

Public Perception of CRISPR-Cas9 Among Youth and Young Adults

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ABSTRACT

Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)-Cas9, a groundbreaking gene-editing tool, has transformed medicine, agriculture, and biotechnology by offering precision and versatility in modifying DNA. Despite its potential to treat genetic disorders and save lives, the application of CRISPR-Cas9 to human genomes raises significant ethical concerns, including unintended consequences, societal inequality, and misuse. To date, only four studies have examined public views on these issues, with the most recent published in 2022. Earlier studies found initial optimism toward CRISPR-Cas9 that later became more cautious, and younger generations generally showed greater support and optimism. Given that public opinion may have shifted in the past three years with the rapid advancement of CRISPR-Cas9, this study examines the ethical perceptions of CRISPR-Cas9 among 461 individuals aged 26 or younger, a demographic likely to influence future societal attitudes and policies. Through surveys, data were collected from the participants on public awareness, familiarity, attitudes, and ethical perspectives toward CRISPR-Cas9. Results reveal that high school students (ages 14-18) and young adults (ages 19-26) show greater awareness, familiarity, and optimism, often supporting therapeutic applications while also expressing concerns about ethical boundaries, equity, overpopulation, and unintended consequences, trends that appear linked to educational exposure. These findings underscore the importance of education that addresses both the promise and the ethical challenges of CRISPR-Cas9, promoting responsible innovation and ensuring its equitable application in society.

Keywords: CRISPR-Cas9; Genetic editing; ethical concerns; survey; therapeutic applications; public perception; generational differences

INTRODUCTION

Genetic editing has revolutionized medicine, industrial biotechnology, forensic science, and agriculture by offering a precise method to cut DNA at specific sites. In agriculture, it has enabled the

development of genetically modified crops such as rice varieties IR64 and IR36, which are resistant to several diseases and pests. These advances have saved at least one billion lives, feeding more than 300 million Americans and 7 billion people worldwide (1, 2). Similarly, applying gene editing directly to humans to correct genetic defects could save countless lives and prevent many avoidable deaths.

CRISPR-Cas9, discovered in 2012, has rapidly emerged as a powerful genetic editing tool, capable of introducing precise DNA cuts for targeted correction of genetic defects and offering potential cures for

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numerous human diseases. However, its application to the human genome raises significant ethical concerns. Early media coverage tended to emphasize optimism. For example, Marcon et al. analyzed 228

U.S. and Canadian news articles published between 2012 and 2017, and found that 37.7% were positive and 27.3% mostly positive towards CRISPR-Cas9, while only 6.5% were negative or mostly negative (3). Although 96.1% of articles highlighted the benefits of CRISPR-Cas9, only 61.4% mentioned its risks, such as off-target edits that could lead to health complications (3). This imbalance likely fueled the initially favorable public perception of CRISPR-Cas9 in human applications.

As media reports began shaping public discourse, survey-based studies revealed that public attitudes toward CRISPR-Cas9 vary by its intended use. In 2016, McCaughey et al. found that approximately 60% of respondents supported using gene editing in children, adults, or embryos to treat life-threatening or debilitating diseases, but there was clear opposition to altering non-disease traits (4). Support also declined with age, with each additional decade increasing the odds of disagreement by 9.3–33.9%, suggesting generational divides between traditional values and openness to biotechnology. Another study by Pew Research Center demonstrated that 68% of U.S. adults were “very” or “somewhat” worried about using gene editing to reduce disease risk in babies, compared with 49% who were enthusiastic (5).

Nevertheless, broad support for CRISPR-Cas9 research has persisted despite caution. Weisberg et al. reported a mean support score of 1.65 (on a -3 to 3 scale) for continued genetic modification research (6), while Uchiyama et al. showed that Japanese patients with genetically linked conditions anticipated CRISPR-Cas9’s benefits but expressed ambivalence, a pattern that mirrored that seen in the general public. However, both studies lacked detailed age-specific analyses, leaving gaps in understanding generational trends. More recently, Commisso reported that 36% of respondents aged 18–24 held positive views of CRISPR-Cas9, compared with only 14% among those aged 55 and older (8). When excluding those unfamiliar with CRISPR, positivity among respondents under 35 approached 50% and younger cohorts also demonstrated higher familiarity (8).

