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Reproductive Embryo Editing: Attending to Justice

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ABSTRACT

The use of genome embryo editing tools in reproduction is often touted as a way to ensure the birth of healthy and genetically related children. Many would agree that this is a worthy goal. The purpose of this paper is to argue that, if we are concerned with justice, accepting such goal as morally appropriate commits one to rejecting the development of embryo editing for reproductive purposes. This is so because safer and more effective means exist that can allow many more prospective parents to achieve the same valued goal and that offer additional benefits.

Keywords: CRISPR; reproductive ethics; distributive justice

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INTRODUCTION

Recent advances in biotechnologies have made plausible not just gathering genomic information but also manipulating the human genome.(Khalil 2020) These new editing technologies allow scientists to add, remove, or alter genetic material at particular locations in the genome. Through somatic modifications, genome editing offers great promise in the prevention and treatment of various human diseases. But these technologies can also be used to modify gametes and embryos. Defenders of gene editing for reproductive purposes contend that it would allow some people to have healthy and genetically related children. These are people at risk of transmitting genetic diseases to their offspring. In this paper, I focus on reproductive embryo editing and its purported valuable goal: allowing people to have unaffected and genetically related children. I argue that if we are concerned with justice, accepting such goal commits one to rejecting the development of reproductive embryo editing. Considerations of justice are relevant to questions regarding the development of reproductive embryo editing for several reasons. First, decisions about research funding priorities involve judgments about what constitutes a fair distribution of resources. Many others have called attention to this concern in the broad context of health priorities and the more particular one of reproductive technologies.(Pogge 2012; Baylis 2019; Daniels 2008; Roberts 1997; Rulli 2019) Second, determinations about whether some means are the most appropriate to meet certain desirable goals also implicate justice considerations. Not only do questions about appropriateness of means involve concerns about opportunity costs, they also involve deliberations about *who* benefits from different means. This second concern is my focus here.[1] Before making my case, I offer a brief overview of genome editing technologies.

[1] I am not committed here to a particular principle of distributive justice. My arguments are clearly consistent with a utilitarian framework. However, my claim that we should reject funding for reproductive embryo editing given that the goal it seeks to achieve can be achieved with other appropriate means for more people is quite minimal and is arguably consistent with any of the major principles of distributive justice, from egalitarianism, to the difference principle, to utilitarianism. At least in principle, it seems that achieving the same valuable goal for more people is something that no theory of distributive justice would oppose. Of course, people might disagree about whether the goal achieved by the various interventions is the same, or

GENOME EDITING TECHNOLOGIES

Although researchers have been using genome editing technologies to modify the mammalian genome for a few decades,(Khalil 2020) many of the technologies available were unreliable and inefficient. Current targeted genome editing technologies with restriction endonucleases are significantly more precise.(Khalil 2020) They allow researchers to introduce new genetic material at random places –as older technologies did-- but also create specific double-stranded breaks at desired locations in the DNA and use the cells' own mechanisms to repair such breaks. A variety of engineered nucleases such as Zinc finger nucleases (ZFNs), Transcription Activator-Like Effector Nucleases (TALENs), engineered meganucleases, and the CRISPR/Cas9 system are now being used for genome engineering purposes.(Khalil 2020)

All of these tools have been successful in some ways, but the CRISPR-Cas9 system is proving to be more efficient, accurate, and cheaper than the other editing tools. The recent Nobel Prize in chemistry awarded to its developers, Emmanuelle Charpentier and Jennifer Doudna,(Mullard 2020) demonstrates the revolutionary nature of CRISPR/Cas9. Of course, CRISPR/Cas9 still presents several challenges, such as off-target effects, reliability, improving delivery to desired tissues, enhancing function, and immunogenic reactions.(Hirakawa et al. 2020) Researchers worldwide are investigating these and other problems with the goal of making the technology sufficiently safe and effective as to become a common therapy tool.

