Commonsense Preparedness for Uncommon Adversities: Lessons from Facing COVID-19 in Mexico, from a Human Ecology Perspective

Federico Dickinson[1]
Department of Human Ecology, Cinvestav-Mérida, Yucatán, Mexico

María Eloísa Dickinson Bannack
Mexican Faculty of Medicine, La Salle University, Mexico City

Hugo Azcorra
Centro de Investigaciones Silvio Zavala, Universidad Modelo, Yucatán, Mexico

Teresa (Tere) Castillo-Burguete
Department of Human Ecology, Cinvestav-Mérida, Yucatán, Mexico

Nina Méndez-Domínguez
Hospital Regional de Alta Especialidad de la Península de Yucatán

Abstract

In 2020, while living through unprecedented health outcomes from the COVID-19 epidemic in Mexico, a human ecology perspective provides us with an unconventional way to analyze the role of the mediate effects of Mexican nutritional impacts and their prevalence in COVID-19-related mortality. According to official data, by the end of September 2020, mortality by COVID-19 surpassed 76,000 confirmed deaths across Mexico; by August 2020, COVID-19 mortality was lower in the center of the country where hospital infrastructure and human resources such as specialized health personnel are concentrated. This regional difference corresponds to the serious socioeconomic inequality characteristic of Mexican society, where southeastern states are poorer. A human ecology perspective allows us to identify and discuss similarities and discrepancies between the prevalence of obesity distribution and COVID-19 lethality across Mexico, and ultimately to provide our thoughts on the preparedness of Mexican society, with epidemiological evidence and a preventive, transdisciplinary scope.

Keywords: COVID-19, human ecology, lethality, Mexico, obesity, prevalence

1 Corresponding author: federico.dickinson@cinvestav.mx.

Introduction

Every day, people and their societies are both protagonists and spectators of the dynamic interactions between their own biology and the predominant norms, traditions, and customs that take place in a complex environment where the only constant is continuous change. Any society's main resource is its own population, not only including adult women and men, but also the elderly, youth, and children. People shape societies with their unique characteristics, and in that uniqueness, certain traits may coexist across societies, as people produce and reproduce behaviors and customs throughout the world and across time and space. This reproduction is both biological and sociocultural: biological through gestation, upbringing, and education, in the broadest sense, of the individuals who will replace those who die; and sociocultural through the maintenance of strong social bonds and institutions such as family, community, commerce, and religion. This biological and sociocultural reproduction occurs in a natural environment, within one or more ecosystems. Through daily life, members of a society or culture produce and reproduce customs and traditions. Cultural production and reproduction includes health and healthcare avenues as part of the sociocultural system.

Azcorra and Dickinson (2020) understand human ecology as the study of complex interactions between ecosystems, sociocultural systems, and *Homo sapiens*' biology. These interactions always occur in a certain place and time (Figure 1) and result in a certain level of health and well-being. If any of the aforementioned elements have suboptimal conditions, the wellbeing of society itself is afflicted. Specifically, when the biological status of a society's individuals is healthy, the health impacts of events, such as pandemics, that exert pressure on ecosystems and sociocultural systems will be lessened. On the contrary, in the face of a deteriorated biological state, impacts on people's health and well-being will be greater, in terms of diseases and fatalities.

The current epidemiological context of world human population and global environmental changes suggest that humanity will face new pandemics of known or unknown pathogens, and that any society must be prepared—with appropriate healthcare personnel, in terms of quantity and capabilities, and robust health infrastructure, but primarily with a healthy population. Obesity prevalence may partially explain the high lethality rates of COVID-19 in Mexico compared to other countries. From these premises, the aims of this article are to estimate mortality due to COVID-19 that can be attributable to the secondary or direct effects of obesity on the Mexican population, and to describe the state cluster prevalence of obesity and lethality rates as well as hospital mortality.