CRISPR-Cas9’s relative simplicity, versatility, and precision have made it a breakthrough in genetic editing with wide-ranging biomedical applications. Yet its

potential for human germline modification has sparked significant ethical debate, centering on unintended genetic effects, societal inequality, and questions of fairness. Understanding public attitudes toward these issues is critical for shaping responsible policy and regulatory frameworks for technologies such as germline therapy and gene drives. As CRISPR-Cas9 advances rapidly, scientists and policymakers will face evolving ethical boundaries informed in part by public opinion. This study investigates generational differences in perceptions of CRISPR-Cas9’s ethical implications, with particular attention to high school students—a group likely to influence future societal norms and policy decisions. By capturing the perspectives of multiple age cohorts, this research aims to inform ethical guidelines that reflect shifting values and enable the responsible integration of genome editing into society.

Collectively, the literature shows that while younger participants generally express more optimism, familiarity, and acceptance of CRISPR-Cas9 than older groups, concerns about ethical boundaries, equity, and unintended consequences remain. Notably, prior research was conducted before 2022 and rarely included high school students, a population likely to exert significant influence on future societal attitudes and policy directions. To address this gap, the present study systematically examines awareness, attitudes, and ethical perspectives toward CRISPR-Cas9 among individuals aged 26 or younger, providing an updated, age-stratified assessment of generational viewpoints.

METHODS AND MATERIALS

Survey Design

The survey, conducted from September 9 to December 26, 2024, began with an age-group question, followed by a CRISPR-Cas9 awareness check (Table 1). Respondents unfamiliar with CRISPR-Cas9 exited the survey immediately; those who were familiar continued to a series of Likert-scale items (1–5) assessing perceived benefits, ethical considerations, and potential applications of the technology. These closed-ended questions were complemented by optional short-answer items that allowed participants to elaborate on their reasoning. The survey also included specific scenarios related to disease prevention, disease cure, and phenotype selection, each measured on the same 1–5 agreement scale, followed by an open-ended “Why?” prompt. All responses were collected anonymously. Quantitative data were analyzed for trends across age

Table 1. Survey questions assessing participants’ age, awareness, familiarity, attitudes, and ethical perspectives on CRISPR-Cas9 genome editing

Question #	Survey Question	Scale / Response Options
1	What is your current age range?	A) Under 14 B) 14–18 C) 19–26
2	Have you heard of CRISPR-Cas9 gene editing before?	A) Yes B) No
3	How familiar are you with the CRISPR-Cas9 genome editing technology?	1 = Not at all familiar 2 = Slightly familiar 3 = Moderately familiar 4 = Very familiar 5 = Extremely familiar
4	How positive or negative is your opinion of CRISPR-Cas9 gene editing technology in general?	1 = Very negative 2 = Negative 3 = Neutral 4 = Positive 5 = Very positive
5	How positive or negative is your opinion of using CRISPR-Cas9 gene editing technology on humans?	1 = Very negative 2 = Negative 3 = Neutral 4 = Positive 5 = Very positive
6a	To what extent do you agree with the statement: “If using CRISPR-Cas9 on humans can decrease the chance of developing a disease or condition, it should be allowed.”	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly agree
6b	Why?	<i>Open-ended response</i>
7a	To what extent do you agree with the statement: “If using CRISPR-Cas9 on humans can cure a disease, including currently incurable diseases such as late-stage cancer, it should be allowed.”	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly agree
7b	Why?	<i>Open-ended response</i>
8a	To what extent do you agree with the statement: “People should be able to use CRISPR-Cas9 to select any desired phenotypes, including non-life-threatening traits such as physical appearance.”	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly agree
8b	Why?	<i>Open-ended response</i>

groups, while qualitative responses were coded into predetermined thematic categories of motivation or concern, such as reducing suffering, ethical boundaries, equity, overpopulation, and potential misuse. Qualitative responses were analyzed using a content analysis approach. The coding was conducted independently by the author and the supervising biology teacher to identify predetermined themes, which were based on ethical concerns of CRISPR reported in a combination of several prior studies. Themes were refined through discussion, ensuring that categories accurately reflected participant reasoning. Consistency was verified through double-coding a subset of responses, and any disagreements were resolved through consensus.

