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# Economic Impact of HIV in the Highly Active Antiretroviral Therapy Era - Reflections Looking Forward

*Juan Oliva-Moreno[1] and Marta Trapero-Bertran[2]*

*[1]Department of Economic Analysis and Finance, Universidad Castilla La-Mancha, Toledo, Spain; [2]Research Institute for Evaluation and Public Policies (IRAPP); Universitat Internacional de Catalunya, Barcelona, Spain*

## Abstract

***The main data on HIV in high-income countries from the standpoint of health economics are updated and discussed. Specifically, issues surrounding the economic impact of HIV are addressed for health care and occupational perspectives. We review the main epidemiological data on the prevalence of disease and foreseeable changes in patterns within the coming years. Recent research on health care costs of HIV/AIDS and the occupational situation of HIV+ people are discussed. In high-income countries, there is an incipient change in trends that indicate that an increasing percentage of the intermediate-age HIV+ population will age prematurely, presenting more frequently comorbidities and becoming more exposed to frailty situations. Accordingly, health-care systems should have to plan their resources to accommodate new determinants of healthcare costs in the HIV+ population. On the occupational side, the decreased life expectancy of HIV+ persons, coupled with more severe health issues, on average may prompt early retirement of this population from the labor market.*** **(AIDS Rev. 2018;20:226-235)**

*Corresponding author: Juan Oliva-Moreno, juan.olivamoreno@uclm.es*

## Key words

***HIV. Health care cost. Labor force participation rate. Economic impact. Comorbidity. Aging***

## Introduction

Since the discovery of the HIV and its manifestation in the form of AIDS, it began to be thought that this might become one of the world's most severe public health issues for decades[1]. Unfortunately, these suspicions have turned out to be prescient. HIV/AIDS has had and continues to have a severe impact on the health of the population, and, in addition, causes serious additional socioeconomic problems for individuals, families, communities, and governments in many countries.

However, in high-income countries, in the space of little more than one generation, HIV/AIDS has progressed from being a terminal disease to a chronic disease – if suitable treatment is available – with high

**Correspondence to:**
Juan Oliva-Moreno
Universidad de Castilla La-Mancha
Departamento de Análisis Económico y Finanzas
Facultad de Ciencias Jurídicas y Sociales de Toledo
San Pedro Martir, s/n
45071 Toledo, Spain
E-mail: juan.olivamoreno@uclm.es

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life expectancy and quality of life prospects for carriers of the virus. Nevertheless, this progress has involved a major social effort in terms of intensive use of healthcare resources, coupled with social costs in the occupational sphere.

People living with HIV are living longer and so encounter comorbidities linked not only with their disease but also with ageing, lifestyle and chronic exposure to antiretroviral therapy (ART).

In this paper, we review and update some of the main data on HIV focused in high-income countries from the perspective of health economics. We shall first review the main epidemiological data on the prevalence of the disease and on the burden that it involves. We shall then address the foreseeable shift in the epidemiological pattern over the coming years, especially in high-income countries. Second, we shall analyze the health cost data provided by some of the main studies conducted in the past decade. Third, we shall look at information on the occupational situation of HIV-positive people. Finally, we end the paper with a range of conclusions and suggestions for future research.

## HIV/AIDS Epidemiology

HIV is still a significant public health problem in the EU/EEA. In 2015, 29,747 new HIV infections were diagnosed in the EU/EEA, and the rate of new infections has not declined significantly over the past decade. An estimated 810,000 persons were living with HIV in the EU/EEA in 2015 (0.2% of the adult population), however, the prevalence is much higher in some countries and among key populations[2]. Total reported cases are expected to increase in the coming years owing to delayed submission of many countries'. Since 2003, annual AIDS-related deaths have decreased by 43%. On the other side, in the world's most hard-hit region – Eastern and Southern Africa – despite the number of people in treatment has more than doubled since 2010, reaching almost 10.3 million people, and consequently, AIDS-related deaths in the region have decreased by 36% since 2010, still, serious challenges lie ahead.

