Do marine aerosols improve human health?

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Throughout mankind's history, exposure to seawater and sea-air have been linked to positive human health effects. The first records of thalassotherapy date back to the ancient Egyptians, Greeks and Romans (Verhaeghe, 1843; Lucchetta *et al.*, 2007). Epidemiological research has fairly recently started to reveal and understand these coastal health effects (Brereton *et al.*, 2008; Wheeler *et al.*, 2012; White et al., 2013). Several hypotheses, related to immunoregulation and physiological mechanisms, have been put forward to explain the blue space/gym effect (Rook *et al.*, 2013; White *et al.*, 2014). Moore (2015) suggested that part of this coastal health effect is caused by the regular exposure to natural or biogenic compounds in sea spray aerosols (SSAs). It is proposed that these compounds induce the health effect via an inhibitory activity on the phosphatidylinositol-3 kinase/protein kinase B/mechanistic target of rapamycin (PI3K/Akt/mTOR) cell signaling pathway. This is based on the fact that the augmented activity of this kinase pathway, is related to multiple pathological conditions (*i.e.* cancers, inflammation, diabetes, neurodegenerative diseases, and immunosuppression) (Laplante *et al.*, 2013).

Interesting marine bioactive compounds, potentially taking part in the suggested biogenics theory, are algal toxins. Phycotoxins are best known for the shellfish poisoning syndromes (*i.e.* amnesic, neurotoxic, diarrhetic and paralytic) they may cause, via contaminated seafood, during harmful algal blooms (HABs). There are, however, also a few published cases where phycotoxins like brevetoxins (Cheng *et al.*, 2005) and ovatoxins (Ciminiello *et al.*, 2014) have been measured in sea spray aerosols (SSAs) on Floridian and Mediterranean beaches, respectively. While these extreme cases induced temporary respiratory syndromes, aerosolised phycotoxins conventionally occur at much lower (harmless) background concentrations. One of the most interesting phycotoxins is yessotoxin (YTX). In our study, we demonstrated that YTXs have a potential positive effect at much lower concentrations as compared to effect concentration of other phycotoxins (*i.e.* brevetoxin, okadaic acid).

In this part of our research, the potential positive health effects of air-borne exposure to YTXs were examined. Since the respiratory system is the first level of exposure in this scenario, *in vitro* experiments were performed, using human lung tissue (A549 cell line). These epithelial adenocarcinoma alveolar cells were exposed for two days to pure standards and artificially produced aerosol extracts of homoyessotoxin (hYTX), a YTX analogue. Additionally, a natural aerosol extract, collected along the surf line in Ostend, was spiked at different doses to lung cell cultures. Both the phosphorylation status of the PI3K/Akt/mTOR kinase pathway and the related effects on gene-expression level were simultaneously assessed as endpoints in the performed experiments. The effects on the kinase pathway were examined using SDS-PAGE and western blotting. The analysis of the gene-expression was performed with RNA sequencing. Together with cell viability assays, previously performed in our study, a unique effects assessment on three different levels of biological organization is possible. An additional exploratory and holistic approach of this research lies in the use of artificial and natural aerosol extracts.

The results of this study will contribute to the mechanistic understanding of the role of biogenics in regulating the PI3K/Akt/mTOR pathway, and thus in understanding the role of SSAs in coastal health promotion.

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