Participants

Participants, all of whom provided informed consent, were recruited from middle schools, high schools, libraries, and parks in the San Gabriel Valley,

Los Angeles, California. Recruitment sites included Walnut, Diamond Bar, Diamond Ranch, Chino Hills, Ontario, Montclair, and Rowland High Schools, as well as three middle schools, three parks, and two libraries in Southern California. Flyers with a QR code directed potential participants to a Google Form, which first confirmed their age group and familiarity with CRISPR-Cas9 before presenting five questions assessing attitudes and ethical perspectives on its biomedical applications. No names, contact details, or other personally identifiable information were collected, and all responses were anonymous. Consequently, the survey involved minimal risk and gathered only non-identifiable data. A total of 461 responses from the survey were collected, categorized into age groups: under 14 (younger participants n=135), 14–18 (High school students, n=209), 19–26 (young adults, n=117). High school students (14–18) comprised the majority, which reflects the study’s primary focus.

RESULTS AND DISCUSSION

Awareness and Familiarity with CRISPR-CAS9 Technology

For the survey question on awareness of CRISPR-Cas9, results indicate that awareness of CRISPR-Cas9 was the highest among high school students (14–18) at 69.9%, followed by young adults (19–26) at 62.4%, while the under-14 group showed considerably lower awareness at 30.4% (Figure 1).

Among those aware of CRISPR-Cas9, familiarity was highest in the 14–18 and 19–26 age groups, with 45.9% of high school students (n = 146) and 60.3% of young adults (n = 73) rating their familiarity as “4” or “5” on a five-point scale (Figure 2). These cohorts, often engaged in formal education that incorporates

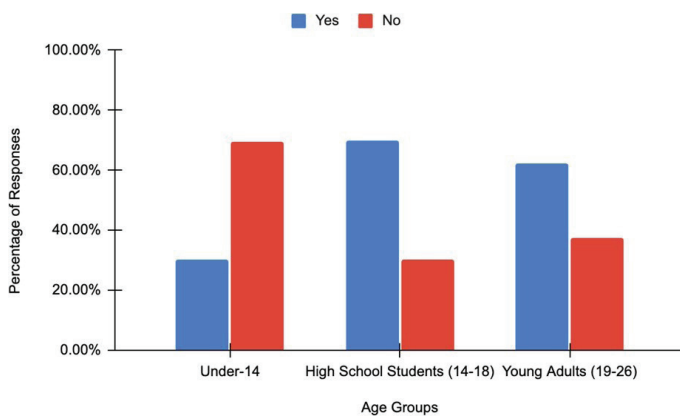


Figure 1. Breakdown of Survey Responses on Awareness of CRISPR-Cas9 Technology by Age Groups.

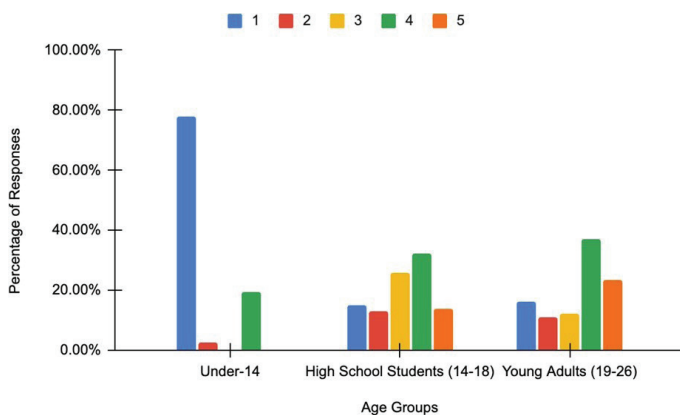


Figure 2. Breakdown of Survey Responses on Degree of Familiarity with CRISPR-Cas9 Technology by Age Groups.

advanced biotechnology topics, demonstrated the greatest depth of knowledge. This combination of high familiarity among high school students and young adults suggests that they not only have greater access to information but also actively engage with scientific concepts, likely fostered by school curricula, online media, and extracurricular STEM activities.

