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COVID-19: Pandemic in Ecuador: a health disparities perspective

COVID-19: pandemia en Ecuador desde una perspectiva de las disparidades de salud

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ABSTRACT

The global COVID-19 pandemic initiated in Ecuador with the patient zero in February 2020 and since more than 40,000 persons have been tested positive to the virus, leaving some 3,500 deceased, while approximately about 10,500 persons above annual average numbers died within March to May. A strict lockdown was applied by mid-March, which resulted to a severe economic crisis in the country. Although during the lockdown occurred a notable decrease in the number of new cases, the spread of the infection was already massive, untechnical, political and economic decisions will certainly lead to continuous wave of infections for months.

Objective Our study postulates, that persons who are most likely to be infected during such secondary wave will be people who have already health issues to which we count besides the known ones, especially those who are already suffer by the distribution of volcanic ashes, as such pyroclastic material is known to affect lunges and thyroids.

Methods A descriptive ecological study of information related to COVID-19 infection at a national level using official data from the Minister of Public Health and volcanic ash fall by geographical area in Ecuador.

Results The mortality rate per canton indicated that those with lower attack rates are the ones with highest mortality rate. For instance, Portovelo (21.3/100,000), Playas (18.4/100,000), Santa Rosa (15.8/100,000), Suscal (15.3/100,000) and Penipe (14.3/100,000) reported the highest mortality rate per 100,000 people. The main distribution of such volcanic material is within the central to northern area of the Highlands and Inter-Andean Valley of Ecuador, due to the analysis of some 7394 satellite images of the last 21 years.

Conclusions We conclude that areas with high vulnerabilities are also most susceptible to develop COVID-19. Such areas with their respective populations will be affected above average and shall be protected in particular within the presently starting during possible second wave of infection.

Key Words: Covid-19; volcanic ash; vulnerabilities; second wave of infection (*source: MeSH, NLM*).

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RESUMEN

La pandemia de COVID-19 inició en Ecuador en febrero de 2020. Desde el inicio más de 40 000 personas han sido oficialmente diagnosticadas con el virus, que ha dejado al menos 3 500 fallecidas, mientras que aproximadamente unas 10 500 personas por encima del promedio anual murieron entre marzo y mayo de 2020. A mediados de marzo se aplicó el confinamiento absoluto en el país, lo que provocó una grave crisis económica y social en Ecuador. Aunque el bloqueo produjo una reducción en el número de casos, la infección estaba propagada ya entre la comunidad y los diagnósticos aumentaron notable debido a decisiones políticas y económicas, que, sin lugar a duda, conducirán a oleadas posteriores de infección por incluso meses.

Objetivo Nuestro estudio postula que las personas que tienen más probabilidades de

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infectarse durante dicha ola secundaria serán las personas que ya tengan problemas de salud. A la vez, proponemos que aquellos pobladores que ya están sufriendo por la caída de cenizas volcánicas y flujos piroclásticos pueden tener más riesgo tal como lo describimos en casos relacionados con cáncer de tiroides y ceniza.
Métodos Es un estudio ecológico descriptivo de la información relacionada con la infección por COVID-19 a nivel nacional, utilizando datos oficiales de contagio del Ministerio de Salud Pública y caída de cenizas volcánicas por área geográfica en Ecuador.
Resultados La tasa de mortalidad por cantón indicó que aquellos con tasas de ataque más bajas son los que tienen la tasa de mortalidad más alta. Por ejemplo, Portovelo (21,3 / 100.000), Playas (18,4 / 100.000), Santa Rosa (15,8 / 100 000), Suscal (15,3 / 100 000) y Penipe (14,3 / 100 000) registraron la tasa de mortalidad más alta por cada 100 000 personas.
La principal distribución de dicho material volcánico se encuentra dentro de la zona centro-norte de la Sierra y Valle Interandino del Ecuador, debido al análisis de unas 7 394 imágenes satelitales de los últimos 21 años.
Conclusiones Concluimos que las áreas con alta vulnerabilidad también son más susceptibles a desarrollar COVID-19. Tales áreas con sus respectivas poblaciones se verán afectadas por encima de la media y estarán protegidas, en particular, dentro del inicio actual durante una posible segunda ola de infección.

Palabras Clave: COVID-19; ceniza volcánica; poblaciones vulnerables (*fuente: DeCS, BIREME*).

