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Role of Biotechnology in mitigating the problems of Women's Health and Wellbeing

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Abstract

Biotechnology has emerged as one of the most influential scientific fields in modern healthcare. By applying biological knowledge, molecular science, genetics, cell biology and advanced technologies, biotechnology has transformed the prevention, diagnosis and treatment of diseases. In global healthcare systems, sex and gender biases have favored cisgender males, which has led women and transgender individuals to be understudied and underrepresented in medical literature. Thus, these populations are largely overlooked in health policy making. Persistent gender inequalities, socioeconomic divides, and racial-ethnic discrimination, particularly in low-resource communities, have exacerbated women's health concerns, delaying advancements in care and accessibility. Biotechnology is particularly important for women's wellbeing because women experience distinct biological, reproductive, hormonal and social health needs throughout their lives.

Biotechnology has contributed to improved vaccines, diagnostic tests, reproductive healthcare, cancer detection, personalized medicine, biopharmaceuticals, biomaterials and digital health technologies. It also offers new possibilities for addressing diseases that have historically been under-researched in women. Despite these advances, substantial challenges remain, including unequal access to healthcare technologies, high costs, inadequate representation of women in research, privacy concerns surrounding genetic data, ethical questions concerning reproductive technologies and disparities between high- and low-resource settings. Therefore, the future of biotechnology must focus not only on scientific innovation but also on affordability, accessibility, safety, ethical responsibility and gender-responsive healthcare. This paper examines the relationship between biotechnology, health and women's wellbeing and discusses how responsible technological development can contribute to healthier and more equitable societies.

Keywords: Biotechnology, healthcare, women's health, genomics, reproductive health, diagnostics, vaccines, cancer, personalized medicine, wellbeing.

Introduction

Even with numerous accomplishments in women's civil rights in the last century, disparities in healthcare, medical research, sociocultural status, and economic influence still impact women's lives today. From an economic standpoint, women have faced difficulties in obtaining the same resources as men due to obstacles in accessing education, employment opportunities, safe housing, and healthcare services[1]. For example, women's access to medical insurance and healthcare infrastructure is restricted and frequently does not adequately address their health requirements[2].

As a result, approximately 10.8 million women in the USA continue to be medically uninsured, while 1.5 billion women and girls globally do not have access to healthcare services or resources[3].

The healthcare disparity worsens among women in middle to low-income communities and transgender individuals[4]. Moreover, there is a biological sex bias in funding and investment for health research and medical innovation. Even with $198 billion USD invested in health research in the USA, merely 4% is designated for women's cancer and 1% for all other female health issues. Moreover, conditions like hepatitis B, which impacts men 2 times

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more than women, men get 41 times greater focus and financial support in clinical or health research, relative to conditions mainly impacting women. This inequality arises from the belief that 'women's health' is specialized, leading to the neglect and under-research of conditions common among women by funding organizations, policymakers, and researchers[5].

The World Health Organization (WHO) and various government agencies have reported that the most prevalent diseases and concerns amongst women are cancer, reproductive health, maternal health, and osteoporosis Fig-1[6,7].

Biotechnology refers broadly to the application of biological systems, organisms, cells or molecular processes to develop products and technologies that benefit society. Modern biotechnology incorporates fields such as molecular biology, genetics, genomics, microbiology, immunology, bioinformatics, tissue engineering and cell biology.

Healthcare is one of biotechnology's most important areas of application. Biotechnology has enabled the development of vaccines, therapeutic proteins, monoclonal antibodies, molecular diagnostic tests, gene-based technologies and other biological medicines.

The World Health Organization (WHO) describes biological therapeutics as medicines produced using living systems such as bacteria, yeast, plant cells or animal cells; these include vaccines, growth factors and monoclonal antibodies. Women's health represents a particularly important area for biotechnology. Women's wellbeing extends beyond reproductive health and includes physical and mental health across the entire life course, from adolescence through older age[8]. WHO emphasizes that biological factors interact with gender-related and socioeconomic factors to influence women's health outcomes.

Historically, gaps in medical research and healthcare have meant that some diseases and health conditions affecting women have been inadequately studied or diagnosed. Biotechnology provides an opportunity to address some of these gaps through more precise diagnostics, personalized treatment, continuous monitoring and improved understanding of biological differences[9].

