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Legalising Germline Editing for the Cure of Congenital Diseases and Disabilities in India: A Human Rights Perspective

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ABSTRACT

Technological advances in the medical field have brought potential solutions for curing genetic diseases. This research paper explores whether legalising germline editing can be instrumental in promoting human dignity in regional groups suffering from genetic diseases or abnormalities. Germline editing is a scientific technique used to correct congenital disabilities not by environmental manipulations but by acting directly on the DNA in the affected person's cells. The technology has raised several political concerns and has been subject to legislative considerations, regulatory actions, and court deliberations across the globe. This technology, posing great revolutionary potential, has been subject to scrutiny owing to its considerable nexus with human autonomy, self-determination, and diversity. Through this research, the authors seek to address the general concerns raised by various theorists and philosophers regarding the threat of violation of human rights posed by the employment of such technology. The paper investigates the Kantian view on dignity and philosophically analyses the ambiguity surrounding the definition of human dignity. Further, the paper focuses on the case studies of various communities that have been exposed to genetic mutations because of certain man-made tragedies and have been suffering from the consequences across generations. The economic viability of germline editing over genome editing for the affected communities as it transcends through generations has been studied by looking into the financial position of the marginalised communities affected. The authors argue that gene therapy can play a significant role in undoing the suffering of the present and future generations. These developments do not seek to upend the current human rights regimes so much as to include a broader set of behaviours under their umbrella.

Keywords*: Congenital Disabilities, Dignity, Genome Editing, Germline Editing, Human Rights.*

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I. INTRODUCTION

The field of genetic engineering underwent a significant transformation in 2012 with the ground-breaking discovery and development of CRISPR-Cas9. CRISPR[3], a natural defence mechanism found in bacteria, enables them to identify and cleave viral DNA. Scientists quickly realised the potential of this system and adapted it for genome editing across various organisms. The following year, in 2013, researchers successfully demonstrated the use of CRISPR-Cas9 for genome editing in mammalian cells, including human cells. This achievement showcased the remarkable precision and efficiency of CRISPR for gene editing purposes.

In a significant development, the first report documenting the utilisation of CRISPR-Cas9 to edit human embryos was published. This event generated ethical concerns and initiated a global debate regarding the implications of germline editing. These experiments were performed on non-viable embryos; no live births resulted from these procedures. However, this publication served as a catalyst for discussions on the responsible and ethical use of germline editing technologies. Later, researchers in the United States achieved a milestone by using CRISPR-Cas9[4] to rectify a disease-causing genetic mutation in viable human embryos. This accomplishment marked the first successful instance of germline editing in such embryos, further advancing the field's capabilities.

Since then, the field of germline editing and CRISPR has continued to progress, with ongoing research endeavours focusing on enhancing these techniques' precision, efficiency, and safety. It remains essential to consider ethical and regulatory factors as fundamental aspects of the ongoing exploration of germline editing and its potential applications.

This article delves into the examination of the potential legalisation of Germline Editing in India for the treatment of congenital diseases, considering it from a human rights perspective. The objective is to explore the distinction between genome editing and germline editing and present arguments in favour of pursuing Germline Editing for disease prevention and as a research tool. The ethical objections raised against Germline Editing are carefully analysed in Section 4, and the article contends that all these objections are ultimately unfounded. Based on the analysis, it is concluded that the moral justification for pursuing Germline Editing outweighs the opposing arguments, making it both morally permissible and desirable to pursue Germline Editing.

[3] Clustered Regularly Interspaced Short Palindromic Repeats
[4] A CRISPR-associated (Cas) endonuclease, or enzyme, that acts as "molecular scissors" to cut DNA at a location specified by a guide RNA

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(A) The Difference between Genome Editing and Germline Editing

Genome editing[5] or Somatic editing alters the person's DNA by targeting genes in specific types of cells. The edited gene is contained only in the target cell, restricting the impact of alteration to that specific cell. It is primarily to treat or cure diseases caused by genetic mutations. In the case of a Sickle cell anaemia patient, the CRISPR techniques are used to correct the genetic mutation by altering the DNA of the blood cells. The scientists collect blood stem cells from the patient, use CRISPR techniques to alter the genetic material producing the defective blood cells and then infuse the modified cells back into the patient, where they produce healthy haemoglobin.

Germline editing alters the genome of a human embryo at its earliest stages. It affects every cell and impacts not only the person but also his or her descendants.[6] In this case, the editing alters the DNA of the egg, the sperm, or the embryo, and as a result of the intervention during the earliest stages of development, the edited gene is copied in every cell. In the case of Sickle cell anaemia patients, CRISPR techniques are used to correct the genetic mutation by altering the DNA of the sperms, eggs, or embryos. The scientists collect the gametes or the embryos and use CRISPR techniques to alter the genetic material present in the gametes or embryos, which would produce the defective blood cells and then infuse the modified cells back into the patient.

