



Modeling the Economic Importance of Health Promotion and Education to Support to Fight Malaria

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Abstract

Malaria is the disease that affects population daily life of Toamasina, the second largest city in Madagascar. The city is in area with a humid climate with high temperatures; a condition favorable for mosquitoes to breed and to transmit the disease. Thus, malaria puts a heavy strain on budgets across all sectors. This study attempts to demonstrate that while acting upon the Knowledge, Attitudes, and Practices (KAP) of the population, which are very weak, an economic gain is within arms reach of the health centers, resulting from a decrease in the number of cases needing treatment. The results show that with a certain level of spending on health promotion activities, there is a large possibility to decrease the number of cases of malaria, because the weak KAP leaves large room for action. A simple mathematical and economic simulation showed that, beyond a threshold level, health promotion and education activities would lead to an economic advantage and savings. However, these actions must be accompanied by diverse measures. These latter points raise more questions of organization and strategy than of financing

Keywords: Malaria; Health spending function; Health education and promotion; Efficacy.

1. Introduction

According to the latest World Malaria Report, released in 2017, there were 216 million cases of malaria in 2016, up from 211 million cases in 2015. The estimated number of malaria deaths stood at 445 000 in 2016, a similar number to the previous year (446 000).

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The WHO African Region continues to carry a disproportionately high share of the global malaria burden. In 2016, the region was home to 90% of malaria cases and 91% of malaria deaths. Some 15 countries – all in sub-Saharan Africa, except India – accounted for 80% of the global malaria burden [1]. Nevertheless, as attention shifts to the Sustainable Development Goals, malaria control is at a pivotal juncture. The past 15 years have seen a 37 % fall in annual global incidence [2].

Malaria and poverty are intimately connected. As both a root cause and a consequence of poverty, malaria is most intractable for the poorest countries and communities in Africa that face a vicious cycle of poverty and ill health. In Africa today, malaria is understood to be both a disease of poverty and a cause of poverty. Malaria has significant measurable direct and indirect costs, and has been shown to be a major constraint to economic development.

Annual economic growth in countries with high malaria transmission has historically been lower than in countries without malaria. Economists believe that malaria is responsible for a ‘growth penalty’ of up to 1.3% per year in some African countries [3].

Madagascar, an island located between the Indian Ocean and the Mozambique Channel in southeastern Africa, is one of countries suffering from malaria because of its geographical position, with high temperatures and long rainy seasons in eastern coastal area which is favorable conditions for the population of mosquitoes, such as anopheles, vector of malaria transmission.

Although four different species of malaria in humans have been observed within the country, *Plasmodium falciparum* remains the most common cause of illness in children under five years of age. Within Madagascar, malaria remains a serious public health issue and a leading cause for seeking-care at health facilities, although incidence initially declined at the beginning of the century [4,5,6,7]. It has been estimated that the malaria burden costs Madagascar over \$52 million annually in terms of treatment costs, lost productivity and prevention expenses [8]. Toamasina is located in eastern coast of Madagascar with malaria perennial transmission.

There is a fact: a high and increasing number of consultations due to malaria at health facility level and overloaded health workers. That reality has unavoidable repercussions on the quality of care on the one hand and on the budget of the center on the other hand.

Malaria control throughout the country is organized through and performed by the National Malaria Control Programme (NMCP). The control program has focused on indoor residual spraying (IRS), distribution of insecticide-treated nets (LLITNs), intermittent preventative treatment for pregnant women (IPTp) and overall improved access to diagnostics and drug treatments supported by education and health promotion with the majority of these interventions available since 2008.

The importance of the medical and economic consequences of malaria conducted us to ask a question: which alternatives would be more interesting, to simply carry out management activities based on the case management by treating cases or to opt for actions targeting to strengthen education and health promotion for behavior change?

The main objective of this study was to demonstrate the cost - effectiveness of actions based on education and health promotion as one of strategies to fight malaria by reducing the number of cases to be treated.