2. Objectives of the Study

The major objectives of this paper are: to explain the relationship between biotechnology and modern healthcare, to examine major biotechnological applications relevant to women's health, to explore the role of biotechnology in reproductive and maternal healthcare, to assess the contribution of biotechnology to the prevention and treatment of women's cancers, to examine the role of genomics and personalized medicine, to discuss emerging biotechnology-based monitoring and diagnostic technologies, to identify ethical, economic and social challenges and to suggest approaches for making biotechnology more accessible and gender-responsive.

3. Biotechnology and Modern Healthcare

Biotechnology has transformed healthcare from a predominantly symptom-based approach toward increasingly molecular and personalized approaches. 1. Vaccines: Vaccination is one of biotechnology's most significant contributions to public health. Modern vaccine development uses biological knowledge to stimulate the immune system against infectious diseases. Vaccines relevant to women's health include those protecting against human papillomavirus (HPV), a major cause of cervical cancer.

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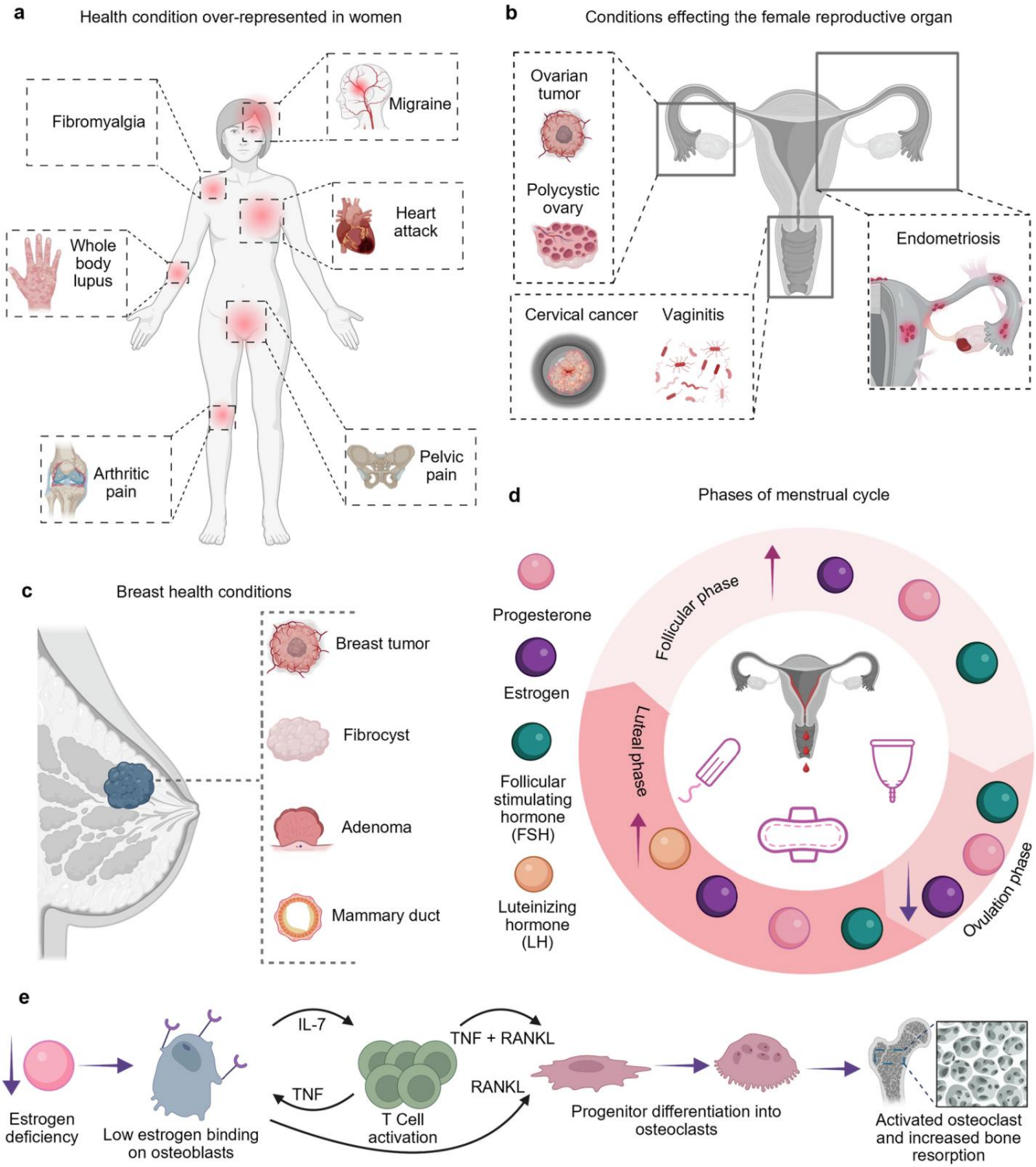