According to the Global Burden of Disease Study[3], the burden of HIV/AIDS measured in terms of disability-adjusted life years (DALYs) increased severely from 1990 to 2005. From 2005 to 2015, however, the DALY burden of HIV/AIDS considerably decreased. Comparing the DALY burden for 2005 with that for 2015, we see a decrease of 32.6%. In 1990, HIV/AIDS was 42$^{nd}$ worldwide as a disease burden in terms of DALY. By 2005, it accounted for the 5$^{th}$ largest burden. Over the past 10 years, however, HIV/AIDS has shifted to 10$^{th}$ place, starting clearly downward trend. In 1990, HIV/AIDS was the 29$^{th}$ leading cause of mortality or years of life lost. By 2005, it was the 4$^{th}$ leading cause, having increased 597.5% with respect to 1990. Over the past 10 years, however, the forward strides in highly active antiretroviral therapy (HAART) have helped to bring down years of life lost by 33.9%, such that HIV/AIDS is now the 7$^{th}$ leading cause of mortality worldwide.

## Current Epidemiological Trends

Having peaked in the mid-1990s, the number of reported cases has gradually declined from 1996 (the year before the widespread introduction of HAART) to 2014 in high-income countries, although the large number of accumulated cases and the high cost of their treatment mean that prevention and improvements to the treatment of HIV continue to be a priority objective of public health policy.

HAART was a radical change in the clinical management of this disease, making it a lifelong condition while awaiting a definitive cure. Over the past 2 years, the number of people living with HIV in ART has increased worldwide by one-third, reaching 17 million, or 2 million more than the 15 million set as a target for 2015 by the United Nations General Assembly in 2011[4]. Medical progress and its concomitant therapeutic enhancements have improved the life expectancy and quality of life of virus carriers. However, as we shall see, this does not mean that their life expectancy is similar to that of the population at large. In 2012, the OAR Working Group on HIV and Aging asserted that current treatment of people living with HIV has increased their life expectancy to more than 70 years. Biological, medical, and social issues change in step with aging with an HIV infection but published evidence on these matters is only barely beginning to emerge. These treatments are not free of issues such as toxicity and other undesired adverse effects. Despite the major therapeutic advances achieved over the past decade, HIV carriers face significant health challenges that potentially affect their life expectancy and quality of life.

One of the main challenges that health professionals and patients are beginning to encounter, and which will increase over the coming years, is the comorbidities inherent in the gradual aging of the HIV carrier population. The accumulation of years of treatment (and lifetime) is bringing to light a new range of issues relating to diseases that, though also common in the HIV-negative population, are more prevalent and tend to appear earlier in the HIV-positive population.

Despite the gradual improvements seen in ARTs and the enhanced survival of HIV-positive people, at least an 8-year gap in life expectancy still remains for HIV-infected compared with HIV-uninfected individuals, even with early treatment and access to care[5,6]. In addition to people who are coinfected with hepatitis C virus, who decrease in number over time but are still significant, particularly among older age groups given the predominance of contagion through use of intravenous drugs, there are other diseases having a greater prevalence or more severe consequences in the HIV-positive population. These include certain types of tumors[7,8], hepatic and renal diseases[9,10], cardiovascular diseases,[11-13] and neurocognitive disorders[14]. In fact, it is estimated that half of HIV-positive people in high-income countries die from causes not associated with HIV/AIDS[15]. Libman[16] explains that the incidence of coronary disease is higher among HIV carriers that non-infected persons of the same age and sex. HIV infection and treatment for it have been found to be associated with premature bone loss, lung cancer, liver cancer, and anal cancer, which present at earlier ages in HIV-positive people. The author highlights that it is crucial to devote time to managing the comorbidities of the disease.

