with fixed covariate vectors X_i and X_j are $\lambda_i(t) = \lambda_0(t)\exp(\beta X_i)$ and $\lambda_j(t) = \lambda_0(t)\exp(\beta X_j)$, respectively. The hazard ratio (HR) is $\lambda_i(t)/\lambda_j(t) = \exp(\beta(X_i - X_j))$. To test the null hypothesis (H_0) of $\beta=0$, we used the likelihood ratio test. Since the Cox model assumes proportional hazards, this was tested by analysis of scaled Schoenfeld residuals with associated p values. We performed additional analyses introducing a restricted cubic spline function to evaluate non-linear associations between atmospheric pollutant exposure levels and survival in women with BC. Factors known or thought to influence BC prognosis were initially analysed by univariate Cox proportional hazard modelling to verify their effect on mortality in our cohort. The factors analysed were tumour grade (I-III, unknown), age at diagnosis (three age groups), and level of urbanisation as defined by the DEGURBA classification (three categories). We ran univariate and multivariate Cox proportional hazards models to estimate HRs with 95% confidence intervals (CIs) of all-cause mortality. PM_{2.5}, PM₁₀ and NO₂ were considered as linear variables. The multivariate model included age, tumour grade, urbanisation and deprivation index to control for the possible confounding effects of these variables on mortality. Time to event or end of follow-up was calculated from the date of diagnosis. Patients alive at the study end were censored. Patients lost to follow-up were censored at the date of loss to follow-up. Cases with missing data (missing disease stage and tumour grade) were assigned to "not specified" categories in the analyses. We also used the Kaplan-Meier method to produce survival curves for quartiles of PM_{2.5}, PM₁₀ and NO₂ exposure, testing the significance of differences between curves with the stratified log-rank test. We used the Nelson-Aalen estimator to plot the cumulative hazard of death for pollutant exposure categories. The analyses were performed using the R statistical package [12].

Results

This report is based on data made available for the ELISAH project by the cancer registries of Girona, Granada, País Vasco and Tarragona for Spain, the Lazio region, Veneto region, Palermo, Trapani and Agrigento provinces and the "Napoli 1 Centro" area for Italy, and the Ivano-Frankivsk region for Ukraine. Data for Greece were provided by the pilot breast cancer registry of Greece, which is being developed by the ELISAH research group.

For the sake of conciseness, we shall refer to the administrative regions that our cohort's geographical units belong to as follows:

- *Sicilia* refers to the provinces of Palermo, Trapani and Agrigento
- *Campania* refers to the "Napoli 1 Centro" local health authority
- *Sardegna* refers to the province of Sassari
- *Andalucia* refers to the province of Granada
- *Cataluña* refers to the provinces of Tarragona and Girona

A total of 137 812 BC cases were collected and checked and a database was built for the storage of clinical and environmental information. For the analysis presented in this report we selected cases diagnosed in the period 2015-2020 according to registry data availability, with a total of 36 794 cases.

Atmospheric pollutant concentrations and degree of urbanisation

We measured the pollutant concentrations and the degree of urbanisation for the cohort under analysis. In Annexes 1-4 we present, for each country, tables that show the average PM_{2.5}, PM₁₀ and NO₂ concentrations (expressed in µg/m³) and the average degree of urbanisation (as defined by the DEGURBA classification) [13] observed simultaneously across the different age groups, deprivation index classes and internal regions.

In Greece, within the Inner Attica region, the analysis shows that the most deprived socioeconomic groups experience the highest levels of exposure to pollutants. This pattern is slightly more marked among the younger population, while no meaningful differences emerge when stratifying by degree of urbanisation.

A comparative analysis of the Italian data shows that differences across age groups are generally limited, with the exception of the oldest population, which appears to be more exposed to pollutants.

The distribution by deprivation index highlights that individuals in the least deprived group experience the highest exposure levels. At the regional scale in Italy, Veneto stands out for its elevated concentrations of atmospheric PM, whereas Campania emerges as the most urbanised region and also the one with the highest exposure to NO₂.

An evaluation of the Spanish data indicates that Andalucia is, on average, the region most exposed to all monitored pollutants, with no clear differentiation attributable to the degree of urbanisation. Stratification by deprivation index reveals that individuals in the least deprived group experience higher exposure to PM_{2.5} and NO₂, whereas the most deprived population shows the greatest exposure to PM₁₀.

In the Ivano-Frankivsk region of Ukraine, the least deprived population – corresponding to residents of the most urbanised areas – shows the highest levels of exposure to atmospheric pollutants. The only deviation from this pattern concerns PM_{2.5}, for which a single observation indicates elevated exposure in the intermediate deprivation group among individuals aged over 70.

Prevalence of exposure

The prevalence of exposure to the atmospheric pollutants under analysis was computed together with the percentage of women exposed above WHO and EU limits.

For the WHO thresholds we considered the 2021 World Health Organization global air quality guidelines [1]. For the EU thresholds, the new Air Quality Directive, approved by the European Parliament, was taken as a reference [14]. The new directive aims, for 2030, to bring European air quality standards more closely in line with WHO recommendations which, however, still remain considerably more stringent.

Pollutant	Reference period	EU 2030 limit value	WHO limit value
PM _{2.5}	Calendar year	10 µg/m ³	5 µg/m ³
PM ₁₀	Calendar year	20 µg/m ³	15 µg/m ³
NO ₂	Calendar year	20 µg/m ³	10 µg/m ³

Table 1 Annual maximum thresholds for air pollutants PM_{2.5}, PM₁₀ and NO₂ set by the EU for 2030 and by the WHO in 2021.

Figure 2 shows the overall proportion (four countries) of women with a diagnosis of BC during the study period (2017-2019) and exposed to PM_{2.5}, PM₁₀ and NO₂ concentrations exceeding EU standard values and WHO guidelines. Despite the difference between the two thresholds, it is clear that the vast majority of women in the ELISAH cohort were exposed to levels of key air pollutants that are harmful to health. The extent of exposure within each country by age and deprivation category is shown in Annexes 5, 6, 7 and 8 for Greece, Italy, Spain and Ukraine, respectively. There were some interesting differences between countries and within internal regions (for Italy and Spain), but in the majority of cases populations were exposed to levels exceeding the WHO limits. In Annex 9, the same data are presented broken down by pollutant type and region.