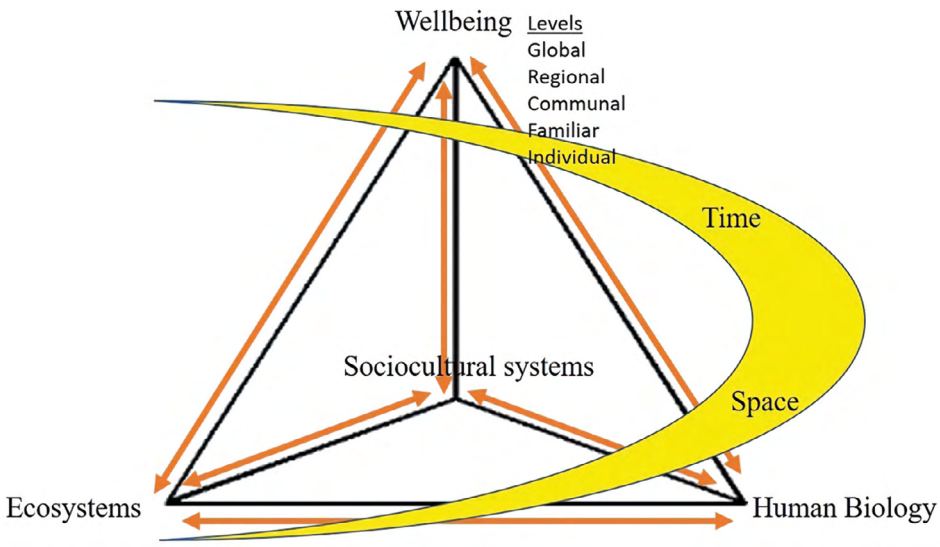

Figure 1. Conceptualization of human ecology showing the interactions between three subsystems.

Source: Azcorra and Dickinson (2020, p. 2).

Background

COVID-19's severe manifestations generate a cascade of detrimental changes in human physiology that can directly derive from respiratory system alterations, but there are also complex mechanisms involving every system in the human body (Yang X. et al., 2020). When an individual with underlying health problems is afflicted by an acute infection due to COVID-19, he/she may be at higher risk for developing severe consequences, including death (Tamara & Tahapary, 2020). In a population where the burden of obesity-related diseases is widespread enough to affect a large proportion of individuals, severe and fatal outcomes are expected to have a greater impact. In their 2018 report on the *State of Food Security and Nutrition in the World*, the Food and Agriculture Organization (FAO) of the United Nations asserted that obesity among Mexico's adult population reached, in 2016, 24.3 million people. Mexico now ranks sixth in obesity among all 150 countries in the world. In this sense, countries such as Mexico may face a more trying pandemic (FAO et al., 2018). From a human ecology perspective, where environment may be understood in a broad sense when it comes to health and well-being, access to and availability of healthcare infrastructure are fundamental environmental resources within socio-administrative and political constraints regarding its use and distribution.

In studies from across the world, underlying chronic diseases (also known as comorbidities), obesity, and smoking have been identified as prognostic factors associated with adverse COVID-19 outcomes (Espinosa et al., 2020). Political discourse in Mexico, since the arrival of the first confirmed case on February 28 (Mendez-Dominguez et al., 2020), has stressed the disadvantages of COVID-19 infection compounded by underlying chronic diseases, with emphasis on obesity, and that the aforementioned constraints may also explain to some degree Mexico's high mortality rates. At some point, this continuous discourse has seemed to indicate that citizens' individual health conditions are a main determinant of COVID-19 mortality in Mexico (Secretaría de Salud, 2020a), but although individual biological aspects such as genetics and heredity are important for the presence of diseases in the population, the factors most strongly associated with disease have to do with the social and environmental aspects that determine living conditions and styles of life of individuals and groups, including their eating habits. The fact that health is, always, a consequence of the complex interactions depicted in Figure 1 calls for a human ecology approach to factors correlated with nutritional status and risk for obesity and its proximate or distant outcomes.

Studies from different nations have estimated lethality from comorbidities in regard to hospitalized COVID-19 patients, finding that habits such as smoking and underlying diseases including obesity, hypertension, and diabetes, as well as respiratory, cardiovascular, renal, and immune system diseases, involve a greater risk for adverse outcomes. In this case, as in other health issues, individuals and social groups with poor health are more vulnerable to any environmental changes, including new pathogens.

