BIOMEDICAL KNOWLEDGE BASE SYSTEM FOR THE PUBLIC HEALTH SECTOR IN KENYA

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Abstract
There has been a growing need in Kenya health sector for an interactive computer-based decision tool that uses both facts and heuristics to solve difficult decisions making problems, based on knowledge acquired from an expert. Recent studies have established that expert system in public health sector does not necessarily disseminate indigenous biomedical knowledge but rather a customized expert system could. Hence, a biomedical expert system is proposed. The front end was designed using Macromedia Dream Weaver 8.0, Macro Media Flash, Html5, Css, Javascript, and jQuery. The Biomedical expert system logic was made using Php, and the Mysql 5.0 was used to develop the back end. Pilot study was then done to test the applicability of the system at Jomo Kenyatta University of Agriculture and technology. Purposive sampling was applied to collect data on public usage of the knowledgebase system where 330 users participated. Classification accuracy of matching and non-matching web searches of greater than 70 % of the target population was achieved. Specificity was satisfactory for all the outcomes.

Key words: Knowledge base, expert system, biomedical knowledge, intelligent system, health sector, domain, heuristics

1.0 Introduction

Knowledge is acquired and represented using various knowledge representation techniques rules, frames, and scripts. Knowledge based systems are artificial intelligent tools working in a narrow domain to provide intelligent decisions with justification. Expert systems (ES) have been used by artificial intelligence (AI) researchers to deduce decision based on codification of knowledge, (Akerkar *et al.,* 2009, Brennan and Strombom (1998), Cimino *et al.,* 2002). In solving the gap in the usage of biomedical resources in Kenya public health sector, there is a need for system that will interpret user query, relate it with database content, and intelligibly compile a report that will guide the user on the optimal decision known. This is a gap that needs to be addressed urgently, because a lot of research did locally have to be published in journals and books to disseminate knowledge. In addition experts are the only persons able to apply this knowledge, but for an ordinary person to get advice on a particular domain, an expert have to be hired (Deber *et al.,* 1996, Goldstein *et al.,* 2004). The expert through his knowledge advices the best course of action the client should take based on the queries made to the knowledge base. This has absolute social economic impacts and with the advancement of IT, it is prudent to develop a biomedical expert system that will be able to make intelligent decisions, thereby substituting the desperate need for experts (Ding and Peng, 2004, Barry, 2002, Harmon, 1992a).

A biomedical system that enables the experts to share their research articles and other relevant articles with the public has not been fully exploited **(**Ding and Peng, 2004, Haas *et al.,* 2001, Hubbard *et al., 2002***).** Data management has been structured in public databases. These have been facilitated by new discoveries in medicine and biosciences. Researchers explores data resources from molecular biology and environmental sciences, utilizing techniques from mathematics, computer science and engineering to predict biological and medical outcomes based on experiments. There is also an attempt to integrate and exploit unstructured data i.e. scientific literature, to obtain the results and findings (Hu *et al.,* 1996). The practice of translating knowledge from research into clinical practice is increasing (Goldstein *et al.,* 2004).

Holmes-Rovner *et al.,* 2000 did a study on semantic integration resources and their use in data, knowledge integration, mining, modeling, interpretation and exploitation in biomedical research. The current studies aimed to guide the way biomedical research is conducted. This study indicates that there is a gap in knowledge; the public require peer reviewed essays from researchers and experts in various biomedical domains to exploit in their knowledge development (Molenaar *et al.,* 2000, Markus, 2007). Knowledge translation activity focuses within organizational context, or specific domain areas i.e. mental health delivery, oncology (Man-Song-Hing *et al., 2005*). Yet there has been little study to develop a customized knowledge base system that will translate indigenous biomedical knowledge from researchers' platform and enable users to get undistorted essays primarily vetted by experts in their respective domain. This paper gives the insight of biomedical knowledgebase development and testing, in order to objectively examine exploitation associated with implementing existing knowledge to increase its application and organizational effectiveness.

2.0 Materials and Methods

2.1 Biomedical Expert System Algorithm

The algorithm allows the interaction of biomedical knowledge base Msql database is via php intelligent scripts. The users, experts, and administrator must register with the system for them to login. (Figure 2).

2.1.1 Algorithm for expert registration

Experts' registers by filling in (Hypertext markup language) HTML form, the names, highest qualification, area of specialty, resume etc. The Php script then notifies them that their application is pending approval.

2.1.2 Algorithm for Expert Article Submission

Experts prepare articles and submit to the knowledgebase database. The form for submitting has various sections i.e. Title, body of article, and Key words. The Php submission script will print out put that article submitted successfully, and is awaiting approval from other experts registered in that domain.

