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One Health and a Computational Biology approach

Saúde Única e uma abordagem na Biologia Computacional

Salud Única y un enfoque en Biología Computacional

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Abstract
The current concept of One Health is based on the union of three inseparable pillars: human, animal, and environmental health, principles that must be paramount in any project or action in a society. The holistic view becomes fundamental to ensure levels of excellence in the health area as a whole, in addition to numerous diseases and pathologies being prevented and combated through the integrated action of professionals in these three areas. Nevertheless, One Health emerges as a worldwide concept and several projects are being based on this common good practice integrated with the most prominent technologies today, such as computational biology. In this way, national measures and laws are also being amended in pursuit of the principle being based on all places and situations that need to use environmental or animal resources for any circumstance. The primary objective of this brief literature review is to exemplify the concept of the One Health approach based on articles that applied the concept practically, with emphasis on prophylactic measures, applications in bioinformatics, and results presented with this well-known foundation.
Keywords: Human health; Animal; Environment; Antimicrobial resistance; Computational biology.

Resumo
O conceito atual de *One Health*, ou saúde única, é baseado na união de três pilares indissociáveis: saúde humana, animal e ambiental, princípios em conjunto que devem ser primordiais em qualquer projeto ou ação perante à sociedade. O olhar holístico torna-se fundamental para garantir níveis de excelência da área da saúde como um todo, além de inúmeras doenças e patologias serem prevenidas e combatidas por meio da atuação integrada dos profissionais das três áreas. Não obstante, a Saúde Única surge como um conceito mundial e vários projetos estão sendo fundamentados nesta prática de bem comum integrado às tecnologias mais proeminentes na atualidade, como a biologia computacional. Desta forma, medidas nacionais e leis também estão sendo alteradas em busca do princípio ser fundamentado em todos os lugares e situações que necessitem utilizar de recursos ambientais ou animais para qualquer circunstância. O objetivo primordial desta breve revisão de literatura é exemplificar o conceito de Saúde Única com base em artigos que trazem o conceito aplicado de forma prática, com ênfase em medidas profiláticas, aplicações na área da bioinformática e resultados apresentados com fundamentação *One Health*.
Palavras-chave: Saúde humana; Animal; Meio ambiental; Resistência aos antimicrobianos; Biologia computacional.

Resumen
El concepto actual de *One Health* se basa en la unión de tres pilares inseparables: la salud humana, animal y ambiental, principios que deben ser primordiales en cualquier proyecto o acción en una sociedad. La visión holística se vuelve fundamental para asegurar niveles de excelencia en el conjunto del área de la salud, además de prevenir y combatir numerosas enfermedades y patologías mediante la actuación integrada de los profesionales de estas tres áreas. Sin embargo, *One Health* surge como un concepto mundial y varios proyectos se están basando en esta buena práctica común integrada con las tecnologías más destacadas en la actualidad, como la biología computacional. De hecho, también se están modificando medidas y leyes nacionales en pos del principio de ser basado en todos los lugares y situaciones que necesitan utilizar recursos ambientales o animales para cualquier circunstancia. El objetivo principal de esta breve revisión bibliográfica es ejemplificar el concepto del enfoque *One Health* a partir de artículos que aplicaron el concepto de manera práctica, con énfasis en medidas profilácticas, aplicaciones en bioinformática y resultados presentados con este conocido fundamento.
Palabras clave: Salud humana; Animal; Ambiente; Resistencia antimicrobiana; Biología computacional.

1. Introduction

In the early ages of civilization, the Greek philosopher Hippocrates considered one of the most important features of medicine, which was reported in his teachings on the concept of the union between health and the environment. From an intellectual perspective, there are many epidemics related to climatic factors and the environment where people live, based on the modern concept of One Health, which after centuries had the term consolidated in 2004, at a symposium in New York, USA, organized by the non-governmental organization *Conservation Wildlife Society*, which brought together human and animal health experts from around the world to discuss the transmission of diseases among humans, domestic animals, and wildlife.

From this perception, the concept of One Health is the set of various practices that work together locally, nationally, and globally to help achieve optimal health standards for humans, animals, and the environment. The one health triad shows how the health of humans, animals, and the environment are linked, being dependent and correlated with one other, in other words, an impact generated on animals will result in environmental consequences for humanity, as well as an environmental impact, which can generate disasters in the Animalia kingdom as a whole (Sinclair, 2019).

