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Cost of malaria morbidity in Uganda

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Abstract

The high burden of malaria, among others, is a key challenge to both human and economic development in malaria endemic countries. The impact of malaria can be categorized from three dimensions, namely: health, social and economic. The economic dimension focuses on three types of effects, namely: direct, indirect and intangible effects which are felt at both macro and micro levels. The objective of this study was to estimate the costs of malaria morbidity in Uganda using the cost-of-illness approach. The study covered 4 districts, which were selected randomly after stratification by malaria endemicity into Hyper endemic (Kamuli and Mubende districts); Meso endemic (Mubende) and Hypo endemic (Kabale). A survey was undertaken to collect data on cost of illness at the household level while data on institutional costs was collected from the Ministry of Health and Development Partners. Our study revealed that: (i) in 2003, the Ugandan economy lost a total of about US$658,200,599 (US$24.8 per capita) due to 12,343,411 cases

malaria; (ii) the total consisted of US$49,122,349 (7%) direct costs and US$ 609,078,209 (92%) indirect costs or productivity losses; (iv) the total malaria treatment-related spending was US$46,134,999; out of which 90% was incurred by households or individual; (v) only US$2,987,351 was spent on malaria prevention; out of which 81% was borne by MOH and development partners. Malaria poses a heavy economic burden on households, which may expose them to financial catastrophe and impoverishment. This calls for the upholding of the no-user fees policy as well as increased investments in improving access to quality of health services and to proven community preventive interventions in order to further reduce the cost of illness borne by patients and their families.

Key words: **Cost of illness, malaria, Uganda**

Introduction

The burden of malaria, among others, poses a challenge to economic development in malaria endemic countries. Sub-Saharan Africa alone accounts for 90% of the 500 million annual malaria cases and a substantive proportion of malaria deaths [Goodman et al 2003].

In 2004 Uganda registered a total of 405,736.875 deaths from all causes. About 70.8% of those deaths were caused by communicable, maternal, perinatal and nutritional conditions; 19.9% were caused by communicable diseases; and 9.3% from unintentional and intentional injuries. Malaria alone was responsible for 9.5 of all deaths in the country; and 13.5% of deaths from communicable diseases (WHO 2011).

The abovementioned deaths and morbidity from all causes lost Uganda a total of 14,145,832.5 disability adjusted life years (DALYs). Approximately 72.2% of DALYs lost resulted from communicable, maternal, perinatal and nutritional conditions; 17.5% from noncommunicable diseases; and 10.4% from injuries. Malaria only accounted for 10.7% of the grand total DALYs; and 14.8% of DALYs lost from communicable, maternal, perinatal and nutritional conditions (WHO 2011).

The impact of malaria has been categorized from three dimensions, namely: health, social and economic. Broadly, the economic dimension of disease burden focuses on 3 main types of effects, namely: direct, indirect and intangible effects. These effects are felt at both macro (national and community) and micro (household and individual) levels.

A number of studies in Africa have attempted to estimate the cost of malaria, e.g. Chuma (Chuma et al 2011) in Kenya; Onwujekwe et al (Onwujekwe et a 2010) in Nigeria; Ayieko et al (Ayieko et a 2009) in Kenya; Castillo-Riquelme et al (Castillo-Riquelme et al 2008) in South Africa; Deressa and Hailemariam (Deressa & Hailemariam 2007) in Ethiopia; Mustafa and Babiker (Mustafa & Babiker 2007) Sudan; Somi et al (Somi et al 2007) in Tanzania; Akazili et al (Aikins et al 2007) in Ghana; Onwujekwe et al (Onwujekwe et al 2004) in Nigeria; Onwujekwe et al (Onwujekwe et al 2000) in Nigeria; Kirigia et al (Kirigia et al 1998) in Kenya; Asenso-Okyere and Dzator (Asenso-Okyere & Dzator 1997) in Ghana; Guiguemde et al (Guiguemde et al 1997) in Burkina Faso; Sauerborn et al (Sauerborn et a 1991) in Burkina Faso; and Shepard et al (Shepard et a 1991)] in Burkina Faso, Chad, Congo, and Rwanda.