Independent of circumstances based on social and ethnic conditions, accessibility to health facilities, dispositions and abilities of governmental institutions in the attempt to reduce the contamination with the COVID-19 virus, the fatality rate is highest among persons with previous health conditions such as cardiac problems, diabetics and most of all, pulmonary diseases and or weaknesses (1). Based on the worldwide reported cases of all countries, COVID-19 starts to be distributed mainly by contacts of one person to another by aerosoles (sneazing, droplets etc.), and by touching contaminated surfaces (i.e., fomites), Airborne transmission can occur in two ways: either through relatively large particles of respiratory fluid (droplets; 101–102 μm) or through smaller such particles that can remain aerosolized (droplet nuclei; « 101 μm) (2). As larger droplets are pulled to the ground by gravity quickly, droplet transmission requires close physical proximity between infected and susceptible individuals, whereas aerosolized transmission can occur over larger distances and does not necessarily require that infected and susceptible individuals are at the same location at the same time.

In Ecuador, COVID-19 created a first hotspot and a rapid contamination of a high amount of people with corresponding high death rate in Guayaquil and the corresponding province of Guayas, due to a variety of circumstances. The mortality rate per canton indicated that those with lower attack rates are the ones with highest mortality rate. For instance, Portovelo (21.3/100,000), Playas (18.4/100,000), Santa Rosa (15.8/100,000), Suscal (15.3/100,000) and Penipe (14.3/100,000) reported the highest mortality rate per 100,000 people.

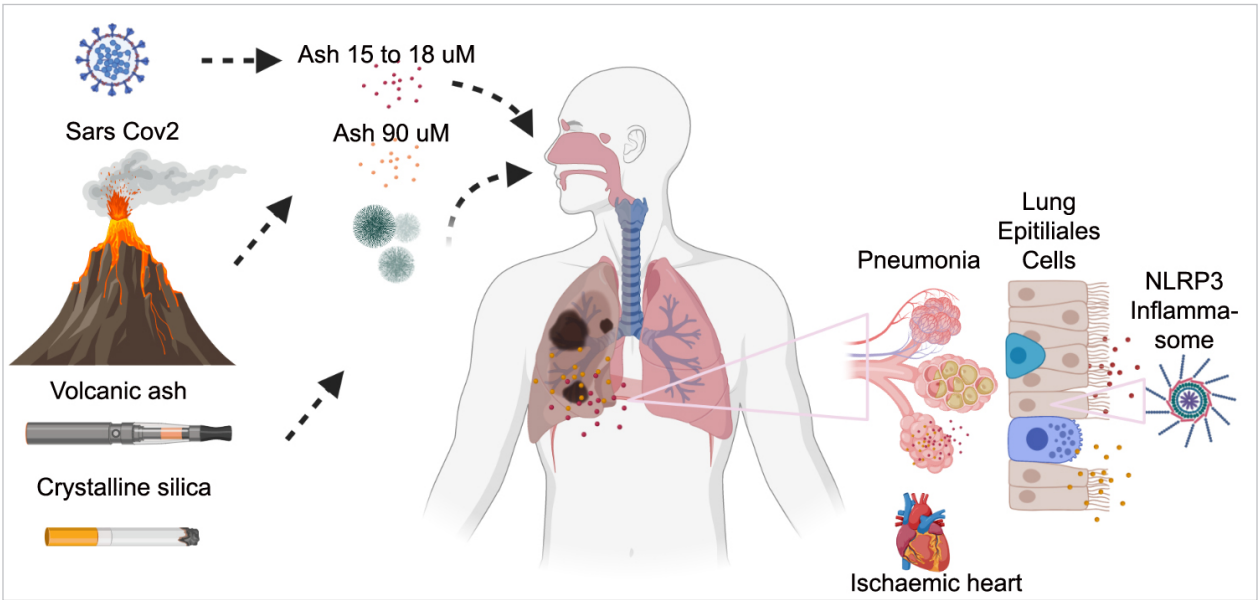
Guayaquil with a mortality rate of 5.8/100,000 was the city with the highest number of confirmed COVID-19 deaths. With time however, also the other 24 provinces of Ecuador caught up in numbers of active cases, smoothing the high rates of the first appearing hot spots (3). Nonetheless, it has been demonstrated that the real number of deceased is much higher than the official numbers, as compared to the mortality rates of previous years within the same months of March and April, which have indicated up to 7,000 deceased in excess in Guayas province only (4). Such high fatality rates based on or because of COVID-19, places Ecuador among the most affected countries worldwide.

Based on such considerations and independent of the aforementioned circumstances, it's a matter of simple arithmetics, to preview, that a nationwide distribution will compromise in a variety of degrees the health of the entire population. Therefore, it is fundamental to ascertain which part of the population will most likely be affected and be severely compromised when COVID-19 will be within all parts of the society. As persons with previous health conditions, especially those with pulmonary, cardiac or diabetic issues, will certainly have a higher death rate than other parts of the population, where they lack such weaknesses, than it is of high priority to isolate and protect such persons.

