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Particle exposure and the historical loss of Native American lives to infections

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Beginning in the 15th century, interactions with Europeans resulted in a cataclysmic decrease in the population of peoples indigenous to the Americas. In addition to deliberate killings and wars, Native Americans died in massive numbers from infections endemic among Europeans. Much of this was associated with respiratory tract infections including smallpox, tuberculosis, measles, and influenza (1,2). In these disease outbreaks, mortality among infected Europeans was significant but deaths were even greater proportionately among affected Native Americans (e.g. the mortality of smallpox could be 20 to 50% among Europeans but entire tribes of North American Indians were eliminated by the same viral infection) (1,2). The disproportionate impact of infections on Native Americans has been attributed to disparities in resistance as a result of the microbe being introduced into an immunologically naïve population. However, members of numerous societies exposed to these pathogens had no prior exposure to the contagion and did not display mortality rates equivalent to Native Americans following the same infection (e.g. smallpox) (1). It has also been proposed that increased susceptibility of the Native Americans to these infectious diseases could be attributed to genetic influences but no heritable factors have been identified thus far. While available records provide a description of the epidemics, they reveal no basis for the observed dissimilarities in mortality to be attributed to different strains of a microbe (e.g. *Variola major* in the native Indian peoples vs. *Variola minor* in the Europeans). Another possible reason for this devastating loss of Native American lives to infectious diseases introduced through interactions with Europeans could include an impact of exposure to particulate matter (PM) associated with the preparation of food and heating. In Europe, the chimney had developed by approximately 1600 as an architectural adaptation commonly employed in homes to diminish exposure of inhabitants to particles released during fuel combustion (3). Residences built in the Americas by Europeans had chimneys for the control of generated smoke. However, use of either a chimney or an equivalent device to reduce indoor exposure to combustion products was uncommon in the domiciles of Native Americans (4). Often in these dwellings, fire pits were built in the ground in the center and there was either no exit or simply a hole in the peak (e.g. a smoke flap or smoke hole) for

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generated smoke to escape. Accordingly, Native American homes (e.g. tipis, wigwams, and long houses) were associated with exposures to high levels of smoke emitted from the burning of biomass such as wood. Extrapolating from comparable situations in which burning of biomass is currently used for preparation of food and heating, particle exposure would have been tens of thousands of micrograms per cubic meter in Native American domiciles and the lower respiratory tract of inhabitants was likely exposed from birth to a large mass of PM (5). Severity of infections and associated mortality are both greater with particle exposure (6). The underlying mechanistic pathways can include particle-induced alterations in 1) the epithelial barrier, 2) ciliary transport, 3) populations of inflammatory cells and their function, and 4) iron homeostasis (7). These pathways are comparable to infection associated with particle exposure in the contemporary world including cigarette smoking, the burning of biomass, environmental tobacco smoke, desert dust storms, and air pollution (8,9). The remarkable loss of aboriginal populations in the Americas which occurred through their interactions with Europeans may reflect, in part, a predisposition to infections resulting from their exposure to elevated PM concentrations. Continued burning of biomass among indigenous peoples may contribute to persisting disparities in respiratory tract infection and mortality (10).

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