One Health's challenge converges to a multidisciplinary approach, regarding different fields of knowledge to solve multicausal problems. In this sense, broader comprehension of health-illness-care determinants should be considered and discussed collaboratively (Limongi & Oliveira, 2020).

In the pandemic context, One Health played a key role in counteracting Covid-19. With the help of professionals from various areas, such as nurses, doctors, veterinarians, biologists, and biomedical professionals, the virus has had partially controlled dissemination to date. Each professional in their area of knowledge assisted in several contexts, such as the hospital front line, treatment of humans and animals, development of vaccines, sequencing of viral strains, detection tests of antibodies and viral particles, writing and dissemination of articles, and scientific research among many other actions. The demonstration of the concept of One Health, with the collaboration of several areas, made it possible to obtain positive results.

In addition, One Health has also been inserted in several contexts such as infectious and parasitic diseases; food security; Covid-19; and computational biology, which plays a fundamental role in many aspects of human society. Besides, antimicrobial resistance, which includes the use and abuse of antibiotics in human, animal, and environmental sectors, focuses on the spread of resistant bacteria and several determinants are inserted in these sectors globally. Most classes of antibiotics used to treat bacterial infections in humans are also used in animals, but a plausible and logical context is to adopt a One Health approach for possible studies on the control of the abuse of such antibiotics (McEwen & Collignon, 2018).

Briefly, this concept is incorporated into a broader scope, being the possible solution to future and present problems. Therefore, it must have recognition by the professionals and the entire population, which indicates the significance of this integrative paradigm. In addition, the use of computational resources has the potential to act alongside the concept of One Health

considering the importance of analyzing and processing data, which will create benefits to the human, animal, and environmental health.

2. Methodology

This research is characterized as a descriptive-discursive narrative review, highlighting the One Health concept as a theme of scientific interest and extreme relevance in society. This bibliographical research aims at the importance of the One Health triad, its socio-environmental impact, and practical examples of the concept. Thus, consistent research was carried out using LILACS, SCIELO, PUBMED, and Google as databases.

In the search for the articles used in this research, the terms "one health", “applications” and “human health” were used, with no exclusion criterion, yet more attention was given to the most recent articles because they have greater application and due to the contemporaneity of the theme, from 2018 to 2022. The present study was conducted through a theoretical approach according to the methods of Galvão et al. (2017), describing data, and textual and descriptive analyses, clearly and concisely highlighted by the authors.

Given the absence of consensus in the scientific community on the definition of the terms "computational biology" and "bioinformatics", as well as their respective areas of activity, for this article the following definition of computational biology was adopted: an area of interdisciplinary knowledge, which integrates engineering, mathematics, computing, informatics, and biology; it is about the use of any computational resources to solve problems of biology and related areas (Nguyen & Wang, 2020).

3. Results and Discussion

All relevant articles related to the results of this narrative review are listed in Table 1 (supplementary material).

3.1 One Health in the Global Context

The One Health approach supports global health safety by improving collaboration and communication at the human-animal-environmental interface. Over the past decade, several countries have implemented the approach, demonstrating undeniable benefits. However, to build the necessary sustainability there is still a lot of effort to be made; One Health advocates and implementers need to collect and provide information to higher government agencies that report and justify public decisions and resource allocations.

Given the wide breadth that nature encompasses, One Health still has certain difficulties in easing projects that reduce environmental impacts clearly and consistently, in addition, new ideas and scientists are emerging over time, renewing the perspectives of new ideas rapidly and seeking the cooperation of health areas themselves.

Solutions to reduce global impact are still in the experimentation and developmental stages. Besides, the perspective for research is positive, and possibly, soon, numerous projects involving a human, animal, and environmental health alliances are increasingly instituted and funded (Sinclair, 2019).

3.2 Infectious and Parasitic Diseases

Considering the social-geographical issues of developing countries, which trigger diseases, a new intellectual view of medicine highlights the vision that associates the health conditions of populations with the environment. Since the first civilizations, the aquatic environment has been indispensable in humanity's survival being overlooked, water resources are used with no regard for sustainability, resulting in various types of toxic waste in the oceans, generated by human and industrial

activity.