This research was departing from the following hypothesis: by acting on the knowledge, attitudes and practices of the population through the implementation of education and health promotion activities, we can reduce the number of malaria cases, and consequently to improve the quality of care offered by the health center.

2. Materials and methods

The study was conducted at a basic health center level 2 called “Organisation médico-sociale interprofessionnelle (OMSI)”. This health center, created 60 years ago, takes in charge beneficiaries from private companies and factories located in Toamasina City. OMSI functions with the contributions of employees and companies. It represents an important part of the health system in the city.

2.1 OMSI management

OMSI is administered by a Management Board headed by a President. A Chief Medical Officer appointed by the Director General headed the executive body. The members of this Management Board are nominated by the most representative employer organizations and the most representative trade-unions. Two representatives from the Government appointed by the Minister of Labor and Social Laws and the Minister of Health, complete the members of the Management Board. The staff of OMSI is composed of 130 persons: 56 at the technical department, 38 at administrative and financial department and 35 support staff. The health center has 16 medical doctors, 3 dental surgeons, 17 nurses, 21 midwives and 2 caregivers. OMSI receives beneficiaries from Toamasina city and its surroundings till 50 kilometers. A total of 15,936 Affiliated Workers from 1.000 company members and 22,988 Families (Women and Children) frequent the Health Center

2.2 Services

OMSI offers services according to the National Health Policy for both curative and preventive care. The Labor Medicine section ensures the medical visits for workers, receives patients in general consultations, delivers medical expertise for work accidents, and checks workplaces to prevent accidents in work places and professional diseases. With general consultation services, the center offers maternal and child health services, including pre- and post-natal care, immunizations, child and newborn care, information, education, communication and health promotion activities. OMSI reports to the District Office of Toamasina I.

2.3 Center environment

The Health Center is located in Toamasina which is the second largest city of Madagascar. Located directly in front of Indian Ocean Sea in the East Coast of Madagascar, Toamasina has a tropical climate. The rainfall is significant, with precipitation even during the driest month. The average annual temperature is 24.0 °C in Toamasina. In a year, the average rainfall is 3246 mm. The city is crossed by the famous “Pangalane Channel” which flows to the sea in the city center. These geographical context and climate are favorable for malaria

development and influence the population health. The data from the “Direction Regional de la Santé Atsinanana” shows that malaria remains the most frequent disease with acute respiratory infections and diarrhea which are common in this type of climate. The city is divided into 4 main parts: the downtown, the residential area, the industrial area and the slums areas. The majority of the population live in slums areas. The city is suffering from bad sanitation. However, the demographic structure of the population in Toamasina shows that it is composed of various ethnic origins but living harmoniously due to the relatively good economic status which attracts workers. This ethnic diversity creates cultural diversity, which, however similar, is notoriously different. From the practices in daily life, through the habits and customs, the difference is visible. Without going into the details, we can say that these parameters influence, in one way or another on population health. For example, for a very long time, the reluctance of certain groups of the population to use family latrines has greatly affected the environment of many areas and places in the city whether for those along the “Pangalane Chanel”. The point of view taken for this study is that health center. The methodology used for this study was divided into two reciprocal and complementary parts: the methodology of collecting data from the targeted population and the analysis of health promotion and education information.

2.4 Data collection and statistical analysis

The study was conducted from 2015 July to September. The data collection began with documentary review followed by questionnaire administered to mothers at the health center level. Considering a malaria cases prevalence of 0.28 with a margin of error of 5%, the sample size was 300 women according to the following formula:

$$N = \frac{Z^2 p(1-p)}{i^2} = 300$$

Where:

- Z = value from standard normal distribution corresponding to desired confidence level (Z=1.96 for 95% CI)
- P is expected prevalence: 0.28
- i is desired precision :0.05.