Positivity Toward CRISPR-Cas9 Technology and Human Applications

Survey responses indicate that positivity toward CRISPR-Cas9 as a technology was highest among participants under the age of 14, with 85.4% rating their outlook as 4 or 5 (most positive) (Figure 3). High school students followed, with 56.2% giving similarly high ratings, while only 38.4% of young adults rated the technology at this level. These results suggest that optimism toward CRISPR-Cas9 as a scientific innovation declines with age, with the youngest cohort showing the strongest support for its advancement.

A similar, though not identical, pattern was observed for CRISPR-Cas9’s application to humans (Figure 4). In the under-14 group, 82.9% assigned a rating of 4 or 5, indicating that their enthusiasm for technology extends to therapeutic uses. Among high school students, 48.6% rated human applications at 4 or 5; notably, a greater proportion selected the highest rating (5) for human applications than for the technology overall, suggesting that perceived value increases when linked to improving human health. Young adults expressed lower overall positivity but showed a concentration of responses at rating 4 (57.5%), reflecting moderate yet cautious support for clinical and biomedical uses. Across all

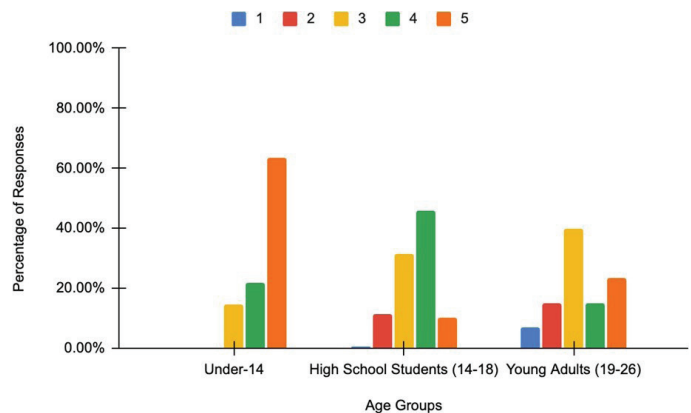


Figure 3. Breakdown of Survey Responses on Perceived Positivity of CRISPR-Cas9 Technology by Age Groups.

younger cohorts, positivity toward human applications often equaled or exceeded that for the technology itself, underscoring the influence of perceived therapeutic benefits on public attitudes toward CRISPR-Cas9.

Support CRISPR-Cas9 for Disease Prevention and Cure

Survey responses show that support for using CRISPR-Cas9 to reduce the likelihood of developing a disease was the highest among the youngest participants, with a gradual decline in endorsement across older cohorts (Figure 5). In the under-14 cohort, 85.4% rated their support as 4 or 5 on the Likert scale; within this group, 22.0% selected 4 and 63.4% selected 5. The predominant justification for this high level of support was humanitarian, with 87.2% citing the potential to reduce human suffering and mortality.

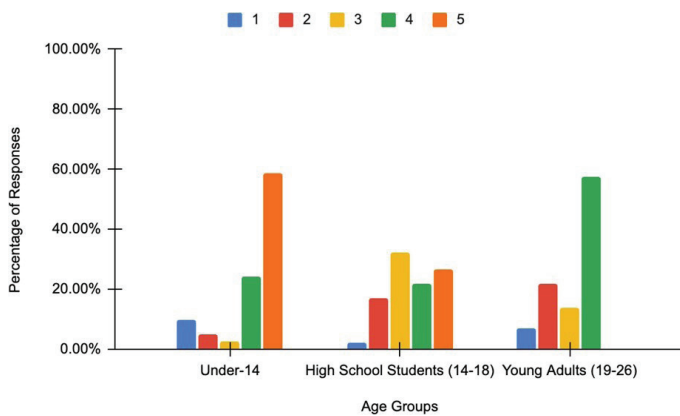


Figure 4. Breakdown of Survey Responses on Perceived Benefits of CRISPR-Cas9 Technology in Humans by Age Groups.