To the best of our knowledge, prior to the study reported in this paper, no study had attempted to estimate the cost of malaria in Uganda. Therefore, our study was meant to contribute to bridging that knowledge gap in Uganda. The specific objective of this study was to estimate the costs of malaria morbidity (illness) in Uganda using the cost-of-illness approach.

Methods

Conceptual framework

Definition of costs estimated

The economic burden of malaria consists of three components: direct costs, indirect costs and intangible costs. Firstly, the direct costs, on the part of government and development partners, typically would include all expenditures on health system inputs used in the prevention and treatment (management) of malaria, and research. It also includes out-of-pocket expenditure by households (patients, family members and friends) on prevention and treatment of the illness as well as transportation costs for both the patient and accompanying family members. Even in the poor countries of Sub-Saharan Africa, households have been found to spend between US$2 and US$25 on malaria treatment, and between US$0.20 and US$15 on prevention each month (WHO 1991).

Secondly, the indirect costs relate to productivity losses, at individual, household and national levels, usually resulting from the indirect effects of treatment seeking, malaria morbidity, mortality and debility. Malaria-related absenteeism, debility and mortality diminish the quantity and quality of working days with resultant adverse effect on economic output. Time lost for caring for sick children, who are more frequently and seriously affected by malaria, exacerbate this economic loss.

Thirdly, the intangible costs include the psychic costs due to anxiety and pain resulting from the malaria illness to the patients, family members and friends. The cost-of-illness approach does not quantify and value this component.

Analytical model

The total cost (TC) incurred by society due to malaria can be expressed as follows:

$$TC = TDC + TIC + ITC \quad \text{.....(1)}$$

Where: TDC is total direct cost, TIC is total indirect cost or productivity loss, and ITC is intangible cost (capturing physical and psychological pain).

The TDC was estimated using equations 2 to 6:

$$TDC = ISC + HDC \quad \text{..... ....(2)}$$

Where: ISC are institutional expenditures incurred by the government, development partners, and other health care providers to treat or prevent malaria; and HDC are expenditures borne by households (including patients, family members and friends) in prevention and treatment of malaria.

$$ISC = MOH_{ME} + NMS_{ME} + DP_{ME} \quad \text{.....(3)}$$

where: MOH_{ME} is expenditure on the malaria control program at the central level; EMRI is expenditure on malaria research for research institutions; NMS_{ME} is expenditure on antimalarials from the National Medical Stores (given that currently purchases are centralised); and DP_{ME} refers to all expenditures on malaria control activities by involved development partners. The data on MOH_{ME}, NMS_{ME} and DP_{ME} components were obtained through a review of Ministry of Health records and interviews of the health development partners (e.g. WHO, Malaria Consortium and USAID) involved in the prevention and management of malaria at the time.

$$HDC = HEP + HET \quad \text{..... ....(4)}$$

Where: HEP is household expenditure on malaria prevention measures such as mosquito sprays, mosquito coils, and ITNs; and HET is household expenditure on treatment per episode including out-of-pocket expenditures for transport to and from clinic, registration fees, consultation fees, laboratory fees, treatment fees, medicines cost, and the cost of subsistence at a health facility.

$$HEP = HPM \times TNH \times ATEP \quad \ldots\ldots\ldots\ldots(5)$$

Where: HPM is percentage of households using prevention measures that require money; TNH is the total number of households in Uganda; and $ATEP$ is the average total annual household expenditure on protective measures.