2.1.3 Algorithm for Expert Voting Articles from other Experts

This is the process of evaluation of the articles submitted by other experts registered in the same domain. The expert is expected to read and assess by critiquing the works, then click on accept or reject button. This directs the logic script to make article available for users querying the database. When the number of those accepting the article exceeds those rejecting it, this will qualify the article to be found when being searched i.e. more than 50% of the votes.

2.1.4 Algorithm for Administrators

The administrators at their interface receive the request to join the biomedical knowledgebase. They validate the details as given in the application by contacting the referees and the institutions where the experts have undertaken training and experience. The expert's validation is also done by the administrator algorithm; it also assigns privileges to all the users of the biomedical expert system.

2.1.5 Algorithm for users to Search Articles

The user queries the knowledge database using the search box at the user interface; where they input keywords and or the topics in question. The output is displayed on a descending list of matching articles and user reads on the content from the biomedical expert system.

2.1.6 Algorithm for Logic Knowledge Representation

Algorithm for logic knowledge representation allows representation of the necessary knowledge by way of making statements such as describing things in the biomedical sciences world. Using the Php syntax it has been possible to develop configurations that constitute each sentence. This entailment is used to determine if the state of affairs is true or false. This will guide user query to match particular articles of interest.

2.1.7 Algorithm for Script Knowledge Representation

This is php syntax that enables biomedical knowledge inference from biomedical knowledge base. This is achieved by integrating the different types of knowledge submitted by this syntax; the user can therefore navigate diverse articles. Retrieved knowledge is required to solve a challenge in a particular domain. Declarative and procedural techniques make the biomedical knowledgebase user-friendly and interactive.

2.1.8 Database Rules

R1 – If an article is rejected it will have a value of zero as indicator.
R2 – If an article is accepted it will have value of one as status indicator.
R3 – When R2 exceeds R1, then the articles with status one will be searchable by users.
R4 – The expert who authors an article shares all privileges with the administrator who may then grant privileges to qualified authors suggested by users.

3.0 Results

This is the php script which links all the processing. The experts registers then the administrators will validate their request, to join the list of the contributors of the biomedical knowledgebase (Fig 1). After the compiling of the paper and submission, the article is assessed by those experts registered in that domain and a vote of yes is an approval where the expert will physically click on approval button. The article may also be critiqued to an extent that the expert will reject it and reasons are given for taking the action. The articles that get more than 50 % of the total votes will be available at the knowledge base for querying by the users.
Administrators- who add experts to the system
Subscribed users- who have subscribed to use the services of the expert system
Experts – who add their expert knowledge to the system.

3.1 The Subscribed User's Section

The user selects a disease from the list and its expert findings are displayed: its diagnosis, prescription, description, etc. The subscribed user's section has four domains: Nutrition, Disease, Drugs, and Herbs. Here the user makes an entry of every time a meal is taken during the day. At the end of the day he can click *View Todays Diets Report* to view if he has fed within the required healthy specification. Here a user selects a drug and enters the number of days taken the drug. Its side effects are displayed according to the duration of intake (Figure 5).

3.2 The Experts Section Interface

There are four types of experts:
-Nutrition experts
-Disease experts
-Drugs experts
- Herbs expert

3.3 Nutrition Experts Login

This is an interface for submitting nutrition information mostly diet. The experts adds particulars of a type and amount of food, the information on BMI and calorific values that qualifies food intakes, disadvantages of particular junk food and the references where the information was read(Figure 3).
They can:
-Add a new food and its repercussions or advantages depending on how it is taken
-Vote for other works submitted by colleagues
-View the number of their works that have been rejected or accepted

3.4 Access of Articles by the Users

This submission will be available for users to retrieve if it is voted by more than 50% of experts registered in that domain of nutrition. When an article is voted out or it voted with less than 50%, the experts must indicate comments on the article explaining why they did not consider it for retrieval by the users of the biomedical expert system (Figure 8).

This is the interface that enables the experts to submit disease data to the Biomedical knowledge base system. The submitted essay must be vetted by other experts that have registered in that particular domain. Articles that have been voted by 50% of the registered experts will be made available by intelligence scripts for users to retrieve as shown on Figure 7.

This is the expert interface to submit data on drug abuse. The expert specify the symptoms and side effects associated with the number of days that the drug is taken and also the references where the expert obtained the information as indicated on Figure 10. The submitted work must be voted by 50% of the registered experts in that domain for it to be made available for users to retrieve it.

