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A Genetic Makeover

Motives for Self-Enhancement with CRISPR

LAURYN LIAO



Honors 291 (Sophomore Seminar)

Mentor: Dr. Zoia Stoytcheva

Societal expectations brought on by social media, intelligence standards, and material measurements of success have shown to be a motivating factor in most peoples' lives, governing many of their choices and decisions. Thus, with the proposition of a technology that could allow people to genetically enhance themselves to a certain extent, society is prompted with a conundrum concerning the regulation and usage of clustered regularly interspaced short palindromic repeats (CRISPR). Currently, the definitions of genetic treatment versus genetic enhancement remain ambiguous and are determined on a case-by-case basis. This article attempts to analyze how societal expectations have impacted the debate on human genetic enhancement. It also evaluates the need for preventative or permissive regulations towards genetic self-enhancement.

Introduction

Clustered regularly interspaced palindromic repeats (CRISPR) is an extremely useful biotechnology capable of making precise edits to DNA^{1,2}. Although CRISPR has many potential applications in humans, a large part of why CRISPR-based human genome research and experiments have been restricted is due to the increasing worry that people will take advantage of the technology for their own selfish desires, primarily for self-enhancement purposes. It has already been proven that genetic engineering is not entirely bad and has a promising future in the healthcare and agricultural industry^{1,2}. However, it would be difficult to separate self-enhancement from necessity

when it comes to controlling the outcome of an individual's life. Although CRISPR is an incredibly promising technology, social pressures and expectations have provided a basis for an underlying motive in favor of human genome editing, which has raised ethical questions about the technology.

CRISPR

After the technology was brought to light, researchers flocked to the promises of the CRISPR system. CRISPR is a class of DNA sequences common in prokaryotes which have the ability to develop acquired resistance against viral infections, when combined with cas-9 enzymes³⁻⁵. With this built-in technology, the potential to selectively develop desirable traits and cut out



I am a UH Mānoa sophomore majoring in Molecular Biosciences and Biotechnology. In the future, I intend to go to medical school to become a physician, hoping to practice here at home in Hawai'i. Written for my Honors 291 biology seminar class instructed by Dr. Zoia Stoytcheva, the content of this paper was inspired by the biotechnology known as CRISPR. I was interested in understanding why self-enhancement is an issue as the technology is made more available. As CRISPR builds its reputation in the medical field as a reliable means to correct genetic mutations, I believe it is important to consider the consequences of this technology, should it be regulated improperly. I hope this piece educates and inspires people to look into CRISPR and become a part of the growing debate surrounding this revolutionary tool.

the undesirable ones become a reality in the laboratory using a short guide ribonucleic acid (RNA) to mark the edit site^{4,5}. Once the short guide RNA binds to the target deoxyribonucleic acid (DNA) sequence, the attached Cas9 enzyme will cut the DNA at the desired spot^{4,5}. Although the CRISPR-cas9 system opens up an entirely unexplored realm of DNA splicing and editing technology, there is much debate over its ethical use. Because CRISPR allows for genetic manipulation, the prospect of designer babies comes to mind^{2,4}. This is one instance that would require regulations, since the process does not occur naturally, and parents would be able to pick and choose the qualities that they want their child to have. This goes against the naturally occurring independent assortment and crossing over that supports an evolving and expanding genome. Despite this, the development of genome editing technology is on the rise.

SOCIAL PRESSURES

Social pressures often govern the decisions, lifestyles, and ideals of individuals. They build and contribute to what is perceived as “social norms” in certain settings. For example, the notion of starting a family by a certain age has led many women to feel pressured into having kids early or “before it is too late.” This is due in part to information about increasing

infertility with age and having the general population of women abiding by this knowledge. In the United States, the average age of becoming a mother increases based on residence. Data from 2016 suggests women living in bigger cities like San Francisco and New York City tend to become mothers around the age of 30 or 31, as reported by The New York Times. This is about a decade later than those living in more rural areas where the average age is 20 to 21⁶. No one declares the social norms of society. However, the majority of people tend to conform to the generalized popular opinion and actions of the larger group⁷. There are social pressures dealing with relationships, lifestyles, health choices, and nearly every other facet of life. Appearance-related social pressures, for example, are influenced by peer and parental pressures involving teasing, ignorance, and establishing appearance related norms (Figure 1). These expectations become internalized and manifested in the daily lives of individuals.

