A Computer Based System for Evaluating the Risk of Contracting Human Immunodeficiency Virus (HIV)

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ABSTRACT

Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS) remain global pandemics. The 2020 statistics released in 2021 showed that about 37.6 million people globally are living with HIV; 1.5 million people became newly infected in 2020 and 690,000 people died from AIDS related cases the same year. A literature search revealed that more than 1.6 million Nigerians have died of HIV/AIDS since the outbreak of the epidemic in 1985 while millions of Nigerians are living with HIV as of today. Certain factors have contributed to this alarming statistic. One of such is the unwillingness by most persons to undertake an HIV test due to the fear of stigmatization. A simple system that can be of help in evaluating a person's risk of contracting HIV without stigmatization is developed in this work. The system takes into account some behavioural factors, signs and symptoms that suggest a person may be at risk of having or be prone to HIV and thus makes a prediction of the risk status based on the input supplied. A simple framework was developed with input from medical practitioners based on their wealth of experience. The input was used to derive twenty two (22) questions centered on behavioural factors, signs and symptoms which were designed to be answered by the users during interaction with the system. A simple evaluation takes place using the user's inputs and a predefined set of rules to classify the risk value as one of (Very High, High, Moderate, Low and Not at Risk) with appropriate advice. The system was implemented in Visual Studio Environment using Visual Basic.Net. It is expected that after using the system, users will be encouraged to go for tests where it is recommended. However, it to be noted that this system does not confirm HIV status as only a blood test can do that.

Key words : Inference Engine, Prediction, Behavioural Factors, Symptoms, Signs, HIV.

1. INTRODUCTION

Human Immunodeficiency Virus (HIV) and AIDS remain global pandemics. By the end of the first decade in the 21st century, approximately 33.3 million people were living with HIV compared to about 26.2 million in 1999, reflecting about 27 per cent increase. High risk factors like unprotected sex, intravenous drug injection, presence of sexually transmitted infections (STIs), multiple sexual partners and substance abuse, early sexual initiation, lack of awareness in relation to HIV and AIDS, heterosexual transmission, poverty, school dropout were among the cited factors that fuel the transmission of HIV [6].

The first two AIDS cases in Nigeria was diagnosed in 1985 and reported in 1986 in Lagos one of which was a young female sex worker aged 13 years from one of the West African countries [19]. The news of this first AIDS case sent panic, doubt and disbelief to the whole nation as AIDS was perceived as the disease of American homosexuals. Some people saw the story about AIDS as a ploy by the Americans to discourage sex and many acronyms, one of which was American Idea for Discouraging Sex emerged at the time. This earlier perceptions, skepticisms and reactions of the Nigerian public towards the 'foreign' AIDS case and HIV/AIDS in general has been well documented in the introductory part of a doctoral thesis on 'Modelling HIV/AIDS Epidemic in Nigeria' that can be found online [6].

The highest numbers of HIV prevalence were found mostly in Benue, FCT, Anambra, Bayelsa and Akwa Ibom States of the federation. These marked differences in the prevalence rates among these states could be due to a number of factors including but not limited to cultural differences, varying levels of education, religion and differing socioeconomic structures. Indeed, there must be interplay of these factors on HIV/AIDS outcomes in these states [6]. The increased in demand for high-quality medical services coupled with the explosive growth of medical knowledge led to the suggestion that computer programs should be used in assisting physicians and other healthcare providers in discharging their clinical roles such as diagnosis, therapy and treatment[12].

2. REVIEW OF RELATED RESEARCH

In the research by Marya Gwadz et al in [2], it was noted that stigmatization was a primary barrier to initial and continuous HIV testing even among individuals living in high risk areas. They further argued that HIV-related stigma is a major deterrent to a range of HIV-related protective behaviours including disclosure of HIV status, linkage to HIV care, uptake of HIV antiretroviral therapy, and medication adherence, particularly among vulnerable populations that are at the greatest risk for HIV infection. The research also noted that in the context of an under-resourced community, HIV stigma was experienced as emerging from, and being perpetuated by, health care organizations and educational institutions, as well as community members. Participants noted it was "better not to know" one's HIV status, to avoid experiencing HIV-related stigma, which could interact with other stigmatized social identities and threaten vital social relationships, life chances, and resources; and this is very dangerous as it will lead to more people being infected.

