

# Pesticide use and COVID-19: An Indictment of Global Agriculture and An Advocacy of the Mediterranean Food Culture

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## Research article

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# Abstract

As an exploratory and theoretical reflection for future articles discussing the perceived green/health qualities of tunisian food as a tourist promotion argument, the article is based on the assumption that the COVID-19 pandemic would have more impact in countries whose population has an immune system weakened by food overtreated with pesticides, and that the Mediterranean food culture, which offers foods with little or no pesticide treatment, is the best diet to develop the necessary immunity to resist COVID-19 and, by extension, resist other pandemics. To demonstrate this, the thematic map technique was used to cross-reference several masses of official statistical data. The results suggest four main categories of countries in relation to the link between deaths from COVID-19 and the use of pesticides in agriculture. This study demonstrates, therefore, the weakness, if not the inaccuracy, of certain hypotheses which are circulating or have circulated in recent months and that attempt to explain each country's response to the COVID-19 pandemic. Thus, assumptions such as the role of quarantine in containing the pandemic, the role of the BCG vaccine and the role of heat will prove unreliable. On the other hand, the hypothesis the paper will defend is that of the role of a healthy Mediterranean and flexitarian diet in strengthening the human immune system, which in turn counteracts the SARS-CoV-2 virus. This sanitary suitability would therefore be an argument for promoting and disseminating this culinary heritage throughout the world and thus contribute to its development as a tourist attraction.

# Introduction

The geography of food has always been in perpetual change, from local to global production and consumption. It started with geographically limited crops. The Near and Middle East are the historical home of wheat and barley; North China is the home of oranges, and in Southeast Asia, we find rice and bananas. Central America is the historical home of corn and cocoa; further south in Andean America, we find potatoes and tomatoes. Africa has given coffee and watermelon and finally, olive trees all around the Mediterranean, etc. In the Neolithic Period, these crops spread like cereals in Europe, Asia and Africa, rice throughout Asia, and maize in Central and South America. This is how these three agricultural areas were established, thus defining three civilizations: the wheat civilization, the rice civilization and the corn civilization (Braudel, 1967). These areas would continue for centuries until they were disrupted by the European conquest of the world: Christopher Columbus, Vasco da Gama, the Dutch East India Company, and others. Other stages mark the evolution of the food geography until the shaping of the three major food models of today: the Mediterranean diet (fruit, vegetables, olive oil, etc.) with a mode of production linked to the rural world and the food crop system, the Chinese model spread around the world thanks to a very large diaspora and the North American model carried by the agri-food industries, which has gradually established itself in developed countries and then in emerging countries, and continues to take place in developing countries, leading to concerns on all fronts: health, environmental, societal and economic. In 2017, the Food and Agriculture Organization of the United Nations (FAO) stated that meat production, of which the most polluting are sheep and cattle, emits greenhouse gases in the order of

21.76 CO<sub>2</sub>eq/kg for the former and 25.51 CO<sub>2</sub>eq/kg for the latter, compared to 0.20 CO<sub>2</sub>eq/kg for cereals (<http://www.fao.org/faostat/en/#data/EI>).

In an unprecedented global health context, that of the COVID-19 pandemic, focusing on changes in the geography of food supply seems to be more important than the search for a vaccine. History has shown that epidemics and pandemics are time-limited but recurrent phenomena. Some have a return capacity that varies from one pathogen to another according to several criteria: its capacity to mutate, its viral load, its reservoir, its contagion or reproduction rate (the famous R<sub>0</sub>), etc. Therefore, finding a vaccine for COVID-19 will not spare humanity from the appearance of another virus if we continue our "risky" food practices; about 60% of all human pathogens and 75% of emerging infectious diseases are of animal origin (Mohammadpour, Champour, Tuteja, Mostafavi, 2020). Consumption of wild animals, over-consumption of animal protein and modified and/or processed products are increasingly becoming practices that threaten human life. Even the consumption of fruits and vegetables has become increasingly at risk due to the large amounts of pesticides these products contain. In some cases, the production of a vaccine or drug would be a pointless financial drain, as in the case of the Tamiflu scandal claiming to treat influenza A (H1N1) or the Pandemrix scandal. Thus, preventing a disease would undoubtedly be more effective than trying to cure it.