Given the existing direct relationship between human and animal health and the environment that surrounds them, the occurrence of leptospirosis transmission is an example of a consequence of this relationship. Neglecting this, and many other diseases, goes against the principles determined by the One Health approach, in which instead of defending the harmony of these three elements, the consequences of these are from political-environmental to socioeconomic concerns (dos Santos et al., 2020).

Leptospirosis tends to create myths in the human and animal context, attributing the blame on the domestic dog as the primary vector (Galvão et al., 2020). Understanding the need for animal vaccination against leptospirosis should be a starting point, considering the characteristics of the bacterial etiological agent (*Leptospira interrogans*), the environment in which the animal (intermediate host) inhabits, in addition to the relationship with the human being and the type of vaccine to be applied (de Souza Suguiura, 2019).

The context of One Health in leptospirosis is evidenced when the solution of this argument is related to the harmony of the three elements ensuring that the environmental context where the animal inhabits gets regular hygiene, application of vaccines, and most importantly, dissemination of information to create awareness in the population on the prophylactic measurements and viable protocols (Silvestrini et al., 2019).

The occurrence of intestinal parasites in humans has been reported since 1681 when researcher Antonie Van Leeuwenhoek reported finding "animalcules" during the analysis of fecal samples by rudimentary microscopes. Fecal dispersion of these microorganisms can contaminate the environment, soil, water, and consequently food, which, when ingested without treatment or hygiene, promotes the re-infection or infection of new individuals.

However, the issue of One Health implies not only to humans and the environment, but animals can also have parasitosis, resulting in a debatable issue of global importance. Thus, parasitosis is a relevant One Health approach and must be related to the human, animal, and environmental areas (Shurson et al., 2022).

3.3 Antimicrobial Resistance

Bacteria are present in the animal, human, and environmental sectors, and consequently, resistant bacteria are found in these settings. The role of One Health in this issue is to promote a proper approach to prevent bacteria from becoming a major problem that still has no resolution. Through the correct identification of diseases in any of the sectors mentioned, it is necessary to indicate the rational use of a given antibiotic, so that the bacterial population is eliminated avoiding the risk of growing in humans, animals, or plants.

Therefore, it is necessary to create surveillance, control, administration, and follow guidelines to contain this resistance to preserve the efficacy of antibiotics and promote acceptable health standards for all sectors involved (McEwen & Collignon, 2018).

The abuse of antibiotics, especially the class of macrolides, during the Covid-19 pandemic is an example to be addressed since they have been heavily prescribed by physicians as a treatment for this disease. This type of medicine is commonly used to treat respiratory tract infections, especially bacterial pneumonia. The indiscriminate use of these antibiotics to counteract the virus ends up generating a selective pressure in the microbiota already existing in the individual and still at risk of undesired clinical consequences. Thus, the use of azithromycin and/or erythromycin, for example, still lacks *in vivo* resolutive assays in the elimination of the SARS-CoV-2 virus (Butler et al., 2021).

The excessive use of antibiotics acts on the selective pressure of bacterial strains causing tolerance in the affected microbial population, thus, subsequent generations express characteristics of resistance to stressor agents. Currently, researchers are employing antibiotics of natural origin, with appreciable prospects involving new combinations with synergistic potential, and possibly inhibiting multidrug-resistant bacteria. Thus, these solutions result in positive impacts on the environment, animals

and humans, which indicates that the One Health concept is indispensable for future projects (Resende et al., 2020).

In this sense, it is disastrous that the ecosystems are being destroyed and several species are largely eliminated. Overall, this new approach is relevant to studying how to clear this impasse; because antimicrobial resistance is the result of resistant bacteria isolated from humans and animals, which can harbor the same type of sequence of resistant genes transmitted by plasmids that can be resistant to the environment and harmful to humans. Due to their resistance, conventional antibiotic treatments do not have the same efficacy, resulting in future questioning; How will we be 30 years from now?