Genome editing technologies can be used to modify somatic cells, thus affecting only the individual in whom the intervention is used. In this context, genome editing is being employed in clinical studies with the aim of curing or treating diseases, such as HIV/AIDS, blood disorders, such as hemophilia, and sickle-cell anemia, and several forms of cancer, including cervical cancer and leukemia.(Hirakawa et al. 2020) Although, this use of CRISPR presents various ethical issues, most see it as an appropriate tool against human diseases, not dissimilar to other medical interventions.

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about what the benefits obtained by the different interventions are –and I address some of these issues below. My claim is that accepting that the goal obtained by reproductive embryo editing can also be obtained with other safe and effective means for more people –and indeed with greater benefits-- and thus that we should pursue those other interventions aligns with the main principles of distributive justice. I believe this constitutes an additional strength of my argument.

More controversially, genome editing technologies are also being used for germline modifications.(Lea and Niakan 2019) These interventions, if used in the context of reproduction, would last throughout the lifetime of the modified individuals and would be transmissible to future generations. Germline modifications necessitate (at least at this point) the use of in vitro fertilization (IVF) and associated techniques to access gametes and early embryos and to transfer edited embryos into women's bodies.(Ma et al. 2017)

Germline interventions can be employed to correct genetic mutations implicated in the development of various human diseases and to improve particular characteristics, i.e., genetic enhancement. CRISPR-Cas9, for instance, has been used already to create genetically modified macaque monkeys.(Niu et al. 2014) Several groups in places where these interventions are lawful have also reported on the use of genome-editing tools to modify the genomes of human embryos for research purposes.(Ma et al. 2017) Although reproductive genome editing is not yet an accepted clinical intervention, in November 2018, a researcher named He Jiankui announced that he had used it to create the first edited embryos to make them less susceptible for HIV infection.(Cyranoski and Ledford 2018) He and his team recruited couples with a male partner who was HIV-positive and a female partner who was uninfected. After creating the embryos, He used CRISPR-Cas9 to edit them so as to disable a genetic pathway that HIV uses to infect cells. According to reports, three babies have been born from the edited embryos. (Cyranoski 2020) He's actions have been widely condemned by the scientific community [2] and he was recently sentenced to three years in prison.(Townsend 2020)

REPRODUCTIVE GENOME EDITING: HELPING PEOPLE TO HAVE HEALTHY AND GENETICALLY RELATED CHILDREN

Defenders of reproductive CRISPR argue that it would allow some people – those at risk of transmitting genetic diseases to their offspring-- to have healthy and genetically related children. (International Commission 2020; NAS 2017; Nuffield Council 2018) Notice that the

[2] Importantly, the most common reasons for such condemnation were not related to the purpose of the intervention –allowing some people to have unaffected and genetically related children—but to the particular target of the intervention (Cyranoski and Ledford 2018).

goal of these techniques cannot be conceptualized as helping people simply to have healthy children. There are many options available to prospective parents who are at risk of transmitting disease-related mutations and who wish to have healthy children.[3] Among them are adoption and gamete and embryo donation.

The idea of having genetically related children as a scientific and societal priority might strike some as inappropriate.(Rulli 2016) I am sympathetic to this claim. Nonetheless, here I want to concede the importance of such desire for two reasons. First, the goal of having genetically related children is one that many people find valuable (Overall 2012). Second, in granting that procreation is an appropriate goal, I am conceding the main argument for the development of reproductive embryo editing, which presupposes the value of procreation. My claim here is that a commitment to that goal requires that one rejects the development of reproductive genome editing on justice grounds.