Following the idea of the reference book "Big Farms Make Big Flu" by Rob Wallace (2016), which explains how global agriculture grew a pandemic, this article proposes to study the role of a quality diet to protect from a pandemic. The demonstration is based on presenting the impact of the intensive use of pesticides in weakening the human immune system in the face of the COVID-19 pandemic.

What is the relationship between the geography of food and the COVID-19 pandemic? Further, how could the intensive use of pesticides in agriculture intensify the impact of COVID-19?

The proposed hypothesis is assumed that COVID-19 would have more impact in countries whose population has an immune system weakened by poor quality food and, generally, a diet not adapted to humans. It is also assumed that the Mediterranean food culture proposes the diet best suited to develop immunity and therefore resist COVID-19 and, by extension, other pandemics.

## **Material And Methods**

### **1.1. Literature review**

#### **1.1.1. The health virtues of the Mediterranean diet**

Between a diet based essentially on industrial products and high-calorie meals and other greener diets such as vegetarianism, vegetalism and, more radically, veganism, the Mediterranean diet would be the most effective solution to bring about an easy change adopted by the consumer. On the one hand, there is no brutal ban on meat consumption, certainly in reasonable portions. On the other hand, the diet is

composed mainly of vegetable proteins that are less expensive to produce and less devastating to the environment (prioritizing seasonal products, food crops, etc.). Moreover, among the objectives of its ENPARD (European Neighbourhood Programme for Agriculture and Rural Development), the European Commission has committed to helping the Southern Mediterranean countries "stimulate local agriculture" (Abis, 2012). To use Derbyshire's (2017) expression, speaking of the Mediterranean diet, the flexitarian diet or "semi-vegetarian diet" (SVD) describes the same mode of diet. The last two names are neologisms. The best definition of the person who practices this diet comes from the website "flexitarisme.com", which describes flexitarians as "those who vegetarianise their diet without being totally vegetarian" (<https://www.flexitarisme.com/fondamentaux/>, consulted on 22/03/2020). Otherwise, it is a matter of eating mainly vegetarian food with the occasional inclusion of meat or fish. According to Derbyshire (ibid), this diet has been shown to be very beneficial to health, with benefits for body weight, improved metabolism, blood pressure regulation, reduced risk of type 2 diabetes and positive effects on the treatment of inflammatory bowel diseases such as Crohn's disease. The author states her conclusions based on an analysis of 25 studies published between 2000 and 2016 in the PubMed database of the National Center for Biotechnology Information. Numerous other studies confirm the superiority of the Mediterranean diet over "typical Western diets" (Childs, Calder, Miles, 2019; Dinu, Pagliai, Casini, Sofi, 2018; Bloomfield, Koeller, Greer, MacDonald, Kane, Wilt, 2016; Pérez-López, Chedraui, Haya, Cuadros, 2009; Sofi, 2009; Sofi, Abbate, Gensini, Casini, 2009; Sofi, Cesari, Abbate, Gensini, Casini, 2008). The Mediterranean diet is also very effective in strengthening the immune system (Dinu et al., ibid; Yahfoufi, Alsadi, Jambi, Matar, 2018; Rahman, Biswas, Kirkham, 2006). The immune system, through the production of antibodies, helps the body recover from diseases, including COVID-19 (Ni et al., 2020). Several studies show that exposure to pesticides used in agriculture severely weakens the immune system (Upadhyay, Rana, Juyal, Bisht, Joshi, 2020; Mitra, Sarkar, Chatterjee, 2019; Christin et al., 2003; Repetto, Baliga, 1997; Vial, Nicolas, Descotes, 1996). Corsini, Liesivuori, Vergieva, Van Loveren, Colosio (2008) show that:

"Epidemiological evidence from Western countries indicates that the prevalence of diseases associated with alterations in the immune response, such as asthma, certain autoimmune diseases and cancer, are increasing to such an extent that it cannot be attributed to improved diagnostics alone. There is some concern that this trend could be, at least, partially attributable to new or modified patterns of exposures to chemicals, including pesticides."