3.4 Covid-19 and One Health

Recent studies on bat biology in China have warned the scientific community that future coronavirus outbreaks similar to SARS-CoV and MERS-CoV would highly likely occur in Hubei Province, China (Aguiar-Oliveira et al., 2020). Such research drew attention to the urgent investigation of coronavirus among bats to detect the timeliest warning signs, and to minimize the impact of future outbreaks or epidemics caused by a coronavirus in China (Butler et al., 2021).

It is important to highlight that the epidemiological leap of wild viruses can occur anywhere in the world since climatic conditions, deforestation, mobility, and population growth linked to the occupation of environments reserved for environmental conservation can contribute to this phenomenon. A study performed in 2019 in sewers in cities in the state of Santa Catarina, Brazil, revealed that samples collected contained the SARS-CoV-2 virus circulating in an urban environment (Aguiar-Oliveira et al., 2020). It is not only the responsibility of the population to avoid contact with wild animals and, consequently, these microbiotas but also for health surveillance authorities to define guidelines to contain or reduce the emergence of wild microorganisms in the hospital environment.

The correlation between environmental impact and human relations may be affected in the animal context through this viral pathogen. The ongoing epidemic of SARS-CoV-2 must be understood in the context of the impact of the phenomena involving human relations with nature and the opportunity to assess and understand the need to achieve unique health with a relevant approach, within the pandemic perspective (Butler et a., 2021).

3.5 Food Safety and One Health

The commitment of managers to public health and food safety converges closely with the concept of One Health, whether in the aspect of the microbiological quality of food products or the sanitation of food production environments. Among the main focuses in controlling pathogenic microorganisms are poultry farms, pig farms, and cattle ranch, as well as industrial environments such as dairy processing plants (WHO, 2020).

Milk is considered an important food, which provides a nutritional source for the general population, especially children. Dairy products contribute significantly to cardiovascular and bone health and benefit the intestinal microbiome (Peng et al., 2020). Besides, it can be attested that milk derivatives can generate the possibility of improvement in some aspects of health since these supplies are rich in probiotics, proteins, and micronutrients (Tesfaye et al., 2019).

Thus, the concept of One Health is positively employed since animals and humans are interdependent, cows need to be healthy to provide humans with raw materials of superior quality standards (Ceballos et al., 2018). As important as ensuring animal health, it is necessary to track products from the farm to the final consumer by maintaining health surveillance of acceptable standards *(farm-to-fork* concept) (Mwanga et al., 2020).

Farm-to-Fork planning is a relevant strategy that can be implemented to bring maximum food quality and safety, by optimizing all steps until the food reaches the consumers. This concept consists of making a global transition to healthy agri-food systems and consequently ensuring the whole planet's safe health. This involves improving the care of cows with the administration of fewer antibiotics and ensuring good feeding to these animals, which will ultimately enhance the quality of milk with better

nourishment to the consumers (Nicastro & Carillo, 2021).

From this perspective, One Health has the potential to promote a proper quality of life for both the animal and the human population, through improvements in the production of these animals, and to prevent the spread of diseases that can affect humans. Thus, the management of diseases and surveillance are factors that bring more food security to dairy consumers and are strongly inserted in the theme addressed in this review (Garcia et al., 2019).

3.6 Application of Computational Biology in One Health

The advancement of science and technology allows the design of new procedures and products. In the health area, based on silico analyzes (analyses performed on computers), simulations and predictions can be made about the behavior of biological systems. These assays are relatively cheaper and faster than in vitro or in vivo assays, and serve as an excellent filter for those promising procedures and products (Straathof et al., 2019). The use of computational resources (in silico analysis) has the potential to work with the concept of One Health and consider, analyze and bring benefits to human, animal, and environmental health. In the following sections, the main applications of computational biology in Single Health are explained.

3.6.1 Pharmacy and Bioinformatics

In the pharmaceutical industry (development of drugs and cosmetics), before new products are made available to society, they must be tested. Testing serves to ensure that these products are effective and are unlikely to result in adverse effects. One of the steps of this validation is to test on animals. Because it is a subject that involves human health (new technologies) and animal health (means of validation of new technologies), it becomes the object of study of One Health. Computational proposals can reduce the frequency of animal testing, therefore reducing animal suffering (Pérez Santín et al., 2021).