To obtain an average cost of treatment for a patient per episode, we have to take into consideration the different choices of treatment (self-medication vs. clinic/hospital) & whether one was treated as an outpatient or admitted at the clinic/hospital. The total annual direct cost of treatment by household is a product of average cost per episode and the total annual number of malaria episodes in the country:

$$ADCT = \left[(SM \times AC_{SM}) + (ADM \times C_{ADM}) + (OPD \times C_{OPD})\right] \times AME \quad \ldots\ldots\ldots\ldots(6)$$

where: $ADCT$ is the annual direct cost of treatment by household; SM is the percentage of cases that self-medicated; AC_{SM} is the overall annual expenditure on transport, medication and other items for those who self-medicated; ADM is the percentage of malaria cases admitted; C_{ADM} is the overall annual expenditure on transport, registration, consultation, laboratory, medicines and other inputs for malaria cases admitted; C_{OPD} is the overall annual expenditure on transport, registration, consultation, laboratory, medicines and other inputs for malaria cases treated at clinic/hospital outpatient departments; and AME is the total number of episodes. This data was obtained from primary household surveys undertaken for this purpose.

The total indirect costs (TIC), i.e. labour productivity losses, were estimated using equations 7 to 11:

$$TIC = L_{HH} + L_{CG} \quad \ldots\ldots\ldots\ldots(7)$$

Where: L_{HH} are the productivity losses due to work days lost by patients; and L_{CG} are the productivity losses due to the work-time lost by relatives accompanying and visiting patients;

$$L_{HH} = AYL_{TW} + APL_{S} \quad \ldots\ldots\ldots\ldots(8)$$

where: AYL_{TW} is the household annual loss of income due to travel and waiting time and APL_S is the household annual loss of income due to malaria-related absence from work;

$$AYL_{TW} = (TT + WT) \times Y_H \times AME \quad \ldots\ldots\ldots\ldots(9)$$

where: TT is return travel time to a clinic/hospital; WT is time spent waiting at the health facility, e.g. obtaining registration card, consultation, diagnosis (laboratory test), pharmacy for prescribed medicines; Y_H is household income per hour; and AME is the number of annual malaria episodes;

$$APL_S = Y_{AL} \times SAW \times AME \quad \ldots\ldots\ldots\ldots(10)$$

where: APL_S is household annual productivity loss due to malaria sickness; Y_{AL} is average annual income loss per household; SAW is percent of people who stay away from work due to malaria episode.

$$L_{CG} = Y_{AYLC} + (ACA \times AME) \quad \ldots\ldots\ldots\ldots(11)$$

where: Y_{AYLC} is average annual income lost per caregiver or accompanying person; ACA is average percentage of total number of consultations accompanied by a caregiver. This data was obtained from primary household surveys undertaken for this purpose. The parameter values used in estimating the aforementioned equations are contained in Table 1.

INSERT TABLE 1

Sampling methods and data

Sample size estimation

According to Bennett et al (1991), a sample size of at least 200 households per district is adequate to provide results at 95% confidence level. The formula takes into consideration a design effect of 1.7 to correct for the bias created when using cluster sampling in place of simple random sampling technique. For the four districts, a sample size of 800 households would have been sufficient. However, this survey covered a bigger sample size of 973 households. The sample sizes allow for interpretation of results at the level of a district.

Sampling procedure

All districts in the country were stratified by malaria endemicity into Hyper/Holo endemic; Mesoendemic and Hypo endemic. Four districts (Kabale (Hypo), Kamuli (Hyper), Mubende (Meso) and Tororo (Hyper)) were then selected randomly from these strata and included in the survey . Districts from the North were not included in the study due to insecurity in the region at the time.

Fifty percent of the sub-counties were then selected randomly from each of the study districts. From the selected sub-counties, 50% of parishes were selected randomly giving a total of 25 parishes for the 4 districts. In each district, 30 villages (LC1) were then selected from the parishes using the probability proportionate to size technique from a sampling frame of villages obtained from the 2002 Census. The technique involved a number of steps. In the first step, a list of villages and their population sizes was drawn. At step two, cumulative totals of the village populations were calculated and entered in a column. At step three, the sampling interval (SI) was determined by dividing the total population in the selected parishes by 30 (the number of villages to be studied). At step four, a number was randomly chosen between 1 and the SI and marked the first selected village. At step five, S1 was serially added to first number and the villages with the corresponding cumulative totals chosen, until 30 villages were selected.
Human capital approach was use to estimate loss in income in case of unemployed individuals.