For many human beings, having genetically related children is not particularly difficult. Indeed, thousands of healthy children are born every day to their genetically related parents. For some, however, realizing this goal is challenging. Some, at a significant risk to women's health and substantial financial costs, decide to use IVF and preimplantation genetic testing (PGT) to fulfill their desire. Prospective parents with a familial disorder can use PGT for monogenic traits in order to identify embryos that have inherited the disease-related allele and discard them.(Fesahat, Montazeri, and Hoseini 2020) The techniques utilized to assess the genome can identify various monogenic disorders, including gene variants with increased disease risk, and late-onset disorders. They can also detect mitochondrial DNA mutations. Fertility clinics also use PGT to identify chromosomal abnormalities. Currently, PGT could also be employed to identify complex (polygenic) conditions, such as congenital diabetes or cardiomyopathies, although fertility societies have not yet accepted the clinical utility of these procedures.(Treff et al. 2020)

Although the use of PGT can help most prospective parents at risk of transmitting disease-related genetic mutations to their offspring, it cannot help everyone.(Viotti et al. 2019) For instance, PGT is unhelpful for prospective parents who both carry two copies of a

[3] By "healthy" I simply mean without the disease-related mutation the prospective parents are at risk of transmitting. Clearly, no one can ever guarantee a healthy baby in any broader sense.

recessive, disease-related, allele (e.g., cystic fibrosis), or where one or both carry two copies of an autosomal (i.e., non-sex chromosome) dominant disorder (e.g., Huntington´s disease). In both of these cases, all the offspring will inherit the disorder. Additionally, PGT won't be useful in a context where fertilization has produced only affected embryos and where advancing age, disease, or cost preclude additional IVF cycles to obtain more embryos. Likewise, PGT might be useless to some women at risk of transferring mutant mtDNA to their offspring. Mutant mtDNA commonly exists in a mix with normal mtDNA in a cell. In these cases, PGT can identify, and discard affected embryos that carry mutant mtDNA. Sometimes, however, all mtDNA is mutant or the mutation load is very high and thus PGT is not useful in identifying unaffected embryos. For these prospective parents, embryo editing techniques such as CRISPR offer hope.

ATTENDING TO JUSTICE

Let us grant then that helping people to have healthy and genetically related children is a valuable goal. I contend that in such a case, a concern for justice commits one to rejecting the development of genome editing for reproductive purposes. This is so, even if it is true that these techniques are the only hope that some people have to conceive healthy and genetically related offspring. As I indicated earlier, determinations about whether particular means are the most appropriate to meet a desirable goal involve deliberations about opportunity costs and about *who* benefits and thus they implicate justice concerns.

Several considerations support my claim that a commitment to justice requires rejecting the development of genome editing for reproductive purposes. Determining whether reproductive embryo editing should be pursued requires an assessment of whether it is safe and if so, whether it is effective, that is, whether it helps us achieve the intended goal of allowing people to have healthy and genetically related children. This is the focus of a number of national and international reports, all of which conclude that pursuing CRISPR for reproductive purposes at this point would be irresponsible and that more research is needed and should continue. (International Commission 2020; NAS 2017; Nuffield Council 2018)

However, appropriate assessments of new technologies also require a determination of whether a desired goal can be achieved by other means that are safe or safer and more effective.

Several of the reports analyzing reproductive embryo editing do attend to this concern. (International Commission 2020; NAS 2017; Nuffield Council 2018) Importantly, whether other means might be safe(r) and more effective than genome editing can be interpreted in two different ways. One, and the way in which all the published reports have understood it, is to assess whether the particular group of people who could be helped by embryo editing in the pursuit of their healthy and genetically related children –those at risk of transmitting genetic diseases-- could achieve that valued goal by other safe and effective means. As we have seen, the answer is that at least for some of those people existing technologies are insufficient.

Another, and surely at least as relevant, way of assessing alternatives is to consider whether other safe (r) and (more) effective means exist or could be developed that could help many other prospective parents –with different types of risks-- achieve the desired goal of having healthy and genetically related children.[4] A review of easily accessible data quickly shows that such is indeed the case. According to the World Health Organization, over 5 million children under 5 years of age died in 2019.(WHO 2020) Most of those deaths were the result of preventable and treatable causes. Leading causes of death were preterm birth complications, birth asphyxia/trauma, infectious diseases, including pneumonia, diarrhea, and malaria, and congenital anomalies. Most of these diseases can be prevented or treated with simple, cost-effective interventions including pre- and postnatal care, immunizations, adequate nutrition, and safe water.