3.5 Questionnaire Results

These results indicated that the people were optimistic to the application of the biomedical health expert system as shown by the positive values in Table 1. Figure 11 shows the respondents who were scored to have endorsed for application positive impacts upon the evaluation of the biomedical expert system.

3.6 Database Scores Analysis

The results of table 2 indicate that with the submission of 5 items in each Database, the searches that matched the data were significant. The non-matching however indicated that more data needs to be added to the Biomedical expert system. There were high hits of non-matching searches for the second month; this indicated that there is a gap in indigenous knowledge in the current databases. This helps to know whether these domains that have been neglected; this system filled this gap by offering a platform.

3.7 Hypothesis Testing Using Macchi-Square Software

The results of chi-square test of 22.05 and 34.28 for the first month and second month is higher than the expected chi-square value of 3.84 (Figure 12 and 13).

4.0 Discussion

Our study focused on knowledge base retrieval in nutrition, diseases, drugs, and herbs medicine domains which represent major contentious issues in tropical countries especially due to the changing of life styles and development. Common infections and parasitic diseases such as Malaria, HIV/AIDS, emerging non- communicable diseases relating to diet and lifestyle have been increasing over the last two decades (Protheroe *et al.,* 2000, O'conner *et al.,* 1999, Nease *et al.,* 1997). The study concept emphasizes the use of a biomedical expert system which will have a role in preventing environment risk factors for nutrition, drug abuse and diseases; this is through the sharing of knowledge in its cross platform. The creation of domain simulation and problem- solving methods is the fundamental end product of basic research in medical informatics (Musen *et al.,* 1996, Praveen *et al.,* 2005, Rulan and Bakken(2002), Scott and Lenert,(1998), Sims *et al.,* 2005). The developed biomedical expert system very well fits the Africa Sub-Saharan and Kenya setup where there is a lot of indigenous knowledge on nutrition, diseases and drugs. This could serve as remedy to the challenges faced in the health sector informatics (Zhang *et al.,* 2000, Praveen *et al.,* 2005, Goldstein *et al.,* 2004). More work needs to be done in order to integrate this system with portable devices such as mobile phones, ipads, and cloud technology. Knowledge base systems are the commonest type of artificial intelligence in medicine. They can be applied in various medicine domains including prediction, design, monitoring, instruction, control, generation of alerts and reminders, diagnostic assistance, therapy critiquing and planning, information retrieval, image recognition, and interpretation (Ding and Peng, 2004, Haas *et al.,* 2001).

5.0 Conclusion

The absolute positive impacts of the biomedical expert system indicated contribution in creating a platform where investigators can validate scientific articles before the users can retrieve them. This is an improvement from previously similar studies with average performance. The knowledge base increased dissemination of knowledge on domains of drugs, nutrition, herbs and disease. In this work we present customized expert systems that enable the experts to share their research articles and other relevant articles with the public. This ensured a wider audience from the society benefit from the articles submitted on the domains of nutrition, diseases and drug which were not there before. The study was successful in its advancement of the knowledge of expert system in appreciating local indigenous information and connecting it to the vast global health knowledge in an attempt to solve the health challenges in Kenya.

The biomedical expert system has shown its potential contribution to the knowledge backbone by providing a platform where investigators can share knowledge on refined articles to domains of nutrition, diseases and drug abuse. Upon the work undertaken in developing the biomedical expert system, it is recommended that the policy makers could ensure that it is adopted in the public health sector. However more work needs to be done especially in the optimization of the biomedical expert system and sensitizing the society on the benefits it has on the health sector. More research needs to be done on application of the expert system on other domains in the health sector. Future work will explore applications of this approach to a range of underlying conditions, laboratory tests, risks and hazards associated within these domains.