Obesity and COVID-19 in Mexico

Obesity can be defined in pathophysiological terms as a chronic disease derived from the increased storage of energy as lipocytes, causing both hypertrophy and hyperplasia of the lipocytes with a consequent increase in adipose tissue volume, with free fatty acids impacting endocrine and mechanical function. Dyspnea can derive from impaired vital breathing capacity, even with increased abdominal pressure (Bray, 2003). Obesity over time facilitates the onset of diseases such as hypertension and diabetes, as part of a metabolic syndrome (OECD, 2017).

Rates of excess body weight (overweight and obesity) in Mexico, both in adults and children, are among the highest in the world. Official reports indicate that 36 percent of children and youth between ages 6 and 19 have excess body weight, and that, for adults, 73 percent of men and 77 percent of women meet criteria as overweight/obese (Instituto Nacional de Salud Pública, n.d.-a). Several sociocultural and political factors such as globalization, poverty, and poor investment in health education have shaped a food environment characterized by Mexican families'

increased dependence on foods with high caloric content and poor nutritional value, which impacts the nutritional and health status of the population in urban and rural contexts. In less favored socioeconomic contexts, excess weight and obesity coexist with chronic malnutrition, generating a cascade of complex biological processes that increase susceptibility to obesity from early stages of development and spread phenotypic and metabolic traits between generations. Obesity plays a determining role in the presence of cardiometabolic diseases. By 2018, it was estimated that nearly 9 million Mexicans lived with a diagnosis of type 2 diabetes mellitus and an unconfirmed proportion of people live unknowingly with this disease. Moreover, nearly 20 percent of Mexicans older than 20 live with hypertension. In recent decades, this epidemiological profile has exerted significant pressure on the country's health system in terms of human resources, materials, and infrastructure.

In Mexico, as of July 30, 2020, COVID-19 in-hospital mortality was 33.5 percent (Carrillo et al., 2020) and included both patients with (53 percent) and without comorbidities; 23 percent of all hospitalized patients were obese. Overall, COVID-19 lethality (among non-severe and severe cases) surpassed 12 percent for patients with and without comorbidities, both ambulatory and under hospital management.

Therefore, understanding the role of such differences in mortality is pertinent in order to prepare Mexican society, its health system, and its citizens with preventive behaviors that may help reduce the adverse impact of possible COVID-19 recurrences and foresee any other eventual emergent human infections.

Material and methods

This is a retrospective study, based on open-access datasets from COVID-19 Epidemiological Surveillance from the General Directorate of Health Information (DGIS), and other official Mexican sources (Secretaría de Salud, 2020a, 2020b; Conapo,[2] 2018). All information was anonymized, obtained from open access digital resources, and transformed into variables for further statistical analysis.

From hospitalization records, we obtained sociodemographic information of each patient, and the type and number of comorbidities, if any. Hospital mortality, here presented in percentages, was obtained from patients' conditions at discharge and considered as caused by COVID-19 when the primary diagnosis was coded as U07.1, meaning "due to COVID-19" according to the International Diseases Coding System.

2 Consejo Nacional de la Población [National Council for Population] (Conapo).

General COVID-19 lethality by state was obtained by accounting for confirmed cases multiplied by 100,000 inhabitants and divided by the population size of each Mexican state, when the primary diagnosis was coded as U07.1. Obesity prevalence by state was determined using height and weight of adult participants (aged >18) from the last National Health and Nutrition Survey (Instituto Nacional de Salud Pública, n.d.-a) to calculate Body Mass Index (BMI), and all cases with BMI ≥30 were coded as obese. Hospital mortality due to COVID-19 was employed for descriptive purposes, while general COVID-19 lethality by state was analyzed as a dependent variable in separate Poisson regression models, with average BMI and obesity prevalence by state cluster as independent variables. For statistical significance, a *p*-value <0.05 was considered significant, while lethality rate ratios were compared to 1.00 as a reference value, where significant values <1.00 were indicators of protective and >1.00 as increased lethality. Post hoc tests were performed to assess goodness of fit. All statistical analysis was performed using Stata 15 software. Maps illustrating distribution of dependent and independent variables are included.