The overwhelming majority of these deaths occur in developing countries, particularly in Sub-Saharan Africa and Central and Southern Asia.[5] Nonetheless, child

[4] Not one of the various reports charged with evaluating heritable genome editing techniques mentions this essential consideration.

[5]This is arguably irrelevant to at least some justice considerations. I point this out because it is relevant to some of the objections presented below.

morbidity and mortality also affect rich countries. Both the United States and the UK, where various national and international reports have given the green light to research on CRISPR for reproductive use under certain conditions, have some of the highest child mortality rates of industrialized countries. In the US, for instance, the under-five mortality rate is approximately 6.5 per 1,000 live births, double the rate of other industrialized nations.(IGME 2020)

Reproductive embryo editing is likely to benefit a staggering low number of prospective parents. According to some estimates, the number of people for whom embryo editing would be the only option to have healthy and genetically related children is in the low hundreds –assuming, improbably, that all of them would avail themselves of the technology. (Viotti et al. 2019) On the other hand, funding basic and applied research in pregnancy and infancy, eliminating barriers to pre- and postnatal care, ensuring that prospective mothers and their children have access to adequate nutrition, and improving social and environmental services, could help millions more to achieve the valuable goal of having healthy and genetically related children.

Furthermore, not only do other means exist that allow more people to achieve the same desirable goal, but these other means have advantages completely absent in the case of genome editing. First, even in rich countries, racial and ethnic minorities are disproportionately affected in their ability to have healthy and genetically related children.(Ely and Driscoll 2020) For instance, in the USA, the 2018 mortality rate for infants of non-Hispanic black women was more than twice as high as that for infants of non-Hispanic white. Mortality caused by short gestation and low birthweight and for maternal complications was highest in infants of non-Hispanic black women. Similarly, in the UK, there are large inequalities in infant mortality rates between white and ethnic minority groups such as Caribbean and Pakistani babies.(Office for National Statistics 2020.) Thus, funding for pre- and post-natal interventions would benefit members of populations who are already marginalized. On the other hand, embryo editing, as a reprogenetic technology, is likely to be accessible mostly to middle and high-class women because of the elevated costs. As indicated earlier, embryo editing will be used in conjunction with IVF and associated techniques. On average, one IVF cycle costs over $12,000. In countries like the US, the majority of those

women would also be white. Even in European countries where reprogenetic technologies are subsidized to a significant degree, socioeconomic factors affect who uses these techniques. (Imrie et al 2021) Long waiting lists and regulatory requirements about numbers of cycles covered by public insurance induce many women to use private fertility clinics. A further advantage of these other measures is that the majority of them would have positive effects not only on the health of children but also on that of their mothers as many of those interventions would be directed at them. Reproductive embryo editing, on the other hand, is unlikely to have any positive effect on the health of the mothers.[6] Additionally, because some of the investments would involve addressing various social determinants of health, these measures are likely to improve the health and social outcomes of many other people in the community. For instance, investment in various infectious diseases would help many other people. Similarly, low education plays an important role in prenatal care utilization,(Blakeney et al. 2019) and clearly investment in education can benefit not just the particular prospective mothers receiving the education but many others.