Currently, temporary fixes can be made to conform to social pressures. The beauty industry has willingly accommodated the changing standards of beauty. For example, the desire for bigger lips has been easily resolved with the addition of lip fillers. This inclination to improve or preserve one’s appearance forms the basis of self-enhancement⁹. For some individuals, dealing with social pressures and the competitive

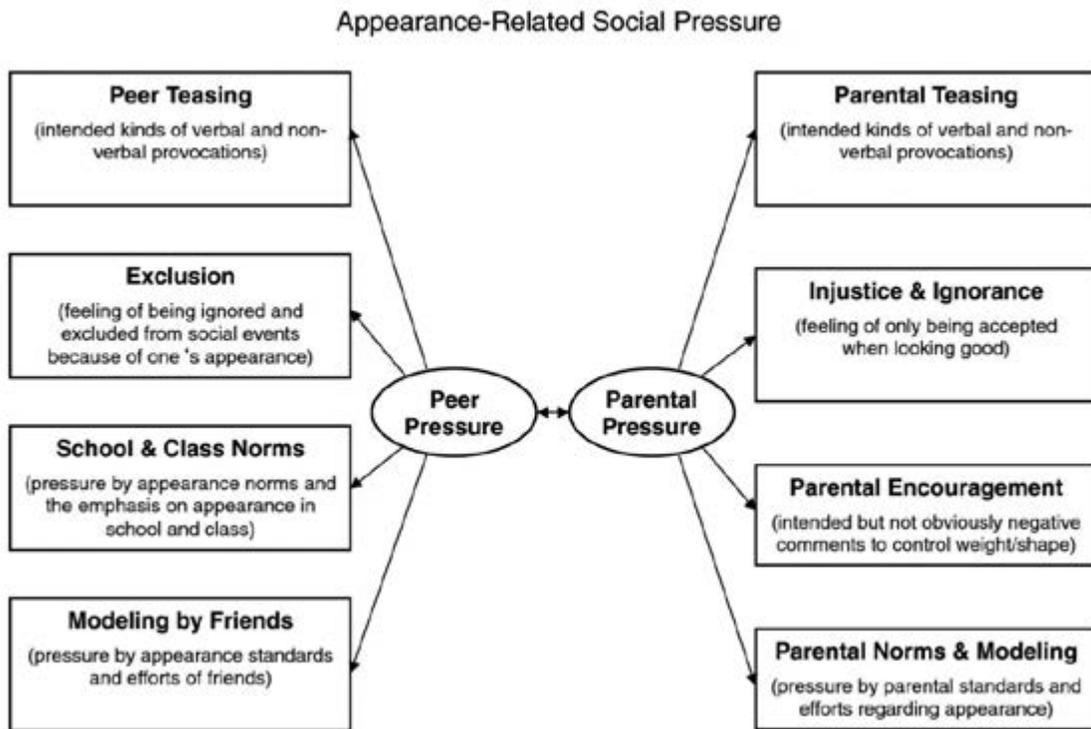


Figure 1 Considered aspects of appearance-related social pressure⁸. The factors that drive appearance related social pressure can be split into two categories: peer pressure and parental pressure. The combination of the two contribute to the development of negative body image and decreased self-esteem.

nature of society involves taking drastic measures to change their appearance or even genetic makeup. With the introduction and application of CRISPR, it would be possible to correct perceived imperfections on a genetic level, meaning the alterations would be permanent. This paper will investigate the sources of self-enhancement motives including social media influence, parental expectations, and beauty standards. It will also evaluate the economic feasibility and ethics of CRISPR as a tool for self-enhancement in the future.

Influencer Influenza

In the past decade, social media has jumped to the forefront of societal values. A single like on a social media photo or retweet has become nearly equivalent to a face-to-face interaction, giving rise to the illusion of being closer to an individual. In 2016, about 3.5 billion of those likes were given daily to nearly 80 million shared photos and videos on Instagram¹⁰. The familiar toxicity that comes with social media has seeped into the cracks of society's foundation. The accessibility of social media contributes to its addictiveness and feelings of isolation, supporting the growth of an increasingly self-conscious society. To corroborate this, multiple studies have linked low self-esteem to frequent social media usage to compensate for the lack of satisfaction in life^{11,12}. Although social media has arguably positive effects, the platform has become a sanctuary for those seeking escape from their unsatisfying lives.