Women aged 15 to 45 years present for any reason at the health center during the administration of the survey were included. The following variables were retained for the analysis: family situation, socio-economic status, knowledge of malaria, attitude towards malaria and practices in preventive and curative care.

EPI INFO Version 6.04dfr, CDC Atlanta was to record and analyze the data collected with the questionnaires. For statistical analysis, The Chi-Square test of independence was used to determine if there was a significant relationship between the parameters of knowledge, attitude and practice with regard to malaria with at the 5% significance. The Chi-Square test was used if the conditions of use were fulfilled if not the Test exact of Fisher was applied. The cost assessment concerned the maternal and child care service, the responsible of health education and communication for behavioral change. This cost estimate was conducted with the Manager,

Administrative and Financial Assistant of the OMSI. The cost estimate followed the weighted average cost method. Prices for consumables (drugs, supplies, etc.) are valued at the OMSI store price.

2.5 Economic approach to study the cost effectiveness of health promotion

The logic of this approach is based on the definition and characteristics of health promotion as any “planned combination of educational, political, environmental, regulatory, or organizational mechanisms that support actions and conditions of living conducive to the health of individuals, groups, and communities”. Having experienced long evolution in time and space, the consideration of promotion and education reached its peak in 1986, with the adoption of the Ottawa Charter. From there, the importance of health education rests on three fundamental bases:

- Health education is a medical imperative in the sense that prevention is better than cure.
- The logic of history has taught us that, all other things being equal, it is cheaper to prevent than cure. And in this sense, health education becomes an economic necessity.
- In the sense that health is both an individual and a collective good, preventing one's own health is like treating others. Also, health promotion in this sense is a civic obligation.

The methodology demonstrated its economic importance by taking into account these fundamental bases of which the medical imperative at lower cost relating to a collective interest. It was therefore an economic evaluation: the cost-effectiveness approach with a modeling trail of comparative costs on economic gains between the current promotional actions and the more intensive and continuous promotional actions and health education to fight malaria.

In consideration of the effects of communication for promoting the methods of prevention by using for instance, mosquito nets (reduction of cases from 20%: in Gambia 45 to 63%, Kenya: between 30 and 40%, Guinea-Bissau: 29 Sierra Leone: 49%, Tanzania 55% and Madagascar: 20%), then economic gains are expected to be beneficial for the promotion and health education to fight malaria in terms of knowledge, attitudes and practices.

The economic approach can be summed up as: comparing in a cost effective way the results between the facts of to keep the current actions with the number of malaria cases that this implies, or to implement health promotion and education actions with potential epidemiological and economic outcomes.

3. Results

3.1 Knowledge of people about malaria

The study showed that 7 out of 10 households have experienced at least one case of malaria since the beginning of the year.

The most affected were children (45%), adults (35%).Regarding the malaria transmission, 32% of interviewed

women replied that malaria is not a communicable disease.

Then, half of those having knowledge that malaria is transmissible, did not know the exact mode of transmission of the disease.

This information suggested that mothers' knowledge about malaria, supposed to be a common disease in Toamasina, was relatively low.

3.2 Attitude and practice of people about malaria

Eighty-eight per cent of households have bednet but the average number per household is very low.

One mosquito net per household with 5 members (average in Madagascar) is not enough to protect the whole family.

For those who did not use mosquito nets, 50% said not to have the habit, 15% think that it's useless and 35% because they do not have enough money.

Contrary, for those who use it, 72% say it is to protect against mosquito bites, 22% say it is to fight against malaria and 6% say it is custom.

The availability of mothers to pay provides relevant information about their behavior with respect to malaria and ways of controlling the disease.

If the sale price of the nets is fixed at 3,000 Ar (sale to users) with an exit price of PSI store at 1,500 Ar, the mothers are available to pay them at an average price of 2,351 Ar.

In other words, the financial questions did not explain at all the weakness of the use of mosquito nets

3.3 Information channels

Eighty percent of households have and listen to the radio and among these 48% listen to educational programs.