In [13], Oguntimilehin *et al* noted that the internet and information communication technology (ICT) infrastructures are transforming the future of health management. This statement was also earlier stated by Agbonifo *et al* in [3] where they noted that the use of telecommunication technologies to deliver healthcare service has been dated back to the birth of television and telephone in 19th century. [13] however further noted that the cost of healthcare delivery systems, products and services continue to rise unabated, especially in Nigeria - a developing nation that needs technology driven by Information and Communication Technology (ICT) as an agent of a revolution, which has changed all aspects of society, the way we talk, learn, communicate, buy and sell.

United Nations and World Health Organization made a case in [18] that artificial Intelligence (AI) holds enormous potential for improving the health of millions around the world if ethics and human rights are at the heart of its design, deployment, and use. Further to this, telemedicine and e-health systems have been proposed as a support tool, to monitor and evaluate HIV/AIDS management strategies. In their research in [15], they noted that one of the challenges of access to treatment through anti-retroviral medication is the difficulty of receiving accurate and up-to-date information at the planning level. Information and Communication Technology (ICT) has been used in a number of pilot studies to address this bottleneck by providing an infrastructure for telemedicine and e-health applications; and this was further supported by Maitrayee in [9]. In his research, he noted that technology provides the opportunity and the spur for rethinking a great number of traditional paradigms. Different health resources can be searched through one common index using a single tool. Networking of computers today plays an important role in communication and dissemination of information.

3. METHODOLOGY
3.1 Description of the Simple Predictive Model

Consultations were made with medical experts; certain factors that can increase the risk of contracting HIV were keenly studied. Also, possible signs and symptoms together with behavioural factors were put into consideration. These were used as input to design the model for predicting the risk of contracting HIV. These risk factors were used to model a simple risk rate predictive system using the signs, symptoms and behavioural factors. Twenty two (22) questions as shown in Table 1 were generated from the combination of the signs, symptoms and behavioural factors as suggested by medical experts. A predetermined set of simple rules was generated to serve as the inference engine of the system based on a simple calculation from the input values.

Table 1: Signs, Symptoms and Behavioural Factors

S/N	Questions
1	Have you been experiencing weight loss for more than a month?
2	Have you been experiencing fever that is not abating for more than a month?
3	Have you been passing watery stool for more than a month?
4	Have you experienced cough in resent time for more than a month?
5	Have you had itchy body rashes for more than two months?
6	Have you had whitish discharges either in your mouth or vagina?
7	Have you observed painful body swellings?
8	Have you experienced boil around the anal region that is not responsive to antibiotic?
9	Have you ever had unprotected sexual intercourse?
10	Do you use lubricants with condoms during sexual intercourse?
11	Do you have more than one sexual partner?
12	Are you sexually attracted to the same gender?
13	Are you the incentive partner during sexual intercourses?
14	Do you engage in oral sex?
15	Do you engage in anal sex?
16	Do you engage in vaginal sex?
17	Have you ever engaged in sex in order to get money?
18	Have you ever been transfused with blood that is not safe or from an unknown source?
19	Have you ever been surgically operated on before using instrument that was not sterilized?
20	Have you ever been injected with unsterilized needles?
21	Have you ever had the course to share needles or sharp objects with people?
22	Have you ever had any of these infections e.g Gonorrhea, Syphilis, Chlamydia Scephis?