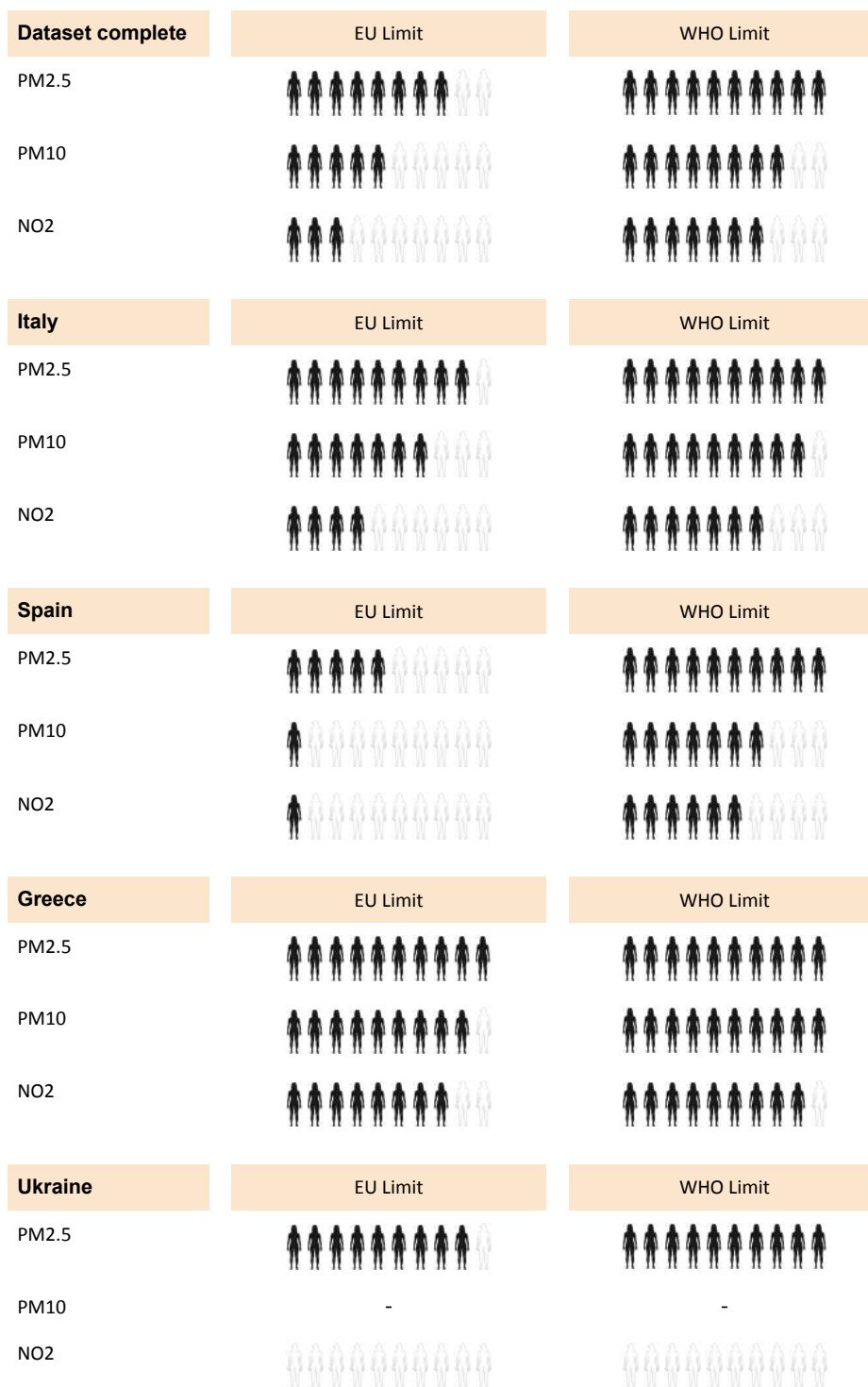


Figure 2 Share of women with a diagnosis of BC exposed to PM2.5, PM10 and NO2 concentrations above current EU standard and 2021 WHO guideline values.

Mortality analysis

From the total ELISAH cohort we selected cases diagnosed between 2017 and 2020 to obtain the closest possible picture of mortality, considering that to compute survival we needed time (at least three years) to observe events. This subcohort comprised 36 794 women. The correlations between the three atmospheric pollutants under analysis were:

- 0.87 for $PM_{2.5} - PM_{10}$
- 0.58 for $NO_2 - PM_{2.5}$
- 0.69 for $PM_{10} - NO_2$

The high correlations between the three pollutants make it difficult to separate the effect of each pollutant from the other two, but make the information more useful for public health. Analysis using scaled Schoenfeld residuals revealed non-linear associations for $PM_{2.5}$, PM_{10} and NO_2 but not deprivation. We split the time axis into two periods for which the proportional hazards assumption was satisfied: 0-3 years and >3 years from diagnosis. Table 2 presents the results for the pollutants and deprivation index. We performed single-pollutant (data not shown) and multi-pollutant analysis. The HR for NO_2 was statistically significant in the first period (0-3 years from diagnosis) and statistically non-significant in the second (>3 years from diagnosis). This finding highlights a “period of susceptibility” for women with BC. $PM_{2.5}$ and PM_{10} did not reach statistical significance, but the strong correlation between the three pollutants, the results of single-pollutant analysis and the HR values led us to hypothesise a possible contribution of $PM_{2.5}$ to mortality. The analysis also showed a statistically significant HR for women from areas with the highest deprivation index (upper quintile).

Exposure	Breast cancer cases (N)	All-cause deaths (N)	HR (95%CI) All-cause death
PM_{2.5} (µg/m³)	36794	5360	Years from diagnosis: 0-3: 1.10 (0.79-1.53) >3: 1.16 (0.74-1.78) 0-5: 1.11 (0.84-1.46)
PM₁₀ (µg/m³)	36794	5360	Years from diagnosis: 0-3: 0.74 (0.45-1.23) >3: 0.54 (0.27-1.09) 0-5: 0.68 (0.44-1.05)
NO₂ (µg/m³)	36794	5360	Years from diagnosis: 0-3: 1.16 (1.02-1.31) >3: 1.09 (0.91-1.32) 0-5: 1.13 (1.02- 1.25)
Deprivation index	36794	5360	Deprivation quintiles, 0-5 years from diagnosis Least: 1 0.92 (0.84-1.01) 0.94 (0.86-1.04) 1.02 (0.92-1.13) Most: 1.18 (1.06-1.31)

Table 2 Hazard ratios (HR) and 95% confidence intervals (CI) for all-cause mortality in relation to PM_{2.5}, PM₁₀ and NO₂ exposure and deprivation index for all ages.

Discussion

The multi-pollutant analysis identified NO₂ as a risk factor, a finding only reported in the global scientific literature to date by a paper by Wei et al. [4]. The continued addition of cancer registries that were not previously included in the analysis will shed light on the roles of PM_{2.5} and PM₁₀.

3. CONCLUSIONS

Key points:

- The ELISAH project succeeded in building a large cohort of BC cases collected by population-based cancer registries, linking information on PM_{2.5}, PM₁₀, NO₂ as well as the deprivation index by neighbourhood
- The vast majority of women of the ELISAH cohort were exposed to levels of PM_{2.5}, PM₁₀ and NO₂ above the threshold suggested by the WHO guidelines
- Analysis of the cohort of women with a BC diagnosis showed a mortality risk related to NO₂ exposure
- Analysis of the cohort of women with a BC diagnosis highlighted a mortality risk related to living in deprived areas
- The previous points prompt urgent application of interventions to reduce atmospheric pollutant exposure as suggested by the WHO to combat BC mortality

4. REFERENCES

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5. ANNEXES

- Annex 1** GREECE - Average PM_{2.5}, PM₁₀ and NO₂ concentrations (expressed in µg/m³) and average degree of urbanisation (as defined by the DEGURBA classification) observed simultaneously across the different age groups and deprivation index classes.
- Annex 2** ITALY - Average PM_{2.5}, PM₁₀ and NO₂ concentrations (expressed in µg/m³) and average degree of urbanisation (as defined by the DEGURBA classification) observed simultaneously across the different age groups and deprivation index classes and across the internal regions.
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- Annex 5** GREECE - Share of women with a diagnosis of breast cancer exposed to PM_{2.5}, PM₁₀ and NO₂ concentrations above the current EU standard and 2021 WHO guideline values. - Complete cohort, cohort broken down by age and deprivation index.
- Annex 6** ITALY - Share of women with a diagnosis of breast cancer exposed to PM_{2.5}, PM₁₀ and NO₂ concentrations above the current EU standard and 2021 WHO guideline values. - Complete cohort, cohort broken down by internal region, age and deprivation index.
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- Annex 8** UKRAINE - Share of women with a diagnosis of breast cancer exposed to PM_{2.5}, PM₁₀ and NO₂ concentrations above the current EU standard and 2021 WHO guideline values. - Complete cohort, cohort broken down by age and deprivation index.
- Annex 9** Share of women with a diagnosis of breast cancer exposed to PM_{2.5}, PM₁₀ and NO₂ concentrations above the current EU standard and 2021 WHO guideline values. - Cohort broken down by internal region and type of pollutant.

Annex 1 GREECE - Average PM_{2.5}, PM₁₀ and NO₂ concentrations (expressed in $\mu\text{g}/\text{m}^3$) and average degree of urbanisation (as defined by the DEGURBA classification) observed simultaneously across the different age groups and deprivation index classes.