THE BEAUTY STANDARD

Social media also plays a large role in the creation of idealistic beauty standards. In Western cultures, society places emphasis on being skinny, having long limbs, full breasts, and perfect lips for women^{13,14}. Likewise, the physical values of men include being lean, muscular, and tall¹⁵. This is reflected in many influencer media accounts such as those of models, jetsetters, and high-profile companies. Also, the emphasis on weight has built a lucrative weight loss industry in America with little promise of actual results.

On the other hand, Eastern beauty standards are quite different from their Western counterparts. Asian societies value a perfectly pale complexion, thin stature, and an overall feminine appearance¹⁶. Unlike Western beauty standards which are different between genders, Eastern beauty standards, specifically in Korea, apply to both men and women¹⁶. While some may fit into the beauty standard naturally, most people desire to change their appearance¹³. Likewise, both Western and Eastern cosmetic industries thrive off selling items, such as makeup or double eyelid tape, that enable consumers to mesh with the beauty standard.¹⁴

Comparison and the desire to fit in according to social pressures provides a basis for self-enhancing technology and

capability. While many oppose the use of CRISPR for self-enhancement, the desire to alter one's appearance is ever present. A prime example of this can be seen in the field of cosmetic dermatology. According to a 2019 consumer survey on the influences of cosmetic procedures put forth by the American Society for Dermatologic Surgery (ASDS), 70% of individuals considering cosmetic treatments are influenced by a combination of social media, influencers, and review websites such as Yelp¹⁷. From the same survey, the ASDS found that the top reasons for pursuing cosmetic procedures includes wanting to look younger, feel more confident, and be more attractive¹⁷. Therefore, if CRISPR technology could be refined enough to make aesthetic procedures more reliable, cheaper, and more permanent, it could potentially satisfy the existing market for cosmetic improvements.

Great Expectations

America, the birthplace of the American Dream ideology, has become a land built on constant competition. Due to the freedoms promised by the Constitution, any citizen can become the person he or she wants to be, if able to compete on the same level as the rest of the group. Therefore, many children born into the Land of the Free, are expected to grow up and stand out in the crowd of people trying to get to the same place. It is no longer about being able to become a contributing member of society because that fact is supposed to be given.

The standards set for future generations are on the rise. Elite college institutions appear to be taking less applicants due to an influx of prospective hopefuls. According to a New York Times article¹⁸, college admission is treated like a lottery, meaning if the student applies to more institutions, he or she can increase their chances of getting in somewhere. Because of the competitive nature of education, the idea of being able to ensure a given child is able to succeed draws some attraction among future parents. Rather than searching for genes positively associated with intelligence, CRISPR could be used to lower the risk of intellectual disabilities associated with genetic disorders¹⁹.

ASSISTED REPRODUCTIVE TECHNOLOGY

The ability to choose the gender or genetic predisposition of a child already exists in Assisted Reproductive Technologies (ART) such as *in vitro* fertilization (IVF). Before it became a widely used solution for infertile couples trying to conceive, IVF was viewed by the public in a similar perspective as CRISPR is currently since it tested the boundaries of reproductive technology both ethically and morally^{20,21}. These processes cater towards infertile couples or couples predisposed to genetic problems. According to the Mayo Clinic, IVF involves extraction of eggs directly from the ovaries. After a sperm sam-

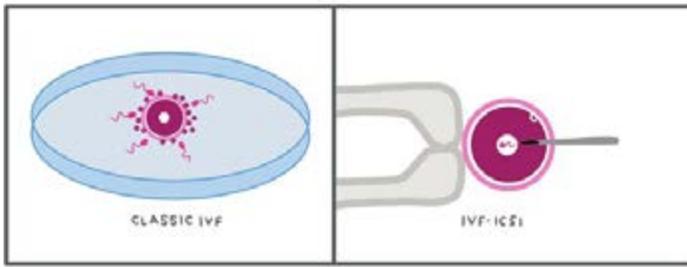


Figure 2 Traditional IVF versus IVF-ICSI. The traditional method of IVF takes advantage of conventional insemination, while the IVF ICSI uses an injection method to implant the sperm into the egg. (Drawing by the author)

ple has been gathered, fertilization begins via two ways: conventional insemination and intracytoplasmic sperm injection (ICSI). Depicted in Figure 2, the first method involves incubating a mixed sperm and egg sample, letting the process occur naturally. The second method involves injecting a sperm into each mature egg, ensuring fertilization²². Implantation into the uterus follows to begin the pregnancy.