One household out of 3 does not have a television set at home, for those who have, only about 55% watch educational programs.

This leads to saying that mass media is not a privileged means for educational messages.

3.4 Independence test

The Chi-Square test of independence was used to determine if there was a significant relationship between the parameters of knowledge, attitude and practice with regard to malaria.

Using the statistical method on chi-square tests, here are the summaries and corresponding interpretations (Table 1).

Table 1: Chi-squared independence test between variables. OMSI, Toamasina 2015

Variables	Chi-squared value	Degrees of freedom	Conclusion
Relationship between Education level and knowledge of transmissibility of malaria	12.592	6	Test not significant. Knowledge of the transmissibility does not depend on the level of education
Relationship between education received on malaria and knowledge about transmission	5.991	2	Test not significant. The educations received have no effect on the knowledge of malaria transmission.
Is the use of mosquito nets related to knowledge of mosquito bite transmission?	3.841	1	There is a relationship between the use of mosquito nets and knowledge of puncture transmissions with $p < 0.05$
Relationships between malaria cases and knowledge about transmission	5.991	2	The test confirmed that those who know the mode of transmission use mosquito nets with $p < (table)$

3.5 Results of cost effectiveness study of the two options

The table 2 shows the summary of the cost analysis of the two options: current actions and health promotion.

Table 2: Results of cost effectiveness study. OMSI. Toamasina 2017. (Cost in Euro)

	Annual cost: A	Averted malaria cases: B	Average cost of malaria C	Cost Efficiency $D = A2-A1/B2-B1$	Averted cost $E = B * C$
Option 1 Current Actions	143.66	-	0.84	-	0
Option 2: Health Promotion Actions	503.56	576	0.84	0.62	486.91

4. Discussion

4.1 Limitations of the study

This study is the first that has assessed the knowledge and practices of women combined with economic dimension using mathematical model. There are some limitations of the findings of this study. For the KAP study, the recall period was limited to the past one year to avoid recall bias over a longer period. This notwithstanding, some amount of recall bias cannot be completely ruled out. During the interviews, the women had to recall many events and questions can be iterative. So, recall bias and misclassification might happen. Knowledge questions may overestimate or underestimate the scope of answers given. For example, if the person responds that the factor that increases the risk of getting malaria is rain, that does not mean that person knows or is not transmitted by mosquitoes. It is difficult to judge the direct relations between knowledge and practice. While it is commonly accepted that knowledge significantly affects the life of an individual or a group of people, it is very difficult to link the direct effects of knowledge to the attitudes and practices of households. Promotional actions have cumulative effects and are continuously spread over a short-term, medium-term and long-term period. Also, considering a period of one year may underestimate or overstate its costs and consequences.

4.2 Relationships between knowledge, attitudes and practices regarding malaria [10]

The results show that the education received had no effect on the knowledge on malaria transmission. This indicates that, as most of the information were received from radio and television, these channels could not deliver a robust basic knowledge. Therefore, to establish a robust knowledge on the disease, these two channels of communication alone to inform and educate the population are not enough: it would be better, to adopt more rigorous and community closed methods.

- For instance, the few educations that women received did not influence behavior and practices influences to remove puddles. This is understandable due to the fact that sanitation is under municipal authorities.
- There is a relationship between knowledge that malaria is transmissible by mosquito bites and the use of the mosquito net. In fact, those who use mosquito nets know at least that mosquitoes are responsible for the transmission of the malaria microbe. As a result, the level of knowledge on malaria and its prevention play a very important role in the behavior and attitude of people. In other words, if we want to increase the use of mosquito nets, this is a promotion is a relevant opportunity.
- It was confirmed that those who know the mode of transmission use mosquito nets and they are those groups of people who have not experienced malaria.

4.3 Economic analysis of the promotion: threshold and conditions of economic efficiency

The health center expenses are a linear increased equation according to the number of disease cases occurred.