Greece

Average concentrations of **PM_{2.5}** = 16.60 $\mu\text{g}/\text{m}^3$

Average concentrations of **PM₁₀** = 26.23 $\mu\text{g}/\text{m}^3$

Broken down by **AGE CATEGORY** and **DEPRIVATION INDEX**

PM _{2.5}		0-49	50-69	70+
		16.53	16.71	16.51
1	17.03	17.05	17.08	16.93
2	18.19	18.51	18.23	17.86
3	16.40	15.39	17.10	16.44
4	15.24	14.82	15.12	15.71
5	19.79	19.83	19.77	19.79

PM ₁₀		0-49	50-69	70+
		26.14	26.41	26.04
1	27.05	27.28	27.08	26.81
2	29.07	29.63	29.20	28.38
3	26.01	24.56	27.16	25.89
4	23.56	22.64	23.37	24.50
5	32.15	32.33	32.02	32.12

Average concentrations of **NO₂** = 25.81 $\mu\text{g}/\text{m}^3$

Average degree of **URBANISATION** =
TOWNS AND SUBURBS

Broken down by **AGE CATEGORY** and **DEPRIVATION INDEX**

NO ₂		0-49	50-69	70+
		24.68	26.30	26.05
1	24.48	24.04	24.55	24.77
2	32.24	31.49	32.43	32.57
3	26.88	23.55	28.94	27.40
4	25.16	22.99	24.82	27.25
5	37.17	37.31	37.21	36.77

URB		0-49	50-69	70+
		TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS
1	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS
2	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS
3	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS
4	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS
5	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS

Annex 2 ITALY - Average PM_{2.5}, PM₁₀ and NO₂ concentrations (expressed in $\mu\text{g}/\text{m}^3$) and average degree of urbanisation (as defined by the DEGURBA classification) observed simultaneously across the different age groups and deprivation index classes and across the internal regions.

Italy

Average concentrations of **PM_{2.5}** = 14.37 μm^3

Average concentrations of **PM₁₀** = 22.78 μm^3

Broken down by **AGE CATEGORY** and **DEPRIVATION INDEX** and by **AGE CATEGORY** and **REGIONS**

PM _{2.5}		0-49	50-69	70+
		14.01	14.31	14.71
1	17.29	17.31	17.29	17.29
2	15.90	15.64	15.83	16.16
3	14.51	14.15	14.40	14.91
4	13.15	12.65	13.10	13.59
5	12.43	12.18	12.34	12.76
Lazio	12.73	12.69	12.68	12.82
Veneto	19.16	19.34	19.15	19.08
Sicilia	11.04	11.05	11.05	11.01
Sardegna	6.80	6.81	6.80	6.79
Campania	12.07	12.09	12.09	12.05

PM ₁₀		0-49	50-69	70+
		22.40	22.69	23.16
1	25.28	25.31	25.26	25.28
2	24.00	23.72	23.87	24.33
3	22.60	22.22	22.42	23.12
4	21.47	20.83	21.39	22.06
5	22.24	21.93	22.13	22.65
Lazio	20.98	20.85	20.88	21.25
Veneto	26.92	27.12	26.90	26.85
Sicilia	19.46	19.46	19.46	19.47
Sardegna	13.05	13.07	13.05	13.04
Campania	25.83	25.85	25.85	25.79

Average concentrations of **NO₂** = 17.88 μm^3

Average degree of **URBANISATION** =
TOWNS AND SUBURBS

Broken down by **AGE CATEGORY** and **DEPRIVATION INDEX** and by **AGE CATEGORY** and **REGIONS**

NO ₂		0-49	50-69	70+
		17.37	17.70	18.49
1	20.42	20.22	20.24	20.75
2	20.33	19.91	20.02	21.00
3	17.99	17.59	17.72	18.65
4	16.67	15.85	16.48	17.59
5	19.55	19.04	19.34	20.26
Lazio	20.96	20.08	20.54	22.30
Veneto	19.52	19.45	19.42	19.67
Sicilia	9.69	9.73	9.78	9.55
Sardegna	3.04	3.05	3.04	3.03
Campania	27.30	27.28	27.32	27.30

URB		0-49	50-69	70+
		TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS
1	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS
2	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS
3	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS
4	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS
5	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS
Lazio	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS
Veneto	RURAL AREAS	RURAL AREAS	RURAL AREAS	RURAL AREAS
Sicilia	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS
Sardegna	RURAL AREAS	RURAL AREAS	RURAL AREAS	RURAL AREAS
Campania	CITIES	CITIES	CITIES	CITIES

Annex 3 SPAIN - Average PM_{2.5}, PM₁₀ and NO₂ concentrations (expressed in $\mu\text{g}/\text{m}^3$) and average degree of urbanisation (as defined by the DEGURBA classification) observed simultaneously across the different age groups and deprivation index classes and across the internal regions.

Spain

Average concentrations of **PM_{2.5}** = 10.10 $\mu\text{g}/\text{m}^3$

Average concentrations of **PM₁₀** = 16.77 $\mu\text{g}/\text{m}^3$

Broken down by **AGE CATEGORY** and **DEPRIVATION INDEX** and by **AGE CATEGORY** and **REGIONS**

PM _{2.5}		0-49	50-69	70+
		10.15	10.12	10.00
1	10.69	10.59	10.71	10.74
2	9.80	9.87	9.80	9.71
3	9.95	10.12	9.98	9.75
4	10.10	10.22	10.07	10.05
5	9.82	9.56	9.95	9.63
Cataluña	9.77	9.94	9.78	9.65
Andalucía	12.09	12.02	12.28	11.81
Pais Vasco	9.64	9.62	9.64	9.68

PM ₁₀		0-49	50-69	70+
		16.87	16.82	16.62
1	17.36	17.07	17.43	17.50
2	15.89	16.02	15.93	15.69
3	16.30	16.65	16.35	15.90
4	17.16	17.47	17.18	16.90
5	19.13	19.22	19.40	18.71
Cataluña	15.49	15.67	15.49	15.34
Andalucía	24.25	24.14	24.52	23.88
Pais Vasco	15.14	15.05	15.15	15.22

Average concentrations of **NO₂** = 12.49 $\mu\text{g}/\text{m}^3$

Average degree of **URBANISATION** =
RURAL AREAS

Broken down by **AGE CATEGORY** and **DEPRIVATION INDEX** and by **AGE CATEGORY** and **REGIONS**

NO ₂		0-49	50-69	70+
		12.39	12.56	12.45
1	14.58	13.95	14.68	15.01
2	11.67	11.74	11.68	11.60
3	12.30	12.42	12.39	12.04
4	12.02	12.15	11.86	12.16
5	10.37	10.35	10.52	10.19
Cataluña	10.93	11.18	10.90	10.74
Andalucía	14.01	13.72	14.39	13.67
Pais Vasco	13.08	12.79	13.09	13.31

URB		0-49	50-69	70+
		RURAL AREAS	RURAL AREAS	RURAL AREAS
1	RURAL AREAS	RURAL AREAS	RURAL AREAS	RURAL AREAS
2	RURAL AREAS	RURAL AREAS	RURAL AREAS	RURAL AREAS
3	RURAL AREAS	RURAL AREAS	RURAL AREAS	RURAL AREAS
4	RURAL AREAS	RURAL AREAS	RURAL AREAS	RURAL AREAS
5	RURAL AREAS	RURAL AREAS	RURAL AREAS	RURAL AREAS
Cataluña	RURAL AREAS	RURAL AREAS	RURAL AREAS	RURAL AREAS
Andalucía	RURAL AREAS	RURAL AREAS	RURAL AREAS	RURAL AREAS
Pais Vasco	RURAL AREAS	RURAL AREAS	RURAL AREAS	RURAL AREAS

Annex 4 UKRAINE - Average PM_{2.5}, PM₁₀ and NO₂ concentrations (expressed in $\mu\text{g}/\text{m}^3$) and average degree of urbanisation (as defined by the DEGURBA classification) observed simultaneously across the different age groups and deprivation index classes.