With ART such as IVF, future parents could opt for a pre-implantation genetic diagnosis (PGD) which detects an embryo's risk for X-linked diseases. If an embryo is at particular risk of developing a sex-linked genetic disease, the separation of X and Y spermatozoa can be used to select the gender with the least risk²³. However, the prospect of being able to pick and choose the gender of an embryo raises ethical concerns. In the future, non-medical use of sex selection could become the new normal for IVF couples. A possible consequence of this could be a gender imbalance within the population, as previously seen in Asian countries which favored male births²³.

Although gender selection in IVF is targeted towards lowering disease risk, adding CRISPR to the picture adds controversy to the widely accepted use of IVF. Though sparingly used in humans thus far, the CRISPR/Cas9 system could give parents and doctors some control over the genome of their future child. According to a study conducted in cattle, CRISPR can be adapted to specifically target certain genes within a genome upon zygotic injection⁴. The experiment proved CRISPR and IVF could be used in conjunction to edit a single gene (PRNP) associated with the development of mad cow disease⁴. This ultimately means that rather than choosing the gender of their child, parents could opt for genomic editing as a means of trait selection or disease predisposition.

The Pretty Penny

On top of chasing the unattainable beauty standard and attempting to fulfill societal expectations, a premium comes to those who fit and exceed the social norm. This provides some motive to fill the shoes of those deemed attractive in the work-

force. Although physical looks and attractiveness proved to earn an individual a higher salary, it was the associated characteristics with being attractive that sold their employers²⁴. In South Korea, the emphasis on appearance impacts an individual's ability to get a job²⁵. Therefore, people feel the need to alter their appearance to be acceptable enough to function in society. This financial bias in favor of attractive and healthy individuals may be explained by stereotyped characteristics associated with those individuals²⁶. A study showed that attractiveness was positively associated with intelligence, good health, and extraversion--all characteristics generally valued in a workplace²⁴. Therefore, although attractiveness may not be the direct cause of salary discrepancies, it does play a psychological role in the opportunities offered to an individual based on associated stereotypes. This provides an outward motive to become more attractive to gain a better place in society.

CRISPR FOR PLASTIC SURGERY

In a market where people desire to change their appearance, developments and ideas for CRISPR applications in plastic surgery have been proposed. Dr. Eric Liao, an associate professor of surgery at Harvard Medical School and a principal investigator at the Harvard Stem Cell Institute evaluated some reasonable CRISPR implications in the field of plastic surgery. These include craniofacial malformations and even aesthetic surgery. For craniofacial malformations such as orofacial clefts, DNA sequencing can be used to find the mutations and subject them to correction with CRISPR²⁷. These sites are prime for CRISPR editing since many arise from single gene mutations. As for aesthetic surgery, the most plausible application for CRISPR would involve targeting and regulating certain genes associated with aging and hair loss. The team also suggests CRISPR could be used to create cheaper and less immunogenic fillers from humanized donor animals²⁷. Although the perfection of this technology lies in the far future, the prospect of its possibility is promising for those looking to permanently alter their appearance.

At What Cost?

While the potential applications of CRISPR are many, feasibility should be considered when devising plans for CRISPR usage. Among the various issues regarding feasibility and practicality, two include the economic side and the ethical side.

ECONOMIC SIDE

While the many promises of CRISPR may advertise a cheap way of gene editing, the true cost of commercial and medical use extends beyond the cost of the technology itself. Development of gene therapies come with the added cost of research,

clinical trials, and patents, putting the true cost of a single genetic treatment in the hundreds of thousands or millions of dollars²⁸. Furthermore, the exorbitant expense of novel therapies may drive insurance companies to refuse coverage of such treatments. Without coverage by insurance, it would be nearly impossible for a patient to pay for the therapy themselves, unless the individual is independently wealthy. As for self-enhancing treatments, insurance companies will likely stay away from coverage of those as well due to the lack of promising research and the reasons for the procedures²⁸. Therefore, while CRISPR may serve as a permanent method of correcting a genetic disorder, the cost of the procedure may not be cheaper than current non-genetic therapies or treatments. Moreover, the monetary expense and lack of potential insurance coverage may restrict many Americans from reaping the therapeutic benefits of CRISPR.