We therefore present this as following form:

$$Y = B + A_1 X_1 + A_2 X_2 + A_3 X_3 + \dots + A_n X_n$$

Where:

Y: total expenditure of the center;

B: Fixed expenditure (costs) of the center

An: Cost of a case of the disease n; Xn: Number of cases of disease n consulting.

For simplicity, we present this function on expense as a linear equation as:

$$y = B + A x$$

Thus, for option 1, we have $y_1 = B + A x$

and for option 2, we have $y_2 = (B + \beta) + A (x - \alpha)$

Where:

β = Expenses of health promotion which are assimilated to fixed charges.

α = The number of averted cases, effect of health promotion.

To continue the analysis, we will equate the two functions:

$$y_1 = y_2$$

$$\Leftrightarrow B + A x = (B + \beta) + A (x - \alpha)$$

$$\Leftrightarrow B + A x = B + \beta + A x - A \alpha$$

$$\Leftrightarrow 0 = \beta - A \alpha$$

$$\Leftrightarrow \underline{\beta = A \alpha}$$

This equality means that the expenses generated by the health promotion are the same as the averted expenses by the reduction of cases number. In other words, this point indicates that we spend the saved sum. Three possibilities can be obtained depending on the cases:

- 1st case: $\beta = A \alpha$, the additional cost from the promotion is equal to the averted cost. Economically, the center spends what it saves.
- 2nd case: $\beta > A \alpha$, the additional cost exceeds the averted cost. The gain was negative.
- 3rd case: $\beta < A \alpha$, the averted cost exceeds the cost of the promotion.

Economically, the center gain is positive.

In the perspective to search a gain, it is therefore crucial that the averted expenses are greater than the expenses generated by the action: $\beta < A \alpha$. Nevertheless, the situation depends on the ability to avoid a high number of illness cases to have a certain evidence of effectiveness: importance of good organization and strategy for implementing actions. In the case of OMSI, the number of averted cases was 576, the average cost of malaria management was 2,159 Ariary (0.84 Euro) and the total additional annual amount for health promotion was 503.56 € - 143.66 €, which equals €359.90. In this case, the expression $\beta = A \alpha$ gives $\alpha = \beta / A = 359.90 / 0.8453 = 425$ number of averted cases. This means that from the level at which the center has the capacity to avoid at least 425 cases per year i.e an average of 36 cases per month or 9 cases per week or more than one case per day, corresponding to the point where the costs of averted cases are equivalent to the costs of health promotion, the center starting to save money. This number of cases is equivalent to a decreasing rate equivalent to 6.70% (425/6340). This rate is therefore the minimum threshold that the center must overtake to make Option 2 benefic than the Option 1. Then, in the line of the simplifying assumption we made, when the center exceeds the threshold of 7% of averted cases due to health promotion and education actions, the center will earn and save money that could be allocated to the service improvement and quality. It is noted that this threshold is easily reachable through the adoption of promotion and education actions. But, to reach this threshold, there are conditions that must be followed rigorously. Because with the expression $\beta = A \alpha$, β corresponds to an amount which could not be increased for various considerations and in addition, it is not proven or obvious that the increase in the budget allocated increases the averted cases, A is assumed to be constant because it depends largely on the price of drugs, so the OMSI cannot manipulate it. Thus, to increase the averted cases, the center should improve its own organization and implement strategies for health promotion. This is the only way to increase the number of averted cases. In other words, it will be necessary to look at the efficiency of the program

The figure 1 shows the representation of this analysis. Some thoughts on promotion costs and avoided costs