Recent studies show that the role of nutrition in supporting the immune system is well established. According to Basil and Levy (2016), the absence of nutrients such as the omega-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), all of which are present in large quantities in fish and plant foods, and therefore in the Mediterranean diet, can lead to delayed or suboptimal resolution of inflammation. Other researchers (Mehta, McAuley, Brown, Sanchez, Tattersall, Manson, 2020; Pedersen, Ho, 2020) argue that these nutrients are all the more important in reducing lung inflammation in severe cases of COVID-19. For their part, Jayawardena, Sooriyaarachchi, Chourdakis, Jeewandara, Ranasinghe (2020) explain that patients suffering from diet-related co-morbidities such as malnutrition, diabetes or obesity represent high-risk populations in the face of the COVID-19 pandemic.

## 1.1.2. Globalising a local food resource

Introducing the flavours and culinary culture of a country to a tourist whose food habits and culture are different, or even the complete opposite, is a complex, if not impossible, task. However, in the wake of the current health crisis, everyone is talking about an "after-world", with more sensitivity and change towards respect for the rights of nature and the functioning of the human organism. Learning in a tourist situation, as discussed in several research studies (Duhamel, 2018; Decroly, 2015; Brougère, Fabbiano, 2014; Brougère, 2012; Peyvel, 2010), could play a key role in this change. It involves participation: "to participate is to learn, but reciprocally to learn is to participate, sometimes in specific and progressive ways" (Brougère and Fabbiano, *ibid*). The authors go on to explain that this "invisible learning" leads to an adoption of what has been acquired. It is, therefore, tacit learning or learning by socialization (Schugurensky, 2007). According to the author, the assimilation of skills and knowledge occurs naturally. Not only does the learner have no prior intention to learn them, but he or she is also completely unaware that a learning activity has taken place. This learning process is defined by Hall and Sharples (2004) as food tourism: "visitation to primary and secondary food producers, food festivals, restaurants and specific locations for which food tasting and/or experiencing the attributes of specialist food production region are the primary motivating factor for travel". This definition is supported by other authors (Presenza, Simone, 2012; Sánchez-Cañizares, López-Guzmán, 2012; Chang, 2011; Smith, Costello, 2009; Park, Reisinger, Kang, 2008). At this stage, it has been demonstrated with the mobilized bibliography that it is possible to adopt a culinary culture following a tourist stay. However, could the tourist become an ambassador for this culture and disseminate it in his or her country of residence?

The "McDonaldization" (Ritzer, 2013) of the "fast food" or "junk food" food culture is a result of globalization and a frenetic lifestyle in which the values of neoliberalism take precedence over the biological functioning of the human body. Calderon-Bony (2012) speaks of a mobility of food practices. From this perspective, a tourist who has capitalised on a Mediterranean diet could spread it when at home. This is, moreover, what Fumey (2007) asserts when speaking of the influence of tourism on individual practices in a global food system. The author adds that "the media sphere and, in particular, the cinema and its culture of freedom" are also privileged vectors. These latter sources of influence on the global food system would be more sensitive to a responsible food culture in relation to humans and nature in a post-COVID-19 era. This is all the more feasible since food is an object in perpetual construction. As Fischler (2001) states, "Food builds the eater: it is therefore natural that the eater seeks to build itself by eating".

In previous research work (Othmani, 2018), I proposed a delimitation of the territory of the Tunisian culinary heritage (TTCH) and showed that North African tourists living outside this territory become fond of Tunisian cuisine after one or more stays in Tunisia.

## 1.2. Method establishment

The use of thematic mapping has made it possible to group together and highlight the correlation of several pieces of information from various sources. The world map superimposes the pesticide consumption in 2017 in Kg/ha, data coming from the Food and Agriculture Organization of the United Nations (FAO), with the data relating to the COVID-19 pandemic, taken from the World Health Organization (WHO) website on 05/14/2020, the date the map was produced. These data concern the number of confirmed cases and deaths due to the pandemic.