Fig-1 **a** Depiction of conditions over-represented in women. **b** Schematics are shown for the progression of gynecological conditions. **c** Depiction of breast health conditions, including breast tumors, adenomas, mammary duct abnormalities, and fibrocystic tissues. **d** Illustration of the monthly female hormonal cycle, highlighting the different phases of menstrual cycle. **e** The role of female hormones in the progression of postmenopausal osteoporosis and the activity of bone-related cells. Created in BioRender. Hosseinidoust, Z. (2025) https://BioRender.com/t20f565. (From Advances in biomonitoring technologies for women's health[12]: Nature Communication 2025)

WHO's 2026 immunization data reported estimated global coverage of 33% among 15-year-old girls receiving one HPV vaccine dose in 2025, illustrating both the progress made and the continuing need for wider access [10].

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Biotechnology also supports the development of newer vaccine platforms and improvements in vaccine manufacturing, quality control and distribution. 2. Biopharmaceuticals: Biotechnology has enabled the production of therapeutic proteins, monoclonal antibodies and other biological medicines. These treatments can target specific biological pathways involved in disease. Such therapies have become important in areas including cancer, autoimmune diseases and other chronic conditions. 3. Molecular Diagnostics: Biotechnology has dramatically improved the ability to identify diseases at the molecular level. Molecular tests can identify genetic material, proteins, antibodies or other biological markers associated with disease. WHO notes that diagnostic technologies are essential for screening, diagnosis, treatment decisions, monitoring and disease surveillance[11]. For women's health, molecular diagnostics can contribute to: HPV detection, cervical cancer screening, detection of reproductive tract infections, genetic testing, pregnancy-related testing, identification of inherited disease risks and cancer biomarker analysis. Earlier and more accurate diagnosis can allow healthcare professionals to intervene before disease becomes advanced.

4. Biotechnology and Women's Health

Women's health is multidimensional. It includes reproductive health but also cardiovascular health, cancer, bone health, mental health, metabolic conditions, infectious diseases and health conditions associated with ageing. WHO emphasizes that women's health should be considered through a life-course approach rather than being limited to pregnancy and reproduction. Biotechnology can contribute across several stages of this life course. Adolescence is an important period for establishing lifelong health[11]. Biotechnology contributes through: HPV vaccination, diagnostic testing, nutritional and metabolic monitoring, research into hormonal and reproductive health and development of safer medicines. HPV vaccination is particularly significant because preventing persistent HPV infection can substantially reduce the risk of cervical cancer.

5. Biotechnology and Reproductive Health

Reproductive health is one of the areas where biotechnology has had a particularly visible impact. 1. Fertility Assessment: Biotechnological techniques can help healthcare professionals investigate reproductive health by analyzing hormones, genetic factors and other biological markers. Advanced laboratory methods can assist in identifying some causes of infertility and support individualized medical decision-making. 2. Assisted Reproductive Technologies: Modern reproductive medicine uses several laboratory-based technologies to assist people experiencing fertility difficulties. These technologies may involve: laboratory fertilization procedures, embryo assessment, cryopreservation, genetic testing in selected clinical circumstances and hormonal and biochemical monitoring. The development of these technologies has expanded reproductive options, although their availability and ethical implications vary between countries and healthcare systems. 3. Prenatal and Genetic Testing: Biotechnology has enabled increasingly sophisticated methods of detecting certain genetic conditions. Genetic testing can provide information about inherited conditions and, in appropriate clinical contexts, can support reproductive and medical decision-making. However, genetic information is highly sensitive. Appropriate counseling, informed consent and protection of privacy are therefore essential.

6. Biotechnology and Maternal Health

Pregnancy involves complex physiological changes that require careful monitoring. Biotechnology can support maternal healthcare through: laboratory blood testing, molecular diagnostics, biomarker analysis, genetic testing, infectious disease screening, monitoring technologies and development of therapeutic biological products. Improved diagnostic capabilities can help healthcare professionals identify complications

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earlier and make better-informed clinical decisions. The greatest benefit occurs when technological advances are combined with accessible antenatal care, trained healthcare workers and appropriate treatment facilities. Technology alone cannot eliminate maternal health inequalities.