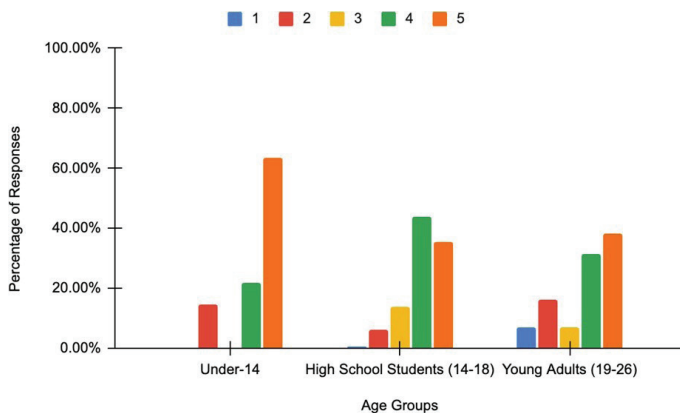


Figure 5. Breakdown of Survey Responses on Support for CRISPR-Cas9 in Reducing Disease Risk by Age Groups.

A smaller proportion, 7.7%, expressed concerns about possible overpopulation, while 5.1% provided unclear or unspecified reasoning (Figure 6). These findings suggest that younger respondents tend to focus on immediate, tangible health benefits rather than long-term demographic or societal implications. This pattern may reflect limited exposure to broader bioethical debates at earlier developmental stages, as well as a greater emphasis on direct individual benefit.

When evaluating the use of CRISPR-Cas9 to cure currently incurable diseases, the under-14 group again demonstrated strong endorsement, with 85.4% rating their support as 5 (Figure 7), indicating a unanimous selection of the highest possible score among those expressing strong support. This result suggests that, for

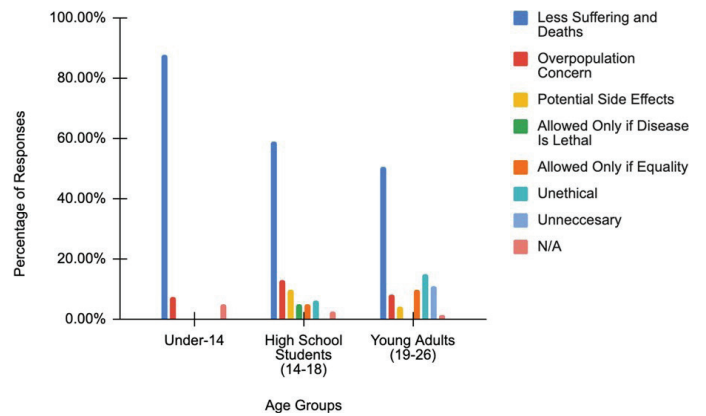


Figure 6. Categorized Response Justifications for Support of CRISPR-Cas9 Use in Lowering Disease Risk Across Age Groups.

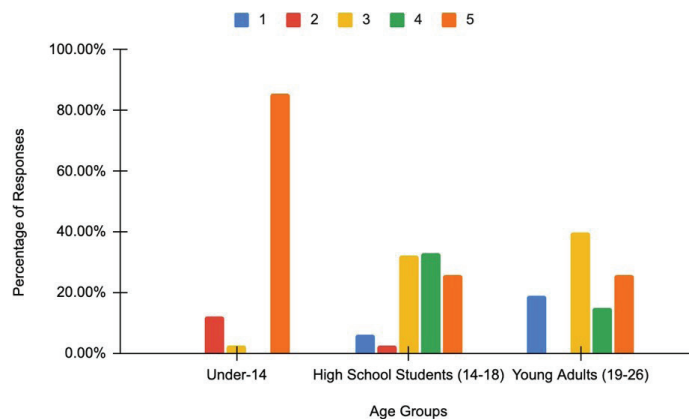


Figure 7. Breakdown of Survey Responses on Support for CRISPR-Cas9 in Curing Currently Incurable Diseases by Age Groups.

many in this age group, direct therapeutic intervention is perceived as even more justifiable than preventive modification. As with prevention, alleviating suffering was the most frequently cited rationale (Figure 8), although in older cohorts, reasoning shifted to include greater consideration of equity, fairness, and potential unintended consequences.

