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Impact of HIV on Global Health: A Comprehensive Review of Epidemiology and Interventions

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Abstract

HIV remains a significant health issue of great concern to the world and with great impact to the individuals and communities on a global scale. This is a comprehensive literature review on the epidemiology of HIV, including both the world prevalence of HIV and the regional variations, especially in sub-Saharan Africa. It discusses the most important modes of transmission including sexual, blood, and vertical transmission and investigates the effectiveness of prevention measures including behavioral interventions, pre-exposure prophylaxis (PrEP) and the current research on vaccines. The obstacles therein encountered in resource-limited settings and the development of drug resistance are also covered in the review. In addition, it brings out international initiatives to contain HIV such as the 90-90-90 goals and the contribution of technology toward improving HIV care. There are directions in treatment of HIV in the future such as long-acting formulations of ART and possible cures. This review highlights the role of further research and policy formulation, as well as global community, in the fight against HIV epidemic and enhancing health outcomes of the affected populations.

Keywords: 90–90-90 goals, ART, drug resistance, epidemiology, global health, HIV, HIV vaccine, PrEP, prevention measures

INTRODUCTION

HIV (Human Immunodeficiency Virus) is still one of the greatest health problems facing the world, and there are far-reaching consequences of the disease to both individuals and groups across the world [1]. HIV was initially discovered in the early 1980s, and it targets the immune system, making the human body prone to attacks by diseases and infections. HIV may result in AIDS (acquired immunodeficiency syndrome), which is usually fatal without treatment. Even though there are great improvements in treatment, such as highly effective antiretroviral therapy (ART) to date, more than 38 million individuals are living with HIV in the world today, with the disease still spreading in many regions of the world, notably in sub-Saharan Africa. HIV has not only affected the global health of the population in terms of morbidity and mortality, but also in terms of its socioeconomic impact [2]. It increases poverty, breaks families, and burdens health systems, especially when resources are scarce. To overcome these issues, it is essential to comprehend and understand the epidemiology of HIV since it encompasses monitoring the spread of the virus, the high-risk groups, and what factors contribute to the propagation of the virus. Epidemiological research also presents good information on how interventions, including ART, Pre-exposure Prophylaxis (PrEP), and behavior modification, could lessen the number of infections and enhance the quality of life among the affected. The research on HIV interventions is the key to creating effective measures that will prevent the transmission of the disease, improve access to treatment, and eventually reach the global objective of eliminating the epidemic of HIV/AIDS. The review outlines the

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need to carry out further research, create policies, and international collaboration to address the prevailing HIV crisis [3].

HIV is still one of the significant public health problems globally with different prevalence and incidence rates in different regions and among different populations. According to the latest reports released by the World Health Organization (WHO) more than 38 million individuals are living with HIV globally and approximately 1.5 million people are infected every year. The incidence of the virus is higher in some areas, particularly sub-Saharan Africa, where close to two out of every three individuals living with HIV are found. The high transmission rates are also typical of the area that is compounded by the lack of access to healthcare, poverty, and the lack of infrastructure in the area of human health [4]. Moreover, social determinants, such as stigma, discrimination, and intervention impediments in other parts of the world, such as Eastern Europe, Asia, or Latin America, have recorded alarming trends of HIV within the last few years [5].

Epidemiology of HIV

The prevalence of HIV in the world is directly related to demographic and socioeconomic factors. HIV is spreading faster in areas where poverty is high, and little access to healthcare and sexual health education exists. Disproportionate rates of infection are also known to affect populations at increased risk of HIV transmission, including men who have sex with men (MSM), sex workers, and those who inject drugs (PWID), because of stigma and inaccessibility to preventive care [6, 7]. Cultural factors, migration patterns, and healthcare policies within the regions are also aspects that contribute to the spread of HIV (Table 1).

Table 1. Global HIV prevalence by region.

