Ambient particulate matter exposure and red blood cell distribution width (RDW): results from a cross-sectional linkage study in Portugal

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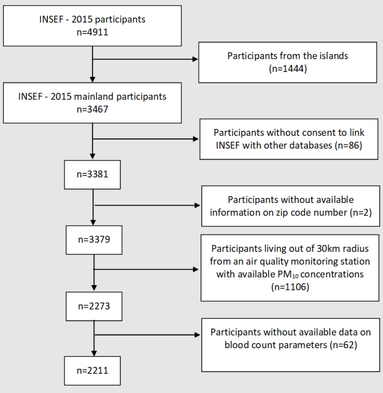
Key finding: Even at low levels of exposure, there was an association between long-term exposure to particulate matter (PM_{10}) and increased values of red blood cell distribution width (RDW)

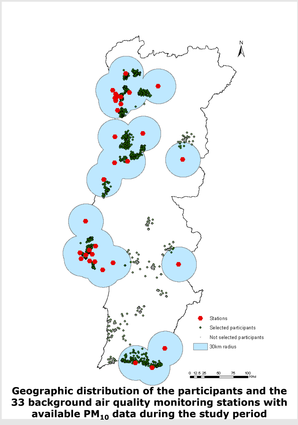
Background and Aim

- PM is being considered an important risk factor for cardiovascular (CV) diseases, which continue to be the leading cause of death in many countries including in Portugal (1,2);
- The pathophysiologic mechanisms linking PM and CV diseases are not entirely known, being a currently research area with a lot of scientific debate (3);
- Epidemiological studies on the association between PM and biomarkers of CV risk conditions are essential to establish the biologic plausibility of the association between PM and CV mortality and morbidity;
- RDW has been identified as an independent prognostic biomarker of multiple cardiovascular diseases (4-6);
- The present study aims to assess the association between long-term exposure to PM_{10} and RDW values, in the adult Portuguese mainland population, in 2015.

Materials and Methods

Study population: 2211 participants of the 1st Portuguese Health Examination Survey (INSEF, 2015) with available data on RDW parameter and living within a 30 km radius of an air quality monitoring station from the air quality monitoring network of the Portuguese Environment Agency with available PM_{10} measurements.





Geographic distribution of the participants and the 33 background air quality monitoring stations with available PM_{10} data during the study period

Health and sociodemographic data: Age, sex, educational level, occupation and lifestyles variables (smoking, excessive alcohol consumption, sedentary and unhealthy diet) were obtained by self-report through the interview. Fresh non-fasting whole blood samples were used to RDW determination.

Environmental data: PM_{10} values were obtained from the QualAr database, available online at the Portuguese Environment Agency (APA) website. For each individual the allocated 1-year average PM_{10} concentrations was the weighted average of PM_{10} concentrations from all stations within 30 km from the participant's residence, in the previous 365 days. This average was weighted by the inverse of the squared distance between the residence and the air quality monitoring stations.

Statistical analysis: Regression coefficients (β) with the corresponding 95% confidence intervals (CI) were obtained by generalized linear regression models analyses for each 10-μg/m^3 increment of PM_{10}. The minimal sufficient adjustment set of variables considered to adjust the models were age, sex, socioeconomic status (educational level and occupation), lifestyles (smoking, excessive alcohol consumption, unhealthy diet and sedentary) and ambient air temperature.

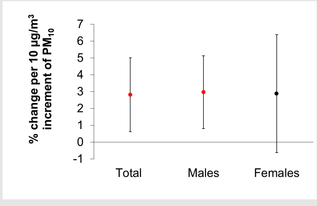
Results

Characteristics of the study participants

Characteristics	Females (n=1195)	Males (n=1016)	Total participants (n=2211)
Age (n=2211) - %			
25-49 years old	52.8	54.0	53.4
50-74 years old	47.2	46.0	46.6
Level of Education (n=2210) - %			
Low education	**54.6**	**62.2**	**58.2**
Medium education	**21.7**	**21.5**	**21.6**
High education	**23.7**	**16.3**	**20.2**
Occupation (n=2047) - %			
White-collar occupation	**69.6**	**56.1**	**63.0**
Blue-collar occupation	**30.4**	**43.9**	**37.0**
Lifestyles variables - %			
Smokers (n=2211)	**16.2**	**26.5**	**21.1**
Excessive alcohol consumers (n=2210)	**20.3**	**53.4**	**36.1**
Unhealthy Diet (n=2210)	**27.0**	**46.1**	**36.1**
Sedentary (n=2198)	41.7	48.1	45.1
Anaemia (n=2191)- %	**7.5**	**2.7**	**5.2**
RDW (n=2211)- %	**13.3**	**13.2**	**13.2**
Individual allocated 1-year average Temperature (n=2211) - (mean, sd)	15.9, 4.1	16.0, 4.0	15.9, 4.0
PM_{10} (n=2211) - (mean, sd)	17.5, 3.0	17.5, 3.0	17.5, 3.0

Results in bold are those with statistically significant difference between Females versus Males, according to the Pearson's chi-squared test. (p<0.05).

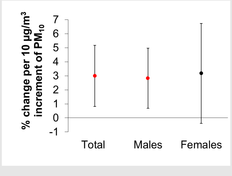
Association between PM10 and RDW values



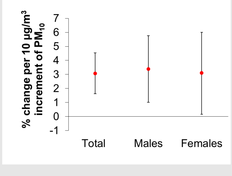
Sensitivity analysis

- 2.82% RDW increase per each 10 μg/m^3 PM_{10} increment. (95%CI: 0.62% - 5.02%)
- Results supported by the sensitivity analysis.

Exclusion of participants with anemia



Restriction to participants living within a 20-km radius of at least one air quality monitoring station



Conclusions

- To the best of our knowledge, this is the first study describing an association between ambient PM_{10} exposure and RDW values. It is uncertain whether changes in RDW due to PM_{10} exposure constitute an adverse health outcome. However, RDW has been identified as an independent prognostic biomarker of multiple cardiovascular diseases, therefore we consider this result to be of relevance to explain the effect of PM_{10} in triggering cardiovascular events.
- Even at relatively low-levels of PM_{10} concentrations, in Portugal, it was possible to detect the PM_{10} exposure effect on RDW values, suggesting that there is no safe level of air pollutants. Our findings suggest that reducing PM_{10} levels would result in additional benefits concerning the cardiovascular health of the population.

References:
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