Somatic cell therapies have been accepted, researched, and tested for over 20 years, and the process is highly regulated worldwide. Germline editing, on the other hand, is comparatively new, and its heritability presents several legal and societal considerations. Germline editing poses various threats like targeting the wrong genes; off-target impacts, in which editing a gene may fix one defect but cause another; mosaicism, in which only some copies of the gene are altered.[7] The scientific community, the U.S., and many other countries have imposed several regulatory restrictions and have introduced substantial policies on the use of germline human genome editing.

(B) Status of Germline Editing in India

Stem cell research[8] has grown in importance in biomedical science. When utilised for therapeutic purposes, stem cells and their derivatives are classified as 'Investigational New Drug

[5] It is also commonly referred to as "gene editing," though genome editing is the more comprehensive term.
[6] R. Alta Charo, GERMLINE ENGINEERING AND HUMAN RIGHTS, AJIL Unbound, vol. 112 (2018), pp. 344-349, 361.
[7] Mary Todd Bergman, Perspectives on Gene Editing Harvard Gazette (2022), https://news.harvard.edu/gazette/story/2019/01/perspectives-on-gene-editing/ (last visited May 24, 2023).
[8] National Guidelines on Stem Cell Research, Department of Biotechnology, Government of India, 2017, available at: https://dbtindia.gov.in/sites/default/files/National_Guidelines_StemCellResearch-2017.pdf.

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(IND)' or 'Investigational New Entity (INE)' under the Drugs and Cosmetics Act of 1940. It might be used in various biomedical fields, including developmental biology, disease modelling, tissue engineering, medication development, and toxicity assessment. The use of stem cells in regenerative medicine has the potential to improve human health by repairing the function of cells and tissues damaged by degeneration or injury.

However, serious concerns exist about using embryos to create human embryonic stem cell (hESC)[9] lines, which might lead to the commodification of human cells and organs. There are other issues with gene editing/modification, human germline engineering, and reproductive cloning. Furthermore, robust technologies for producing pluripotent stem cells[10] from several sources are being developed, which may be freely available for therapeutic purposes, frequently without reason. The potential danger of tumorigenicity of stem cells, given their ability to proliferate indefinitely, the risk of contamination and genomic changes resulting from in vitro manipulations, and the limitations related to immunological tissue incompatibility between individuals are all serious concerns. These factors increase the likelihood of exploitation of individuals, particularly those from poor communities.

The National Guidelines for Stem Cell Research prohibits human germline editing and reproductive cloning in order to safeguard the interests of the people and reduce the proliferation of indiscriminate use of stem cell-based therapies without establishing their safety or therapeutic efficacy.

II. CASE STUDY

(A) The Impact of Endosulfan: Unveiling its Environmental Consequences

The tragic after-effects of Endosulfan in Kerala's Kasaragod have seeped deep into the lives of the affected community. *Endosulfan* is a restricted-use pesticide particularly effective against aphids, fruit worms, beetles, leafhoppers, moth larvae, and white flies on various crops. The component was sold as a mixture of α- and β-endosulfan. Due to its hazardous nature, the pesticide is not approved for residential usage. In various states of India, the farmers are extensively using it for eradicating pests, and the administration is majorly through aerial

[9] hESC are derived from the inner cell mass of an embryonic blastocyst five days after fertilisation. hESC are undifferentiated pluripotent stem cells that have the capacity to either self-renew indefinitely or to differentiate into any cell in the body when exposed to the correct combination of signalling and growth factors. hESC lines are clonal populations of undifferentiated hESC maintained indefinitely *in vitro*.

[10] Rona S. Weinberg, Chapter 81 - Overview of Cellular Therapy, in Transfusion Medicine and Hemostasis (Second Edition), ed. Beth H. Shaz et al. (Elsevier 2013), 533-540, ISBN 9780123971647, available at: https://doi.org/10.1016/B978-0-12-397164-7.00081-1.

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spraying or direct application to plants or soil.[11]

In 1978, the Plantation Corporation of Kerala (PCK) began spraying this highly toxic organochlorine pesticide aerially on its cashew plantations extending over 4.500 hectares in the Kasaragod district of Kerala. The authorities employed this pesticide for a period ranging from 1978 to 2001 in nearly 15 panchayats.[12] The pesticide, having a half-life of 60 to 800 days[13], contaminated the soil and water in the region. The damage caused by this highly toxic pesticide was widespread, sparing no food chain level. The State and the authorities defended using the relatively cost-effective pesticide, arguing it is a "safe chemical."[14] Subsequently, due to severe political scrutiny, the State of Kerala temporarily ceased the aerial spraying, and the lower court verdict in the case of Thiruvamkulam Nature Lovers Movement v. Plantation Corporation of Kerala[15] banned the use of Endosulfan and all its formulations within the State.