Region	HIV prevalence (%)	Estimated number of people living with HIV (millions)	Estimated new infections (millions)
Sub-Saharan Africa	4.7	25.7	1.1
Asia and the Pacific	0.2	5.1	0.3
Latin America	0.4	2.4	0.2
Eastern Europe and Central Asia	1.3	1.3	0.1
North America	0.4	2.3	0.1
Western and Central Europe	0.2	1.6	0.1

Modes of HIV Transmission

HIV is spread in various ways, and each entry mode contributes a major part to the epidemics of HIV around the globe. Sexual transmission is the most prevalent form of transmission in which HIV is transmitted via unprotected vaginal, anal, or oral sex with an infected person. Bodily fluids like semen, vaginal fluids, and rectal fluids contain the virus, and once they come in direct contact with the mucous membranes, they cause sexual intercourse [8, 9]. The transmission through this route is especially notable in areas where the prevalence of unprotected sex is high, and there is low access to preventive measures against HIV, including condoms and Pre-exposure Prophylaxis (PrEP).

Bloodborne transmission is another significant mode of transmission, and it happens when infected persons' blood is exposed to other people's broken skin or mucous membranes. This may occur by sharing needles among injecting drug users, transfusion with infected blood products, organ transplants or accidental needle–stick injuries during medical practice [10, 11]. Even though bloodborne transmission is less prevalent in the general population owing to the creation of better safety measures and screening, it is still a major threat among certain groups of people, like persons who inject drugs and people undergoing unregulated medical interventions.

Finally, the term vertical transmission is used to denote the transmission of HIV from an infected mother to her child when she is pregnant, delivers the child, or is breastfeeding. It is also an important

issue in areas with high HIV rates and where maternal health and antiretroviral therapy (ART) are not easily available. Nevertheless, the probability of vertical transmission can be minimized with an appropriate treatment, particularly in cases where the mother is on ART throughout pregnancy and delivery [12].

This number demonstrates the key human-to-human routes of HIV infection, namely sexual, bloodborne, and vertical (mother-to-child), as some of the most important areas in which healthcare efforts must be focused to curb the spread of the virus (Figure 1) [13].

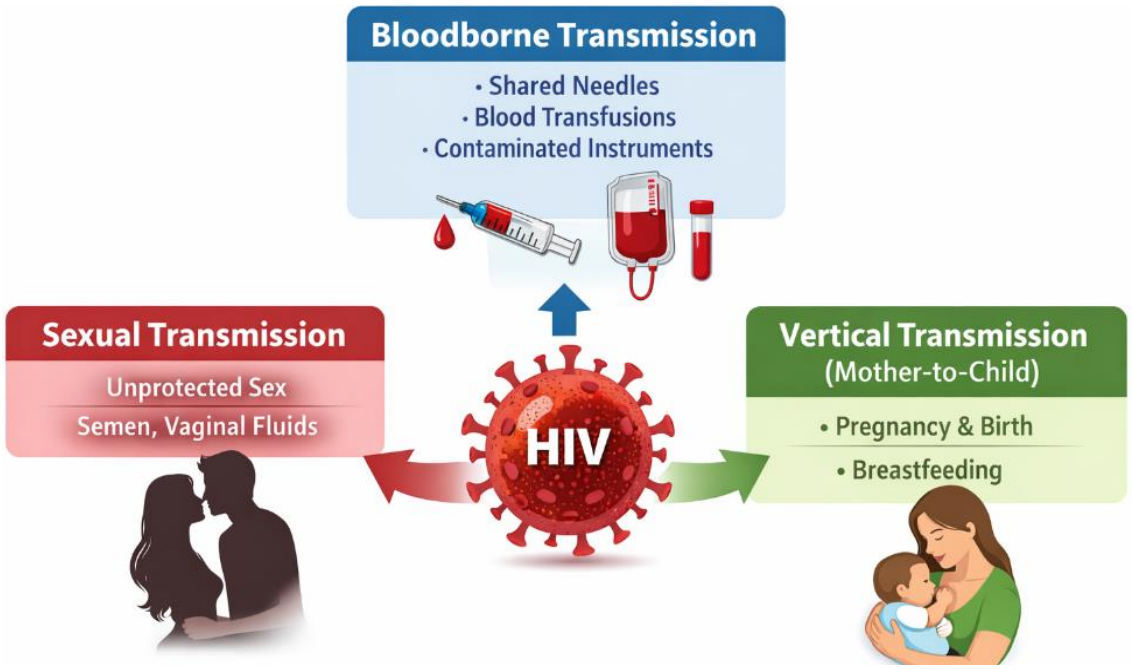

Figure 1. Pathways of HIV transmission.