Further buttressing the need to reject the development of reproductive embryo editing if we are concerned with justice, is the fact that science and technology are social goods (Kitcher 2001; Kourany 2010) Thus, their benefits should accrue not just to a few, lucky ones, but to as many as possible. (Kitcher 2001; Kourany 2010; Mann et al. 2018; Chapman 2016) This should be of concern in policy making. Indeed, the recognition that science and technology are essential to the improvement of living standards and can directly enhance human capabilities but that too often those in poor countries are less likely to enjoy the benefits of science and technology and that their needs are often neglected is grounding a current push to consider access to the benefits of scientific progress and its applications as a universal human right to which all people are entitled.(Chapman 2016; Mann et al. 2018; Donders 2011) In fact, as evidence shows, people trust science and technology in great part because they aim at serving the needs of the public.(Critchley and Nicol 2011; Hendriks, Kienhues, and Bromme 2016) Attending to the needs of the many people who can be helped to attain the valuable goal of having healthy and genetically related children by various safe

[6] Indeed, given that reproductive embryo editing requires the use of IVF, women using reproductive embryo editing would be exposed to various risks.

and effective strategies seems precisely what science should be doing. It might well be the case that the biomedical sciences are not in the business of solving all social and political problems that might contribute to the preventable deaths of millions of children. However, understanding the social determinants of health and providing strategies to address them is certainly part and parcel of the health sciences.

SOME OBJECTIONS

Several objections may be presented against my arguments. First, one might object that the target population that reproductive embryo editing and pre-and postnatal interventions aim to help are very different. The goal of reproductive embryo editing is to help people *at risk of transmitting certain genetic diseases*. On the other hand, the interventions I propose seek to address many health issues, most of which are not directly tied to genetics and are not transmitted by the prospective parents.

I agree that the target populations for these various types of interventions are different. However, the issue at stake is one of helping people to fulfill their desire for healthy and genetically related children. Reproductive embryo editing is useful for parents at risk of transmitting genetic conditions, but other interventions would be helpful to people with other risks. I take it that when people find the goal of having healthy and genetically related children worthwhile, they are not referring only to those who are at risk of heritable genetic diseases. Moreover, it is hard to see on what grounds one could justify the claim that the desire of parents at risk of transmitting heritable genetic conditions is more deserving of attention than that of parents at risks of having children affected by low birth weight or malaria, for instance.

Second, one might also object that requiring comparisons of the kind I suggest between new technological developments with alternative means would spell the end of scientific and technological progress. Clearly, the objection goes, we could be investing in feeding the poor, improving living conditions, or educating girls –to name just a few alternatives-- rather than on a variety of technological developments, as such measures are likely to benefit many more people.

This objection also fails. My argument is not that, if one cares about justice, we should invest in feeding the poor or similar projects instead of reproductive embryo editing.[7] My argument calls for attention to the goal for which reproductive genome editing is by all accounts being developed. A goal that many people are likely to find worth pursuing. Such goal is to help prospective parents to have healthy and genetically related children. But this goal can be promoted by other, safe(r), and definitely more cost-effective means. Many of such means are easily accessible. Unless one wants to argue –unpersuasively-- that the interests of a few hundred (Viotti et al. 2019) prospective parents at risk of transmitting genetic diseases to their children are more deserving of attention –and resources-- than those of millions of prospective mothers at risk of preterm birth complications, or infants at risk of infectious diseases, and congenital anomalies, then that there are other safe(r) and more effective means of advancing our desired goals is imminently relevant to evaluations of reproductive embryo editing. Indeed, it is an essential aspect of any ethically sound technological assessment.

Third, another objection to my argument has to do with feasibility. Many of the factors that lead to child morbidity and mortality are the result of social and political arrangements that make it difficult or impossible for some women to have access to adequate nutrition, safe water, or financial resources. Addressing these problems is not the role of the biomedical sciences. Moreover, tackling these factors would require challenging and perhaps unachievable institutional changes. It would involve an extensive period of time before results are obtained. On the other hand, the objection might go, promotion of genome editing research is quite feasible and, if appropriately funded, it is likely that reproductive genome editing could be used to help prospective parents in a relatively short period of time.