One of these proposals is molecular docking. Docking consists of predicting the preferential orientation of binding between two molecules. When determining a binding molecule (typically a drug), a target molecule (typically a protein), and a region of the target molecule, the algorithm tests and points out the various binding positions between the two molecules. The higher the score assigned to the position, the higher the binding affinity (Crampon et al., 2021). Finally, molecular docking works as a screening of those drugs most likely to be efficient.

During the search for new molecules, their toxicity is a very important feature to be considered and is unknown until experiments are conducted. To filter out potentially toxic molecules, and consequently not carry them forward to *in vivo* experiments, *in silico* analyses are performed. One of the ways to conduct these analyses is by using machine learning algorithms. *Random forests*, genetic algorithms, and artificial neural networks are some of the machine-learning techniques used in the toxicity analysis of new proteins (Vishnoi et al., 2020).

"DeepDream" is a Google project that exaggerates pattern recognition by an artificial neural network. Metaphorically, it is as if the machine "dreamed", so the name "DeepDream". Utilizing DeepDream, scientists at the University of Washington have developed a promising new method for finding new molecules that are efficient (Anishchenko et al., 2021).

The use of these computational resources - and many others - converges to reduce the use of animals in experiments on new molecules. And when necessary, the use of animals, the probability of adverse effects is lower.

3.6.2 Epidemiology and Pathology

Most infectious diseases contracted by humans are of animal origin and many diseases that culminated in plagues (such as Black Plague and Covid-19) are also of animal origin (Greger, 2021). Therefore, there is an interaction between human and animal health in the field of epidemiology and pathology. In this context, there are two main approaches to computational biology: one using mathematical modeling (Metcalf et al., 2020) and the other working together with genomic surveillance (Chakraborty

& Barbuddhe, 2021).

The mathematical approach consists of constructing mathematical models using computational resources. The models are created from a large amount of data, which includes statistics of previous epidemics and more recent data such as increased number of cases of a given disease, mortality rate, symptoms presented, location, and even Google™ searches. These models can make predictions for years, so they can predict the emergence of new diseases, epidemics, and outbreaks, as well as the situation of an epidemic over time. Thus, mathematical models applied to epidemiology and pathology help in the containment of new diseases and epidemics (Metcalf et al., 2020).

Genomic surveillance is the constant monitoring of possible pathogens present in animals. These monitoring and mathematical models can minimize, or even prevent, the emergence of diseases and epidemics. As an example, we mention the swine flu epidemic of 2009. Studies indicate that the H1N1 virus already circulated in pigs years before the beginning of the epidemic. Therefore, genomic surveillance, if implemented, could have prevented the epidemic. To optimize genomic surveillance, computational biology proposes *in silico* analyses to study the collected genomes (Chakraborty & Barbuddhe, 2021).

3.6.3 Ecology and Bioinformatics

It is known that human action has irreversibly attacked the environment. Deforestation for the exploration of natural resources and excessive emission of polluting gasses into the atmosphere that causes global warming and consequently melting glaciers are some examples of human actions that harm the environment. The deterioration of environmental health directly and negatively implies human and animal health. Therefore, to keep humans and animals safe, it is necessary to keep the environment in its natural balance. Therefore, environmental preservation measures should be used, and computational biology can help in this process, making these measures more efficient (Ahmad et al., 2022).

To preserve natural resources and sustainably use them, machine learning algorithms help in the decision-making and management of these resources. Water and biodiversity are two examples of resources to be managed with machine learning support (Shivaprakash et al., 2022).

Another application of computational resources in ecology is to estimate the deforestation of green areas. From images of Earth captured by satellites and the alliance between computer vision and machine learning algorithms, it is possible to analyze the deforestation situation of a given area in the future, and then make decisions to minimize more catastrophic scenarios.

4. Conclusion

This research highlights the importance of the One Health concept demonstrating its application critically in various contexts and approaches, given the broad concepts presented, One Health must permeate the current and contemporaneity, making it possible to be increasingly present in our present-day. Finally, several areas of study should be based on the basic principles of One Health. The literature demonstrates the importance of the approach itself, therefore, it is of full importance that future projects involving areas of health, environment, and animal, treat as a basic topic the One Health approach. In addition, the possibilities of future approaches using this study as a basis for the production of new works are of full applicability, emphasizing the concept of One Health and its applications in computational biology in their studies, reviews, and analysis.

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