7. Biotechnology and Women's Cancer

Cancer is one of the most important areas where biotechnology and women's health intersect. Breast and gynecological cancers including cervical, ovarian and endometrial cancers, require effective prevention, screening, diagnosis and treatment. 1. Cervical Cancer: Cervical cancer is strongly associated with persistent infection by high-risk types of HPV. Biotechnology has contributed to: HPV vaccines, molecular HPV testing, improved screening, biomarker research and molecular characterization of tumors. These approaches support a shift from treating advanced disease toward prevention and early detection. 2. Breast Cancer: Biotechnology has contributed to understanding the molecular characteristics of breast tumors. Genomic profiling can help classify tumors and identify molecular features that may influence treatment choices[14]. Research into cancer genomics has enabled increasingly detailed characterization of tumors and their associated genetic alterations. 3. Ovarian and Endometrial Cancers: Research into molecular biomarkers, genetics and tumor biology is helping scientists better understand gynecological cancers. Emerging approaches include: genomic profiling, molecular biomarkers, liquid biopsies, targeted therapies, immunotherapy research and computational analysis of tumor data. Recent research indicates that liquid biopsy technologies are increasingly important in precision oncology, although challenges remain in analytical validation, sensitivity and broader clinical application[15].

8. Genomics and Personalized Medicine

Genomics is transforming medicine by allowing researchers to examine an individual's genetic information and understand how genetic variation influences disease risk and treatment response. Personalized medicine aims to move away from a uniform treatment model toward approaches that consider individual biological characteristics. Potential applications for women's health include: hereditary cancer risk assessment, pharmacogenomics, tumor genomic profiling, inherited disease testing, reproductive genetics and individualized cancer treatment[16]. Cancer genomics can help identify inherited variants associated with cancer susceptibility while also providing information about genetic changes within tumors. Recent research has also explored the use of genomics for earlier cancer detection and risk stratification[13]. However, genomic information must be handled responsibly. Genetic discrimination, privacy violations and psychological consequences of poorly communicated results are important concerns.

9. Biomonitoring and Wearable Technologies

An emerging area connecting biotechnology, biomedical engineering and digital health is continuous biomonitoring. Wearable and portable technologies can potentially monitor physiological variables and biomarkers over extended periods. A 2025 review in Nature Communications identified emerging biomonitoring technologies relevant to women's health, including wearable devices and point-of-care diagnostic tools for areas such as fertility, pregnancy, gynecological cancers, infections and post-menopausal osteoporosis[12]. Potential benefits include: continuous health monitoring, earlier identification of abnormalities, personalized health information, remote healthcare support, improved disease management and greater awareness of reproductive and general health. Nevertheless, technology should complement rather than replace qualified medical care.

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10. Biotechnology and Menstrual Health

Menstrual health has increasingly become recognized as an important component of women's wellbeing. Biotechnology can contribute through: hormone-related research, diagnostic testing, investigation of reproductive disorders, biomarker discovery, menstrual monitoring technologies and research into conditions associated with abnormal menstruation. Conditions such as endometriosis and polycystic ovary syndrome (PCOS) can have substantial effects on physical, reproductive and psychological wellbeing. Better biological understanding and improved diagnostic approaches may help reduce delays in diagnosis. This is particularly important because conditions affecting women have historically been affected by gaps in research and clinical recognition. WHO identifies gender bias in research, data collection, service design and clinical practice as an ongoing challenge.

11. Biotechnology and Menopausal Health

Women experience substantial biological changes during menopause and later life. Biotechnology may contribute to understanding and managing: bone health, cardiovascular risk, hormonal changes, metabolic changes, osteoporosis and age-related conditions. Biomonitoring technologies are being explored for post-menopausal osteoporosis and other health conditions affecting women later in life. The objective should be comprehensive wellbeing rather than focusing solely on hormonal changes.

12. Biotechnology and Mental Wellbeing

Women's wellbeing cannot be separated from mental health. Biological, social and economic factors can interact to influence psychological wellbeing. Women may encounter additional pressures related to caregiving, discrimination, violence, employment conditions and unequal access to healthcare. WHO highlights these structural factors as important determinants of women's health. Biotechnology can contribute indirectly through: neurological research, biomarker discovery, pharmacogenomics, development of new medicines and research into biological mechanisms associated with mental health conditions. However, mental wellbeing cannot be reduced to biological factors alone. Social support, education, safety, economic security and access to psychological care are equally important.