The contamination and exposure to the same gave birth to several physical and mental disabilities and neurobehavioural disorders. The infliction was across all categories of people, as there were numerous cases of cancer of the liver and blood, bone deformities, infertility, undescended testis among men, miscarriages and hormonal irregularities among women, skin disorders, congenital heart diseases, and asthma.[16] Local reports also reflect a rising trend in psychiatric problems and suicidal tendencies. The children were born with several congenital disabilities. These included mainly disorders of the central nervous system, including cerebral palsy, cleft palates, retardation of mental and physical growth, epilepsy, and congenital anomalies like stag horn limbs.

Endosulfan has been banned nationwide by a Supreme Court order[17] passed in 2011. The residue of a 20-year-long disaster, owing to the short half-life of the pesticide, left in the environment would be minuscule. Although this substantially eliminates the dangers of future contamination and exposure, the mutations caused by the deadly toxin transfer across generations through human genetic material. The inheritance of these deformities by future generations could be halted by genetic engineering, specifically germline editing. Such an

[11] Dinesh Mohan, Food vs Limbs: Pesticides and Physical Disability in India, 22 ECON. & POL. WKLY. A23 (Mar. 28, 1987).
[12] Mathew, R. (2021, November 17). No end to Endosulfan tragedy. https://www.thehindu.com/news/cities/Thiruvanantha puram/No-end-to-Endosulfan-tragedy/article16888527.ece
[13] Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry, "Toxicological Profile for Chloroform" (U.S. Department of Health and Human Services, 1997), available at: https://www.atsdr.cdc.gov/ToxProfiles/tp41-c1-b.pdf.
[14] S. Mohammed Irshad & Jacquleen Joseph, An Invisible Disaster: Endosulfan Tragedy of Kerala, 50 ECON. & POL. WKLY. 61 (Mar. 14, 2015).
[15] Nature Lovers Movement v. State of Kerala, 1999 SCC OnLine Ker 191
[16] *supra* note 9 at 65.
[17] Democratic Youth Federation of India v. Union of India, (2014) 14 SCC 549

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interception would mean editing the current generation's genetic material with modern technology, eliminating the abnormalities that may be genetically transferred.

(B) Bhopal Gas Tragedy: Echoes of Tragedy

The Bhopal Gas Tragedy[18] was one of the worst industrial accidents in the history of humankind. On 3rd December 1984, about 40 tons of methyl isocyanate escaped from a pesticide facility owned by Union Carbide Company, an American company with an Indian subsidiary. The gas swept over the heavily populated neighbourhoods near the industrial plant, killing three thousand eight hundred people and causing significant morbidity and premature death for thousands.

In the aftermath, the doctors predicted that the affected population would experience "sterility, kidney and liver infections, tuberculosis[19], vision impairments and brain damage" in the short run. Research carried out by ICMR for around a decade showed striking disturbances in the eyes and the respiratory system. In addition to this, the exposed population showed multiorgan involvement. Among the people who had been exposed, there were additional reports of coma cases, gastrointestinal problems, and CNS lesions. Since then, the prevalence of psychological and behavioural disorders has not diminished since then.

All sexes and all age groups were impacted, from in-utero conception through old age. There were early signs of immunological disruptions, with unanticipated implications on host vulnerability to environmental infections and other risks[20]; chromosomal abnormalities were detected in the early acute phase. Abortions were more frequent, and intrauterine development was slowed in some kids delivered to exposed mothers. It is obvious that monitoring side effects and caring for the sick would take years.

In February 1985, the Indian Government filed a complaint in the United States Federal Court for a $3.3 billion claim against the Union Carbide Company. However, by 1986, all these cases before the US District Court had been moved to India based on "*forum non conveniens*[21]", i.e., the case should be moved to a more convenient venue so that the trial could go on more efficiently. In 1989 in the case of the State of Madhya Pradesh v. Warren Anderson and Others, the Supreme Court in India approved a settlement of the civil claims against Union Carbide for

[18] Edward Broughton, The Bhopal disaster and its aftermath: a review, 4 Environmental Health 6 (2005), available at: https://doi.org/10.1186/1476-069X-4-6.
[19] S. Sriramachari, The Bhopal Gas Tragedy: An Environmental Disaster, 86 Current Science 905 (2004), available at JSTOR, http://www.jstor.org/stable/24109273 (accessed May 25, 2023).
[20] Betwa Sharma, Bhopal Gas Tragedy: 'New' Victims, 41 Economic & Political Weekly 1613 (2006), available at JSTOR, http://www.jstor.org/stable/4418132 (accessed May 25, 2023).
[21] '*Forum non conveniens'* refers to a court's discretionary power to decline to exercise its jurisdiction where another court, or forum, may more conveniently hear a case.

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$470 million.