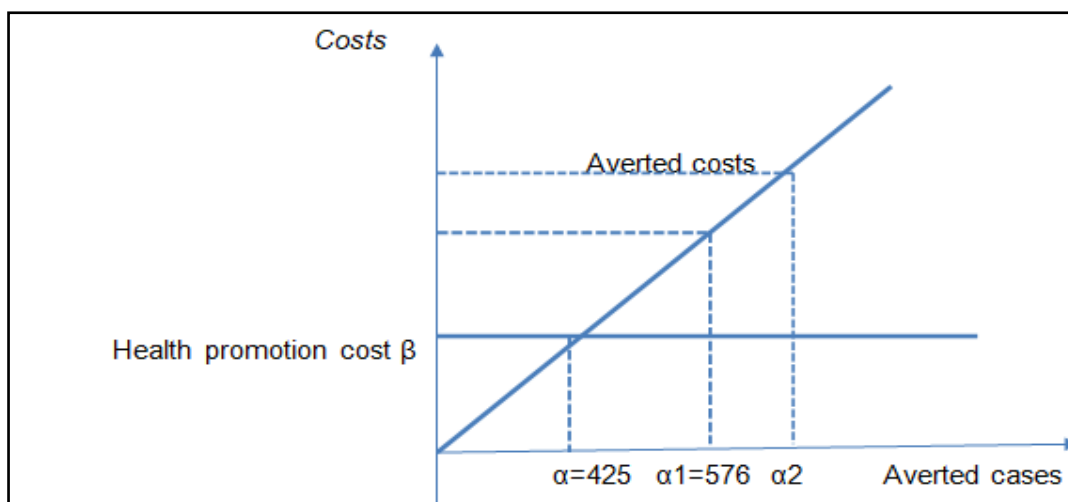


Figure 1: Linear equation of averted cases From the point $(\alpha; \beta)$ whose value is $\alpha = 425$ cases avoided (6.70% decrease) and, $\beta = 143.66$ €, the costs of the promotion are lower than the avoided costs. In other words, the center will release from the economy, but given the fact that it is difficult to increase the expenditures, the increase in averted cases depends on the way and strategy to promote: efficiency.

What happens if there is a rise or fall in the cost of disease? (Figure 2).