This graphic illustration can be used to explain the spread of HIV in the various body fluids, as well as the significance of precautionary devices, needle exchange schemes, and maternal healthcare services in regulating the transmission of the virus [14].

HIV AND CO-INFECTIONS

The co-infection of HIV with other diseases (especially, tuberculosis (TB), hepatitis and malaria) dramatically deteriorates health outcomes and changes the treatment strategies. The greatest and most frequent complication of HIV is co-infection with tuberculosis. TB causes the greatest number of deaths among HIV-positive individuals where the immunocompromised condition brought about by the HIV infection makes one susceptible to TB infection and the opposite is also true because TB speeds up the progression of the HIV disease [15, 16]. The overall burden of the two infections presents a great difficulty to diagnosis and treatment since both conditions demand combined care and specific therapy. Another dominant issue is the co-infection of hepatitis and HIV especially Hepatitis B and C that are more common in people with HIV. Co-infected persons are also at risk of having a higher chance of liver disease, such as cirrhosis and liver cancer as well as developing complications, linked to using antiviral medicines since HIV medicines may interact with hepatitis medicines. On the same note, co-infection of malaria and HIV is a problem of concern, especially in sub-Saharan Africa, where the two infections are endemic. HIV also impairs the immune system, which exposes one to serious malaria, and the malaria can worsen the progression of the HIV and make it harder to manage [17, 18]. Treatment of people with HIV who have co-infections is a complex issue that would require a combination of treatment activities to treat the cases of two different infections to effectively treat them, minimize the morbidity rates related to both infection types.

ANTIRETROVIRAL THERAPY (ART)

Antiretroviral Therapy (ART) has played a leading role in the management of HIV, with a big change in the life expectancy and quality of life of people who are HIV positive. Through the years, ART has transformed from the initial use of monotherapy to the current standard of combination therapy, whereby a combination of drugs of differing classes is used to attack the virus at different stages of its life cycle [19]. A milestone was made in the late 1990s with the introduction of highly active antiretroviral therapy (HAART), which caused the viral loads to reduce significantly and HIV-related diseases to be averted. With the current ongoing developments in ART, more powerful drugs that have fewer side effects and regimens have been developed, which have led to increased adherence and outcomes for patients. Nevertheless, ART availability remains a big challenge in the world especially in the low and middle-income economies, where there is a possibility of inadequate healthcare infrastructure. Millions of people do not receive proper treatment, despite the efforts put up by organizations, such as the WHO and UNAIDS, to increase access [20]. Moreover, the problem of drug resistance is growing bigger and bigger, because in the long run, the virus may become altered, and it may become resistant to ART, especially in those instances when patients lack regular medication. This poses a problem to the effectiveness of treatment and requires the development of new medications and methods. Comparison of First-Line ART Regimens is a comparative study of the most popular first-line ART regimens in terms of their effectiveness, adverse effects, and patient adherence (Table 2) [21].

Table 2. Comparison of first-line ART regimens.

Regimen	Components	Efficacy (%)	Side Effects	Adherence Profile
Tenofovir + Emtricitabine + Efavirenz	NRTI + NRTI + NNRTI	>90	Insomnia, dizziness, rash, liver toxicity	Moderate.
Abacavir + Lamivudine + Dolutegravir	NRTI + NRTI + INSTI	>95	Hypersensitivity, headache, nausea	High.
Tenofovir + Lamivudine + Darunavir	NRTI + NRTI + PI	>90	Diarrhea, nausea, liver toxicity	Moderate.
Dolutegravir + Lamivudine	INSTI + NRTI	>95	Headache, nausea, insomnia	High.