APPENDIX

Biomedical expert system user's algorithm

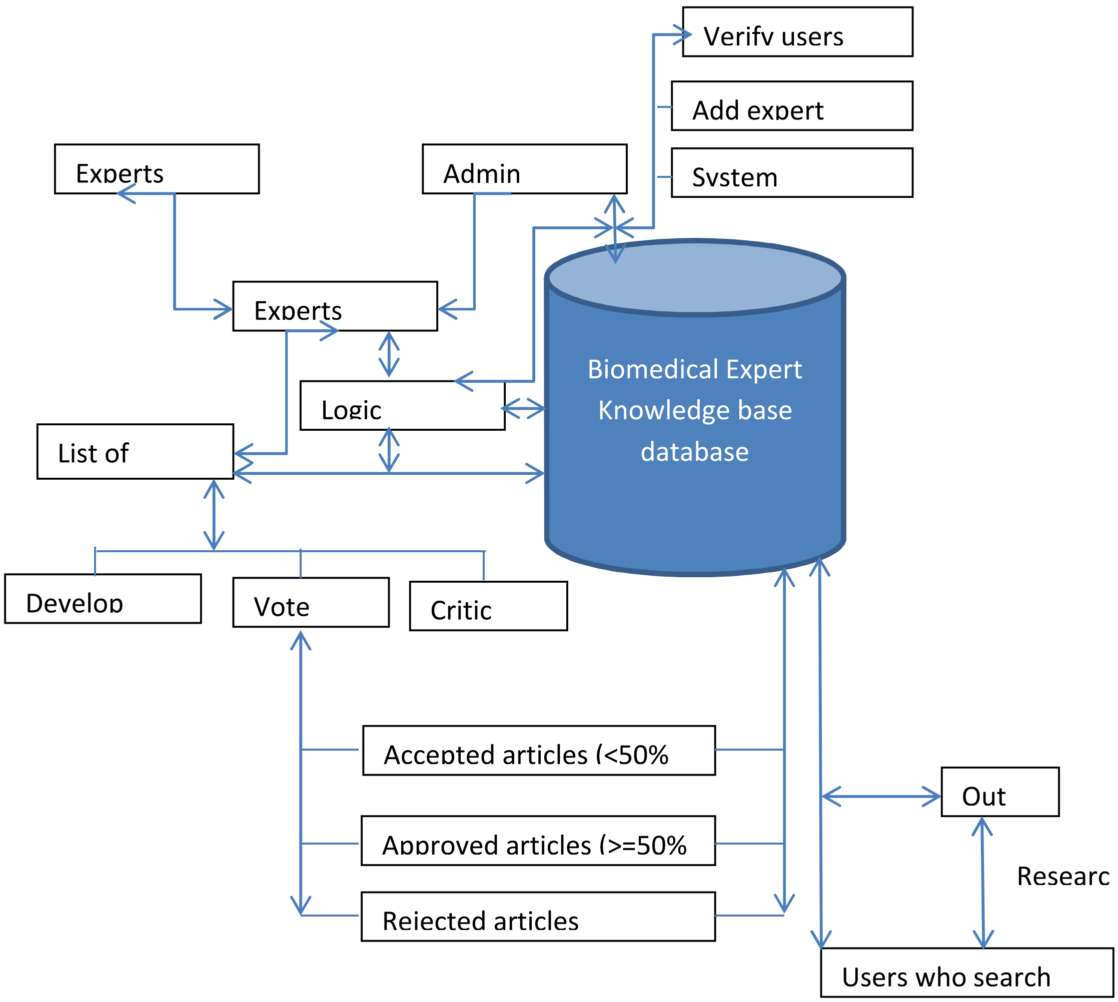

Figure 1: Integration of the expert system components

The above diagram shows how the various sections in the knowledge base are assembled together.

The systems login page

Figure 2: The Log in and register page

The user selects a domain from the list and its findings are displayed.

Nutrition Database interface

Figure 3: The log in nutrition interface

This is the user interface that allows the interaction with the biomedical knowledge base MySQL database via perl/php logic intelligent scripts. Here the user makes an entry of every time takes a meal during the day. At the end of the day a click enables view the day's diets report to view required healthy specification.