Results

The Ensanut survey sample (Instituto Nacional de Salud Pública, n.d.-b) included 8,446 participants (with 65 percent women) aged >18, including complete anthropometric information. All 32 states were represented in the analysis. The Ensanut 2018 sample, representative of the Mexican population, included 3,128 individuals with a BMI of ≥30kg/m^2 (obesity), representing 37.02 percent of all adult participants, with a prevalence by sex of 41.72 percent among females and 28.40 percent among males. Average BMI was significantly higher for women (28.74±.079) than for men (26.95±.093) (Figure 2). According to epidemiological data, by the end of September 2020, mortality by COVID-19 surpassed 76,000 confirmed deaths, including ambulatory and hospitalized patients (Secretaría de Salud, 2020b); COVID-19 mortality is lower in the center of the country, surrounding the capital city, where hospital infrastructure and human resources such as specialized health personnel are concentrated (Figure 3), corresponding to the serious socioeconomic inequality characteristic of Mexican society.

Figure 2. Prevalence distribution of obese adult population (BMI≥30kg/m²).

Source: Authors' summary, based on National Health and Nutrition Survey (Instituto Nacional de Salud Pública, n.d.-a).

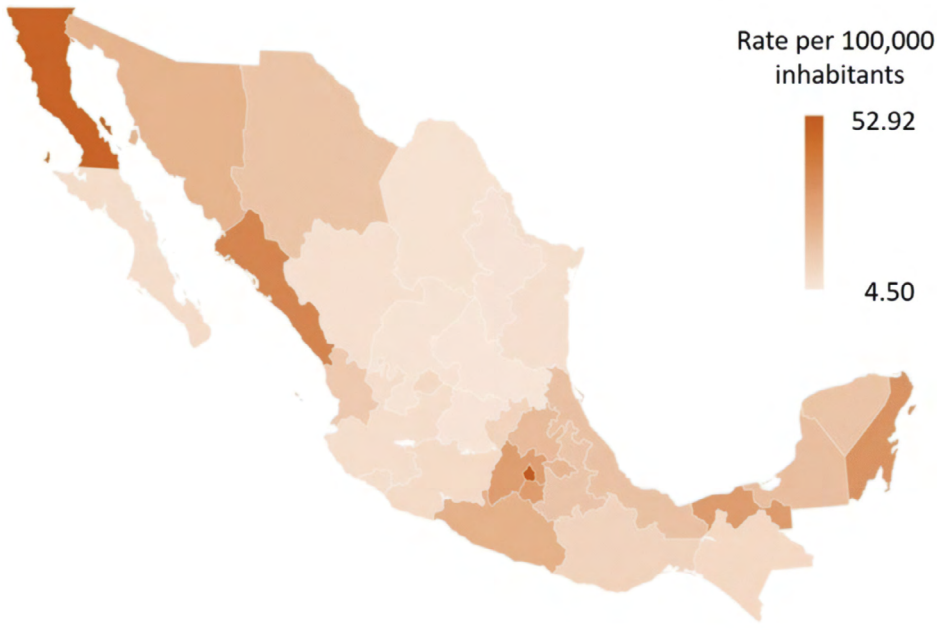

Figure 3. COVID-19 mortality rate per 100,000 inhabitants, as of July 30, 2020.

Source: Authors' summary (see 'Material and methods' for further details).

Nationwide average obesity prevalence, average BMI, mortality, and hospital mortality due to COVID-19 are presented in Table 1.

Table 1. Descriptive statistics regarding anthropometric status and death frequency due to COVID-19 in the 32 Mexican States.

Variable	Mean/percentage	Standard deviation	95% confidence intervals	
Hospital mortality (%)	33.62	6.32	18.60	47.74
Mortality rate*	17.18	12.67	4.50	52.93
Obesity prevalence (%)	40.63	49.90	0.00	100.00
Mean BMI#	28.57	5.89	17.16	38.96

* Mortality rate was calculated by 100,000 inhabitants according to population projections for mid-2020 decade.