Ukraine

Average concentrations of **PM_{2.5}** = 12.67 $\mu\text{g}/\text{m}^3$

Broken down by **AGE CATEGORY** and **DEPRIVATION INDEX**

PM _{2.5}		0-49	50-69	70+
		12.67	12.62	12.73
1	12.93	13.08	12.97	12.72
2	12.65	12.67	12.57	12.76
3	12.72	12.63	12.47	13.46
4	11.56	11.44	11.53	11.77
5	12.48	12.52	12.53	12.29

Average concentrations of **NO₂** = 4.05 $\mu\text{g}/\text{m}^3$

Broken down by **AGE CATEGORY** and **DEPRIVATION INDEX**

NO ₂		0-49	50-69	70+
		4.07	4.05	4.02
1	4.56	4.76	4.57	4.35
2	3.58	3.59	3.55	3.64
3	3.74	3.66	3.63	4.08
4	3.18	3.18	3.16	3.22
5	3.76	3.81	3.82	3.53

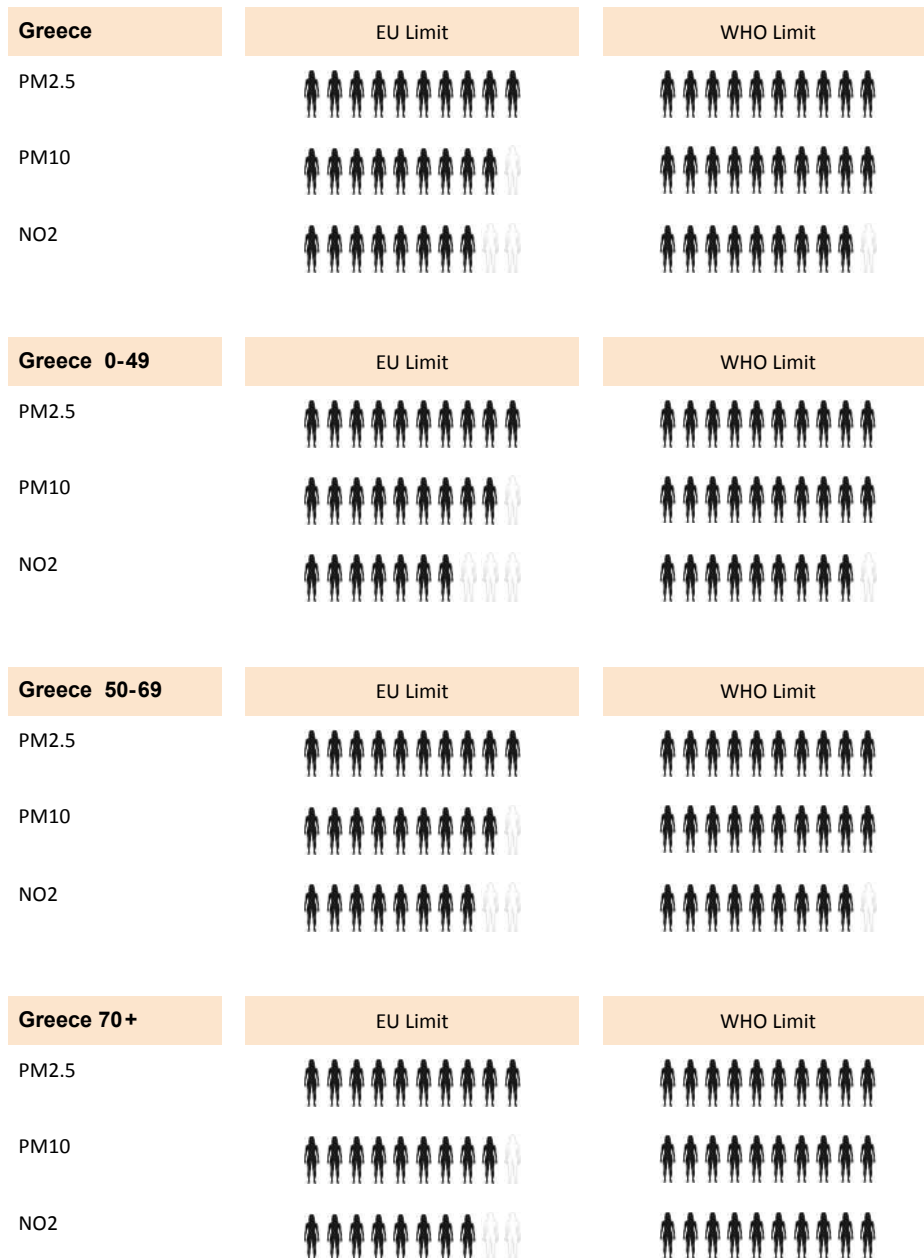
Average degree of **URBANISATION** =
RURAL AREAS

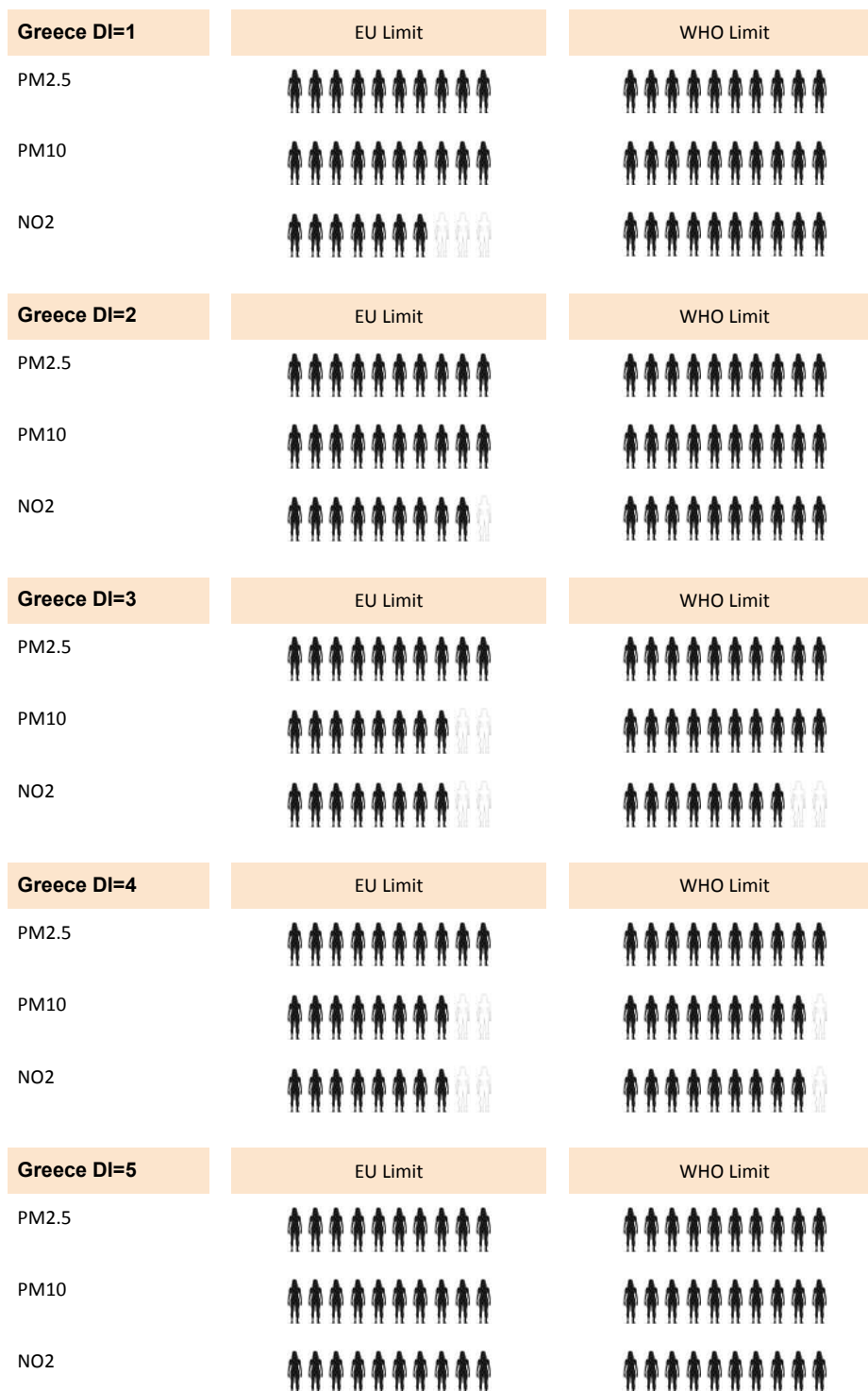
Broken down by **AGE CATEGORY** and **DEPRIVATION INDEX**