Drugs Database interface

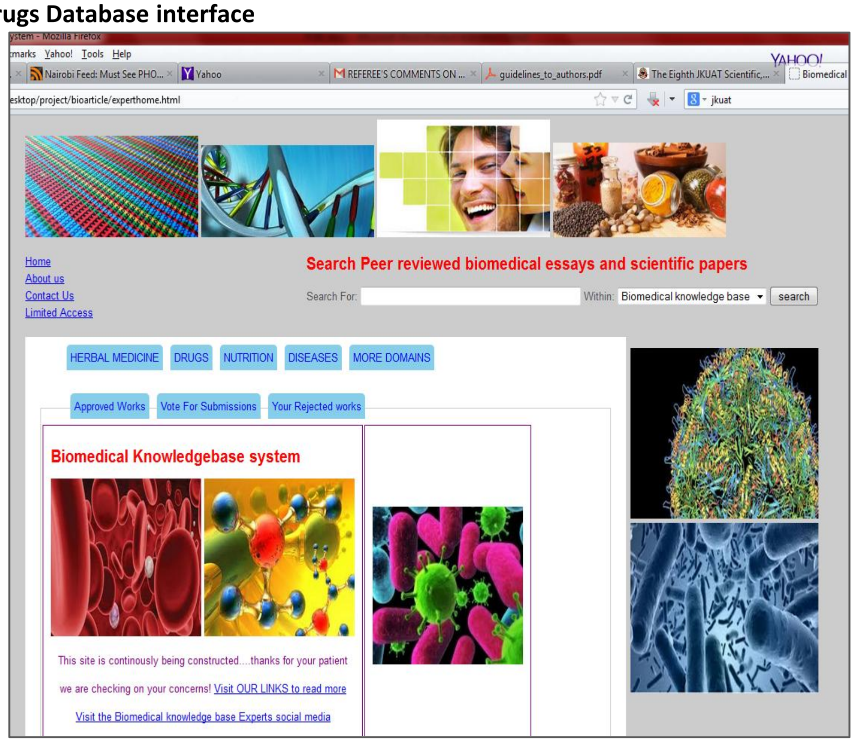

Figure 4: Drug articles submission interface

This is the interface to submit data on drug abuse. The experts specify the symptoms and side effects associated with the number of days that the drug is taken and also the references where the information was obtained.

Food submission interface

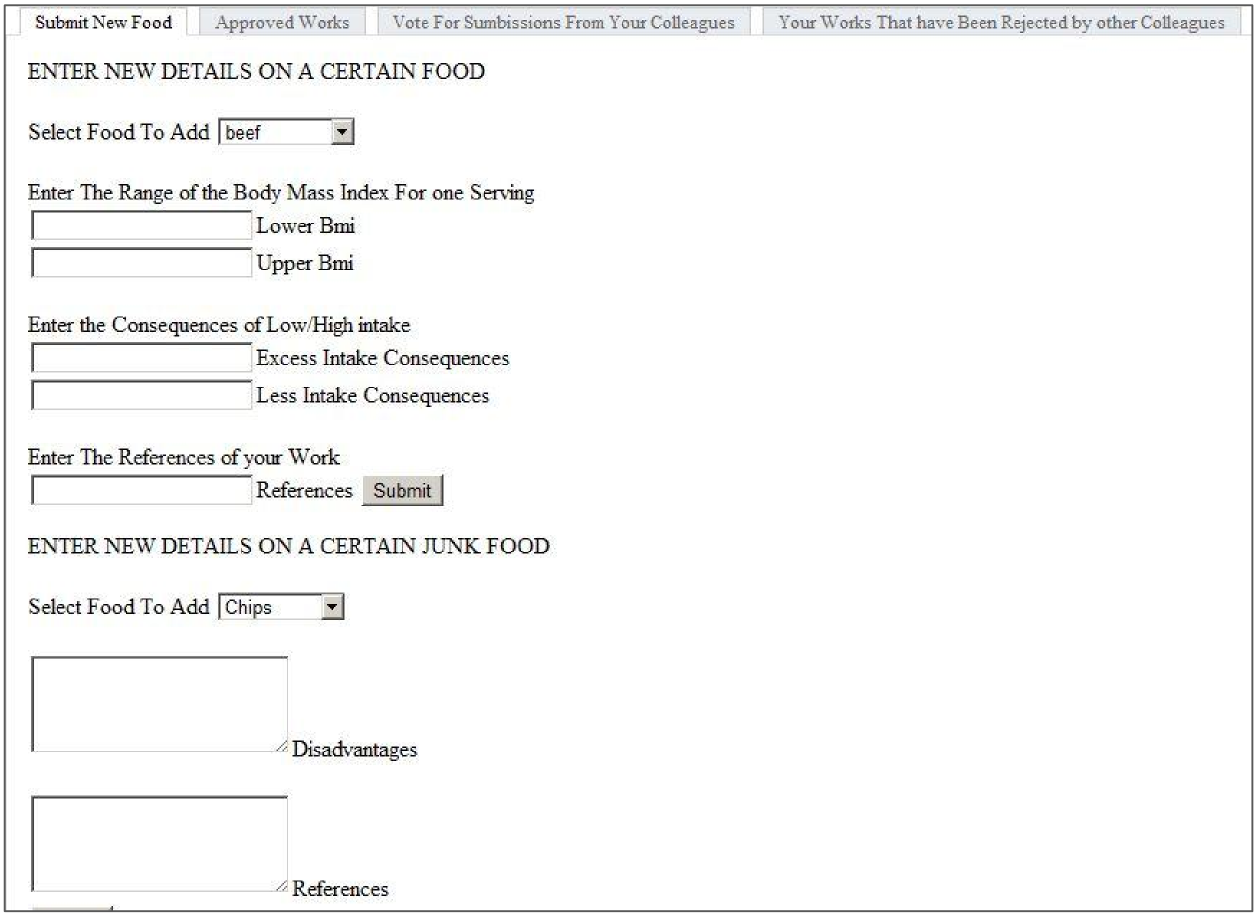

Figure 5: Drug articles submission interface

This is the interface to submit data on food. The experts add particulars of a type and amount of food, the information on BMI and calorific values that qualifies food intakes and also the references where the information was obtained.