According to a study conducted by ICMR, it was found that Methyl Isocyanate damages human DNA by interacting with proteins. The research found two patterns. Although those who were significantly exposed to the gas had fewer aberrant cells, the frequency of aberrations within such cells has grown with time. Another observation was an increase in chromosomal abnormalities, even in persons who had only been minimally exposed to the gas. Germline editing is a powerful tool for correcting these disease-causing gene mutations in human embryos and preventing them from passing on to future generations. This effective interception would include using contemporary technology to modify the present generation's genetic material, removing any defects that may have been genetically passed.

III. MUTATIONS ARE INEVITABLE

Genetic mutations are inevitable and necessary for the development and propagation of humankind. A recent study has identified 9 ways genetic mutations can occur. Among these, one mechanism dealt with inaccurate copying of DNA, another with the chemical damage that occurs to the DNA.[22] The study further identified prominent and active machinery during the early stages of development or embryonic development. Decades of research on genetic mutations and human evolution reflect that mutations are inevitable.

The mutation rate of stable genomes is estimated to be 10−10/bp per cell generation.[23] However, in certain physiologic conditions, the rate of mutation increases dramatically. For example, the immunoglobulin (Ig) genes can undergo mutation at a rate that exceeds the basal rate by more than a million-fold.[24] In another example, a lac I transgene in mice (in the 'Big Blue' transgenic mouse) undergoes mutations more frequently than expected, assuming a basal mutation rate. [25]

Germline editing has faced massive scrutiny owing to its tampering with nature's forces and the natural way of human formation. The genetic modifications introduced with the help of modern technology are similar in nature to the natural mutations that are bound to occur. Moreover, the mutations in the genome dwarf the potential of what can be done artificially with CRISPR. The

[22] *Origins of Mutation*. (2021, August 12). Harvard Medical School. https://hms.harvard.edu/news/origins-mutation#:~:text=%E2%80%9CGenetic%20mutations%20are%20a%20rare,biomedical%20informatics%20in%20the%20Blavatnik

[23] Baer CF, Miyamoto MM, Denver DR, Mutation rate variation in multicellular eukaryotes: causes and consequences, 8 NATURE REV. GENET. 619 (2007).

[24] Wabl M, Burrows PD, von Gabain A, Steinberg C, Hypermutation at the immunoglobulin heavy chain locus in a pre-B-cell line, 82 PROC. NAT'L ACAD. SCI. U.S.A. 479 (1985).

[25] Buettner VL, Hill KA, Scaringe WA, Sommer SS, Evidence that proximal multiple mutations in Big Blue transgenic mice are dependent events, 452 MUTAT. RES. 219 (2000).

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increased attention drawn to CRISPR and artificial mutations is turning a blind eye towards the sufferings of generations.

The slow natural process, which renders unprecedented results, should be weighted less compared to the precise functioning of germline editing. Germline editing functions by laying out the blueprint for accurate results. Hence, this 'precision medicine' can be an efficient and effective tool in eliminating defects. The denial of access to such techniques can, in fact, be seen as a human rights violation as the person is denied the right to be healthy. If there exists no cure for a particular disease and generations are forced to remain suffering, germline editing techniques can be transformative.

The inevitability of mutations in human genes eliminates the contention that scientists are advocating 'cloning'.[26] Reproductive cloning is defined as the deliberate production of genetically identical individuals.[27] The process of editing genetic material in germline editing only removes the specific genetic material that is defective. The "corrected" cells will be subject to mutations in the future as it transcends through generations. This eradicates the contention that 'clones' or a specific 'class' of people will be created using this technology.

IV. ANALYSIS OF THE PREVALENT ETHICAL OBJECTIONS

(A) Prevalence of Consanguineous Marriages in India

Consanguineous marriage is the legal union of a male and female of a common ancestor related by blood.[28] The most common form of consanguineous marriage is between first cousins. The first National Family Health Survey (NFHS-1; 1992-1993) shows the prevalence of consanguineous marriages in India at 14%, whereas the second Indian Human Development Survey (IHDS-II, 2011-2012) shows its prevalence at 8%.[29] Marriage between Sapindas is still legal in India under the veil of customs and traditions, albeit prohibited by the laws in force[30].

Children born out of consanguineous marriages are at an increased risk of genetic disorders owing to the expression of autosomal recessive gene mutations that they inherit from their common ancestors. The closer the biological relationship between parents, the greater the probability that the children will inherit identical copies of one or more detrimental recessive

[26] https://www.ncbi.nlm.nih.gov/books/NBK223960/ (last visited [May 24, 2023]).
[27] National Academies Press (US), Cloning: Definitions And Applications, in SCIENTIFIC AND MEDICAL ASPECTS OF HUMAN REPRODUCTIVE CLONING - NCBI BOOKSHELF, https://www.ncbi.nlm.nih.gov/books/NBK223960/#:~:text=Reproductive%20cloning%20is%20defined%20as,identical)%20twins%20are%20natural%20clones (last visited [May 24, 2023]).
[28] S. Acharya & H. Sahoo, Consanguineous Marriages in India: Prevalence and Determinants, 23 J. HEALTH MGMT. 631 (2021).
[29] *Ibid.*
[30] Hindu Marriages Act, 1955, 25 of 1955 (India).