Smit et al.[17,18] point out that the HIV-positive population is aging and that these people will increasingly develop non-transmissible diseases. The purpose of their research was to quantify the change and the future implications for HIV treatment in the Netherlands. They constructed an individual-based model of the aging HIV-infected population in the Netherlands to monitor HIV carriers including their non-transmissible diseases as cardiovascular diseases (hypertension, hypercholesterolemia, myocardial infarction, and cerebrovascular accidents), diabetes, chronic renal disease, and osteoporosis, contemplating comedication for these disorders. The model was parameterized with 10,278 patients of the Dutch ATHENA cohort from 1996 to 2010. Projections were calculated to 2030. The model suggests that the average age of HIV carriers receiving ART will increase from 43.9 years in 2010 to 56.6 years in 2030. The over-50s group will see the largest increase, shifting from 28% in 2010 to 73% in 2030. 84% of HIV-positive people will have at least one non-transmissible disease, such as hypertension, myocardial infarction, stroke, diabetes, and osteoporosis and an estimated 28% will have three or more non-transmissible diseases by 2030. The authors point out that the profile of HIV-positive people in the Netherlands is changing, with a growing number of elderly patients with multiple comorbidities. These changes mean that, in the near future, HIV treatment will increasingly have to resort to a wide range of medical disciplines, and to the detection and monitoring of protocols to ensure continuity of quality evidence-based care. It seems likely that these patterns will also be seen elsewhere in Europe and North America[19]. The implications of this trend for the treatment of HIV-positive people may emerge as a significant challenge to be addressed by a more complex clinical approach, where the maintenance or improvement of the quality of life of the HIV-positive population might require greater investment in health-care resources.

In addition, evidence is beginning to emerge that the HIV carrier population ages more rapidly than the general population[20], thus it can be said of them that they age prematurely[21]. The concept of "frailty," defined as a biological syndrome involving a decrease in the homoeostatic functional reserve and in the capacity for response to external stressors as a result of an accumulation of deficits in several physiological systems, as a predictor of vulnerability[22], will be key to future research on the health and use of health care and social services of HIV-positive people. The presence of frailty has demonstrated high predictive value for the progress of the state of health of the general population. Some studies are beginning to show that people in a state of frailty require more health-care resources than non-frail people[23]. The older HIV carrier population is showing wider prevalence of frailty with respect to the non-HIV population, and frailty appears at an earlier age[24,25]. The economic impact of this new reality is unknown as to the specific figures, but the likely future trend can be foreseen.

Mention is due to the projection for the coming 20 years calculated for the ICONA cohort on aging and disease burden for HIV for Italy[17,18]. The model analyses the aging of a cohort of close to 7500 Italian HIV-positive patients receiving ART from January 1, 2010, to December 31, 2035, or their death. The cohort also involves a probabilistic simulation of clinical events (arterial hypertension, dyslipidemia, chronic renal disease, diabetes, malignant tumors, cerebrovascular accidents, acute myocardial infarction, and mortality). The model was constructed using data for 1997-2010 and validated using 2010-2015 data outside the sample to assure that the projection was robust. In relation to aging, the model projects that the average age of patients in ART will increase from 46.1 years to 58.8 years in Italy from 2015 to 2035. The proportion of ART patients over 50 will increase from 30% to 76% from

2015 to 2035. The proportion of ART patients free of comorbidity will decrease from 36% to 11% from 2015 to 2035 in Italy. The proportion of ART patients with three or more comorbidities will increase from 10% to 46% from 2015 to 2035. The most prevalent comorbidities in these patients were and will continue to be those relating to cardiovascular risk. The increasing burden of comorbidities will be driven by cardiovascular disease (hypertension, dyslipidemia, cerebrovascular accidents, and acute myocardial infarction), diabetes and chronic renal disease. Cardiovascular disease will contribute with the greatest burden, affecting 57% of patients in 2015 and 85% by 2035[17,18].

Finally, two studies that provide evidence on the differences between life expectancy and mortality in the HIV-positive population compared to the non-carrier population were developed on the basis of the CoRIS network and the Kaiser Permanente insurance company. The data provided by the CoRIS network on mortality in a Spanish cohort of HIV carrier patients commencing ART indicates that those patients display a mortality rate of 1.02 deaths per 100 people per year of follow-up. This means that overall mortality in this cohort is close to 6.8 times greater than in the non-carrier population of the same age and sex. The groups displaying the highest mortality rates were those aged 50 and above, or who had been diagnosed with AIDS on commencement of treatment, or with comorbidities such as coinfection with the hepatitis C virus[26].