Selection of Households

The process of selecting households began at a central location (either at a bar, shop or cross-road) within each village. For this study a village was taken to correspond to a local council (LC1). The direction was determined by spinning a pen and the first household selected; thereafter the survey team moved to the front-door neighboring household until a minimum of 7 households were studied in each village. If no appropriate respondent was found in a selected household, the next neighbouring household replaced it.

Study population

The study population comprised of all members in the sampled households. A household was defined as a group of people living together (having lived together for at least one month) and sharing meals. The questionnaires were administered to adults/heads of households.

Data collection

This survey employed structured interviews and collected data on expenditures for malaria for the past one month. A structured questionnaire was used to collect data from households on their expenditure on treatment and prevention of malaria and; working hours lost due to illness in the one month prior to the survey. This involved the estimation of time lost by the malaria sufferers and carers. This was then monetised to estimate the economic opportunity cost. For preventive measures, data on the rate of use of a given intervention in the past two months was collected.

In order to ensure that respondents have a common understanding of malaria, the following symptoms were taken as indicative of malaria:

- For children: Fever and/or a hot body with or without any of the following; weakness; sleepiness; loss of appetite; vomiting; and diarrhoea.
- For adults: Headaches, weakness, fever and joint pains with or without any of the following; temperature; bitterness of the mouth and vomiting.

For institutional costs, a separate structured questionnaire was used for data collection from Ministry of Health Malaria Control Program, National Medical Stores, expenditures on Malaria at the district level (Public and Donors), and public and donor expenditure on malaria research.

3. Results:

Characteristics of household members

Out of the 973 households included in the survey, 23.9% were from Kabale, 27.6% from Kamuli, 22.2% from Mubende and 24.7% from Tororo districts. The total number of household members in the survey was 5597 with 49.5% being male and 50.5% being female. The average household size was 5.8 persons. About 79% of the household members were above 5 years, 20% were between 1–5 years, and only 1% was less than 1 year. Figure 1 portrays that 4% of household members had more than 11 years of education, 39% had 1–4 years of education, and 14% had no education. Overall, only 47% had had more than 4 years of education (*Figure 1*).

INSERT FIGURE 1

Figure 2 shows that 40% of household members were students and 26% were peasant farmers. Only 8% of the household members sampled were earning a salary from their primary occupation.

INSERT FIGURE 2

Morbidity and health seeking behaviour

Table 2 presents frequency of malaria episodes by district and age. Tororo district had the highest one-month malaria prevalence (36 cases per 100 population) while Kabale district had the lowest prevalence (22 cases per 100 population). The prevalence did not vary much across the districts. About 24.6% of the 5621 household members reported having experienced an episode of malaria during the last one month. Of those that had had malaria, 87.1% had only one episode, 10.0% had two episodes, and 2.9% had more than two episodes. About 0.7% of persons with a malaria episode were under one year old, 34.8% were 1-5 years old, and 64.5% were above five years of age.

INSERT TABLE 2

Action taken by patients for malaria treatment

Table 3 presents the actions taken to treat malaria by 1383 persons who reported to had malaria a month prior to the survey. About 2% did nothing, 39% self-medicated, 1% consulted herbalist, 56% went to clinic/hospital and 1% another source.

INSERT TABLE 3

Table 4 shows the patients average expenditure by action taken to treat malaria. The overall expenditure per case for those who self-medicated was US$1.00 and for those who went to the clinic/hospital (OPD) was US$4.8. The average overall expenditure per case for those who self-medicated as second action was higher than those who self-medicated as first action and the cost of medication was the main determinant. Similarly, for those who went to a clinic/hospital as a second action, the average overall expenditure per case was higher than for those who went as a first action; drug and treatment costs were again the main determinant.