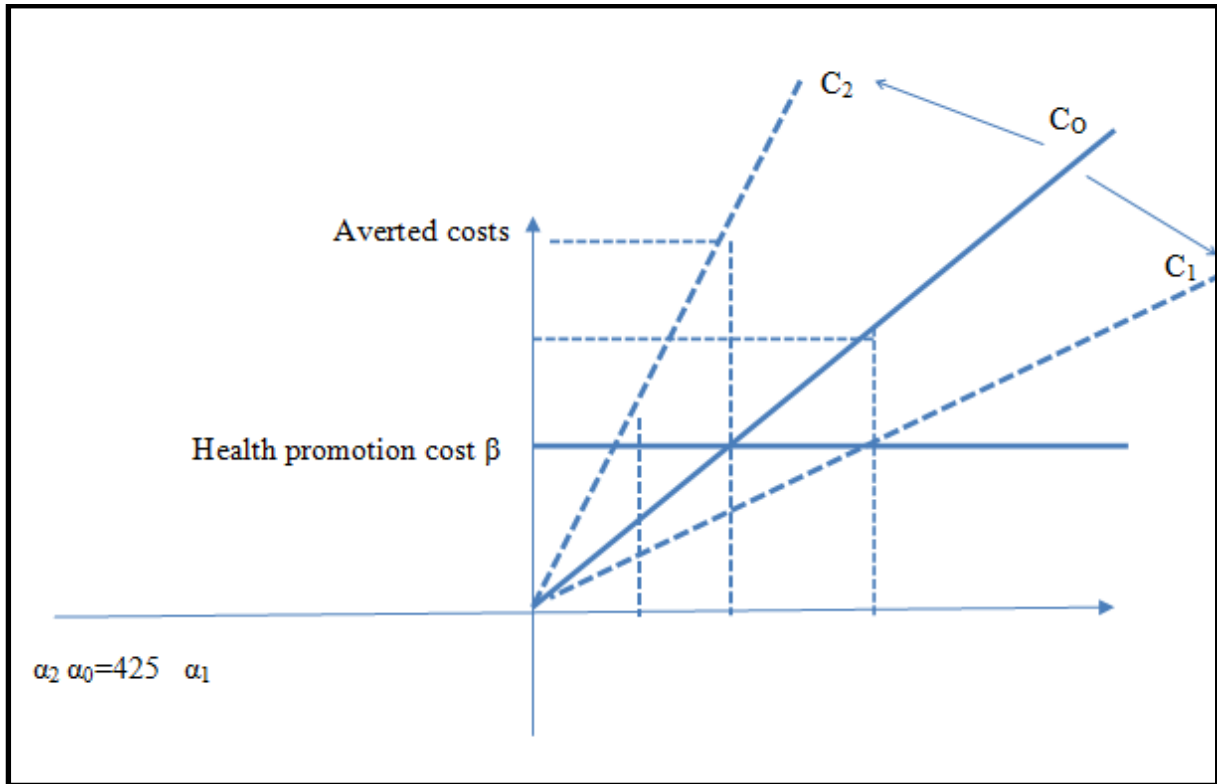


Figure 2: variation of cases management costs

C_0, C_1, C_2 : Cost linear equations of averted costs $\alpha_2 < \alpha_0 < \alpha_1$

β : Cost of the promotion

C_2 represents the averted costs when the unit costs of diseases increase (the slope of the line is greater than that of C_0)

C_1 represents the averted costs when the unit costs of diseases decrease (the slope of the line is less steep compared to C_0 line).

The points α_0, α_1 and α_2 on abscise (number of averted cases) are the crossings with the health promotion costs. These are the points where the costs of the promotion are equal to the averted costs, i.e. the dead point.

In the case of C_1 (lower unit cost of illness), the number of averted cases α_1 which equates β is greater than α_0 , in other words, we will need to avoid a slightly higher number of cases to exceed β , the costs of the promotion.

In the case of C_2 (higher unit cost of illness), the number of averted cases α_2 which equals β is less than α_0 , in other words, a slightly smaller number of cases is sufficient to exceed β .

It can be found that if the costs of diseases increase, it is more advantageous to aim for a reduction of cases through promotion and health education. In other words, when costs increase, a small number of avoided cases

already represents a significant economic advantage because it makes the promotion profitable.

4.4 Need to maximize the effectiveness of the promotion

When the cost of promotion decreases, a lower number of averted cases is enough to make it profitable. When the cost increases, the center needs to avoid much higher cases for the profitability of the action (Figure 3).