HIV PREVENTION STRATEGIES

HIV preventive measures include various methods targeted to prevent the spread of the virus, and, in particular, both behavioral and biomedical measures. Educational and behavioral interventions are important in creating awareness on how HIV is transmitted and encouraging safe behaviors, including condom use, frequent HIV infections, and decreased high-risk behaviors such as having unprotected sex and sharing needles [22]. These can be done by community-based programs, media campaigns, and school-based education, and the audience that is most at risk can be targeted such as the youth, men who have sex with men (MSM), and individuals who inject drugs. Pre-exposure Prophylaxis (PrEP) is a new intervention on the biomedical front. PrEP is the intake of antiretroviral drugs by people with high risks of infection who are HIV-negative and who take them regularly, which significantly decreases the risk of HIV transmission in case of regular use. The promise of this strategy has been great in the prevention of the spread of HIV among high-risk populations and is increasingly being incorporated into public health programs. Moreover, developing vaccines and cure research is also a serious endeavor, given that the long-term aim of the agenda is to offer a vaccine that gives permanent immunity against HIV. Even though no HIV vaccination has so far been developed successfully, the future in this field shows a positive perspective, with a number of contenders in the clinical trials [23, 24]. Further, studies on possible remedies, such as gene therapy and functional cure options, are underway, and this gives a ray of hope that it can one day cure the virus. This is a multi-level prevention measure based on these combined prevention strategies that would contain the epidemic of HIV and eventually mitigate the effects of the disease on the world.

HIV IN VULNERABLE POPULATIONS

HIV affects vulnerable groups, such as women and children differently, and these people are more susceptible to HIV due to gender-based disparities, inadequate healthcare services and mother-to-child

vertical transmission. Men who have sex with men, sex workers, and injecting drug users are considered key populations because of their increased risks of being infected with HIV due to social stigma, criminalization, and limited access to prevention and care services. Discrimination against these groups is a frequent event, and it prevents them from attempting to access and obtain proper healthcare [25, 26]. Moreover, HIV care stigma and discrimination are also crucial factors, because it is not always possible to encourage people living with HIV to have access to testing, treatment, and support due to the societal attitudes and prejudices, which only contribute to the further spread of the virus. The special attention of these groups means that these special populations need specific interventions, legal safeguards, and stigma-reduction mechanisms to achieve equal access to HIV prevention and treatment services.

GLOBAL EFFORTS TO CONTROL HIV

The major world bodies to combat HIV have been international organizations like the United Nations (UN) and the World Health Organization (WHO) which have established far reaching targets to curb the global burden of HIV. The UN Strategy on HIV/AIDS and the WHO Strategy on HIV Global Health Sector are meant to increase access to prevention, treatment, and care, particularly in countries with high burdens. These efforts aim at reducing the rate of new HIV infections, universal access to antiretroviral therapy (ART), and addressing the needs of the key population groups affected by HIV. The 90-90-90 targets, which are set by UNAIDS and envisage the 90% of people living with HIV to be diagnosed, 90 percent of the diagnosed to be on ART, and 90 percent of those on ART to have viral suppression by 2020, are one of the most important global targets. Though it has been achieved, gaps still exist in achieving these targets, especially in sub-Saharan Africa and in marginalized population groups, where access to care and treatment is still low. The Global HIV Response and Key Targets (90-90-90). show the progress towards the targets, shedding light on the achievements and current challenges in global efforts to control HIV (Figure 2) [27, 28].