INSERT TABLE 4

Households/individuals preventive costs

Table 5 depicts the percent distribution of households by mode of protection against mosquito bites. Overall, mosquito nets, mosquito repellents and other modes of protection were used in almost the same proportions in the sampled households that protected themselves against mosquitoes. Overall, 16.4% of households did not use any protective measure against mosquitoes; this was more pronounced in Kabale district.

INSERT TABLE 5

Table 6 presents the average annual household expenditure on protective measures by district. The total annual average household expenditure on protection against mosquito for the 387 households that protected themselves against mosquitoes was US$125 giving an average expenditure of US$0.32 per household. The greatest average expenditure was on sprays US$61.49 and the least on mosquito nets US$5.96.

INSERT TABLE 6

Figure 3 presents reasons for using the different modes of protection against malaria infection. Majority of households using bed-nets and aerosol sprays said they preferred them because their perceived effectiveness. Mosquito coils and other modes of protection were preferred because of they are cheap.

INSERT FIGURE 3

Some of the factors considered in estimating indirect costs included company to consultation, distance to clinic/hospital, travel time, waiting time, sick days and lost income, and lost income of caregivers.

Company to consultation: The majority (59.4%), of the household members who consulted a clinic/hospital were accompanied by a parent/guardian with a smaller proportion (14%) accompanied by their spouses or relatives. In 23.6% of the consultations, the patients were unaccompanied.

Distance to clinic/hospital: The distance to a clinic/hospital for most of the household members who consulted a clinic/hospital was less than 5 kilometers (KM) overall and in the individual districts. *Figure 4* depicts that Kabale district had the highest proportion (43%) of its household members traveling for more than 5 KM to get to a clinic/hospital.

INSERT FIGURE 4

Travel time: Figure 5 shows that other than Kabale, majority of household members in the rest of the districts took not more than one hour to get to a clinic/hospital. In Kabale, majority of the household members (48.5%) took 1-2 hours to get to a clinic/hospital for treatment.

INSERT FIGURE 5

The monetary value of travel time can be estimated on the basis of average income and the average amount of time spent traveling.

Waiting time: As shown in Table 7, the average waiting times before obtaining services at the clinic/hospital was longest for obtaining cards and consultation; between 12-29 min. Overall, Mubende district household members experienced the shortest waiting times (less than 60 min for all services). Household members in Kamuli experienced the longest waiting times, up to 106 min (1hr 45 min) for all services, just over 30 min on consultations and just over 20 min on laboratory services.

INSERT TABLE 7

On average travel to a clinic/hospital takes 1 hour, hence 2 hours for a return journey, and waiting at the health facility takes 1.5 hours. In total, about 3.5 to 4hours are spent on these two activities per episode of malaria. Average income per working day (8hours) of the sampled group is US$2.25. Hence, income per hour is US$0.28. Four hours lost in travel and waiting amounts to about US$1.12 per malaria episode.

Sick days and lost income: Figure 6 portrays the occupation of household members who suffered from malaria by district. Of the household members who got malaria in the one month prior to the survey, 75.2% reported to have been cured within 7 days and 24.8% after 7 days. Most household members who suffered from malaria were preschool children (37.8%), students (30.8%) and peasants (20.8%). Unlike other districts, peasants formed the majority in Kabale district. In all districts the employees and self-employed formed less than 10% of household members who suffered from malaria.

INSERT FIGURE 6

Overall, 52.4% of household members with malaria stopped work/normal activities. The proportions of members who stopped work/normal activities in the different districts were: Kabale 50.9%, Kamuli 27.1%, Mubende 52.4%, and Tororo 79.2%. For household members with malaria who did not stop work, overall 15.5% reported to have cut down work/normal activities while the rest continued to work normally. The proportions of members who cut down work/normal activities in the different districts were: Kabale 11.3%, Kamuli 5.6%, Mubende 36.7%, and Tororo 39.3%.