ETHICS

Although price and practicality play a major role in the future use of CRISPR, the bigger debate focuses on the ethical and moral consequences of genetic engineering, specifically when it involves the germline editing. In this case, an individual may be affected by a single genomic edit for the rest of his or her life and potentially pass the edits down to progeny³. Currently, there is a lack of information about the long-term effects of CRISPR germline editing to determine whether it is safe to conduct. Furthermore, the debate over germline engineering encompasses the ongoing debate about life and when it begins, since the process involves an embryo. Therefore, the bioethical debate over CRISPR application towards embryos is centered around the rights of the entity. The same issue arose when IVF was introduced.

Conclusion/Discussion

There are two paths of CRISPR enhancement. One involves leveling the playing field for individuals who are born at a disadvantage. The second involves putting an individual above average standards for personal gain. The appeal of this cutting-edge technology comes from its varied usage and ability to let individuals pick and choose desirable traits. Although the fine tuning and development of CRISPR for commercial use lies in the far future, the possibility and desire for genetic enhancement is ever present.

Because of this, the technology must be regulated early on to avoid future loopholes, and precautionary measures must be in place to ensure any CRISPR research is conducted responsibly and ethically. One of the few realistic regulatory approaches would involve establishing an international regulatory board, most likely under the observance of the United Nations. Of course, the ethics side of each CRISPR case involving

genetic enhancement or correction is specific to the respective situation. However, this raises further questions on how and who will be able to deem CRISPR practices ethical and moral.

An alternative and indirect method of combatting CRISPR enhancement could involve parental and peer intervention as well as involvement. Positive reinforcement and acceptance of individuals could help lessen the burden of society's expectations. The findings of Helfert and Warschburger suggests social pressures are suffered most during mid-adolescence, making it a particularly vulnerable period. Thus, by receiving consistent support and acceptance from peers and parents, individuals may feel less inclined to seek drastic methods for changing themselves.

It is rather difficult to define a line between enhancement and genetic treatment. In most cases, arguments can be made in favor and in opposition, depending on how you approach the situation. This aspect makes the problem of CRISPR technology difficult to resolve, given that much of it lies in personal opinion and morals. While CRISPR promises near medical miracles in the realm of disease prevention, potential unintended consequences of CRISPR will likely involve some level of self-enhancement by CRISPR technology. Whether a parent desiring to make their child more fit for society or an individual wanting to improve their appearance, the basis for CRISPR based self-enhancement has been set. Therefore, regulatory actions must be set to either prevent, make exceptions, or allow the future use of CRISPR towards self-enhancing procedures.

Works Cited

1. Chen K, Wang Y, Zhang R, Zhang H, Gao C. CRISPR/Cas Genome Editing and Precision Plant Breeding in Agriculture. *Annu Rev Plant Biol.* 2019;70:667–697. doi:10.1146/annurev-arplant-050718-100049
2. Rodríguez-Rodríguez DR, Ramírez-Solís R, Garza-Elizondo MA, De Lourdes Garza-Rodríguez M, Barrera-Saldaña HA. Genome editing: A perspective on the application of CRISPR/Cas9 to study human diseases (Review). *Int J Mol Med.* 2019;43(4):1559–1574. doi:10.3892/ijmm.2019.4112
3. Brokowski C, Adli M. CRISPR ethics: moral considerations for applications of a powerful tool. *J Mol Biol.* 2019;431(1):88–101. doi:10.1016/j.jmb.2018.05.044
4. Bevacqua RJ, Fernandez-Martín R, Savy V, et al. Efficient edition of the bovine PRNP prion gene in somatic cells and IVF embryos using the CRISPR/Cas9 system. *Theriogenology.* 2016;86(8):1886–1896.e1. doi:10.1016/j.theriogenology.2016.06.010
5. Doudna JA, Charpentier E. The new frontier of genome engineering with CRISPR-Cas9. *Science.* 2014;346(6213):1258096. doi:10.1126/science.1258096
6. Bui Q, Miller CC. The Age That Women Have Babies: How a Gap Divides America. *The New York Times.* <https://>