The question of whether early commencement of ART with more effective and better-tolerated treatments might improve life expectancy in HIV-positive patients has been partly answered in a research effort based on data sourced from the Kaiser Permanente organisation in California[27]. For their analysis, the authors drew on data on 24,768 HIV-positive people and 257,600 non-carrier people, with similar access to health care. Each HIV-positive person was paired with 10 non-HIV people of the same age, sex, medical site and year of care. The HIV-positive population displayed higher percentages of people with a history of smoking (45% vs. 31%), hepatitis B or C (12% vs. 2%) or alcohol or drug abuse at some point (21% vs. 9%). Of people commencing ART, 18% had a CD4 count above 500 cells/mm$^3$. The number of deaths among the HIV-positive group changed from 7,077 per 100,000 people per year in the period 1996-97 to 1,054 per 100,000 people per year by 2011, whereas in the non-HIV group the mortality rate did not change significantly over that period. During that time, life expectancy at age 20 increased from 19 to 53 additional years in the HIV group, whereas in the non-HIV group it shifted from 63 additional years to 65 years[27]. Overall, in the period 2008-2011 a person with HIV at age 20 could expect to live for a further 49.3 years as against 62.3 years for people without HIV – a difference of 13 years. Ethnicity, sex, transmission path, and presence of comorbidities also affected life expectancy.

In summary, therapeutic improvements have translated into increased survival and improved quality of life in HIV-positive people. However, this involves an epidemiological transition in the pattern of morbidity and mortality. First, HIV-associated morbidity has decreased, but other disorders have increased competitively, in particular, chronic liver disorders, cardiovascular disease, and other aging-associated diseases. In summary, life expectancy and quality of life have improved since the introduction of HAART, but this does not mean that health of HIV+ persons is equivalent to that of the uninfected people.

A notable concern present in recent works is whether the potential policies of budget cuts in some countries and the exclusion of certain groups from access to health-care services can have undesirable consequences on the treatment and spread of HIV infection[28,29].

Although the economic crisis has remitted, at least in macroeconomic figures, the consequences of it on health-care systems have been profound. A challenge for those countries that have faced the most severe cuts is maintaining quality in the health services provided and cover health needs of the population. It is still too early to draw definitive conclusions, but this is a field in which future research should pay special attention.

## Direct Health care Costs of HIV Infection

Estimates of the costs associated with HIV infection provide valuable information about the economic impact of a disease by laying bare the effort required in terms of allocation of health-care resources by society to provide the care needed by virus carriers, or by revealing the opportunity cost in the form of loss of other social resources. Information on costs is also necessary to carry out an economic assessment to establish the cost-effectiveness of prospective prevention interventions and new treatments versus existing ones. Research that examines the additional cost of lifetime health care for patients living with HIV from an incidence perspective is especially valuable[30], although most of the papers, we shall refer to take a

prevalence approach. Incidence-focused research tells us about the potential saving we would achieve if a case or set of cases of contagion were prevented, whereas prevalence-focused research tells us about the specific economic impact of a disease over a specific period (generally, 1 year) per patient or within a given population. The selected papers commented on below estimate the health care cost for HIV-positive people. We have not included papers – interesting though they are – that focus on partial issues, such as the cost of ART, without considering other health-care resources.

As already discussed, the introduction of HAART was a major milestone in the management of the disease. From an economic standpoint, it clearly led to a rise in the total cost of treatment. This is not necessarily because the annual cost of treating a patient is higher than before the emergence of these treatments; rather, it is because, given the longer life expectancy of affected patients, the cost of treating a patient throughout his or her lifetime undergoes a notable increase[31,32] in comparison to the 1980s and the early 1990s[33].