For those household members who stopped work/normal activities, those with jobs/duties lost on average 8.4 days and those going to school lost on average 6.2 days. On average work/normal activities was cut down by an average of 5.5 hours/day.

Overall, the average household loss in earnings due to absence from work by malaria patients was US$4.12 per month with Mubende and Tororo districts having the highest average household loss of US$5.91 and US$5.64 respectively. As shown in Table 8 average annual household loss in earnings was US$49.47.

INSERT TABLE 8

Lost income of caregivers: Figure 7 shows that of the caregivers who suspended normal duties to care for the malaria patients, the majority were adults (95%) and female (90.6%). Most of the caregivers were peasants (70.1%) or housewives (18.9%). Table 9 presents average monthly and annual loss in earning of caregivers by occupation. The overall average monthly loss in earnings by the caregivers when taking care of malaria patients was US$2.50, while the annual loss was US$30.0. Self-employed caregivers incurred the greatest average loss in earnings of about US$18.58 while housewives incurred the least average loss of about US$2.53.

INSERT FIGURE 7

INSERT TABLE 9

Summary of direct and indirect costs:

Table 10 provides a summary of the direct and indirect costs of malaria morbidity. The annual total direct cost (TDC) was US$ 49,122,349 – 94% for treatment and 6% for prevention. Out of which 14.1% was annual institutional expenditures on malaria control (i.e. ministry of health, national medical stores and development partners) (ISC), 1.1% was annual total household expenditure on malaria (HEP), and the 84.8% was annual total household direct cost of treatment (ADCT). Approximately 73% of the ISC was borne by development partners. About 78% of HEP was borne by malaria patients who sought care at the clinic/hospital outpatient department. Clearly, the household bore the majority of direct costs of malaria morbidity in Uganda.

INSERT TABLE 10

The annual total indirect cost was US$609,078,209. Fifty-two percent of the total productivity losses were attributed to patients' absence from work due to malaria sickness (APL_S). Forty-six percent of the of the total productivity losses consisted of work time lost by relatives and friends accompanying and visiting patients (L_{CG}). Two percent of the total productivity losses were due to patients' travel and waiting time (AYL_{TW}).

The grand total economic loss attributable to the 12,343,411 malaria cases in Uganda was US$658,200,558, i.e. 92.5% indirect costs and 7.5% direct cost. The average grand total economic loss per malaria case was US$ 53.32; which consists of direct cost of US$4 per case and indirect cost of US$49.3 per case.

4. Discussion:

Due to the high morbidity of malaria, Uganda incurred a substantial cost of about US$658,200,558 in the year 2003. Remarkably, a very significant proportion (92%) of this burden was related to loss of productivity as a result of morbidity. Moreover, this amount excludes costs related to premature death due to malaria. The biggest economic burden (98.9%) is borne by households/communities.

Out of the total direct cost of US$49.1 million, about US$42.2 million (86%) came from household's out-of-pocket payments. Dividing the latter by the total number of cases yields average direct cost borne by households of US$3.4 per case. This Uganda estimate is lower than US$6.50 per case in Mozambique

(Castillo-Riquelme et al 2008), US$6.3 per case in Sudan (Mustafa & Babiker 2007) and US$8 per case in Burkina Faso [15] but higher than US$2.50 per case in South Africa (Castillo-Riquelme et al 2008), US$2.71 per case in Ghana [10], US$0.102 per case during rainy season and US$0.153 per case during dry season in Tanzania [9], US$2.76 per case in private clinics and US$1.44 per case at public facilities in Ethiopia (Akazili et al 2007), US$1.683 per case in Nigeria (Onwujekwe et al 2004), US$1.84 per case in Nigeria (Onwujekwe et al 2000), US$1.81 per case in Ghana (Asenso-Okyere & Dzator 1997), US$1.83 in Burkina Faso, Chad, Congo (Shepard 1991), and US$2.58 in Rwanda Ettling & Shepard DS 1991). The high cost of treatment burden shouldered by households may expose them to catastrophe and impoverishment. This calls for the upholding of the no-user fees policy as well as more investments in improving access to quality of health services and community preventive measures in order to further reduce the cost of illness borne by patients and their families (Nabyonga et al 2005).