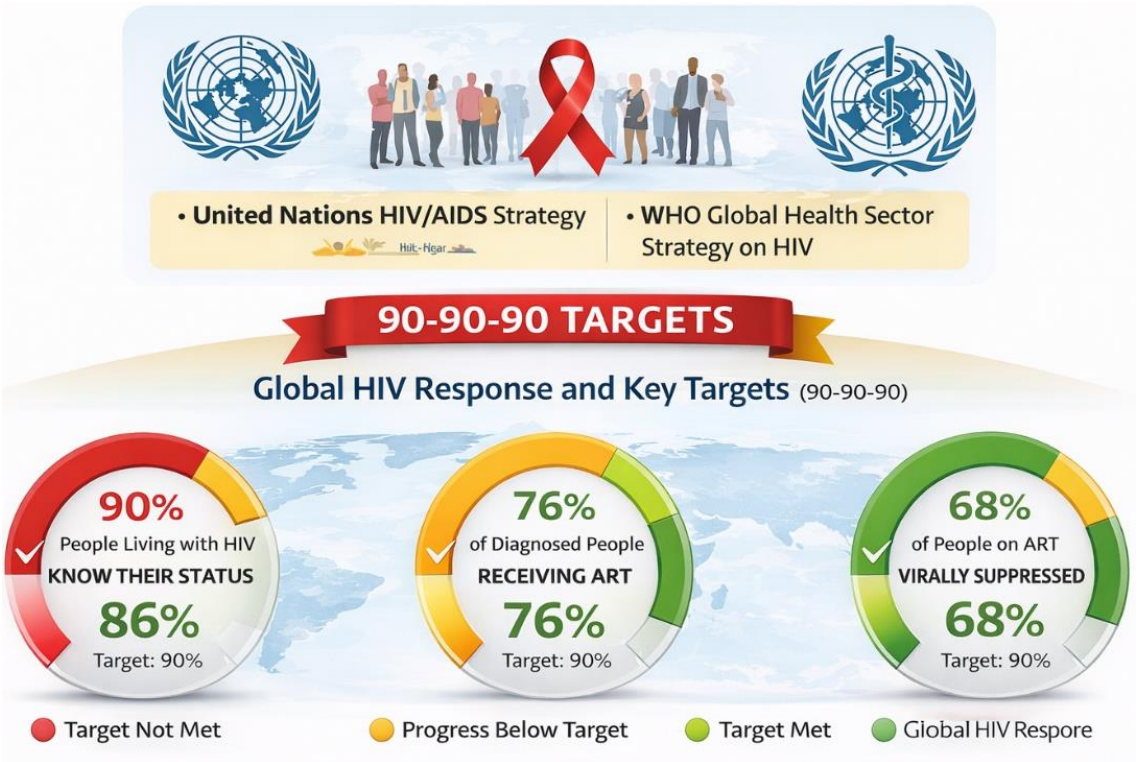

Figure 2. Global HIV response and key targets (90-90-90).

The figure illustrates the world development and the difference to reach the 90-90-90 targets and indicates the essential trends and points of additional intervention.

DIFFICULTIES IN CONTROLLING HIV AND FUTURE PROSPECTS.

The strategies of HIV control are affected by serious challenges, particularly in resource-limited environments, where access to health services is often inadequate. These environments have a shortage of funds, poor healthcare facilities, and a prevalence of co-infections like tuberculosis, which makes it harder to treat HIV. In addition, in these areas, there is a shortage of qualified medical staff, which complicates the provision of prompt and quality HIV care. Regarding the trends that have been noticed in the field of HIV within the research, there are new developments that have been made in the field of vaccine development, gene therapy, and long-acting ART formulations, which have given a new hope in this war against the virus. The production of a functional cure to HIV and preventive vaccines remains in the research, which would have transformed the future of HIV treatment. Also, technology is important to enhance HIV prevention and treatment, and digital health interventions, including mobile applications, telemedicine, and AI-based diagnostics, can be used to boost adherence and monitoring of patient results, especially in settings with limited resources [29, 30].

CONCLUSION

Conclusively, although it is clear that much has been done to tackle the global response to HIV, it is evident that there exists a lot to be done. The multifaceted approach is the key to epidemic control due to its emphasis on attaining better access to antiretroviral therapy (ART), managing the new tendencies in the research, and applying the technological progress that can break the resource barriers in resource-deficient conditions. The policies should be made in a way that guarantees equal access to healthcare by all populations, minimizes stigma and offers education of higher quality to enhance the prevention strategies. It is necessary to have a concerted effort that includes governments, international organizations, healthcare providers, and researchers to achieve the global goal of ending the epidemic of HIV/AIDS. Reaching this will necessitate sustained dedication, ingenuity and coordination across all societal layers to cut down the new infections, enhance the lifestyles of those who are already in the virus and eventually eradicate the virus as a social ill.

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