- www.nytimes.com/interactive/2018/08/04/upshot/up-birth-age-gap.html, <https://www.nytimes.com/interactive/2018/08/04/upshot/up-birth-age-gap.html>. Published August 4, 2018. Accessed May 7, 2020.
7. Mallinson DJ, Hatemi PK. The effects of information and social conformity on opinion change. *PLOS ONE*. 2018;13(5):e0196600. doi:10.1371/journal.pone.0196600
 8. Helfert S, Warschburger P. The face of appearance-related social pressure: gender, age and body mass variations in peer and parental pressure during adolescence. *Child and Adolescent Psychiatry and Mental Health*. 2013;7(1):16. doi:10.1186/1753-2000-7-16
 9. Sedikides C, Alicke M. The five pillars of self-enhancement and self-protection. In: ; 2018.
 10. Hawi NS, Samaha M. The Relations Among Social Media Addiction, Self-Esteem, and Life Satisfaction in University Students. *Social Science Computer Review*. 2017;35(5):576–586. doi:10.1177/0894439316660340
 11. Blachnio A, Przepiorka A, Rudnicka P. Narcissism and self-esteem as predictors of dimensions of Facebook use. *Personality and Individual Differences*. 2016;C(90):296–301. doi:10.1016/j.paid.2015.11.018
 12. Denti L, Barbopoulos I, Nilsson I, et al. Sweden's largest Facebook study. Published online March 6, 2012. Accessed February 27, 2020. <https://gupea.ub.gu.se/handle/2077/28893>
 13. Ngo NT. What Historical Ideals of Women's Shapes Teach Us About Women's Self-Perception and Body Decisions Today. *AMA Journal of Ethics*. 2019;21(10):879–901. doi:10.1001/amajethics.2019.879.
 14. McKay A, Moore S, Kubik W. Western Beauty Pressures and Their Impact on Young University Women. *IJGWS*. 2018;6(2). doi:10.15640/ijgws.v6n2a1
 15. Stanford JN, McCabe MP. Sociocultural influences on adolescent boys' body image and body change strategies. *Body Image*. 2005;2(2):105–113. doi:10.1016/j.bodyim.2005.03.002
 16. Rhee SC, An S-J, Hwang R. Contemporary Koreans' Perceptions of Facial Beauty. *Arch Plast Surg*. 2017;44(5):390–399. doi:10.5999/aps.2017.44.5.390
 17. Skin Experts. American Society for Dermatologic Surgery. Published 2019. Accessed February 27, 2020. <https://asds.net>
 18. Hartocollis A. Greater Competition for College Places Means Higher Anxiety, Too. *The New York Times*. <https://www.nytimes.com/2016/04/21/us/greater-competition-for-college-places-means-higher-anxiety-too.html>. Published April 20, 2016. Accessed February 26, 2020.
 19. Ilyas M, Mir A, Efthymiou S, Houlden H. The genetics of intellectual disability: advancing technology and gene editing. *F1000Res*. 2020;9. doi:10.12688/f1000research.16315.1
 20. Wymelenberg S, Medicine (US) I of. *New Technologies: The Ethical and Social Issues*. National Academies Press (US); 1990. Accessed March 5, 2020. <https://www.ncbi.nlm.nih.gov/books/NBK235272/>
 21. Singer P, Wells D. In vitro fertilisation: the major issues. *J Med Ethics*. 1983;9(4):192–199. doi:10.1136/jme.9.4.192
 22. In vitro fertilization (IVF)—Mayo Clinic. Accessed February 26, 2020. <https://www.mayoclinic.org/tests-procedures/in-vitro-fertilization/about/pac-20384716?page=0&citems=10>
 23. Eftekhari TE, Nejatizadeh AA, Rajaei M, et al. Ethical considerations in sex selection. *J Educ Health Promot*. 2015;4. doi:10.4103/2277-9531.157184
 24. Maestriperi D, Henry A, Nickels N. Explaining financial and prosocial biases in favor of attractive people: Interdisciplinary perspectives from economics, social psychology, and evolutionary psychology. *Behavioral and Brain Sciences*. 2017;40. doi:10.1017/S0140525X16000340
 25. Besman A, Seprina R, Rahman PHA. The Change of Beauty Standard, A Korean Wave Phenomenon Findings from Bandung City. In: Atlantis Press; 2018. doi:10.2991/icomacs-18.2018.28
 26. Kanazawa S, Still MC. Is There Really a Beauty Premium or an Ugliness Penalty on Earnings? *J Bus Psychol*. 2018;33(2):249–262. doi:10.1007/s10869-017-9489-6
 27. Roh DS, Li EB-H, Liao EC. CRISPR Craft: DNA Editing the Reconstructive Ladder. *Plastic and Reconstructive Surgery*. 2018;142(5):1355–1364. doi:10.1097/PRS.0000000000004863
 28. Sherkow JS. CRISPR, Patents, and the Public Health. *Yale J Biol Med*. 2017;90(4):667–672.