This objection fails for two reasons. It might be the case that solving the problems that prevent many parents from having healthy and genetically related children is difficult. Nonetheless, if one is concerned with justice, this should hardly lead us to ignore the legitimate desires of millions of prospective parents. Research has opportunity costs, the money used to ensure that genome editing can help some (very few) people to have genetically related children will be unavailable for other purposes. (Baylis 2019) Evaluations

[7] Although, of course, this argument could also be made.

regarding the potential benefits of new technological developments thus should include considerations about how to obtain the desired outcome in the most efficient ways. Hence, although it is not the task of biomedical scientists to solve current social and political arrangements that contribute to many women's inability to have healthy and genetically related children, it is certainly the task of policy makers to consider how best to use scarce resources to achieve desired goals.

Moreover, the objection underestimates societies' ability to change priorities and is too ready to accept the status quo. This seems not only premature but a sure way to ensure that we avoid seeking any changes. It also fails to recognize the significant uncertainty that exists over when or whether the safety issues affecting embryo editing will be appropriately resolved to allow its clinical application.(Ledford 2020; Hirakawa et al. 2020) This contrasts with the significant evidence that we have regarding the positive effects of many of the other interventions defended here.(Requejo et al. 2020)

Fourth, a further objection is that my concerns about opportunity costs are misplaced. Private, rather than public money has been a significant source of funding for genome editing technologies and, whenever it is thought to be ready for clinical use, patients' resources are likely to cover the costs of reproductive embryo editing in the clinic. These resources are thus unlikely to be invested in the interventions needed to help those other prospective parents to have healthy and genetically related offspring.

It is true that at least some funding for development of reproductive embryo editing will be from private sources. But this does not undermine my argument. In many countries, this research receives public funding, which will not be available for other, more cost-effective projects to achieve the same goal. Similarly, the training of the investigators working on these technologies and of the physicians who might eventually use them in their clinics also involve the use of public resources. Additionally, various other public costs could also ensue from the utilization of reproductive embryo editing even if patients paid out of pocket. For instance, because uncertainties about long term risks, public funding will be needed to ensure adequate follow-up of children born after genome manipulation. And given that genome editing involves the use of IVF, costs to healthcare systems could also result from the increased use of services by women who use genome editing technologies and by the children born with the help of these technologies. Moreover, even if all funding for these

technologies were to come from private sources, such funding can affect the direction of biomedical research in ways that ultimately create opportunity costs. After all, a particular research focus to solve some problem can lead scientists away from other, more effective, alternatives.

Fifth, one might also object that, by analogy, my argument could be used against funding research on rare conditions and orphan drugs. Rare diseases affect small numbers of people and thus pharmaceutical companies do not find research on such disorders cost-effective. (Kacetl et al. 2020) In response, many rich countries have legislation providing tax breaks and market exclusivity to pharmaceutical companies that produce orphan drugs. Arguably, these resources could be used for research and treatments for common diseases, which would contribute to save the lives of many more people.

The issue of funding for rare diseases is an extraordinarily complex one about which I do not pretend to have a solution.(Kacetl et al. 2020) It involves a conflict between the ethical principles of non-abandonment or duty to rescue, equity, and beneficence and reasonable people can have opposing views about the issue.(Gericke, Riesberg, and Busse 2005; Kacetl et al. 2020; Juth 2017) However, I do not believe that the argument I present here can be extended –without additional assumptions—to the issue of funding for rare diseases and orphan drugs. My argument is not only about the numbers of people who can be helped with different types of interventions. It is primarily about the ability of several types of interventions to advance a particular goal. What that goal is can make a difference in determinations about whether numbers matter or how much they matter. Indeed, most modern societies have decided that ensuring patients' access to interventions for the prevention and treatment of severe and life-threatening diseases is an ethical imperative as legislation on rare diseases show. No such agreement exists with reproductive embryo editing. Of course, this could change. However, given the significant disagreements that exist on a variety of aspects related to research with embryos, such agreement seems unlikely any time soon. More importantly, the analogy between rare diseases and embryo editing does not hold. First, it is not clear on what ethical grounds one could compare the effects on wellbeing of not being able to have genetically related children with those of having devastating and fatal diseases. Second, people have multiple alternatives to becoming parents and thus enjoying many of the benefits that come with parenting, even if they believe

a genetic connection would enrich that relationship. On the other hand, people with rare conditions have no other alternatives unless we develop new treatments.