In this study, the majority of malaria patients (56%) went to a clinic or hospital for their treatment, 39% self-medicated and only 3% did nothing. This strongly justifies efforts to improve coverage of services. It is important to understand the barriers faced by the 3% of malaria patients that did nothing who are likely to be among the poorest in the community. Not seeking care at all may cause negligible direct costs but they may incur enormous indirect costs as a result of not seeking care.

For those who self-medicated, the average costs were estimated at about US$1.00 per person per episode out of which 62% was contributed by the costs of drugs. This finding is comparable to findings of studies undertaken elsewhere. For example, a study on the economic impact of malaria in Africa estimated that out of pocket expenses for a mild malaria episode was about US$0.82 of which 87% was the cost of drugs and the rest was the travel costs (Shepard 1991). Another study done in Nigeria estimated the household expenditure on per episode of a malaria case at US$1.84 (Onwujekwe et al 2000). Self-medication may contribute to fuelling the growing problem of parasite resistance to malaria medicines in Africa; partially due to the fact that patients may not purchase the full dosage of medicines.

At the household level, the annual indirect costs of seeking treatment included those relating to travel time and waiting time (US$13,824,620), sick days (US$317,526,842) and time of caregivers (US$277,726,747). The annual average total indirect cost was US$ 49.3 per case of malaria. This consists of US$1.12 per case due to annual losses in patient travel and waiting time; US$25.72 per case due to patients annual total loss absence from work due to malaria sickness; and US$22.5 per case due to annual total productivity losses incurred by relatives accompanying and visiting patients.

In Uganda the average monthly income loss from: travel and waiting time was US$1.12 per case of malaria; absence from work due to sickness was US$4.12 per case; and care givers loss of working time was US$2.50 per case. Therefore, the average total monthly productivity loss was of US$7.74 was lower than the US$8.01 per case in Burkina Faso, Chad, Congo, and Rwanda (Shepard 1991). However, the monthly productivity loss in Uganda was higher than US$4.08 per case in Ethiopia (Deressa & Hailemariam 2007), US$3.2 per case in Sudan (Mustafa & Babiker 2007), US$0.597 during rainy season and US$0.889 during dry season in Tanzania (Somi et al 2007); US$4.52 indirect cost per case in Ghana [10]; US$5.998 per case in Nigeria (Onwujekwe et al 2004); US$1.28 per case in Nigeria (Onwujekwe et al 2000); US$6.87 per case in Ghana (Asenso-Okyere & Dzator 1997); and US$3.7 per case in Burkina Faso (Guiguemde et al 1997).

5.0 Conclusion

In a nutshell, the costs of malaria are quite high both at the individual household and institutional levels. Since the disease affects the young people, it leads to decreased long-term economic growth and thus presents a big economic burden for the country.

Household survey information has been very instrumental in the calculation of both direct and indirect costs

incurred on malaria treatment and prevention efforts. As Sauerborn *et al* [16], the estimation of the burden to the households is essential given the substantive costs related with productivity losses. Unfortunately, due to insufficient data and methodological challenges, these costs are usually not estimated when assessing the malaria burden. Our results show that productivity losses constitute about 93% of the total cost of illness.

The study has shown that labour loss due to malaria (US$609,078,210) far outweighs both direct cost of operating and organizing health services (US$49,122,349), which works against poverty eradication efforts and socioeconomic development of the country.