For example, looking at annual health care cost, Stoll et al.[34] pointed out a decline in direct health care costs of 32% in Germany from 1997 to 2001. Tramarin et al.[35] also reported a 25% decline in health care costs per person/year in Italy from 1994 to 1998 (from €15,390 to €11,465, in 1999 values). Merito et al.[36], also in Italy, pointed out a decline between 1997 and 2002, although the annual costs of ART per patient are widely different from those referred in the study mentioned before (a shift from €5,073 per patient to €3,149). However, Krentz et al.[37] identified an increase of 71% in Canada from 1995 to 2001 (moving from C$655 per patient/month of treatment to C$1,119). The discrepancy does not arise only among research carried out in different countries. In France, Flori et al.[38] pointed to a decline of 25% in the cost per patient from 1995 to 2000, whereas Basuyau et al.[39] detected a powerful increase in the cost when comparing the period 1992-1996 to 1996-2000, probably reflecting the widespread of HAART from 1996 onward.

In 2014, we published a systematic review of the economic impact of HIV for the five most populous countries of Western Europe: Spain, Germany, France, Italy, and United Kingdom[40]. This research revealed wide variability in the estimates of annual cost per patient for HIV treatments between the various countries considered. In Spain, for instance, annual health care costs, at 2010 values, came to €11,638. The annual cost of treatment estimated for Germany and the United Kingdom was considerably higher; that for France was closer to Spain's, while Italy's was lower. Combining this information with the epidemiological data available for the diagnosed HIV population, the authors estimate that HIV health care costs account for 1.25% of health care costs in Spain, 0.49% in Italy, 0.9% in the United Kingdom, 0.52% in France and, in Germany, despite the high cost per patient, 0.48%, given low prevalence.

Since the publication of that review paper, other research on high-income countries has updated the information on HIV treatment costs[41-47]. Heslin and Elixhauser[41] calculated HIV-related hospitalizations in United States from 2006 to 2013. The authors estimate that hospitalizations with a principal diagnosis of HIV decreased by 49% from 2006 to 2013, declining from 72,486 to 36,970, respectively. This meant that the aggregate costs of HIV-related hospital stay decreased by 12% from 2006 to 2013, declining from $3.2 billion to $2.83 billion (at 2013 prices). Cavalcanti et al.[48] analyze HIV patient data in the east, west, and south of the United States, and show that both CD4 count and age are explanatory variables for changes and increases in HIV-positive patient costs.

In the context of longer life expectancy for virus carriers, Brennan et al.[49] foresee a growing demand for outpatient services in the coming years. The authors argue that micro cost research is needed so as better to support the decisions that are to be made in the coming years in the light of this paradigm of older HIV patients. They quantify the average monthly cost of outpatient care for HIV patients in Ireland at €973 (95% confidence interval, €938-€1,008). The paper by Krentz and Gill[50] focuses on the age-linked increase in HIV care costs in an HIV population. Their research included all HIV carriers aged 16 and above receiving care from January 1st 2000, to January 1st 2011, in southern Alberta in Canada. The proportion of patients aged 50 and above increased from 9.6% to 25.4%, and the proportional total costs for people aged 50 and above increased from 25% of the costs for the entire cohort to 31% in 1999 and 2010, respectively. Research on this issue has also been conducted in Spain. Although they have not translated their findings into terms of cost, Gimeno-Garcia et al.[51] identify higher health-care resource utilization among HIV-positive elderly males than males in the general population. On the first consultation with specialists, and in emergencies and hospitalizations - although as the authors point out, the main health care cost for these patients

continues to be ART. In their paper, the authors show how the HIV-positive population aged 50-54 uses 19% more resources in emergency services and 6.1% more hospital revenue versus the general population, leading to a total annual cost of €8,929 (median) per patient.

Guaraldi et al.[52] addressed the hypothesis that the increase in the prevalence of non-infectious comorbidities (NICMs) in HIV positive people could lead to a rise in the direct costs of health care in comparison to the population at large. The authors' intention was to estimate and describe the factors that contribute to direct health care costs among HIV-positive people, with a focus on care for NICMs. Using a control case study methodology, HIV-positive people in ART (cases) were compared to the general population of a similar sex and age included in the CINECA ARNO database (controls). The NICMs evaluated included cardiovascular disease, hypertension, diabetes mellitus, bone fractures, and renal failure. The health care cost data evaluated included costs of pharmacy, outpatient care and hospital care. Linear regression models were constructed to evaluate total cost predictors for control case care. Average total cost per person for health care was greater for HIV patients with associated NICM than for the controls – general population – for all age ranges considered. If people aged 50 and above having a CD4 count of <200 cells per mm3 are compared to people aged under 50 with a CD4 count of <200 cells per mm3, we see that the former is associated with a health care cost that is 5% higher than for the latter. If we again compare these two age groups, but where the CD4 count is more than 200 cells per $mm^3$, the rise in health care cost is reduced to approximately 2.6%. This study demonstrated that the premature aging process affects HIV-positive people in a way that translates into an additional cost for this population. Comorbidities and multi-pathologies involve a health care cost (excluding ART) 3 times higher than that of HIV infection ***per se*** ($8,911 vs. $2,878 – 2009 data). The authors recommended continued monitoring in prospective studies of the impact of the aging process in HIV-positive people on the total cost.