## Results

### 2.1. The use of pesticides as a factor in the development of the pandemic

Data from the map show that the countries that use the most pesticides are the countries most at risk from the COVID-19 pandemic. Countries coloured yellow contain small pink circles (confirmed cases) and even smaller blue circles (deaths caused by COVID-19). However, countries whose colours are turning red have larger circle diameters, reflecting a more severe impact caused by the pandemic.

The graph essentially provides the same information presented in the map. However, it better shows the correlation between the amount of pesticides consumed and the damage caused by the COVID-19 pandemic in each country.

- Group 1: countries with no COVID-19 deaths. These countries have very low pesticide consumption, less than 0.05 kg/ha.
- Group 2: countries with a death toll of no more than 100 people. These countries have pesticide consumption ranging from 0.1 to 1 kg/ha.
- Group 3: countries with a death toll of no more than 500 people. These countries have a pesticide consumption between 1 and 2.2 kg/ha.
- Group 4: countries with the highest number of deaths in the world. These countries have a very high pesticide consumption, which in some cases can reach 6.14 kg/ha (Italy), 13.07 (China), or 13.9 kg/ha (Ecuador).

In each of these four groups, there are countries to which the rule does not apply. This will be discussed in more detail in the discussion section. In addition, this sub-section wanted to present the relationship between the food consumption of pesticides and the health impact caused by COVID-19 in the world.

## Discussion

Wallace (1996) offers sensible alternatives to “lethal agribusiness”, a term used by the author to talk about capitalist agriculture or global agriculture. Some, such as farming cooperatives, have integrated pathogen management, and mixed crop-livestock systems, etc. These local solutions are already in practice outside the agribusiness network. However, for a global problem like the pandemic, a global

solution is needed. The recurrent argument repeated by the capitalist system to justify global agriculture is that of feeding the world. However, the development of cardiovascular disease, obesity and diabetes, all of which represent forms of aggravating co-morbidity of COVID-19, are essentially due to this food culture that is being proposed to us. In addition to the food itself, this food culture destroys the ecosystem by seeking to produce more animal protein at the expense of the resources of the land and the natural habitats of wild animals, where some zoonoses are found. This is what has aptly been described by the evolutionary epidemiologist Rob Wallace (Wallace, Liebman, Chaves, Rodrick Wallace, 2020). The article discusses the idea that the Mediterranean diet would represent a food culture capable of stemming the COVID-19 pandemic and preventing the emergence of future ones. This idea is built on presenting the development of the COVID-19 pandemic in the world in relation to the rate of pesticide use in agriculture by each country.

Since the emergence of the COVID-19 pandemic, several hypotheses have been put forward to try to explain why it affects some countries more than others. Some say it is related to the application of the containment measures. Quarantine, isolation and containment are measures that have proved their effectiveness against viruses in the history of infectious diseases, as confirmed by several researchers. Leprosy in China (from the 16th century) and smallpox (from the end of the 17th century) are examples cited by Bretelle-Establet and Keck (2014), and the SARS epidemic (which appeared in 2003) is an example relayed by Patrice Bourdelais (2014). In the example of COVID-19, these measures seem to have limits. One need only compare WHO statistics on the state of development of the pandemic in two countries that are geographically close and with very dense inter-mobility: France and Tunisia. For France, the first three cases were announced on January 24, and 22 days later (15 February), the first death occurred. One month later (17 March), containment began, recording 175 deaths and 7,652 confirmed cases. After almost two months of containment (May 11, the first day after strict containment), the counter showed 26,338 deaths and 137,073 confirmed cases. On May 26, the statistics recorded 28,379 deaths and 142,482 confirmed cases. At the antipode, the first case in Tunisia was recorded on 2 March. Eighteen days later (20 March), the country announced the first death, with 54 confirmed cases. Two days later (22 March), containment was stipulated (3 deaths and 77 confirmed cases). Forty-three days later (4 May, the first day after strict containment), there were 42 deaths and 1,013 confirmed cases. On May 26, the statistics show 48 deaths and 1,051 confirmed cases. In the case of Tunisia, the announcement of social assistance by the State for the benefit of destitute citizens during the confinement period led to crowd movements in front of post offices on 23 March (<http://www.webdo.tn/2020/03/23/tunisie-les-bureaux-de-poste-pris-dassaut/>). Following this event, which was repeated in all Tunisian cities, the number of cases increased slightly, but not the number of deaths. This little comparative reminder shows that containment was certainly a measure that slowed down the pandemic, but it really could not control it effectively. Moreover, this measure could only be limited in time, given the economic constraint.