URB		0-49	50-69	70+
		RURAL AREAS	RURAL AREAS	RURAL AREAS
1	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS	TOWNS AND SUBURBS
2	RURAL AREAS	RURAL AREAS	RURAL AREAS	RURAL AREAS
3	RURAL AREAS	RURAL AREAS	RURAL AREAS	RURAL AREAS
4	RURAL AREAS	RURAL AREAS	RURAL AREAS	RURAL AREAS
5	RURAL AREAS	RURAL AREAS	RURAL AREAS	RURAL AREAS

Annex 5 GREECE - Share of women with a diagnosis of breast cancer exposed to PM2.5, PM10 and NO2 concentrations above the current EU standard and 2021 WHO guideline values. - Complete cohort, cohort broken down by age and deprivation index.

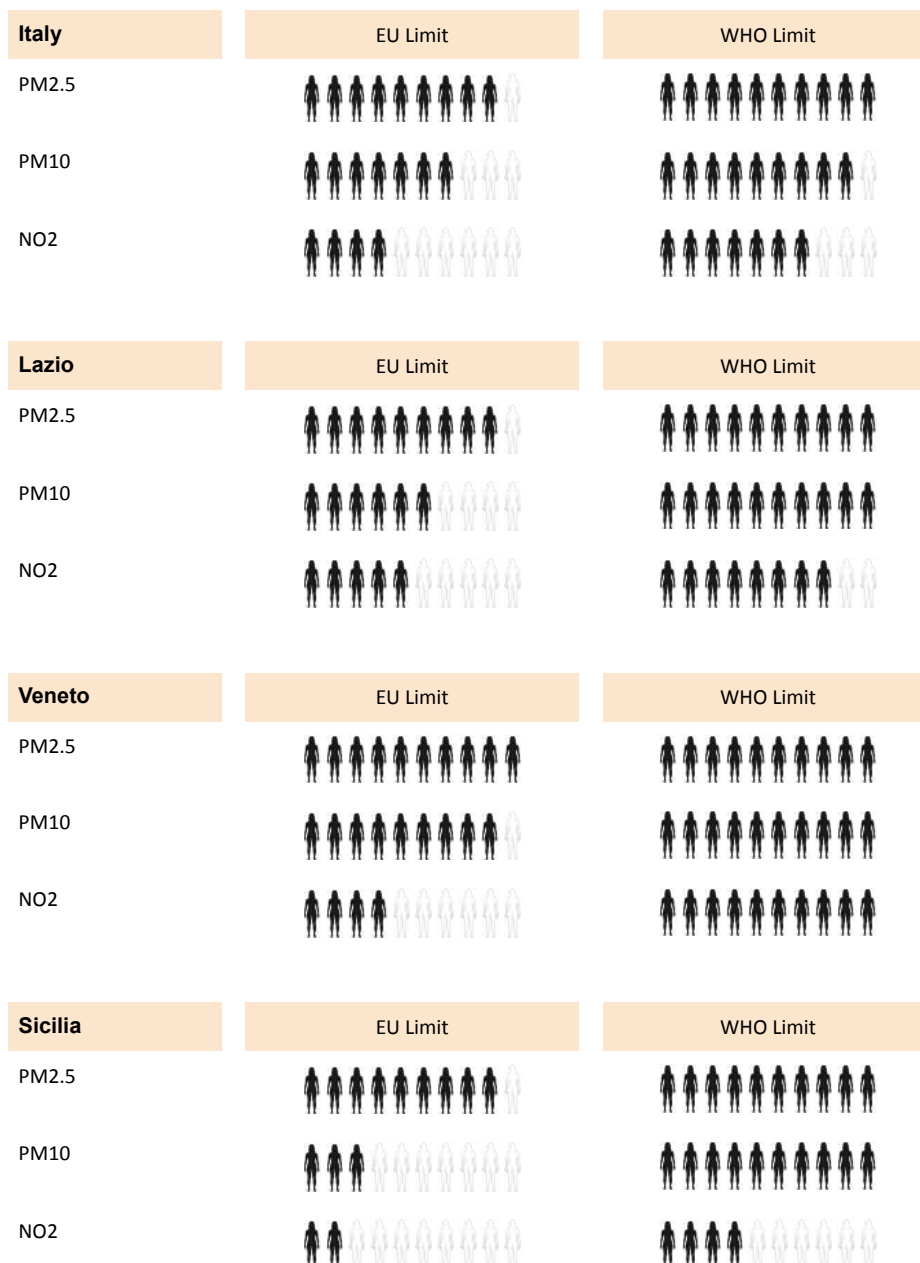
GREECE



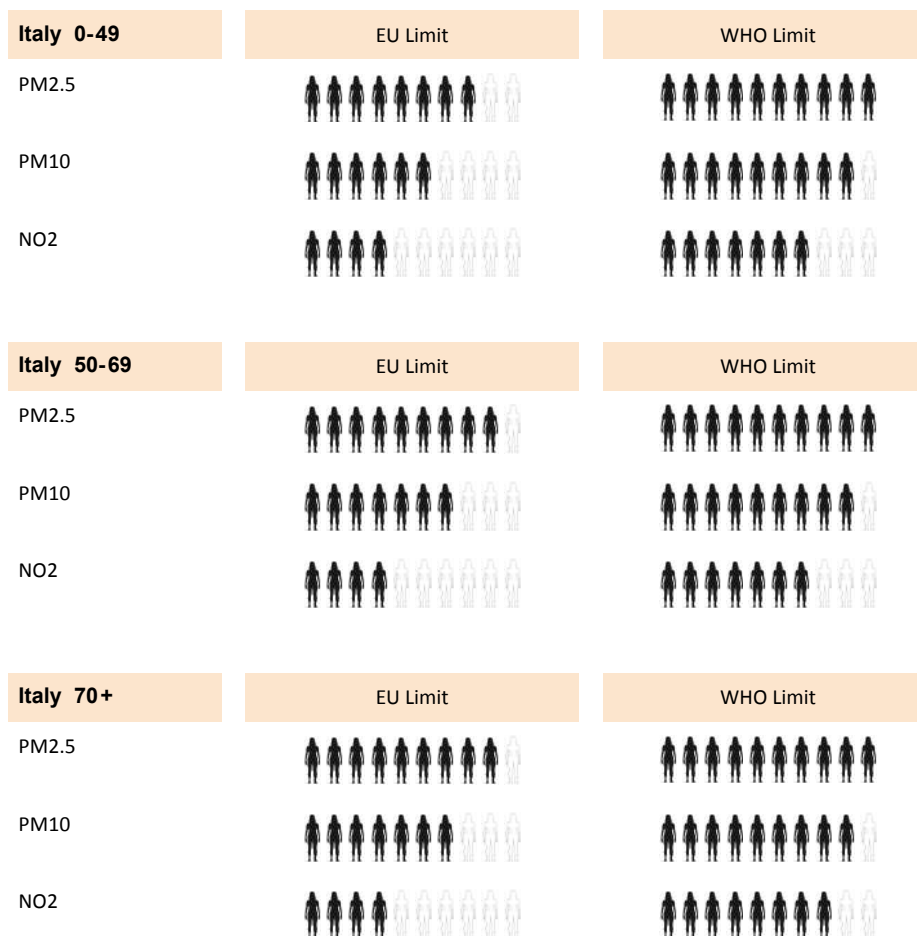


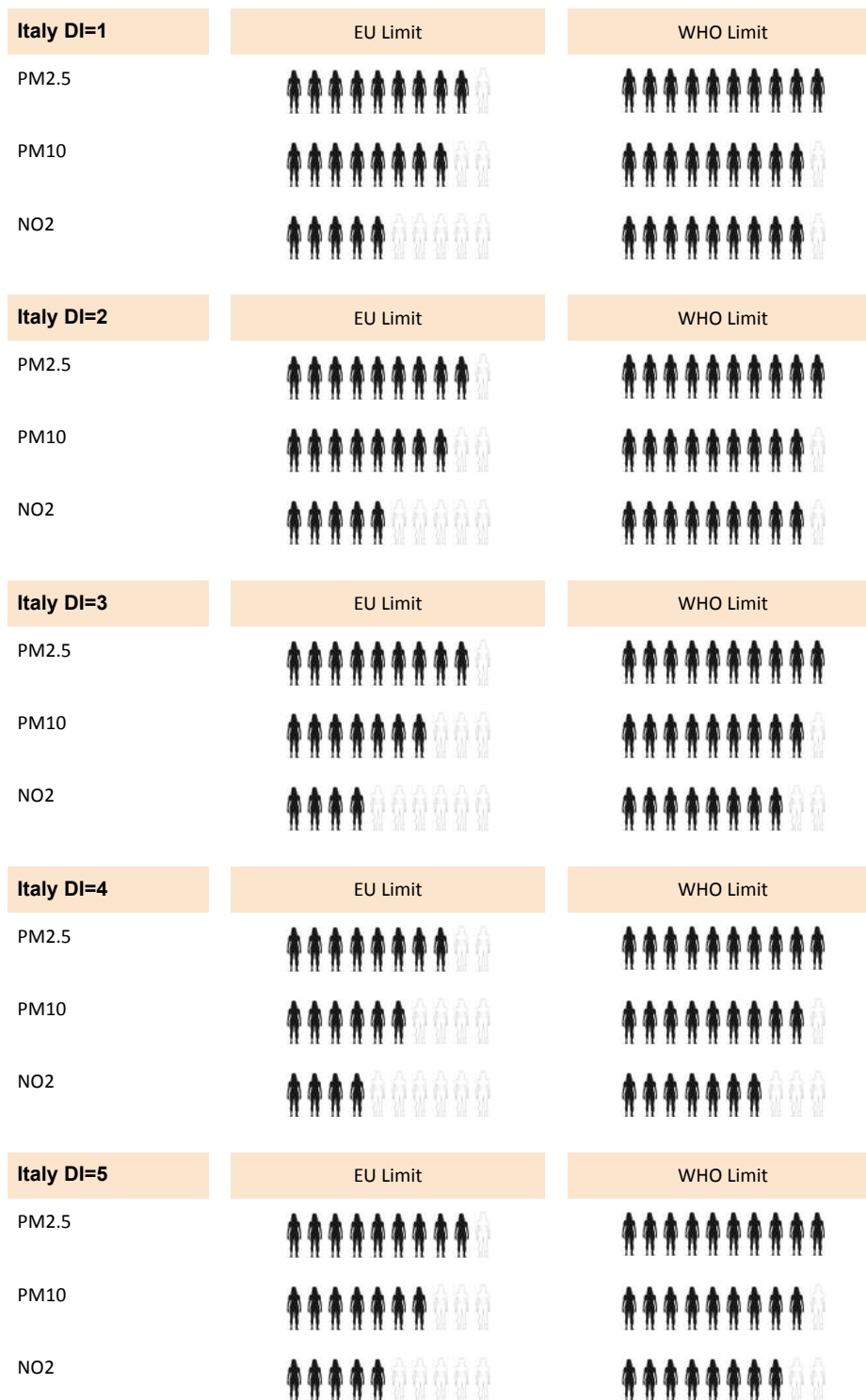
Annex 6 ITALY - Share of women with a diagnosis of breast cancer exposed to PM2.5, PM10 and NO2 concentrations above the current EU standard and 2021 WHO guideline values. - Complete cohort, cohort broken down by internal region, age and deprivation index.