Disease submission interface

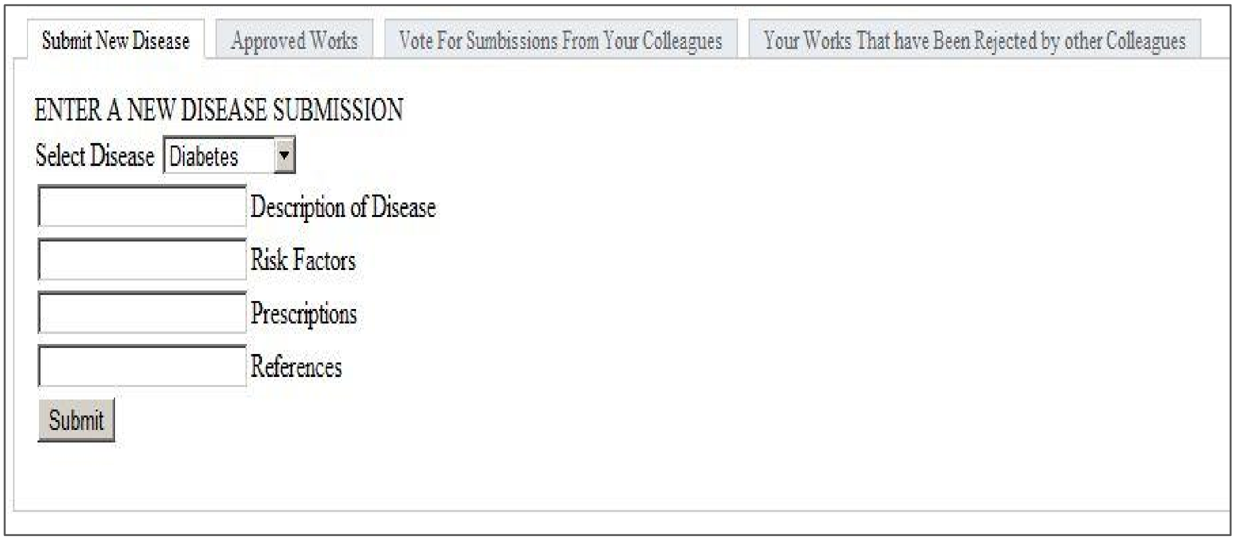

Figure 6. Disease articles submission interface

The experts specify the disease to make a contribution to the biomedical knowledge base. Disease details include risk factors, prescriptions and references.