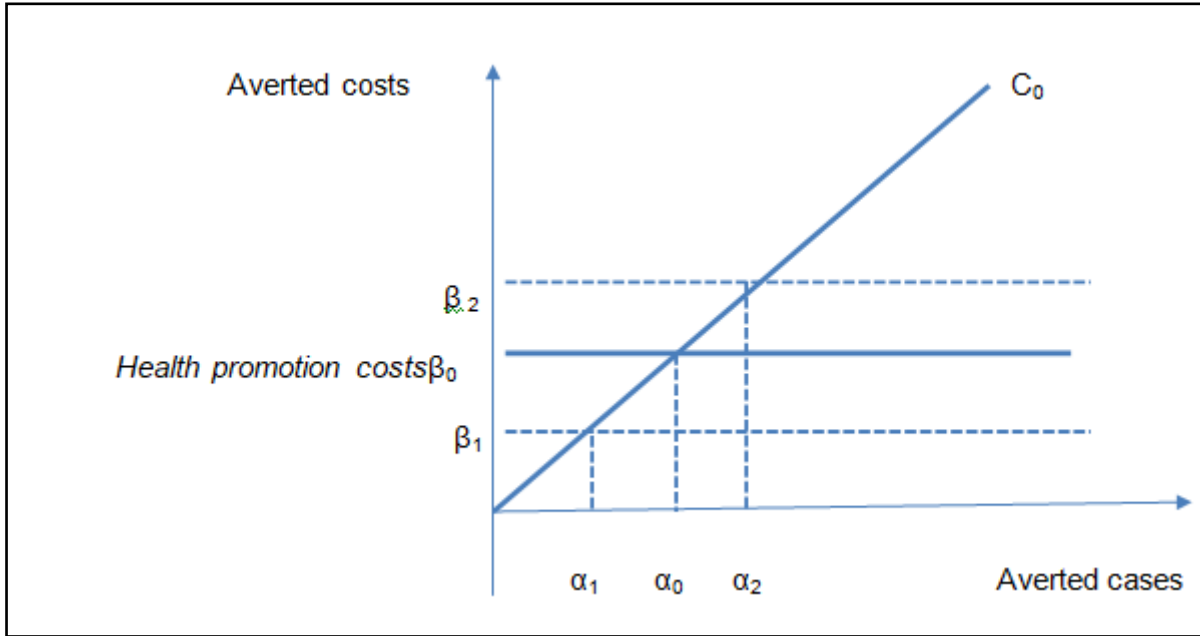


Figure 3: Variation of health promotion costs.

In fact, when the center plans to invest more in the promotional action, it is necessary to aim for a result which responds to the desire for profitability, it is the reason why to focus on efficiency of the expenses dedicated to planned actions. Therefore, that the benefits of promotion can be summed up as a great economic interest, an action that covers the short, medium and long term, and a broad-based action with the participation of all. Education and health promotion should not involve only a small group of people. Each one, group or entity has different abilities to influence population behavioral change. Then, Health promotion should cover the widest range of population groups (according to the available resources).

At the international level, researches have shown a growing willingness of experts to advance in the consideration of health promotion and education, which is reflected in the continued organization of international seminars: INPES in Paris (effectiveness of promotion in 2003), Vancouver Canada (promotion effectiveness in 2007), Hong- Kong (on partnership in 2010) [11].

The purpose of this study was to demonstrate the economic importance of health promotion and education and specially to see its cost - effectiveness. It was seen during the study that, in addition to the low standard of living for households, their knowledge and practices regarding malaria are very low, whereas the majority of households have experienced at least one case of malaria since the beginning of year.

This shows the importance of health promotion and education. The extension of mathematical models has led to the conclusion that a promotion action, implemented with a certain level of expenditure, may be benefic in economic and technical considerations. Therefore, it will be more interesting to consider the benefits of promotion and education at Health Centers, the achievement depends more on the organizations while the benefits have a very interesting economic and financial dimension.

5. Recommendations and Conclusion

The Health Center is recommended to implement a dissuasive project of promotion and education of health with a communication plan. As it has been proven that promotional and educational interventions can greatly reduce malaria cases, effective promotion will significantly reduce Health Center expenses and load allowing improvement in quality of service.

Companies and population should raise their interest in increasing their knowledge with rational practices on fight against malaria.

The Nation Program to Fight against Malaria department must review its policy and strategies by prioritizing promotion and education interventions.

The main purpose of this study was to demonstrate the economic and medical importance of health promotion and education and specially to study its cost - effectiveness. By establishing the evidence that most of the population living with low-income, women's knowledge, attitudes and practices regarding malaria are low and the area is in high level of malaria transmission, this study shows that health promotion and education is crucial.

Compared to the high cost of disease management, the promotion interventions find easily their interest and credibility. Indeed, even a modest budget with a good organization and an effective strategy, a decrease of number of cases would impact on the performance of Health Center. Then, other measures must be implemented to reinforce sustained education in the short, medium and long term, mass sensitization, the commitment of the government, companies and other organizations, sine qua non conditions for success and effectiveness. The analysis extension in mathematical model has led to the conclusion that a promotion action, provided with a certain level of expenditure, may be beneficial in economic and technical terms.

The benefits of promotion and education in health services depend on the best organizations with considering economic and social dimension as cross-cutting intervention.

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The entire responsibility for the study rests of the author.

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