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genes.[31] In India, an estimated 4,95,000 infants with congenital malformations, 3,90,000 with G6PD deficiency, 21,400 with Down syndrome, 9,000 with beta-thalassaemia, 5,200 with sickle cell disease and 9760 with amino acid disorders are born each year.

Consanguineous marriages have been correlated with increased rates of early childhood malformations.[32] Many recessive genetic diseases are incompatible with life and reproduction, leading to a counter-selection of these pathogenic variants in the populations with ancient practices of consanguinity.[33] Obesity is a risk factor for multiple diseases, including cardiovascular disease, insulin resistance and type 2 diabetes mellitus. Recent studies have found an association between ACE II polymorphisms and obesity in the offspring of first cousins[34], that the metabolic pathway that regulates obesity is influenced by genetic background[35] along with other environmental factors[36]. The variants in the same genes have different penetrance and consanguineous populations may be enriched for both rare and common genetic variants contributing to an overall increase in obesity.[37]

The genetic disorders originating from consanguineous marriages in India can be cured with the help of germline editing using CRISPR techniques. The defective gene can be identified, and the DNA can be altered to remove the genetic material causing the production of defective genes. This rids the current generation, as well as the future offspring of that generation, from genetic disorders arising as a result of consanguineous marriages.

(B) Prevention is Better than Cure

Technological advancements and innovations in the medical sphere have revolutionised disease approaches. Pharmaceutical and Biotechnology companies in India spend a windfall[38] every year on Research and Development. According to a report, in the financial year of 2020, Lupin,

[31] Rabah M. Shawky et al., Consanguinity and its relevance to clinical genetics, 14 EGYPT. J. MED. HUM. GENET. 157 (2013).
[32] Fareed M & Afzal M, Genetics of consanguinity and inbreeding in health and disease, 44 ANN. HUM. BIOL. 99 (2017).
[33] G. Temaj, N. Nuhii, & J.A. Sayer, The impact of consanguinity on human health and disease with an emphasis on rare diseases, 1 J. RARE DIS. 2 (2022).

[34] Alshammary AF & Khan IA, Screening of obese offspring of first-cousin consanguineous subjects for the angiotensin-converting enzyme gene with a 287-bp Alu sequence, 30 J. OBES. METAB. SYNDR. 63 (2021).
[35] Speakman JR et al., Set points, settling points and some alternative models: theoretical options to understand how genes and environments combine to regulate body adiposity, 4 DIS. MODEL. MECH. 733 (2011).
[36] Sheikh AB et al., The interplay of genetics and environmental factors in the development of obesity, 9 CUREUS e1435 (2017).
[37] Saeed S, Arslan M, Froguel P, Genetics of obesity in consanguineous populations: toward precision medicine and the discovery of novel obesity genes, 26 OBESITY (SILVER SPRING) 474 (2018).
[38] U.S. Department of Commerce, International Trade Administration, "India - Healthcare and Medical Equipment," Country Commercial Guides (U.S. Government Publishing Office), available at: https://www.trade.gov/country-commercial-guides/india-healthcare-and-medical-equipment.

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Dr Reddy's, and Cipla, leading pharma companies in India, spent approximately 225 204, and 173 million U.S. dollars, respectively, on research and development. According to DGCIS[39], Kolkata, Ministry of Commerce, India imported pharmaceutical products worth approximately 42,943 crores[40].

Research and studies conducted worldwide sought to explore the scope of germline editing to prevent genetic disorders. It has been shown through scientific research that germline editing has the potential to "cure" defective genes by editing the genetic material during the early stages of development. The employment of CRISPR or similar techniques to remove defective genetic material can be an efficient alternative to the pharma "cures". This eliminates the need to find cures for genetic diseases as the disease can be prevented using such techniques.

(C) The Alleged Nexus between the Human Genome and the Human Dignity

The Deontological theory of Kant advocates the preservation of human dignity as the zenith of human duty. Through his philosophical view, Kant has dealt with two major ethical principles – the dignity of the being and categorical imperatives. The moral principle of the categorical imperative is given by reason. It states that we are to act only in such ways that the maxim of our action, i.e., the principle of governing our action, could be willed as a universal law. In another formulation of the categorical imperative, Kant specifies that we must always respect humanity in ourselves and others by treating humans always as ends in themselves and never merely as means.