It has been demonstrated in a variety of countries that the emission of volcanic ash generates thyroid cancer (5). Due to the special geodynamic setting of Ecuador and its associated active volcanism, has led the country to have the worldwide highest rate of thyroid cancer (6,7). Volcanic ash is a highly underestimated respirable natural hazard, as its distribution and deposition usually doesn't lead to primary deaths among nearby and far living populations, except if higher amounts of ashes may lead to burial and asphyxiation or to physical damage due to roof collapse (8). Nonetheless, the dispersal of ash generates a major cause of morbidity following eruptive events, as its presence is able to generate primarily a variety of health issues such as ocular, nasal, throat and skin irritation,

besides more severe pulmonary problems (9). Hereby, volcanic ash in a variety of amounts and sizes may accelerate some pre-existing respiratory conditions, such as bronchitis and asthma in a longer time period after the volcanic activity (10) (Figure 1).

Figura 1. Activation of protein complex (inflamamasome NLPR3) in lung cells in vitro and in vivo by inhalation of volcanic ash



Furthermore, it has been evidenced in several volcanic environments, that an elevated presence of volcanic ash has caused an increase of thyroid cancer and lymphatic leukemia among populations within the range of ash-fallout areas, with a variety of influences within different ethnicities (11,12). Such inconveniences are reversible and may diminish once exposure ceases (13). This evidences that the presence of volcanic ash leads to a variety of pulmonary weaknesses and are prone to a higher than regular vulnerability towards COVID-19 infections.

Therefore, the current study will preventively support the prognosis of populations in areas susceptible to COVID-19, where a significant part of the public has been diagnosed with thyroid cancer, diseases related to chronic respiratory diseases, which most likely are related in the function of the distribution of recurrent volcanic ash. Therefore, we assume that the areas susceptible to the distribution of volcanic ash in Ecuador, could be suspected of being preferably affected by the Sars COV-2 virus and this condition should be further studied by an epidemiological monitoring.

RESULTS

Due to the subduction of the oceanic Nazca plate below the South American and Caribbean continental plates, some 250 volcanoes emerged in the Ecuadorian territory, of which most of them are extinct (14). Some 19 volcanoes are considered to be active in mainland Ecuador, of which five of them have been erupting in the last two decades (15). These five active volcanoes have been Sangay (permanent activity with higher intensity in 2004-2011, 2013 and 2016 as well as strong intensity in 2018-2020), Tungurahua (1999-2016, with minor interruptions), Guagua Pichincha (1999-2001, 2009), Reventador (2002-2020, with major interruptions) and Cotopaxi (2015), of which all of them have emitted volcanic ash in a variety of amounts and reach (15,16,17). The distribution of the fine-grained ash has been able to be traced by the available data from the Ecuador Satellite Imagery of the Satellite Services Division of the National Environmental Satellite, Data, and Information Service (NESDIS) for the period between September 1999 and May 2020 (Fig. 2). These data based on 7394 satellite images have been evaluated and allowed to characterize the area of influence of the volcanic ash precipitation, origin of a high amount of health vulnerabilities.

Volcano ashes have a huge diversity in morphology and composition. We have already studied, both in morphology and composition, different ashes coming from Cotopaxi, Pichincha and Tungurahua volcanoes (18,19). For the characterization, evaluation and analysis of all samples, we have used a field emission gun scanning electron microscope (FEG-SEM), brand TESCAN model

MIRA3. The chemical analysis was carried out by an EDX of the brand BRUKER detector XFlash 6130, resolution 123 eV (Mn alpha), installed in the SEM chamber. The ash samples were fixed onto SEM stubs using an adhesive layer and sputter-coated with gold (99.99% purity) before the imaging process. The main elements analyzed were Na, Mg, Al, Si, P, K, Ca, Ti, Mn, Fe. SEM pictures showed that ashes are quite inhomogeneous in their morphology. Size is quite dependent of the distance of the sampling and could be from some nanometers to millimeters. As an example, from last Cotopaxi explosion, size was from 10 nm to 300 um at 20km distance from the crater, and a mean size 113.5 um. Compositions of ashes of Pichincha, Cotopaxi and Tungurahua volcanoes are listed in Table 1. The volcanic ashes were mainly juvenile, except of those of Cotopaxi volcano, which have been reworked material. Therefore, shapes and morphologies of ash particles were predominantly rounded and less angular.