Quiros-Roldan et al.[53] also evaluated the association among age, sex, monitoring period, CD4 cell count at the outset and chronic diseases with per capita cost using multivariate regression models in patients with HIV/AIDS. This study, based on the population of a health district in northern Italy, was designed to investigate the burden of chronic diseases and health costs for HIV-positive people in comparison to the general population within the Brescia local health agency district over a period of 12 years (2003-2014). The chronic diseases of interest evaluated in 3-year periods were: Cardiovascular and cerebrovascular diseases, hepatic diseases, dyslipidemia, diabetes, cancer, gastrointestinal diseases, neuropathies, severe psychiatric disorders, chronic respiratory diseases, and renal failure. The prevalence of most comorbidities increased over time but was significantly reduced (annual average change –0.7%) when adjusted by age and sex, which indicates that they are significantly associated with aging in the HIV-positive population. The cost for HIV-positive patients increased (+25%), mainly due to the cost of medication (+50%), but stabilized in the last few years of the period. CD4 cell count on diagnosis was an important predictor of the cost of HIV treatment. The authors concluded that the costs relating to HIV infection were mainly dependent on the cost of the medication. However, they suggested that investment in HIV-focused public health programs might improve the prognosis for virus carriers, reduce transmission of HIV infection and lighten the overall burden of chronic diseases. Renal failure, psychiatric disorders, and cancer were the costliest comorbidities, with an increase in cost per capita of €13,665, €8,172, and €7,557, respectively. Cost per capita was positively associated with age (+€36 per year of age), years of monitoring, CD4 cell count at study commencement (+€2,452 for subjects with CD4 count of <200 cells / mm3) and the presence of chronic diseases. In particular, an increase was observed of €3,700 for subjects with, in comparison to those without, at least one chronic disease.

HIV-positive people tend to have a higher risk of acquisition of comorbidities owing to unhealthy living habits, such as smoking, obesity, alcohol dependence, and substance abuse. However, the influence of these factors on the increased cost of associated comorbidities has not yet been studied[53].

In summary, although the health cost associated with HIV treatment – especially pharmacological treatment – continues to be predominant in the total health care costs for HIV-positive people, the increased life expectancy brought about by HAART is leading to an age transition where people aged 50 are becoming a larger proportion. Although the number of studies that have focused on this population subgroup is limited, the appearance of non-transmissible diseases in these people is clearly emerging, and the cost of their treatment is increasing.

Supplementary Table 1 summarizes the main features of the key papers published on the health care costs of HIV in the past few years.

## Non-health care costs of HIV infection: Labor force participation

Although most of the research on the economic impact of HIV has focused on estimating the health care costs of the disease, other socially relevant costs exist which have been favorably affected by therapeutic progress.

In the introduction of the HIV/AIDS + Work Technical Cooperation Report (www.ilo.org/aids), Franklyn Lisk, the Head of the ILO Programme on HIV/AIDS and the World of Work, points out that "Apart from the heavy toll on the lives of individuals, the global HIV epidemic reduces the supply of labor and undermines the rights and livelihoods of millions of men and women workers and those who depend on them. The loss of skills and experience reduces productivity and diminishes the capacity of national economies to deliver goods and services on a sustainable basis." In the same report, it is stated that "The fact that almost three-quarters of the 40 million people living with AIDS are workers means that workplace action is a decisive factor in strategies to break the grim cycle of the epidemic. The capacity to access, analyze and apply knowledge related to the disease is essential in mitigating its health, social, and economic impacts[54]."