High school students maintained generally high levels of support but displayed greater differentiation between prevention and cure scenarios. Specifically, 79.5% rated 4 or 5 for prevention, compared with 58.9% for cure (Figures 5 and 7). Their reasoning for prevention reflected both humanitarian aims (58.9% citing reduction of suffering and mortality) and a broader range of cautionary perspectives, including potential overpopulation (13.0%), risk of side effects (9.6%), ethical concerns (6.2%), equity conditions (4.8%), restriction to lethal diseases only (4.8%), and unclear reasoning (2.7%) (Figure 6). The greater diversity of responses in this cohort suggests a more nuanced engagement with the ethical and societal dimensions of advanced biotechnologies. Collectively, these patterns indicate that while younger participants strongly prioritize the humanitarian potential of CRISPR-Cas9, older age groups tend to balance these perceived benefits with a wider range of ethical and practical considerations.

Support CRISPR-Cas9 for Phenotype Selection

When asked about using CRISPR-Cas9 to select non-life-threatening traits, responses revealed a pronounced age-related divide (Figure 9). In the under-14 cohort,

support was high, with 80.5% rating their support as 4 or 5. Among these supporters, the most common justification was that such selection would increase individual happiness or perfection (78.1%), while only 14.6% raised concerns about potential societal disruption. This pattern suggests that the youngest participants tend to focus on perceived direct benefits to the individual, often without giving equal weight to broader ethical or systemic considerations.

In contrast, young adults showed complete opposition to phenotype selection, with 0% rating their support as 4 or 5 and a striking 86.3% rating it as 1 or 2 (Figure 10). Their reasoning underscores a strong emphasis on ethical and societal implications: 35.6% deemed such use unethical, 26.0% considered it unnecessary, 21.9%

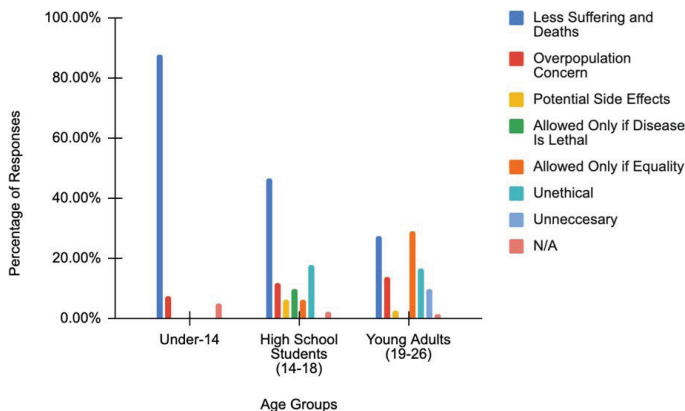


Figure 8. Categorized Response Justifications for Support of CRISPR-Cas9 Use in Treating Incurable Diseases Across Age Groups.

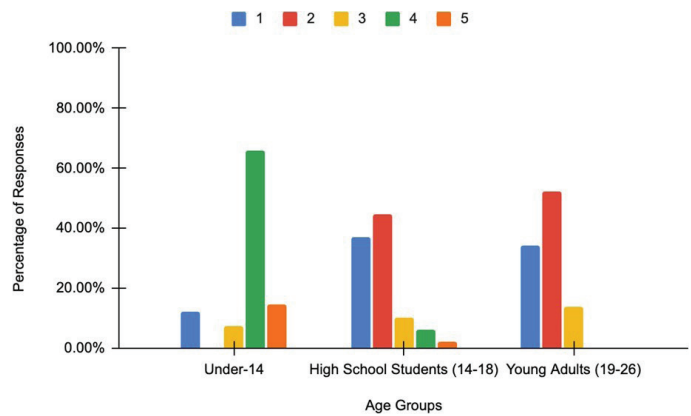


Figure 9. Breakdown of Survey Responses on Support for CRISPR-Cas9 in Selecting Desired Phenotypes, Including Non-Life-Threatening Traits, by Age Groups.