Authors from socio-legal spheres across the world have surfaced their opinions on germline editing and its diminishing nature of dignity[41]. The general opinion among the authors regarding germline editing is that since dignity is embedded in our genome, we must refrain from altering it. They contend that safeguarding the human genome by whatever means is not consistent with upholding human dignity but that humans should not arrogate the power to alter it. Another concern revolves around the universality of germline editing, given the threats of discrimination in several regards posed by it. The economic and social disparities would lead to asymmetric accessibility and unequal distribution of resources leading to the widening of the social gap. They contend that such a divide would cater to the wealthy individuals eliminating all possibilities of disabilities from amongst themselves, leading to the formation of a 'privileged

[39] Directorate General of Commercial Intelligence and Statistics
[40] Directorate General of Commercial Intelligence and Statistics, "Administrative Report" (Directorate General of Commercial Intelligence and Statistics, [2020]), available at: https://www.dgciskol.gov.in/Admini_report.aspx.
[41] Deryck Beyleveld & Roger Brownsword, Human Dignity, Human Rights, and Human Genetics, 61 Modern L. Rev. 661 (1998), available at JSTOR, http://www.jstor.org/stable/1097127 (accessed May 25, 2023).

class.'

The nexus drawn between human dignity[42] and the human genome is fundamentally flawed when viewed from the perspective of autonomy. The authors of this paper contend that legalising germline editing would cater to the amelioration of groups with congenital disabilities and diseases. The concept of dignity is elusive and vague hence the lines of demarcation of what constitutes dignity and what does not remain murky. The genetic modification of the gametes or embryo is not treating humans as a means to a healthy population but merely increasing that person's dignity, the end in itself.

Article 1 of the Universal Declaration of Human Rights states, "All human beings are born free and equal in dignity and rights." The principle of dignity which is associated with the concept of autonomy - is an intrinsic and non-negotiable value shared by all human beings, solely by virtue of belonging to the human species. The concept of dignity and rights in the case of embryos, which forms the crux of the opposer's argument, can be termed a legal fallacy. Legal jurisprudence does not render personhood to embryos or unborn persons, thereby making them incapable of holding rights and duties.

(D) The Right to Free Future

The advocates of the non-legalization of germline editing contend that all beings have the right to be born without any interference that modifies their capabilities or their futuristic opportunities. The 'Right to an open future,' a term coined by Joel Feinberg, the right to an open future encompasses a set of moral rights children possess that are derived from the autonomy rights of adults.[43] Essentially, the right protects the interests of the child by ensuring that others do not determine major life choices before they acquire the ability to make them. It distinguishes between what parents are allowed to do for their children and what parents ought to provide for their children.

Germline editing is believed to be intrusive in a child's present and future life as the major decisions regarding their capabilities and health are decided by their parents, albeit for their own good. The children are deprived of natural life as their genetic material or their own makeup is tampered with, according to the general opposition.[44] The general opinion that man should not "play God" operates on the premise of "Mankind assuming powers beyond our station or

[42] Iñigo de Miguel Beriain, Human dignity and gene editing: Using human dignity as an argument against modifying the human genome and germline is a logical fallacy, 19 EMBO Reports 10 (2018), e46789, DOI: 10.15252/embr.201846789.
[43] Joel Feinberg, The Child's Right to an Open Future, in WHOSE CHILD? 124-53 (W. Aiken & H. LaFollette eds., Rowman & Littlefield 1980).
[44] Joel Feinberg, The Moral Limits of the Criminal Law: Harm to Self, 325-326 (Oxford University Press 1986).

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our ability to control." Altering the genetic material and, thereby, the future of an unborn child is opined as against the rights of the future child.[45]

The 'Right to a Free Future' advocated for by various authors contradicts the 'Right to a healthy future.' The elimination of defective genes to ensure that the being is born free of genetically inherited diseases helps secure a dignified future. The removal of medical impairments increases the autonomy and agency of the person, which in turn, according to the Kantian view, should increase the dignity of life. Every child, provided science allows for the same, has and is able to access the opportunity to be born healthy sans congenital diseases and disabilities. The right to a better future should be weighed more than the morally influenced 'Right to an Open future.'

(E) It Kills the Diversity

The Disability Pride Movement is built on the theme that our common perceptions of disease and disability are mistaken. It is contended that if Germline editing is employed overzealously, it might eliminate valuable forms of diversity from the human species.[46] The presence of Immuno-diversity[47] and Cognitive diversity[48] can be, under certain circumstances, beneficial to societal growth. There have been intense debates in philosophy on distinguishing healthy forms of human diversity from disease and disability.

The argument that Germline editing stigmatises the disabled and propagates the idea of eliminating the "biologically inferior" is prominent.[49] The advocates against such genetic intervention aid the wrong perception that people who are said to carry supposedly "bad genes," are in a state of constant suffering and hold a less valuable place in society. It is contended that expanding human diversity in all its forms, including disability, would "strengthens the human community ethically and biologically because it opens the public and private sphere to a variety of perspectives, life experiences, ideas, and solutions to live together with mutual flourishing."[50]

Holding such arguments against the integration of science and technology into the sphere of human genetics can be detrimental to the healthy future of society. The plausibility that some diseases and disabilities add valuably to society does not carve out the many others that