In Spain, the various waves of the HIV Hospital Survey (conducted by the Office for the National Plan on AIDS)[55] show that in the past few years the average age of HIV-positive people has increased (owing to improved life expectancy). In 2013, the average age of survey respondents was 46.2 years (47.3 years in males and 43.2 years in females).

### *Labor Force Participation. International Literature*

Until the introduction of HAART, disease progression would drive out a vast majority of HIV-positive people from the labor force. The first series of available studies conducted in high-income countries in the 1980s and early 1990s found that an HIV diagnosis had a devastating effect on the likelihood of staying in work[56-60].

However, the significant improvements in the life expectancy and quality of life of HIV-positive people have substantially changed this state of affairs. Supplementary Table 2 summarizes some features and main results of papers on the labor force participation of HIV-positive people. Dray-Spira et al.[61] found that 46.8-58.8% of HIV-positive people were in employment, and one-third of those who were unemployed reported being in search of a job. Rabkin et al.[62] concluded in their paper that people who were already employed at the start of monitoring were highly likely to keep their jobs. Goldman and Bao[63] and Bernell and Shinogle[64] found that when patients received a HAART, this substantially increased the likelihood of their staying in work. The results were more marked when treatment commenced at early stages of the infection.

However, this does not mean that an HIV diagnosis has no effect on the labor force participation of HIV-positive people. Dray-Spira et al.[65] found that the cumulative probability of leaving work was 14.1% 2 years after diagnosis and 34.7% 5 years after. Comorbidities such as diabetes or hypertension and, to a lesser extent, signs of depression were associated with an increased risk of leaving work. Auld[66] suggests that the decline in the percentage of employed HIV-positive people is a result of the adaptation of those people's expectations to an adverse shock to health that involves shorter life expectancy. This author estimates that the impact of the diagnosis involves a 25% decrease in the probability of being in work. Oliva[67] showed that, jointly with health variables, sex, age, education, most probable cause of contagion, or psychological issues have a strong effect on labor participation.

Other research has highlighted the importance of psychological aspects when explaining labor force participation[68-71] and reinforce the fact that salary is not as important an explanatory factor for the occupational situation of HIV-positive people as it is for the population at large[72]. In their study, Elzi et al.[73] found that 4382 people (75.6%) were fully able to work, 471 (8.1%) were able to work part-time, and 947 (16.3%) were unable to work. Recovering the full capacity to work was associated with higher educational attainment and viral suppression. The presence of psychiatric comorbidity and greater age was negatively associated.

Another highlight is the fact that voluntary or forced departure from employment after an HIV diagnosis may have an effect that persists throughout the following years, with significant economic consequences for HIV-positive people and for society[65,74]. The research by Annequin et al.[75] conducted in France found that the economic downturn has had a higher impact on the HIV-positive population with respect to the population at large. Specifically, from 2003 to 2011 the em-

ployment rate among HIV-positive people slightly declined, and the unemployment rate increased, whereas in the general population the employment rate held steady and the unemployment rate increased only slightly.

Although no specific studies focus on the older population, in most of the papers reviewed the probability of being employed is seen at intermediate ages, and later decreases gradually. Some papers specifically point out this effect. Elzi et al.[73] pointed out that greater age is negatively associated with full physical and mental capacity to work. Groß et al.[76], having pointed out that the probability of unemployment among the HIV-positive population was higher than in the population at large, identified that the presence of frailty and the severity of the disease negatively affected the probability of being employed. Wagener et al.[74] indicated that age (from 40 years onwards) and the presence of mental and physical function problems reduced the probability of being employed.

In summary, despite the therapeutic improvements arising from the introduction of HAART, which have led us to a scenario that is widely different from that seen in the 1990s, the likelihood of being employed and the occupational experiences and opportunities of HIV-positive people continue to be different from those of non-carriers[77]. Immunological state, comorbidities and psychological disorders are key explanatory variables associated with the labor force participation of HIV-positive people, but so are age, sex, educational attainment, and cause of contagion. HIV-positive people are generally less likely to be employed than the general population.