If it was not containment that explained this difference in COVID-19 behaviour in the two countries, then what could explain it? Some researchers have hypothesized that the BCG vaccine was effective against COVID-19. In the famous scientific journal *Nature*, O'Neill and Netea (2020) put forward the hypothesis that induction of trained immunity by BCG could provide protection against COVID-19. In a preliminary

study using publicly available data on COVID-19 in 199 countries/regions and the BCG World Atlas, Sala and Miyakawa (2020) claim that the number of total cases and deaths per one million population were significantly associated with the country's policy concerning BCG vaccine administration. According to this BCG World Atlas (<http://www.bcgatlas.org/>), France is certainly among the countries not covered by the vaccine, as are Italy and the USA, all of which were heavily impacted by the COVID-19 pandemic. However, Brazil, also badly affected, is among the countries that currently have a universal BCG vaccination program, as is Tunisia (Zwerling, Behr, Verma, Brewer, Menzies, Pai, 2011). Thus, this hypothesis regarding the efficacy of the BCG vaccine against COVID-19 shows its limitations. A third hypothesis, supported by researchers such as Moriyama et al. (2020), is based on the fact that the seasonal cycle of respiratory viral diseases will decrease the infectious cases (i.e., the higher the temperature, the less contagious the virus). This hypothesis is not demonstrated in the case of COVID-19, as Bashir, Ma, Bilal, Komal, Bashir, Tan and Bashir (2020) report. Even the WHO statistics deny it; a country such as Qatar, with an average temperature of 30 °C for the month of May, recorded 45,465 confirmed cases for the 26th of that month, with an average of 1,500 confirmed cases recorded daily since 1 May. The same trend exists for hot countries such as Saudi Arabia, Egypt and Morocco. The most logical hypothesis in explaining the development of the COVID-19 pandemic is the one presented in Fig. 1. The excessive use of pesticides in agriculture – reflecting a weakened immune system – explains the logic behind the development of the severity of the COVID-19 pandemic around the world. Some countries that deviate from this rule (see Fig. 2) are experiencing other interfering parameters such as the presence of high pre-sepsis in the case of Kazakhstan (8,969 confirmed cases as of 26 May) or the presence of high urban density, as in the example of India (145,380 confirmed cases for the same date). Researchers have confirmed a positive association between these two parameters and COVID-19 infections: Sobral, Duarte, da Penha Sobral, Marinho and de Souza Melo (2020) in the case of precipitation and Moccia, Gerbino, Lionetti, Miragoli, Munaron, Pagliaro, Pasqua, Penna, Rocca, Samaja and Angelone (2020) in the case of urbanization. This paragraph has shown that the spread of the COVID-19 pandemic in the different countries of the world does not follow a logic based on the hypotheses propagated by some researchers, such as the effectiveness of the containment measure alone, the effectiveness of the BCG vaccine or the seasonality, to limit or even contain the contagiousness of the virus. However, this propagation logic is well explained by the weakening of the human immune system, which is fed by agricultural products treated with large quantities of pesticides. This conclusion is further aggravated by the addition of parameters such as the rate of precipitation and the degree of urbanization.

## Conclusion

This study follows a geographical approach. Although its various arguments are based on medical references from renowned journals such as *Nature*, these conclusions must be verified in a medical context to confirm or refute them. The sources of COVID-19 pandemic statistics also represent a form of limitation for this study. The multiple criticisms of WHO in relation to its management of this latest health crisis and the difference in the method adopted by each country to measure deaths and cases confirmed

by the COVID-19 represent its greatest weakness. However, when compared with statistics from Johns Hopkins University (JHU), while there are some notable differences, they are minimal, and the trends from the two sources are in harmony. This consideration of two different sources of statistics gives some legitimacy to the data presented in this study.