ITALY



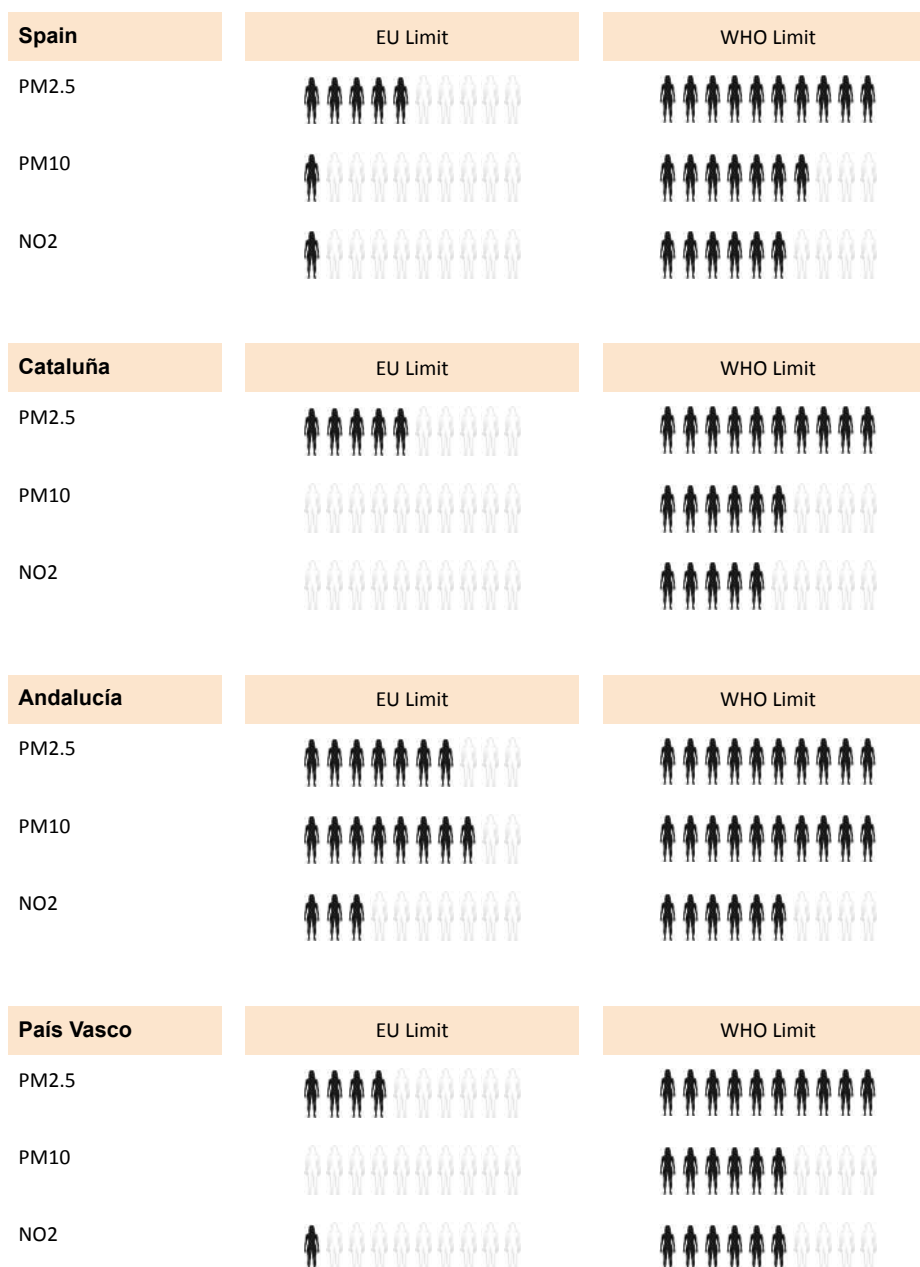


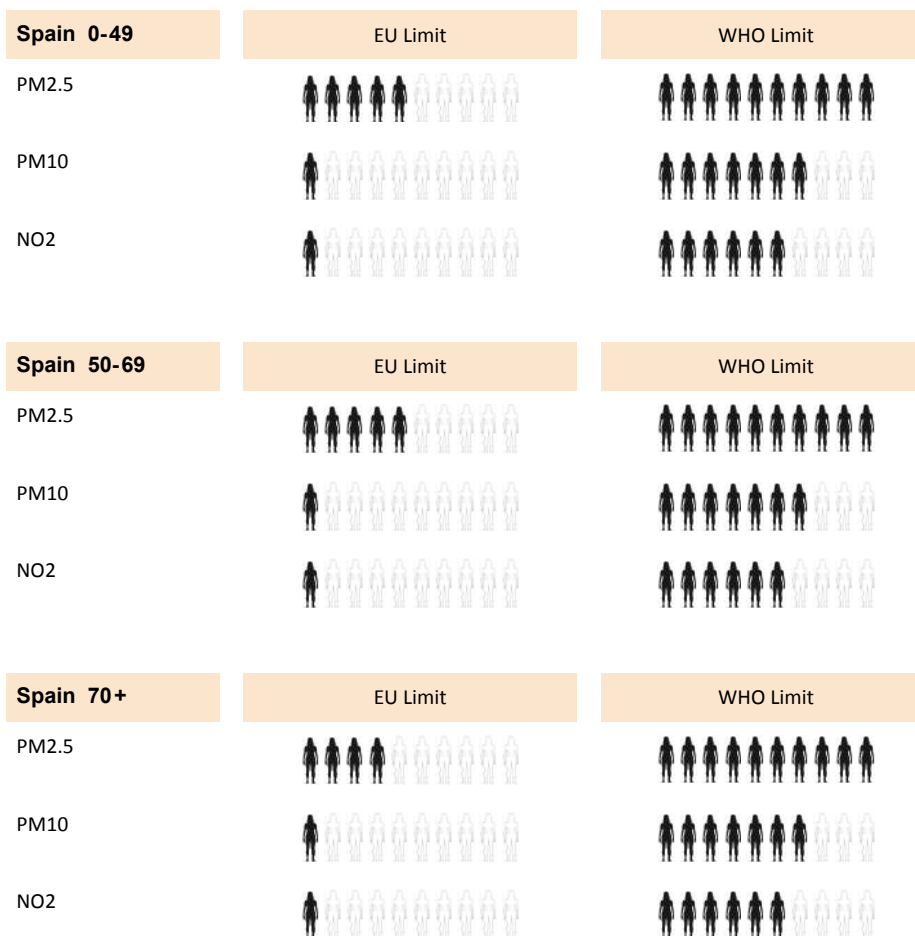


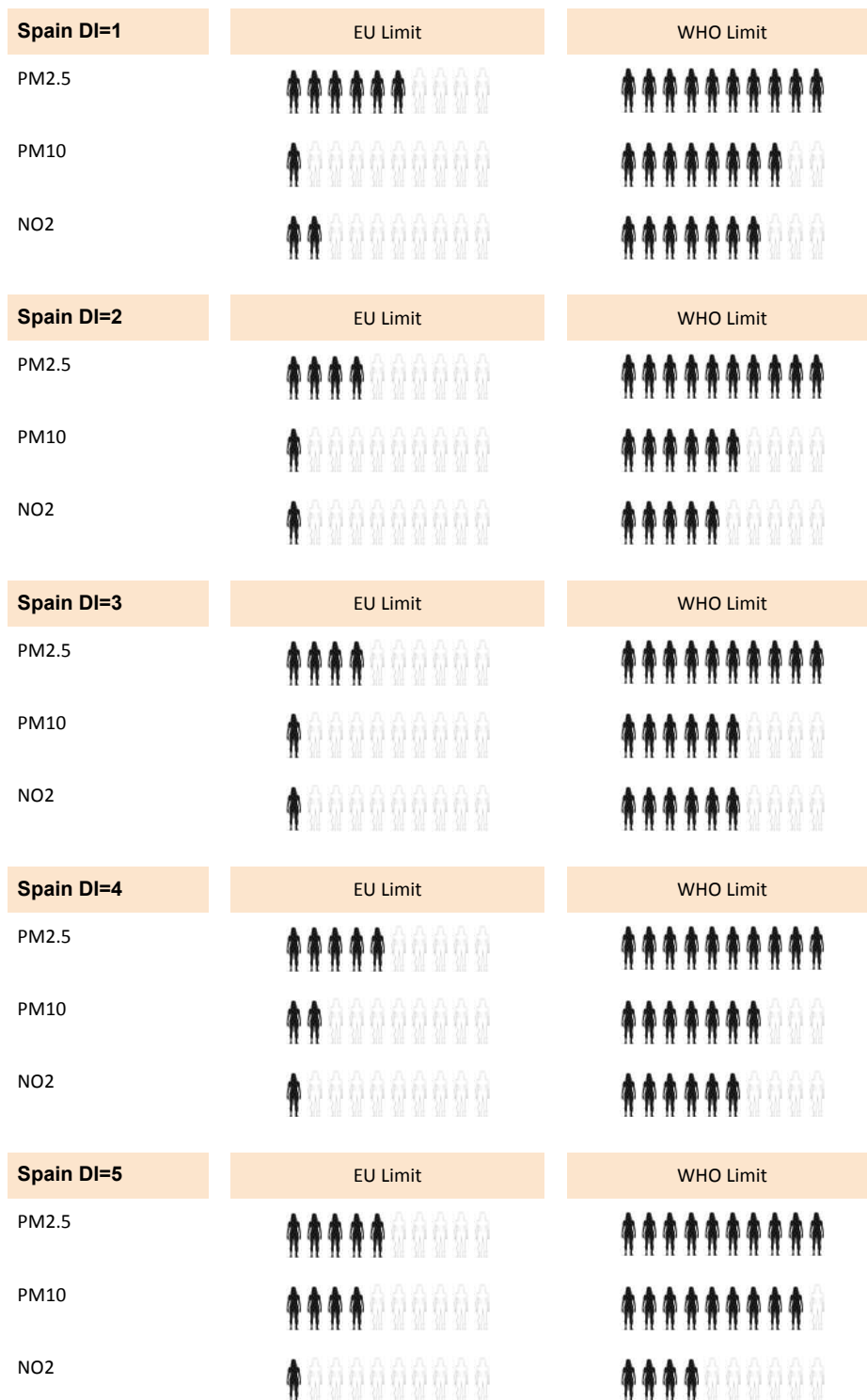


Annex 7 SPAIN - Share of women with a diagnosis of breast cancer exposed to PM2.5, PM10 and NO2 concentrations above the current EU standard and 2021 WHO guideline values. - Complete cohort, cohort broken down by internal region, age and deprivation index.