BMI: Body Mass Index = weight (kg) ÷ height (m^2).

Source: Authors' summary (see 'Material and methods' for further details).

Lethality rate variability was significantly associated with the most recent obesity prevalence in each state, indicating a direct association between lethality and obesity across Mexican states (Table 2). Post hoc tests ensured goodness of fit with p values of 0.20.

Table 2. Poisson regression indicating association between state lethality rate ratio due to COVID-19 per 100,000 inhabitants and anthropometrics of the state population in Mexico as of July 30, 2020.

State lethality	LRR	Standard error	Z	*P*	95% confidence interval	
Obesity prevalence	1.82	0.16	7.00	<0.001	1.54	2.16
Average BMI#	1.05	0.01	5.88	<0.001	1.03	1.06
Post hoc test =	Deviance goodness of fit = 36.09 = 0.2051				Pseudo R2 = 0.1231	

BMI: Body Mass Index = weight (kg) ÷ height (m2); LRR: lethality rate ratio.

Source: Authors' summary.

Discussion

The Mexican population is largely afflicted by obesity and its related proximate and distant health consequences, as we have mentioned above. From our understanding, this fact is a consequence of a deep imbalance in the interactions between ecosystems and sociocultural systems, reflected in the biological status of the Mexican population (Figure 1). Such imbalance increases the vulnerability of population not only to known disease agents, but to new, unknown, pathogens such as SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2, the virus that causes COVID-19),

to which no human population had immunological experience. This great challenge must teach us, from a human ecology perspective, how to face future contingencies similar to this one.

In their recent systematic review, Tamara & Tahapary (2020) found that obesity is a risk factor for COVID-19 infection and the severity of COVID-19 infection in populations from several geographical regions, while Carrillo et al. (2020) found, in the analysis of nearly 70,000 cases of hospitalized patients diagnosed with COVID-19 in Mexico, that obesity was not, in itself, a predictor of death, but that it did increase the risk for other outcome severity indicators. The discrepancy from Carrillo et al. (2020) can be explained by their analysis of only hospitalized patients, while our study reflects a general population analysis stratified by state, including mortality in relation to generalized state population and not only from hospitalized individuals, since mortality has also occurred outside hospital premises.

We have identified how lethality rates across Mexico can be marginally, but significantly, explained by state obesity prevalence, which has proven to explain 12 percent of the variability in deaths across states. Nevertheless, we would be remiss not to mention that lethality is a complex phenomenon that, from a human ecology perspective, may also be understood in terms of environmental and social correlations that, for this case, may be represented by access to and availability of health infrastructure resources and the socio-administrative/sociopolitical decisions on how to employ them.

In this sense, we can certainly assert that environmental and social determinants need to be objectively evaluated to critically analyze how to find better strategies for improving access to, availability of, and use of health infrastructure resources. On the other hand, we may also seek our own opportunities for improving our lifestyles and health profile as a population and nation.

One main lesson taken from the COVID-19 epidemic in Mexico is at the individual level, and another is at the societal level. In the first case, we have learned once again the importance of self-care, healthy lifestyles, and food choices for good health; in the second case, we must strive as a society to eliminate or, at least, reduce the current poverty rate (42 percent, Coneval,[3] 2019) and the economic and social inequality of Mexican society (OECD, 2020)—structural elements that jeopardize human biology and, thus, human well-being (Figure 1). We need also to ensure that governmental public health policies, and social and economic measures, inhibit and dismantle the current obesogenic environment in which Mexican population

3 Consejo Nacional de Evaluación de la Política de Desarrollo Social [National Council for the Evaluation of Social Development Policy] (Coneval).

lives. It is necessary to hold national and transnational companies accountable for producing, distributing, and selling ultra-processed foods and beverages with aggressive advertising campaigns, many targeting children and youths.

If Mexican society takes advantage of these two lessons, it will surely be in a much better position to face future pandemics, whenever they arrive.

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