Impact of social relationships on health

There is considerable evidence that social relationships can influence health, but only limited evidence on the health effects of the personality characteristics that are thought to mold people's social lives. We asked whether sociability predicts resistance to infectious disease and whether this relationship is attributable to the quality and quantity of social interactions and relationships. Three hundred thirty-four volunteers completed questionnaires assessing their sociability, social networks, and social supports, and six evening interviews assessing daily interactions. They were subsequently exposed to a virus that causes a common cold and monitored to see who developed verifiable illness. Increased sociability was associated in a linear fashion with a decreased probability of developing a cold. Although sociability was associated with more and higher-quality social interactions, it predicted disease susceptibility independently of these variables. The association between sociability and disease was also independent of baseline immunity (virus-specific antibody), demographics, emotional styles, stress hormones, and health practices.

Along with human population, the inequality in the distribution of global income has grown in recent decades (7). In 1992, 15% of people in the world's richest countries enjoyed 79% of the world's income (8). In every continent, in giant city systems, people increasingly come into direct contact with others who vary in culture, language, religion, values, ethnicity, and socially defined race and who share the same space for social, political, and economic activities (9). The resulting frictions are evident in all parts of the world.

Ecologists and population biologists have long used the logistic model of population dynamics as a way to understand the cause and effect relationship between carrying capacity and population size (Wilson & Bossert, 1971; Gotelli, 1998). As Malthus (Petersen, 1979) and Darwin (1859) understood, in the absence of limitations on resources, i. e., space and food, populations will grow exponentially. However, if resources are limited, the growth rate begins to decelerate well below the maximum population size that the environmental resources can support. Deceleration continues until a more or less equilibrium level is reached. This equilibrium occurs near the asymptote of environmental limits. When plotted, the resultant growth takes the form of a sigmoidal or S-shaped curve. Typically, in the laboratory and field.

The second “ evolution” refers to the industrial revolution, which took place mainly in the 18 th century alongside the global agricultural revolution (Cohen, 1995). The third “ evolution” is the advancement of public health and medicine which began in 1945. This led to a stark rise in the population as the development of vaccines and antibiotics increased life expectancy in the countries with access to them (Butler, 2004). The final “ evolution”, per Cohen (1995), is the fertility “ evolution” which began in the 18 th century and has still not emerged in some developing countries (Cohen, 1995). Contraception and education for women have contributed to a fall in fertility rates among more developed countries (Butler, 2004).

The end of the Second World War marked a fifth turning point in human population growth (Hibbard *et al* ., 2006). No one had ever lived through a

doubling of the population until after the Second World War and now, some of us have lived through a tripling of the population (Cohen, 2003).

Today, the human population is distributed unevenly around the globe; with 60 percent residing in Asia, 16 percent in Africa, 10 percent in Europe, 9 percent in Latin America and the Caribbean and the remainder living in North America and Oceania (Cohen, 1995). Not only are we unevenly distributed, but so are our resources. In 2015, 795 million people do not have enough to eat (FAO, 2015). Simmons (2000) describes this phenomenon as a " logistical distribution problem". We produce plenty of food on Earth, enough to feed everyone, yet millions starve to death every year (Simmons, 2000). Global life expectancy is expected to increase to 83 years by 2095 and by then, the human population will have at least doubled (UNDP, 2015). This will put further stress on our resources. If we struggle to feed everyone today, we will certainly struggle to feed a longer-living, doubled population in the future (UNEP-GEAS, 2012).

How has carrying capacity been estimated?

Many concepts have been used to try and decipher a limit to the human population. These include optimum population, carrying capacity and limits to growth (Van den Bergh & Rietveld, 2004). What these concepts have in common is that they all acknowledge the basic requirements for a human being to survive; water, land, food and other resources from nature (Van den Bergh & Rietveld, 2004). These resources have a limit and so it follows that the human population also has a limit (Van den Bergh & Rietveld, 2004).

Thomas Malthus' theory about human population growth provided the basis for the concept of carrying capacity in relation to humans (Seidl & Tisdell, 1999). The infamous theory was put forward in 1798. Malthus proposed that it was in built into the population curve for the population to run out of resources, causing a decline in the population by " positive checks" (e. g. disease, famine, war) or by " preventative checks" (e. g. marriage restrictions) (Butler, 2004). Malthus' theory, though flawed, became so influential partly due to the attitude of Victorian England in the 18 th century (Seidl & Tisdell, 1999). During this time, disease and poverty was rampant among the lower classes as they moved into cities (Seidl & Tisdell, 1999). The concept may have been relevant at Malthus' time, but the human population has moved far beyond these limits now (Seidl & Tisdell, 1999). Verhulst (1838) epitomized Malthus' theory through the omnipresent logistic equation (Figure 2) (Lima & Berrymand, 2011).