## Variables more Involved in the Shift in HIV Budget in the Near Future

Concluding remarks from the two previous sections, there are different variables that are expected to most influence the economic impact of HIV in the near future, and these are summarized in Figure 1.

## Conclusions

Despite the major social and economic impact of HIV/AIDS, there are wide gaps in the research on this disease that are yet to be filled. The current situation in high-income countries is one of an increasing percentage of the intermediate-age population with HIV/AIDS, who will age prematurely and with a higher likelihood of comorbidities and exposure to frailty processes. This will affect the economic burden of disease in terms of both direct health care costs and non-health care costs. Against this background, it will be important to study the development of annual treatment cost per patient, possible changes in the distribution of health care costs (hospitalization, consultations, tests, etc.) and other social costs, such as those associated with labor force participation. It is very likely that the health-care impact of HIV will increase in the coming years. Today, the details of this expected development are not fully known, but early research indicates that the process of emergence of comorbidities not directly associated with HIV in the older population, and the premature aging undergone by some of these patients, translates into increased contact with the health-care system. One of the gaps in the research that remains to be covered is the lack of robust evidence indicating which comorbidities generate the most impact in terms of shorter life expectancy, loss of quality of life, and higher economic cost.

As to health care costs, it will be important in the coming years to study and produce evidence on the development of the annual cost of treatment per patient and possible changes in the distribution of health care costs (medication, hospitalization, consultations, tests, etc.) owing to this paradigm shift in the HIV-positive population. This information should be combined with the existing data to arrive at a better understanding in the health-care field of changes in economic impact due to comorbidities not necessarily directly related to HIV.

As to the labor force participation of HIV-positive people, although the occupational status of this group has improved over time, the probability of an HIV-positive person being in work is lower than for someone who does not carry the virus. The research so far indicates that a key time in the occupational status of HIV-positive people is the months or even weeks following diagnosis. The adaptation of HIV-positive people's expectations to a negative shock on health may increase the probability of their leaving the labor market. The literature shows that the person's state of health (measured in terms of immunological status, self-perceived health, and mental health) and other behavioral patterns (most probable cause of contagion and drug use) and variables common to the general population (age, sex, educational attainment, and work experience) are the main determinants of labor force participation and of the probability of being employed. Hence a middle-aged male with a high level of educational attainment who is employed at the time of diagnosis and infected through sexual transmission, and is in a good state of

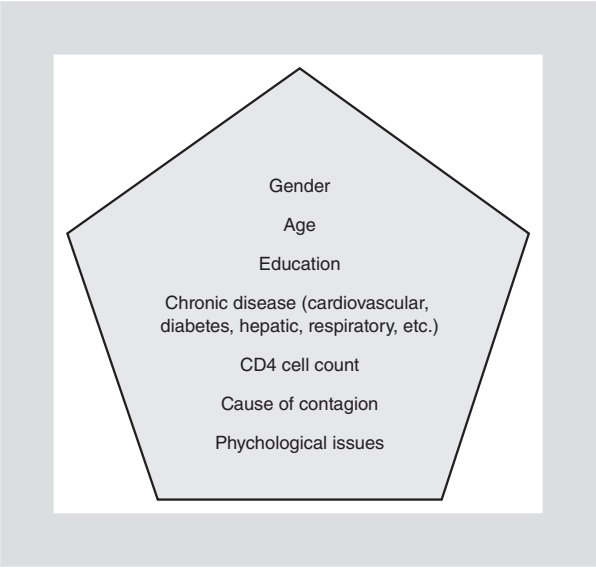


**Figure 1**. *Most influential variables on future HIV economic impact.*

health is highly likely to remain employed. On the other hand, the scant research on the topic suggests that age is a variable that is negatively associated with the probability of being employed as from 40 to 45 years onward. More research is required to analyze the labor force participation of HIV-positive people at stages close to the legal retirement age.

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## *Supplementary data*

Supplementary data are available at AIDS Reviews journal online (http://www.aidsreviews.com). These data are provided by the author and published online to benefit the reader.

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