[45] *Ibid.*
[46] Gyngell C, Enhancing the species: genetic engineering technologies and human persistence, 25 PHILOS. TECH. 495 (2012).
[47] Diversity in the genes that influence innate immunity
[48] Diversity in the genes that affect our cognitive traits
[49] *supra* note 4 at 347.
[50] S. S. Garland-Thomson, The Dark Side of CRISPR, SCIENTIFIC AMERICAN (Feb. 16, 2021), https://www.scientificamerican.com/article/the-dark-side-of-crispr/#:~:text=Genome%20editing%20is%20a%20powerful,categorize%20as%20diseased%20or%20genetically.

negatively affect societal growth and development. The position taken by many that such technology would stigmatise the already disabled people is ill-founded. The apprehension of stigmatisation fails to be a reasonable ground to deny multiple congenitally disabled others a healthy future.

The argument that such technology would kill valuable diversities is an overstretch as the genetic material of all human beings is vulnerable to natural mutations over time. The contention that this technology would lead to a "biologically superior class," is defeated by the forces of natural mutation. Genetic therapeutic technology merely cures or removes the diseases and disabilities that obstruct the peaceful, healthy lives of people with congenital diseases and disabilities. It kills not the diversity among human beings but the root that disables them from enjoying standard privileges.

(F) Bioethics

Germline editing presents a multitude of significant bioethical[51] challenges that demand careful consideration. One major concern revolves around the possibility of unintended consequences and long-term effects that may impact future generations. The permanent nature of germline alterations raises important questions regarding informed consent and the rights of individuals who cannot consent themselves. Moreover, it is crucial to ensure equitable access to germline editing technologies to prevent the exacerbation of existing social inequalities.

For families who have witnessed the profound suffering caused by genetic diseases in their children, germline editing represents a ray of hope, offering the potential to eliminate debilitating mutations from future generations. However, the broader social implications of genome editing must not be overlooked, particularly regarding socio-economic disparities. Critics argue that germline editing could widen the gap between the privileged and those living in poverty, further reinforcing societal inequalities.

Therefore, while genome editing holds tremendous potential for alleviating human suffering, it necessitates a meticulous examination of ethical concerns[52] related to fairness, justice, and the potential reinforcement of existing social divisions. Additionally, ethical considerations[53] must address the potential for enhancing non-medical traits, which raises questions about fairness

[51] A. Ouellette, Disability and Bioethics, in Reference Module in Biomedical Sciences (Elsevier 2014), ISBN 9780128012383, https://doi.org/10.1016/B978-0-12-801238-3.00186-0.
[52] Giovanni Rubeis & Florian Steger, Risks and benefits of human germline genome editing: An ethical analysis, 10 Asian Bioethics Review 133 (2018), DOI: 10.1007/s41649-018-0056-x.
[53] Sebastian Schleidgen et al., Human germline editing in the era of CRISPR-Cas: risk and uncertainty, inter-generational responsibility, therapeutic legitimacy, 21 BMC Med. Ethics 87 (2020), available at: https://doi.org/10.1186/s12910-020-00487-1.

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and the redefinition of societal norms and desirability.

Establishing comprehensive regulatory frameworks[54], robust scientific research, and open dialogue among scientists, policymakers, and the public are of utmost importance to navigate the complex bioethical[55] landscape of germline editing. This collective effort is essential to ensure the responsible and ethically sound utilisation of this powerful technology while considering the impact on equity, social dynamics, and the well-being of future generations.

V. Economic aspect of using germline editing in place of genome editing

Germline Editing and Genome Editing are genetic engineering techniques[56] that can potentially be used to treat congenital diseases in humans. Germline Editing can eliminate the genetic mutations causing congenital diseases by modifying the genetic material of an embryo. On the other hand, genome editing can only modify the genetic material of a patient's existing cells, limiting its effectiveness in treating genetic diseases. Therefore, germline editing may have a more significant long-term economic benefit[57] than genome editing as it can potentially eradicate the disease in future generations, reducing healthcare costs[58]. India's healthcare system might save billions of dollars in medical expenses and raise the standard of living for future generations by avoiding hereditary illnesses through germline editing. The cost of germline editing may be higher initially due to the need for specialised technology and trained professionals. However, the cost of germline editing could decrease over time as the technology becomes more widely available and efficient.

In contrast, the cost of genome editing may remain relatively constant as it requires ongoing treatment and monitoring. The ethical and societal ramifications of germline editing, which may influence its commercial feasibility, must be considered. Germline editing raises some ethical concerns, including the potential for unintended consequences and the creation of "designer babies" with predetermined physical or mental traits. The ethical and social concerns could impact the public's acceptance and adoption of the technology, affecting its economic viability.

