

Beyond human limits: the ethical, social, and regulatory implications of human enhancement

A critical ethical concern surrounding human enhancement technologies is their potential to exacerbate social inequality. If enhancements, whether genetic, cognitive, or physical—become widely available, will they be accessible to all, or only to those who can afford them? This question is particularly pressing given the current disparities in access to healthcare and medical services globally. If access to enhancements is limited by socioeconomic status, we risk creating a new form of social stratification, where individuals who are genetically or cognitively enhanced hold significant advantages in health, intelligence, and physical abilities.

Historically (from the agriculture revolution to the present day), social status has been based on wealth and resources, but selective genetic improvements could lead to the formation of biological castes, where one's genetic identity becomes a new marker of privilege or disadvantage. This scenario poses a grave threat to social cohesion and even to the sustainability of our species. If some individuals are biologically engineered to possess superior traits—such as higher intelligence, increased strength, or disease resistance—it could widen existing social divides, creating a class of “genetically elite” who dominate others not just economically, but biologically.

Furthermore, germline editing, could have long-lasting societal consequences. As these modifications are passed down through generations, we may see the emergence of classes of individuals defined by the quality of their engineered genome. More critically, such interventions may limit evolutionary adaptability and reduce the genetic diversity necessary for resilience against environmental changes, emerging diseases and overall unpredictable future challenges. This possibility raises concerns about long-term societal impacts, as the creation of biologically distinct classes could perpetuate inequality across generations, threatening both the ethical foundations of equal opportunity and the broader stability of human society.

Chiara Gerardi , Christodoulos Xinaris, *frontiersin.org*, 09 July 2025