Based on the evaluation of the satellite images, the five active volcanoes, which are situated within the NNE-SSW oriented volcanic chains and the Amazon Basin, emitted volcanic ash mainly towards the west covering a huge proportion of the central and northern areas of the Inter-Andean Valley of Ecuador and even the southern part of Colombia (Figure. 2). The preferred direction towards west (between 250 and 290 degrees) has been

Figura 2. Main volcanic ash distribution in Ecuador based on the activity of the volcanoes Tungurahua (TUN; 4412 satellite images), Reventador (REV; 1971), Sangay (SAN; 829), Cotopaxi (COT; 151) and Guagua Pichincha (PIC; 31), with the three most populated cities Quito (Q), Guayaquil (G) and Cuenca (C)

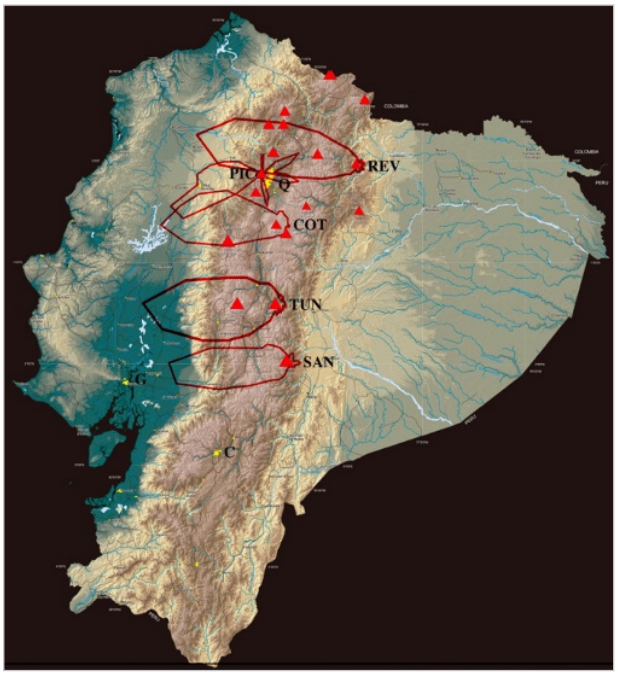


Table 1. Average weight percentage of each element (wt. %)

	Si	Al	Ca	Fe	Na	Mg	K	S
Pichincha	47,2	17,7	8,7	9,4	5.1	2,4	5,2	1,6
Cotopaxi	41,6	20,3	13,4	9,3	5,4	1,8	2,8	3,3
Tungurahua	45,1	17,2	10,9	10,7	4,2	2,4	4,4	1,5

Mn<1%, Ti y P<1.5%

indicated with almost 60% of all possible directions. This does not exclude volcanic ash precipitation in southern regions and cities such as Cuenca and Loja or coastal cities such as Guayaquil, but these are less frequented and therefore minorly affected areas.

Although it is known so far, that not every contact with a corona infected person leads to an infection and the risk of passing on the new virus or become infecting varies in different situations, while the decisive factor is the virus dose, i.e. the amount of viruses that a person comes into contact with (3). Based on the aforementioned results, it's a matter of time when after a period of several weeks of almost complete lockdown, the referred persons with such circumstances and preconditions will be affected after the lockdown will be revoked and a second infection wave may occur. The risk is particularly high if measures to reduce or limit the outbreak are given up too early, also because the world is still in the middle of the first wave of the coronavirus outbreak (20). The contagion cannot be expected to remain low just because it should be in a downward trend right now, which it is not in general in Latin America and in Ecuador in particular. Therefore, the infection rate can rise again at any time.

Ecuador has had in the near past a difficult economic situation already based on the oil price, fatal politics as well as natural disasters and their consequences, prior to the Pandemic (21,22). With the declared lockdown by March 16, the financial circumstances have led to an economic disaster of the country, where the Ecuadorian government decided to release thousands of state employees, to shut down or fuse ministries as well as other state organizations and the collapse of incoming tax revenues, which has led to the close to bankruptcy of Ecuador´s state economy. Therefore, the constitutional president declared the revocation of the lockdown for May 4, without further evaluating the virus-spreading situations in urban and rural areas. Such decision has been criticized by many, which has led the government to hand over

the decision of the stepwise end of the lockdown to the mayors of the cities and governors of the provinces. The opening itself shall follow a scheme of completion of a variety of conditions. Nonetheless, local authorities decided already to these openings based on political and not scientific, technical and or medical parameters. This is a second wave with an announcement.

Ecuador has already by end of May prior to the stepwise end of the lockdown the highest death rate by far in South America when compared to deaths per million citizens, being above 201, followed by Brazil and Peru with below 170. The most affected Ecuadorian public however, will be the persons who are in the shadow of the ash fall out within the Highlands and Inter-Andean Valley as well as may reach also Colombia, where similar issues exist, as indicated in the current study (23, 24).

Ecuador has been stronger affected than any other country in South America by the global COVID-19 pandemic, when counting deaths per million citizens. Due to the non-existing reduction of infections during a two months lasting lockdown, and based on political as well as economic decisions, a premature opening towards regular social and economic activities may led to the beginning of a secondary wave of infections. The secondary wave will most likely affect vulnerable persons within the Highlands and Inter-Andean Valley of Ecuador, as it is implied that such specific group of persons are already suffering by pulmonary and thyroid issues due to the distribution of volcanic ash of the nearby volcanoes ♥

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