13. Major Benefits of Biotechnology for Women's Wellbeing

The major potential benefits include: 1. Early Detection: Molecular diagnostics and biomarker technologies can identify disease at earlier stages. 2. Prevention: Vaccines and genetic risk assessment can support preventive healthcare. 3. Precision Treatment: Genomic information can help identify therapies appropriate for particular biological characteristics. 4. Improved Reproductive Care: Biotechnology has expanded diagnostic and laboratory capabilities related to fertility and reproductive health. 5. Better Cancer Management: Genomics, molecular diagnostics, targeted therapies and immunological approaches are improving cancer research and treatment. 6. Continuous Monitoring: Wearable and point-of-care technologies can potentially provide more frequent health information. 7. Scientific Understanding: Biotechnology allows researchers to investigate diseases at cellular and molecular levels, potentially revealing mechanisms that were previously poorly understood.

14. Challenges and Limitations

Despite enormous potential, biotechnology is not automatically beneficial or equally accessible. Because of: 1. High Cost: Advanced genetic tests, biological medicines and sophisticated diagnostic equipment may be expensive. 2. Unequal Access: Technologies may be concentrated in urban or wealthier healthcare systems,

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leaving rural and low-resource populations behind. WHO emphasizes the importance of equitable access to safe, effective and quality-assured diagnostic technologies. 3. Gender Bias in Research: Historically, women have been underrepresented in some areas of medical research. This can produce knowledge gaps and affect diagnosis and treatment. 4. Privacy of Genetic Data: Genetic information can reveal information about individuals and families. Strong data protection and informed consent are essential. 5. Ethical Issues: Biotechnology raises ethical questions involving: reproductive technologies, genetic testing, embryo research, gene editing, ownership of biological data, informed consent and commercialization of healthcare. 6. Technological Dependence: Excessive dependence on technology can create problems if healthcare systems lack trained professionals, infrastructure or reliable electricity and internet access. 7. False Positives and False Negatives: No diagnostic technology is perfect. Incorrect results can cause anxiety, unnecessary treatment or delayed diagnosis. Therefore, biotechnology must remain subject to rigorous clinical validation.

15. Gender Equity and Biotechnology

Scientific innovation must be accompanied by gender equity. WHO emphasizes that gender can affect healthcare-seeking behaviour as well as the delivery of health services, meaning that gender-responsive approaches are important for effective healthcare programmes. A gender-responsive biotechnology framework should include: 1. Greater representation of women in biomedical research. 2. Collection of sex- and gender-disaggregated health data where appropriate. 3. Research into diseases disproportionately affecting women. 4. Affordable access to essential technologies. 5. Inclusion of women from diverse socioeconomic and geographic backgrounds. 6. Protection of privacy and informed consent. 7. Participation of women in scientific and policy decision-making.

16. Biotechnology in Rural and Low-Resource Communities

The benefits of biotechnology should not remain limited to advanced hospitals. Point-of-care diagnostics, portable testing devices and simplified laboratory technologies may allow some healthcare services to reach remote populations. The WHO emphasizes that health systems need mechanisms to assess and improve access to diagnostic technologies, particularly in low-resource settings[17]. For countries such as India, important priorities include: affordable diagnostic technologies, mobile health services, rural laboratories, trained healthcare workers, women's health awareness, HPV vaccination, maternal health services, screening programmes and digital health infrastructure. Technology should be designed around the realities of communities rather than assuming that every patient has access to sophisticated hospitals.

17. Ethical Considerations

Responsible biotechnology requires a balance between innovation and human rights. 1. Informed Consent: Individuals should understand what a genetic or biological test means before consenting to it. 2. Privacy: Health and genetic information should be protected against unauthorized access or misuse. 3. Equity: Scientific progress should benefit different socioeconomic groups rather than widening existing inequalities. 4. Safety: New biological products and diagnostic technologies require rigorous evaluation for quality, safety and effectiveness. WHO maintains international standards and regulatory approaches for biological products. 5. Autonomy: Women should have meaningful participation in decisions concerning their own healthcare.

18. Future Prospects

The future of biotechnology is likely to become increasingly personalized, data-driven and preventive. Important areas of future development include: artificial intelligence-assisted diagnostics, multi-omics, liquid

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biopsies, precision oncology, advanced biomaterials, improved reproductive technologies, personalized vaccines, cell-based therapies, gene-based therapies, wearable biosensors, point-of-care diagnostics and digital health integration. The combination of genomics, artificial intelligence and biotechnology may enable increasingly sophisticated disease-risk prediction and early detection. Current research is already investigating genomic approaches for cancer prevention and early detection. However, technological advancement should be accompanied by stronger regulation, ethical safeguards and equitable access.