3.2 Experimental Set Up and Result

The questions are set up for binary answers, hence a user responses can only either be a YES or a No to each question. The numbers of YES and NO is used to perform the prediction using the simple formula given in Equation1 and the classification range is given in Table 2:

$$\text{Detection Value} = \frac{N_Y}{22} * \frac{100}{1} \% \qquad (1)$$

Where N_Y = Number of Yes

Table 2: Classification Range

Range	Classification
80-100%	Very High
60-79.99%	High
30-59.99%	Moderate
1-29.99%	Low
0%	Not at Risk

Implementation and Discussion of Result

This research fully takes into consideration the fact that only a blood test at approved designated health care facilities can truly confirm the HIV status of an individual. However, if the subject desires to undertake an evaluation test to know his or her stands, this research work is a good fit for that. The system was implemented in Visual Studio Environment using Visual Basic.Net. Users are expected to lunch the software after a successful installation of the Software set up. The software has five major Graphical User Interfaces (GUIs). They are Front Page or Opening Page, Personal Information pages, Risk Evaluation pages, Result page and a Print Page.

The user provides their information in the Personal Information Page. After the information is successfully provided, the user precedes to the Risk evaluation pages. This is where the twenty two (22) questions are made available to the user. Since the questions require Yes/No answers, the user only has to select either a YES or a NO to respond to each question. After this interaction, a submission is made to the system and the system uses the evaluation formula to access the risk level of the user. The screenshot of the Front Page is shown in Figure 1, Personal Information Page is shown in Figure 2, Risk Evaluation pages are shown in Figures 3 and 4 while HIV Risk Prediction/Result page is shown in Figure 5. Figure 6 is a page which avails the user the opportunity to print the result of the evaluation.
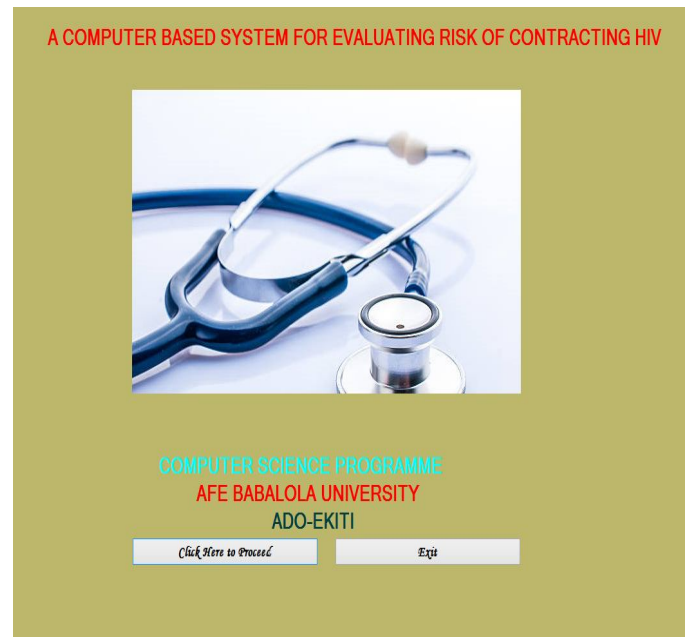

Figure 1: Screenshot of the Front Page.

Figure 2: Screenshot of mini Personal Information Page

27

Figure 3 : Screenshot of HIV Risk Evaluation Page 1

Figure 4: Screenshot of HIV Risk Evaluation Page 2

Figure 5: Screenshot of HIV Risk Prediction/Result Page

Figure 6: Screenshot showing user's opportunity to print the result

4. CONCLUSION

This research highlighted the fact that stigmatization is a primary barrier to initial and continuous HIV testing even among individuals living in high risk areas. This has engendered potentially dangerous habits like unwillingness to undertake HIV tests, non-disclosure of HIV status. These have in turn affected linkage to HIV care, uptake of HIV antiretroviral therapy, and medication adherence, particularly among vulnerable populations that are at the greatest risk for HIV infection; and more so contributed to the spread of the disease. We strongly argue that stigmatization will not be an issue for individuals who undertake their initial HIV evaluation with the use of this application. More so, the system has been designed to give appropriate advice depending on what output the user gets. The system also strongly advocates an actual blood test for HIV as it is the only way the HIV status of anyone can be confirmed.

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