This study demonstrates the weakness or even inaccuracy of certain hypotheses that have been circulating and are still circulating since recent months and that attempt to explain each country's response to the COVID-19 pandemic. Thus, the hypothesis of the role of quarantine is not really effective in containing the pandemic. As for the respective hypotheses regarding BCG vaccine and heat, these have proven to be unreliable. The hypothesis the present article strongly supports is that of the role of a Mediterranean and flexitarian diet based on products with little or no pesticide treatment in strengthening the human immune system, which in turn counteracts the SARS-CoV-2 virus.

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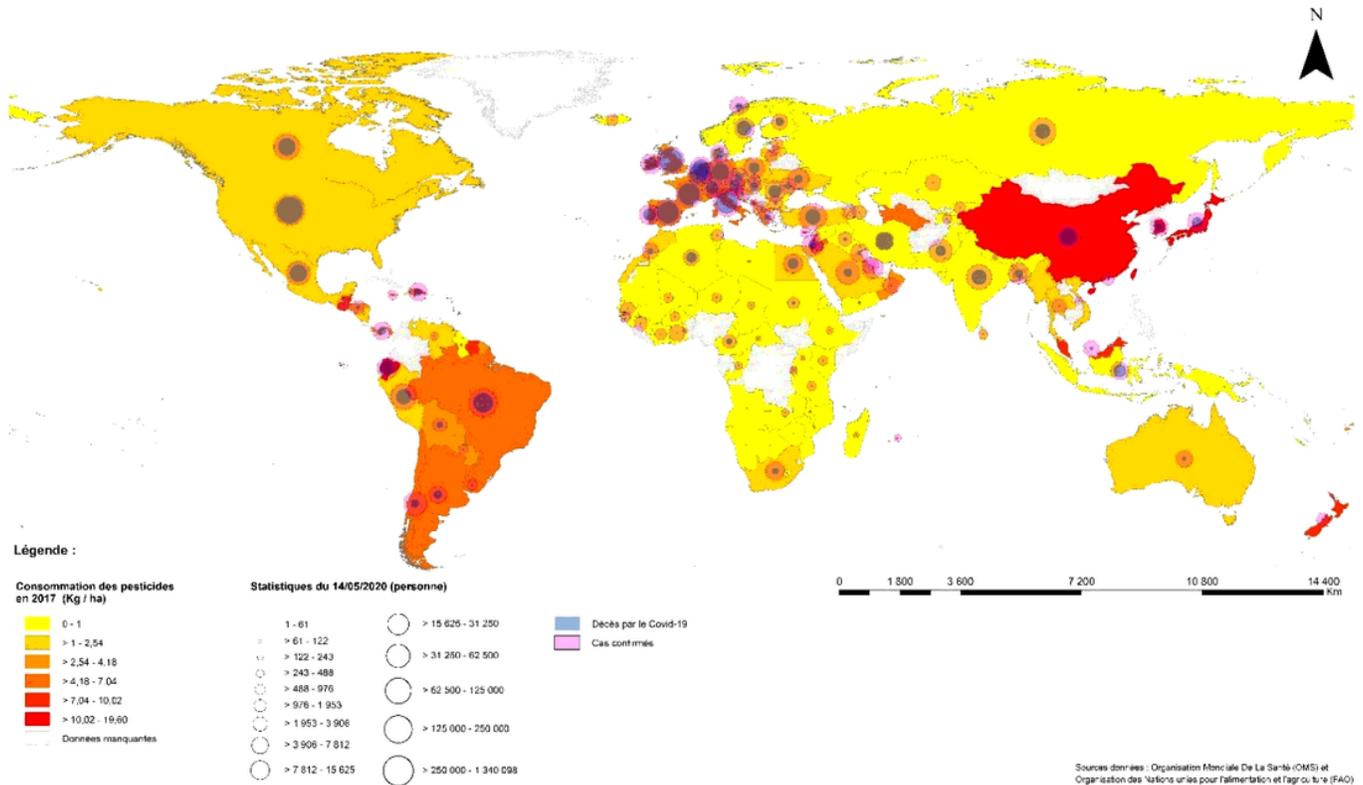
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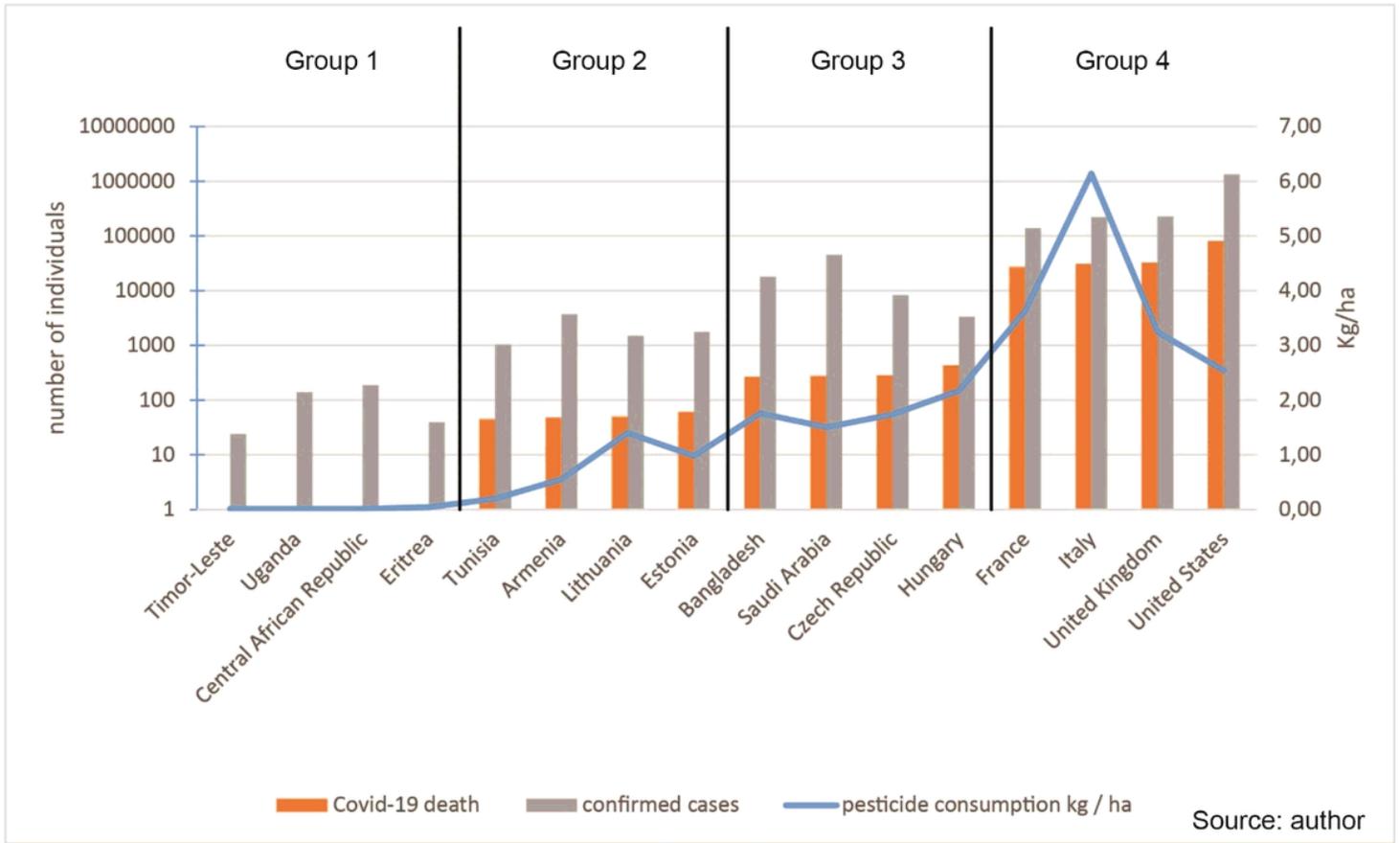
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## Figures



**Figure 1**

Relationship between pesticide consumption and the development of the COVID-19 pandemic in the world (update data 05/14/2020) Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.



**Figure 2**

Graph showing the correlation between the use of pesticides in agriculture and the spread of the severity of the COVID-19 pandemic around the world (update data 05/14/2020)