Herbs database interface

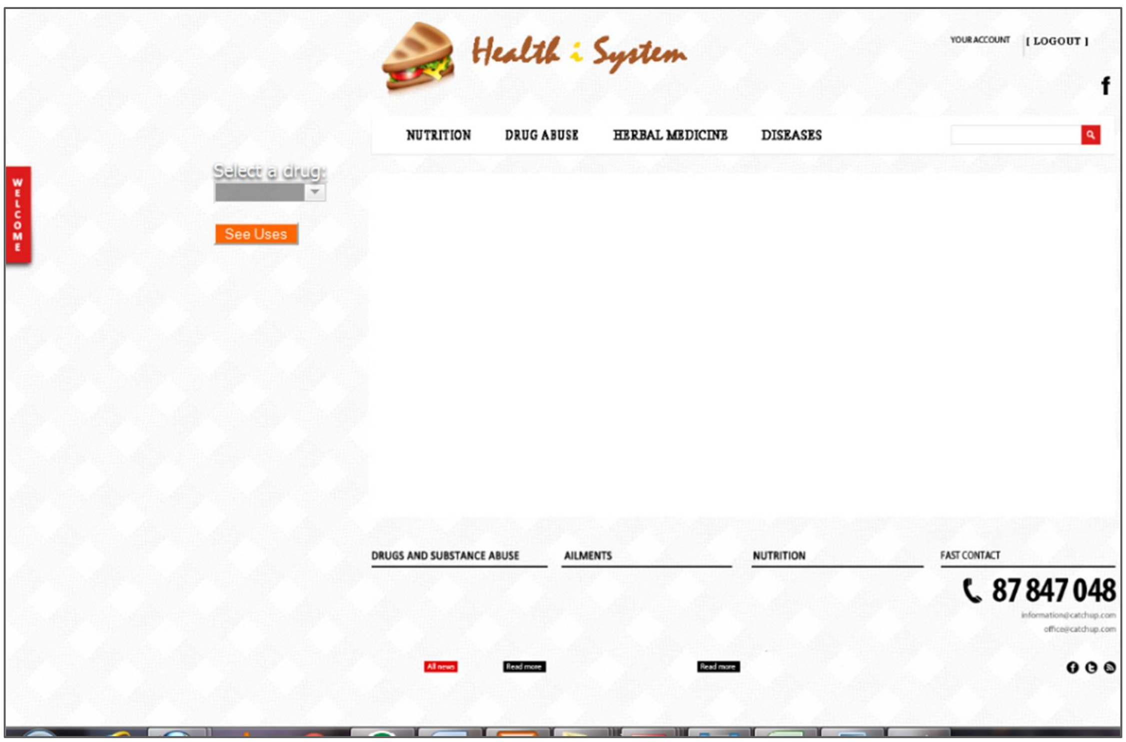

Figure 7: Herbs articles submission interface

This is the expert interface where article on herbs are added to the knowledge base.

Drugs Experts article submission interface

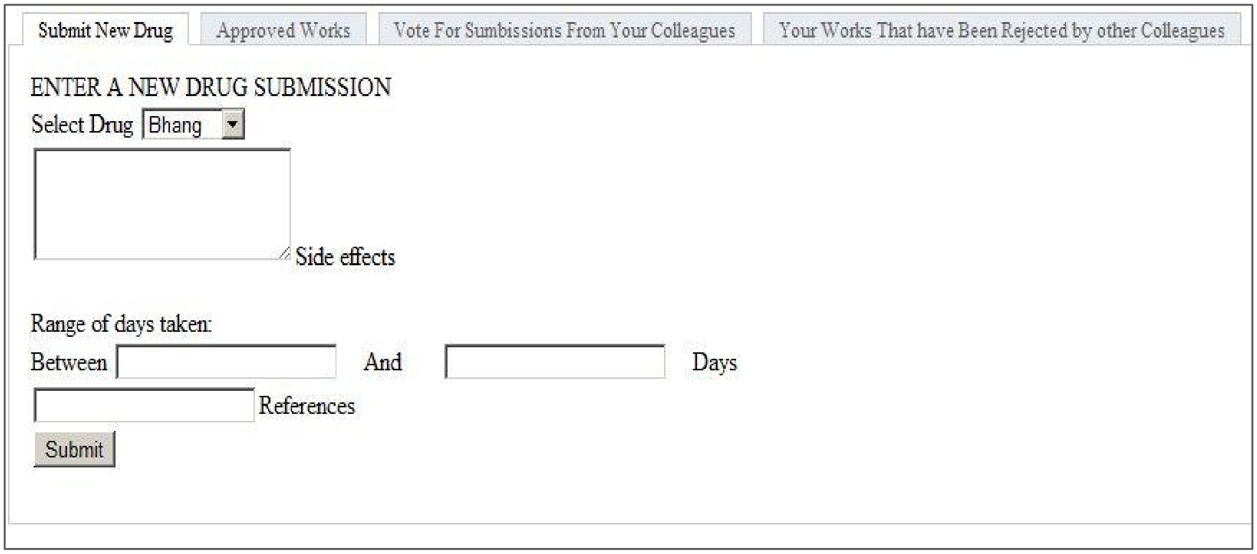

Figure 8: Drugs submission interface

The submitted articles must be voted by more than 50% of the listed experts in that domain for the logic algorithm to allow users searching the database.

Chi-square Test.

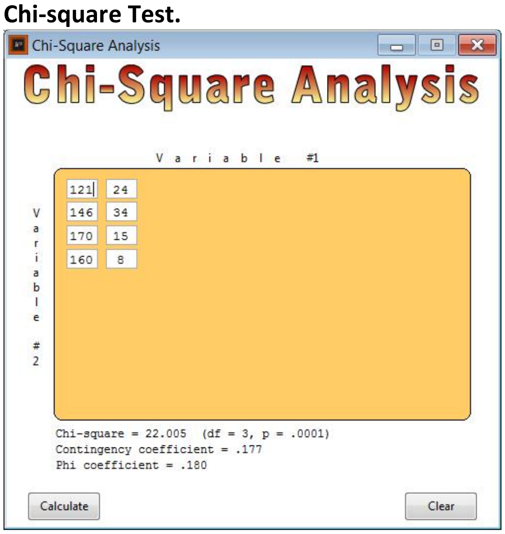

Figure 9: Chi-square for first month = 22.05

The results of chi-square of 22.05 for the first month is higher than the expected chi-square value of 3.84.