[54] Jodi Halpern et al., Societal and Ethical Impacts of Germline Genome Editing: How Can We Secure Human Rights? 2 CRISPR J. 293 (2019), DOI: 10.1089/crispr.2019.0042.
[55] Fatma Betül Ayanoğlu et al., Bioethical issues in genome editing by CRISPR-Cas9 technology, 44 Turk. J. Biol. 110 (2020), DOI: 10.3906/biy-1912-52.
[56] Agustina I. Whelan et al., Gene Editing Regulation and Innovation Economics, 8 Front. Bioeng. Biotechnol. 303 (2020), DOI: 10.3389/fbioe.2020.00303.
[57] Paul D. Mitchell et al., Economic issues to consider for gene drives, 5 J. Responsible Innovation S180 (2018), DOI: 10.1080/23299460.2017.1407914.
[58] Anne W. T. Muigai, Expanding global access to genetic therapies, 40 Nature Biotech. 20 (2022), available at: https://doi.org/10.1038/s41587-021-01191-0.

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Overall, the economic impact of using germline editing versus genome editing for treating congenital diseases in India would depend on a variety of factors, including the cost of developing and implementing the technology, the effectiveness of the treatments, the acceptance of the technology by healthcare providers and patients, and the regulatory framework governing their use. It is significant to emphasise that genome and germline editing create ethical and social issues that should be considered in any economic study.

(A) Threats Specific to India – where the regulations might fail (Corruption)

India will face multiple challenges in implementing genome editing for humans, including ethical, legal, and social issues. While somatic cell therapies are targeted and do not affect future generations, editing the germline or reproductive cells alters heritable DNA. Corruption is a significant obstacle to implementing genome editing, and it can manifest in various forms, such as bribery, nepotism, and cronyism, at different levels of the process. The advancements in gene editing also have implications for national and international security since CRISPR/Cas9 can modify pathogens, making them more virulent, increasing host range and transmission, and enhancing resistance to therapy. In order to combat corruption, there should be a commitment to transparency and accountability throughout the implementation process, including independent oversight, public reporting, and penalties for corrupt behaviour.

A strong ethical framework[59] should also be in place to prioritise patient safety and well-being. The current regulatory systems are fragmented, requiring an integrated and coordinated approach to gene editing. Communicating relevant information on gene editing advancements and obtaining their consensus on gene editing regulations is crucial. A global framework for oversight is necessary to prevent irresponsible gene editing applications. The WHO[60] has established an advisory committee to develop global standards for governance and oversight of human genome editing, including creating a transparent global registry to monitor human gene editing. Countries must establish a uniform format to register all human gene editing experiments within their boundaries.

VI. Conclusion

In this article, we have demonstrated that research on germline editing can be conducted in a safe manner with manageable and reasonable risks. CRISPR-Cas9 technology has brought the

[59] Committee on Science, Technology, and Law; Policy and Global Affairs; National Academies of Sciences, Engineering, and Medicine; Olson S, editor, International Summit on Human Gene Editing: A Global Discussion, MEETING IN BRIEF, Washington, D.C., National Academies Press (US), 2016, available at: https://www.ncbi.nlm.nih.gov/books/NBK343651/.
[60] World Health Organization

world onto its toes with a multitude of ethical concerns attached to it. The dignity of the living and the future generations have been brought into consideration with an evolutionary technology with the potential of undoing decades of evolutionary inaccuracies. The concept of Kantian preservation of dignity, the Right to an Open future and human diversity is not threatened by technology as it merely works towards securing the dignity of future generations with a safe and healthy future.

The National Guidelines for Stem Cell Research in India prohibits human germline editing and reproductive cloning. Studies conducted have evidenced the prevalence of various genetically transmitted diseases in India. Further, the prevalence of consanguineous marriages under the garb of customs further increases the threat of such congenital disorders. Analysing the social and economic disparities prevalent in the nation, it is pertinent that germline editing be legalised. The legalisation will have to be combined with measures to gag the threat of a corrupt system.

The Human Rights movements across the world have long been striving towards a healthier and safer environment for all human beings.[61] Efforts to improve the standard of living have been undertaken worldwide, along with efforts to rid the world of life-threatening diseases. CRISPR and its associated technologies have the potential to improve health and well-being by providing treatments for genetic diseases. However, ensuring equality, non-discrimination, informed consent, privacy protection, and ethical boundaries is crucial.[62] International cooperation and inclusive societal discussions are necessary to establish ethical standards and address concerns. By upholding these principles, CRISPR can be harnessed while respecting human rights.

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[61] Deryck Beyleveld & Roger Brownsword, Human Dignity, Human Rights, and Human Genetics, 61 MOD. L. REV. 661 (1998).

[62] *See*, Proceedings of the Third Session of the International Bioethics Committee of UNESCO, September 1995: Volume 1, at 120 (referring to the three French Acts on bioethics of July 1994), said:

It is, therefore, fortunate and encouraging that a number of countries have, like France, set out over the last decade to equip themselves with bioethics laws. This trend illustrates a growing awareness around the world that legislators must, despite the difficulties, act to ensure that science develops with respect for human dignity and fundamental human rights and in line with national democratic tradition.

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