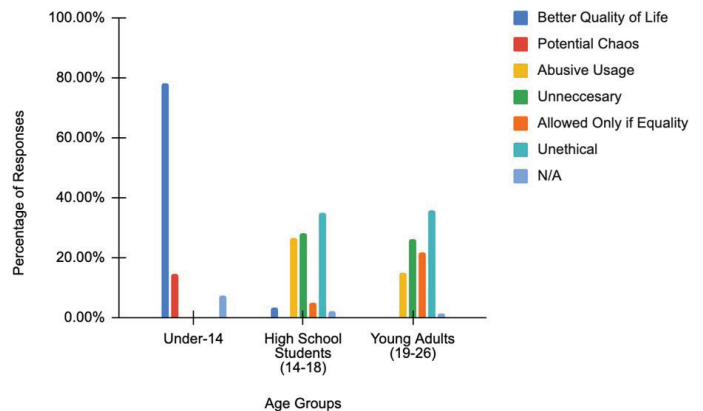


Figure 10. Categorized Response Justifications for Support of CRISPR-Cas9 Use in Choosing Desired Phenotypes Across Age Groups.

supported it only under strict equality conditions, 15.1% expressed concerns over potential misuse, and 1.4% gave unclear reasons. This uniform rejection, especially when compared to their more nuanced support for CRISPR applications in disease prevention (69.9% rating 4 or 5) and cure (41.1% rating 4 or 5), reflects a clear boundary in acceptable applications. For young adults, optimism about CRISPR's medical potential is tempered by a critical lens on its ethical and societal consequences, particularly when the application is non-medical.

CONCLUSIONS

The survey results reveal distinct generational differences in awareness, familiarity, and attitudes toward CRISPR-Cas9 gene-editing technology. Younger cohorts, particularly high school students and young adults, demonstrate higher exposure and familiarity, likely due to coverage in modern educational curricula. This increased awareness translates into greater optimism about CRISPR-Cas9's potential, particularly for reducing disease risk and curing currently incurable conditions. High levels of support in the under-14 group suggest a largely uncritical acceptance, with ethical considerations often secondary to perceived benefits such as reduced suffering and improved quality of life.

In contrast, high school students and young adults, while generally positive, exhibit a more balanced view—recognizing potential benefits yet expressing concerns about ethical boundaries, equity, overpopulation, and unintended consequences. Both groups strongly oppose non-therapeutic applications such as phenotype customization, indicating a shared recognition of the ethical dilemmas these could pose.

As these younger cohorts, those most supportive of CRISPR-Cas9, progress into positions of influence, societal integration of genetic editing technologies may accelerate. However, differences in ethical perspectives within these groups underscore the need for periodically reevaluated guidelines that account for diverse values, lifestyles, and levels of technological exposure. Future scientists and policymakers will be responsible for establishing frameworks that address fairness, accessibility, and potential misuse. Education on both technological potential and ethical implications will be essential to ensure equitable and responsible applications.

This study has several limitations. The survey sample was not evenly distributed across age groups,

with fewer responses from certain segments, limiting the statistical power to detect trends across all younger cohorts. Recruitment methods may have introduced selection bias toward individuals with a greater interest in science or technology. The self-reported nature of familiarity and attitudes may also be influenced by social desirability bias. Additionally, the cross-sectional design captures a single time point, preventing analysis of how opinions evolve over time. Finally, cultural, regional, or socioeconomic factors were not controlled for, which may limit generalizability to broader populations.

Future studies should recruit more diverse and balanced samples across different age ranges, cultures and socioeconomic groups to improve generalizability. Longitudinal research could track shifts in awareness and ethical stances as CRISPR-Cas9 evolves, while experimental studies such as targeted educational interventions may clarify how informed knowledge shapes attitudes. Additionally, examining how public opinion influences policy and regulation will be crucial as these younger generations gain greater societal influence, ensuring CRISPR-Cas9 is integrated in ways that are equitable, responsible, and aligned with public values.

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CONFLICT OF INTERESTS

The author declares that there are no conflicts of interest regarding the publication of this article.

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