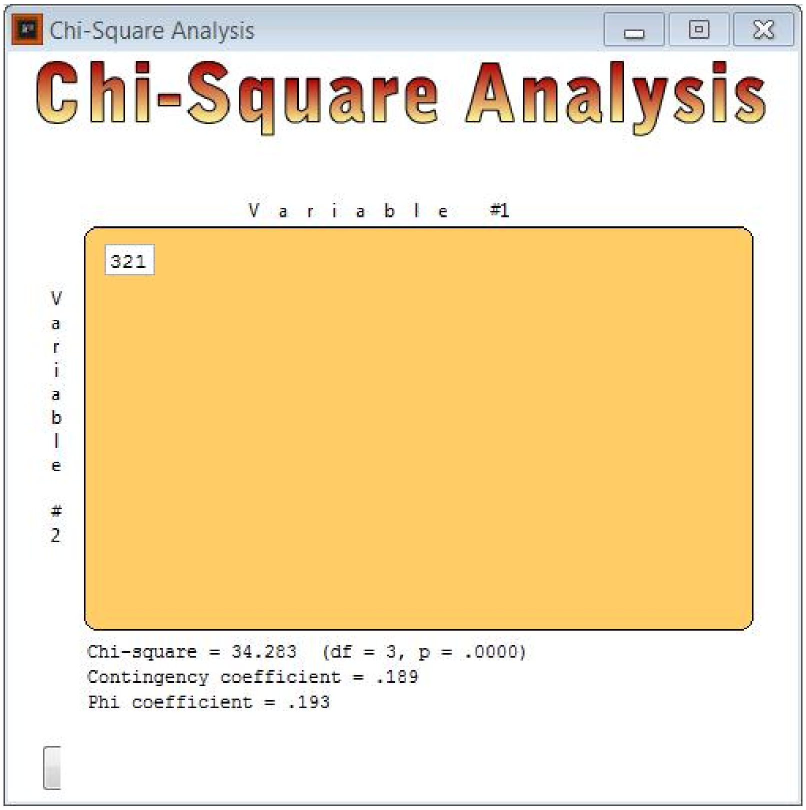

Figure 10. Chi- square for the second month = 34.28

The results of chi-square test of 22.05 for the first month is higher than the expected chi-square value of 3.84.

Questionnaire

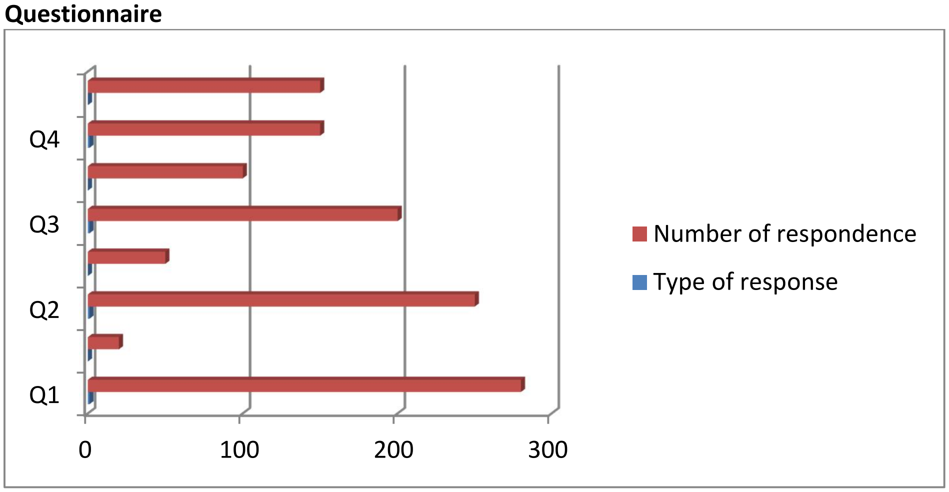

Figure 11. Evaluation of opinions in usage of biomedical expert system

These results indicated the high number respondents thereby creating necessity on the awareness and usage of the biomedical knowledge base system in Kenya.

Search Scores results

Table 1: Database search score analysis

	Scores for the first month		**Scores for the second month**	
Type of Biomedical search Database (Submitted articles had hits counted).	**Non-Matching search**	**Matching search**	**Non-Matching search**	**Matching Search**
Nutrition	121	24	321	33
Disease	146	34	211	18
Drug Abuse	170	15	198	48
Herb	160	8	70	26
Publications	27	1	30	3

The searches that matched the data were significant. The non-matching however indicated that more data needs to be added to the Biomedical expert system.

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