SPAIN

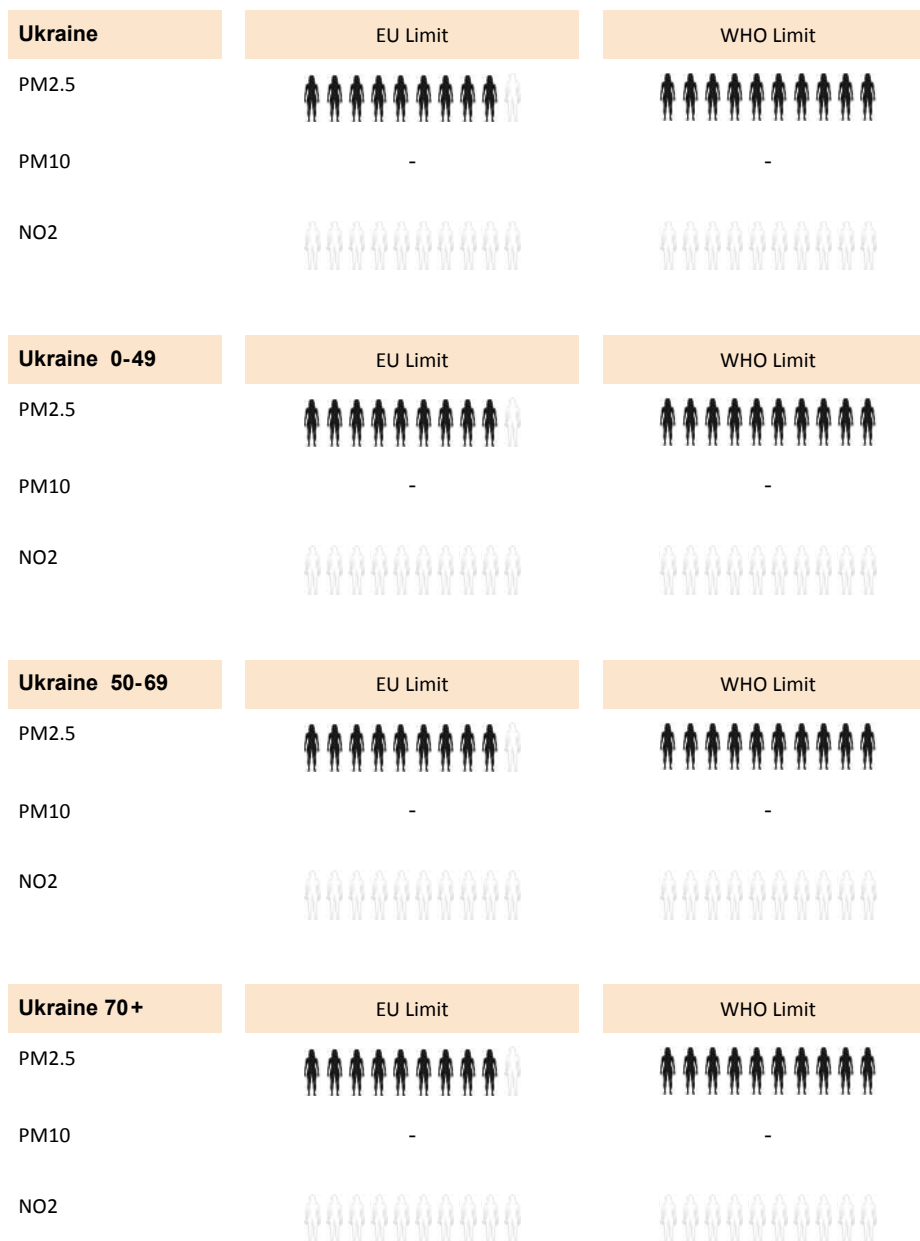


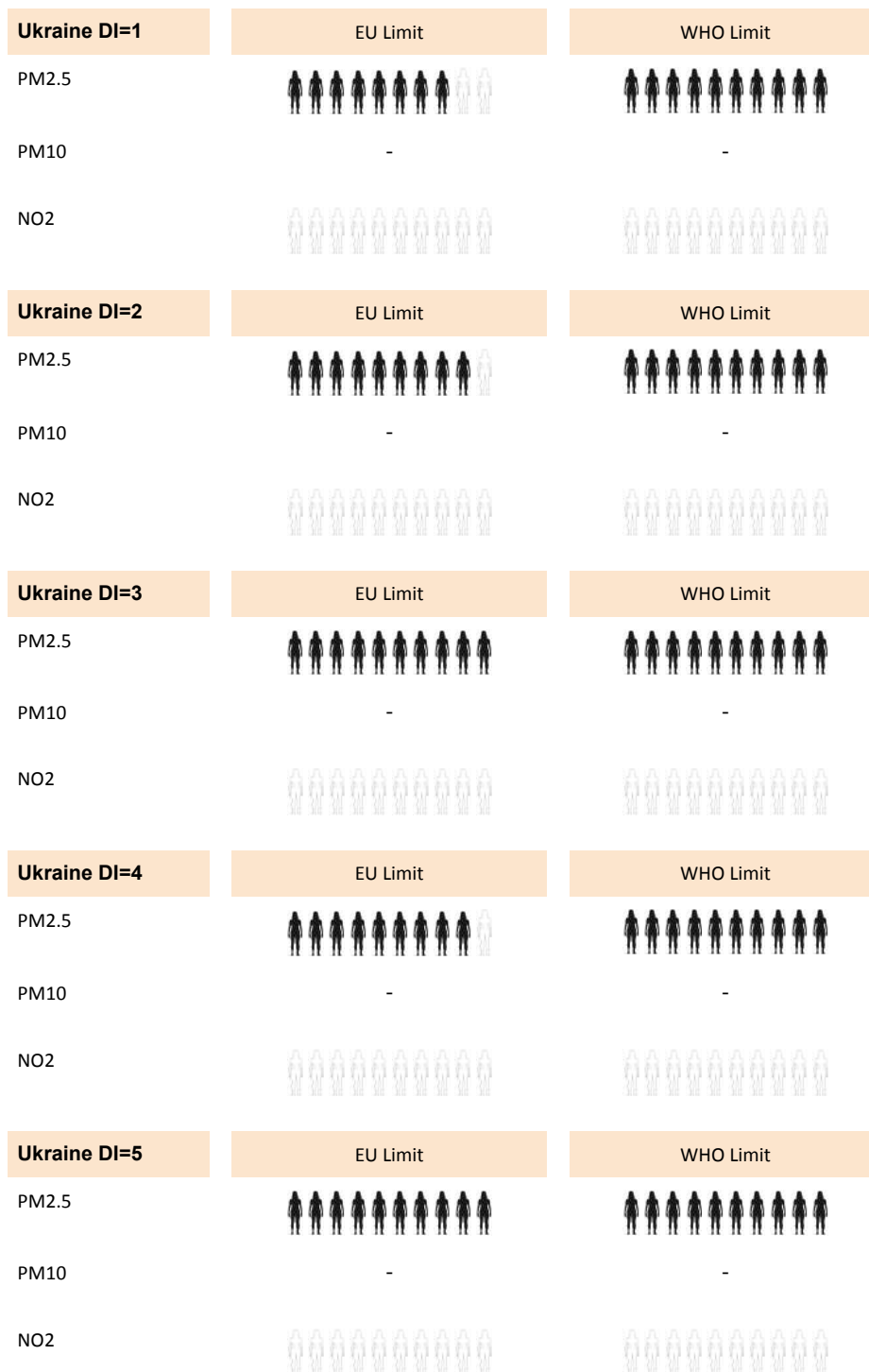




Annex 8 UKRAINE - Share of women with a diagnosis of breast cancer exposed to PM2.5, PM10 and NO2 concentrations above the current EU standard and 2021 WHO guideline values. - Complete cohort, cohort broken down by age and deprivation index.

UKRAINE





Annex 9 Share of women with a diagnosis of breast cancer exposed to PM2.5, PM10 and NO2 concentrations above the current EU standard and 2021 WHO guideline values. - Cohort broken down by internal region and type of pollutant.

PM2.5



PM 10

Regions	EU Limit	WHO Limit
Attica		
Andalucía		
Campania		
Cataluña		
Ivano-Frankivs'ka Oblast	-	-
Lazio		
País Vasco		
Sardegna		
Sicilia		
Veneto		

NO2