19. Recommendations

To maximize biotechnology's contribution to women's wellbeing, the following measures are recommended: 1. Increase women's representation in biomedical research. 2. Invest in research on under-studied women's health conditions. 3. Make essential diagnostic technologies affordable and accessible. 4. Strengthen HPV vaccination and cervical cancer prevention programmes. 5. Expand molecular and point-of-care diagnostic services. 6. Improve rural and community-level healthcare infrastructure. 7. Protect genetic and health data through strong privacy frameworks. 8. Provide appropriate genetic counselling alongside genetic testing. 9. Promote women's participation in biotechnology and scientific leadership. 10. Ensure that emerging technologies are clinically validated before widespread adoption. 11. Develop gender-responsive health policies. 12. Promote public scientific literacy so that people can understand both the benefits and limitations of biotechnology.

20. Conclusion

Biotechnology has become a powerful instrument for improving human health. Its applications range from vaccines and biological medicines to molecular diagnostics, genomics, cancer treatment, reproductive technologies and continuous health monitoring. For women's wellbeing, biotechnology offers particularly important opportunities. It can contribute to preventing cervical cancer through HPV vaccination, improving cancer diagnosis through molecular and genomic technologies, supporting reproductive and maternal healthcare, facilitating personalized treatment and developing new approaches to monitor health throughout the life course. At the same time, biotechnology cannot independently solve the social and structural determinants of women's health. Cost, unequal access, gender bias in research, privacy concerns and ethical challenges can limit its benefits. Women's health must therefore be approached as a combination of biological, medical, psychological, social and economic wellbeing. The ultimate goal should not simply be to create more sophisticated technologies, but to create safer, more accessible, affordable and equitable healthcare. When scientific innovation is combined with ethical responsibility, gender-sensitive research and universal access, biotechnology can become a major force for improving women's health and strengthening the wellbeing of society as a whole.

References

1. Shaw, L. J. et al. Quality and equitable health care gaps for women: attributions to sex differences in cardiovascular medicine. *J. Am. College Cardiol.* **70**, 373–388 (2017).
2. Sutton, M. Y., Anachebe, N. F., Lee, R. & Skanes, H. Racial and ethnic disparities in reproductive health services and outcomes, 2020. *Obstet. Gynecol.* **137**, 225–233 (2021).
3. 3.Women's health got worse in 2021, global survey finds. https://www.cnn.com/2022/09/21/health/global-womens-health-index-2021/index.html (2022).
4. Magnus, M. et al. Development of a telehealth intervention to promote care-seeking among transgender women of color in Washington, DC. *Public Health Nurs.* **37**, 262–271 (2020).

eISSN 3139-2377
RESEARCH WORK
A Monthly, Open Access, Peer Reviewed International Research Journal
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5. White, J. & Clayton, J. The gender health innovation gap: a perspective from the NIH Office of Research on Women's Health. *Med.* **3**, 298–301 (2022).
6. Common chronic diseases in women compared to men. https://www.canada.ca/en/public-health/services/publications/diseases-conditions/common-chronic-diseases-women-compared-men-aged-65-years-older.html (2021).
7. WHO. Ten top issues for women's health. https://www.who.int/news-room/commentaries/detail/ten-top-issues-for-women's-health (2015).
8. World Health Organization. Women's Health. WHO Health Topics.
9. World Health Organization. Biologicals. WHO Health Topics.
10. World Health Organization. Immunization, Vaccines and Biologicals. WHO.
11. World Health Organization. Diagnostics. WHO Health Topics.
12. Moghimikandelousi, S. et al. (2025). Advances in biomonitoring technologies for women's health. Nature Communications.
13. Gu, M. et al. (2026). Harnessing genomics for early cancer detection, risk stratification and prevention. Nature Genetics.
14. Chakravarty, D. & Solit, D. B. (2021). Clinical cancer genomic profiling. Nature Reviews Genetics.
15. Valpione, S. et al. (2026). Advancing the applications of liquid biopsies in oncology. Nature Reviews Genetics.
16. de Voer, R. M. & Valle, L. (2026). Integrating germline and tumor sequencing to improve hereditary cancer diagnosis and care. European Journal of Human Genetics.
17. World Health Organization. Gender and Immunization. WHO Immunization, Vaccines and Biologicals