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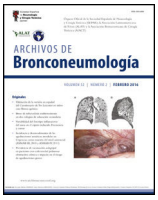

Editorial

E-waste: Rare earth elements, new toxic substances in cigarettes and electronic cigarettes☆

La e-basura: *rare earth elements,* nuevos tóxicos presentes en los cigarrillos y cigarrillos electrónicos

Cigarette smoke is estimated to contain more than 5000 chemical components,[1,2] of which up to 98 inhaled toxic compounds have been associated with cancer, cardiovascular and respiratory diseases.[3] Pollution by heavy metals, including rare earth elements (REEs) and other minor elements, has increased over the past decade, partly due to the use of technological and electronic devices.[4] Although some of these heavy metals are needed to sustain life, most are not essential, and indeed are known to produce adverse effects on human health even at very low concentrations due to their high degree of toxicity (e.g. arsenic, cadmium, chromium, lead, and mercury).[5] Other elements, some of which are essential, have also been classified by the Agency for Toxic Substances and Disease Registry (ATSDR) as toxic to living organisms at high concentrations.[6] The ATSDR lists 275 priority pollutants, including 23 heavy metals[6] which are also found in smoke and tobacco products as a result of environmental pollution.[3] This new group of pollutants, known as REEs, have been acquiring a great deal of environmental importance, and their systematic use in the development of smartphones, tablets, computers, photocopiers, telephones, rechargeable batteries, etc. has already generated a new occupational and health safety risk.[4,7–10] REEs are metals that include scandium, yttrium and the 15 elements of the lanthanide group (lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium)[10] and are the source of e-waste.[4,7] Tobacco plants can accumulate REEs when these contaminants are present in the soil.[11] Tobacco growers use certain techniques that make tobacco more susceptible to the accumulation of toxins; tobacco plants deplete the macro and micronutrients of the soil in which they are grown, and this process is intensified by agricultural practices used to increase the amount of nicotine in the leaves of the plant.[12]

As a result, we can conclude that the use of cigarettes and even electronic cigarettes (e-cigarettes) is a source of exposure to these emerging pollutants known as REEs. Large studies must be conducted to determine the effect of these elements on human health, and we call on national governments and worldwide organizations to impose multiple mandatory strategies at all levels for the management of this e-waste.

The evidence available to date on the accumulation of these metals in cigarettes and e-cigarettes is unequivocal. Zumbado et al.[11] analyzed the levels of 33 metals used in tech industries in manufactured cigarettes and roll-your-own (RYO) cigarettes, studying both the tobacco and the paper and filters. They looked not only at heavy metals conventionally listed as toxic but also at e-waste products, and found that all elements that appear in the ATSDR list were present in both rolling paper and tobacco, with the exception of mercury, that was not isolated in blond tobacco, black tobacco, or "slim" cigarettes. Most REE elements were found in almost all samples (all of them were found, but some only sporadically). Cigarette paper contained higher levels of most elements than the tobacco itself (or even much higher levels, in the case of antimony, selenium, silver, thallium, uranium, and vanadium). When the authors measured the concentrations of elements in the paper of manufactured cigarettes, they found significant differences depending on the type of tobacco: in black tobacco cigarettes, significantly high concentrations of 7 elements (barium, copper, lead, antimony, selenium, and vanadium) were found. Likewise, the levels of REE elements were practically double those of "slim" cigarettes, which in contrast contained high concentrations of silver. The paper used to roll blond cigarettes had the lowest concentration of those elements. The concentrations of these metals in tobacco were always higher in black tobacco, and they were also found in different concentrations in the paper of RYO cigarettes, with high levels being detected in flavored papers. The authors conclude that black tobacco contains the highest levels of these toxic metals, the paper used to wrap tobacco significantly modifies the levels of these elements, and flavored and fast-burning papers contribute to higher levels of these heavy metals. Badea et al.[13] analyzed 42 heavy metals including REEs in the blood of non-smokers, smokers, and e-cigarette users and found the highest levels of copper, molybdenum, zinc, antimony and strontium among smokers, and selenium, silver, tin and vanadium among e-cigarette users. Beryllium, europium, and lanthanides were detected more frequently in e-cigarette users than in smokers; moreover, more than 10 different REE elements were identified in 11.8% of e-cigarette users. Serum levels of cerium and erbium in e-cigarette users increased as consumption increased. The authors conclude that tobacco smoke is an important source

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of heavy metals, while e-cigarettes are a potential source of REE. An understanding of the toxic substances present in e-cigarettes is becoming increasingly important in public health due to events associated with e-cigarette use that are currently coming to light in the USA,[14] and death rates are showing that the uncontrolled use of a product that contains chemical substances is unacceptable.

Drago et al.[15] found that smoking in enclosed spaces was associated with elevated levels of suspended particles measuring less than 2.5 μm ($PM_{2.5}$) of cerium, lanthanum, cadmium, and thallium which were associated with a higher probability of respiratory symptoms among adolescents and children. REEs (lanthanum, cerium, europium, and gadolinium) have also been found in the semen of tobacco and alcohol users, but without affecting its quality.[16]

Conflict of interests

JIG-O has received c for speaking engagements, scientific consultancy, clinical trial participation, and preparation of publications for (in alphabetical order): AstraZeneca, Chiesi, Esteve, Faes, Gebro, Menarini and Pfizer. CG-Q has received honoraria for participating in clinical trials from GSK.

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