Finally, a related objection can point out that I am failing to consider the fact that although reproductive embryo editing might initially help only a small number of people, its use could grow as the technology is developed. For instance, rather than directed at prospective parents at risk of transmitting serious genetic conditions, it could be directed at prospective parents at risk of transmitting minor genetic diseases. Or, it could be used for those who have other technological alternatives such as PGD. The numbers of people benefiting from this technology would thus increase. Moreover, the goal of the technology could change –from helping people to have healthy and genetically related children to improving the human species for instance—thus increasing the number of people who could use it.

That the use of reproductive embryo editing is likely to increase if it is developed is quite plausible as often the target population for reprogenetic technologies has increased after they are available.(de Melo-Martín 2017) However, that this could be the case should not be –without further argumentation-- considered an argument in favor of the technology. This is so because the assessment of risks and benefits of technologies is related to their goal. One might argue that when no other options exist, using reproductive embryo editing to help some people who are at risk of transmitting devastating diseases to their offspring might be worth the risks –and uncertainties—of the technology. But such assessment would be quite different if the goal of the technology is to help people at risk of transmitting not particularly serious diseases for instance, of if the goal itself is questionable, such as enhancing one's child. What the aim of a technological intervention is has essential relevance for the assessment of its risks and benefits –and thus for whether it should be pursued.

Importantly, I am not proposing that we should disregard the legitimate interest of people who might benefit from reproductive genome editing simply because they are just a few. If our resources were unlimited, and to the extent that our society agreed that the goal of having genetically related children is one worth pursuing by various means, then it might well be feasible to also address the interests of these prospective parents. However, given that our resources are limited, there are no ethically compelling reasons to consider the interest in having healthy and genetically related children of those who could benefit from

genome editing as more important than the one of those who would profit from access to adequate pre and postnatal care or to vaccines and treatments against childhood infections. On the contrary, strong ethical reasons, reasons of justice, exist to attend to the interests of this latter group.

CONCLUSION

I have argued here that insofar as one is concerned with justice, agreement that having healthy and genetically related children is a valuable goal commits one to rejecting the development of embryo editing for reproductive purposes. This is so, because that same goal could be achieved by many other, safe(r) and more cost-effective methods, because such other methods are likely to help marginalized communities, and because science and technology are public goods.

The arguments I present here aim at persuading all of us as citizens who have a stake in the technologies that are developed and implemented and on the kinds of societies that we would wish to create. Ultimately, in democratic societies, governance of technologies such as CRISPR should involve more than just scientists or those with an interest in the development of the technology. But my arguments also aim at persuading policymakers and those charged with assessing the risks and potential benefits of reproductive genome editing technologies. National governments and international organizations use these assessments to make decisions about how to regulate a technology. I have argued here that reproductive genome editing assessments –and thus decisions based on them--are faulty. This should certainly be of relevance to risks assessors and policy makers.

None of the arguments presented here are new. In some sense, they are not particularly controversial. And yet, at a time when unjust racial and ethnic health disparities are occupying national and international headlines, concerns about the health of those already marginalized and disadvantaged have little uptake. The insistence on evaluating reproductive genome editing as if resources were unlimited pays lip service to current appeals to address such health disparities. Similarly, criticisms that other alternative means of achieving the goal of having healthy and genetically related children --like the ones proposed here-- are unfeasible certainly fail to challenge the status quo. That most of the assessments of reproductive embryo editing keep disregarding the ways in which scientific

and technological knowledge can help to either address injustices or contribute to perpetuate them is surely a way to remain complicit with current conditions.

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