There is need for intensified sensitization about malaria prevention to increase uptake of preventive measures such as treated insecticide-treated nets (ITNs) to offer more effective protection against mosquito bites.

Availability, affordability and perceived effectiveness are the main determinants in choosing a protection measure against malaria. Efforts should be made to increase availability and minimize costs of the recommended preventive measures e.g. ITNs if coverage of these interventions is to increased. There is need to target the poor in the distribution of ITNs because they suffer more serious economic consequences and higher cost burdens.

5. Conclusion

A functional structure made up of holons is called holarchy. The holons, in coordination with the local environment, function as autonomous wholes in supra-ordination to their parts, while as dependent parts in subordination to their higher level controllers. When setting up the WOZIP, holonic attributes such as autonomy and cooperation must have been integrated into its relevant components. The computational scheme for WOZIP is novel as it makes use of several manufacturing parameters: utilisation, disturbance, and idleness. These variables were at first separately forecasted by means of exponential smoothing, and then conjointly formulated with two constant parameters, namely the number of machines and their maximum utilisation. As validated through mock-up data analysis, the practicability of WOZIP is encouraging and promising.

Suggested future works include developing a software package to facilitate the WOZIP data input and conversion processes, exploring the use of WOZIP in the other forms of labour-intensive manufacturing (e.g. flow-line production and work-cell assembly), and attaching a costing framework to determine the specific cost of each resource or to help minimise the aggregate cost of production.

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Table 1: Parameter values used in the calculations of cost of malaria in Uganda

Variable	*Value*
MOH_{ME}	***US$247,222***
NMS_{ME}	***US$1,592,288***
DP_{ME}	***US$5,074,059.26***
HPM	***35%***
TNH	***4,938,400***
ATEP	***US$0.323***
SM	***39%***
AC_{SM}	***US$1***
ADM	***10%***
C_{ADM}	***US$5.73***
OPD	***90%***
C_{OPD}	***US$4.8***
AME	***12,343,411***
TT	***2 hours***
WT	***2 hours***
Y_H	***US$0.28***
Y_{AL}	***US$49.47***
SAW	***52%***
Y_{AYLC}	***US$30***
ACA	***76.4%***

Table 2: Malaria episodes by district and age

Characteristic	Number of household members	Malaria episodes						Total	
		One		Two		More than Two			
		No	%	No	%	No	%	No	%
District									
Kabale	1341	240	20.0	20	14.5	5	12.5	265	19.2
Kamuli	1615	376	31.3	21	15.2	10	25.0	407	29.5
Mubende	1177	225	18.7	23	16.7	15	37.5	263	19.1
Tororo	1488	361	30.0	74	53.6	10	25.0	445	32.2
	5621	**1202**	**100.0**	**138**	**100.0**	**40**	**100.0**	**1380**	**100.0**
Age									
< 1 year		6	0.5	1	0.7	2	5.0	9	0.7
1 - 5 years		407	34.0	57	42.2	14	35.0	478	34.8
> 5 years		785	65.5	77	57.0	24	60.0	886	64.5
		1198	**100.0**	**135**	**100.0**	**40**	**100.0**	**1373**	**100.0**

Table 3: Action taken to treat malaria by district

	Action taken to treat malaria											
	Nothing		Self-medicated		Consulted herbalist		Went to clinic/ hospital		Other		Total	
Characteristic	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
District												
Kabale	6	17.6	45	8.3	0	0.0	218	27.9	2	28.6	271	19.6
Kamuli	2	5.9	261	48.2	8	40.0	128	16.4	3	42.9	402	29.1
Mubende	15	44.1	109	20.1	11	55.0	127	16.3	2	28.6	264	19.1
Tororo	11	32.4	126	23.3	1	5.0	308	39.4	0	0.0	446	32.2
Total	**34**	**2.5***	**541**	**39.1***	**20**	**1.4***	**781**	**56.5***	**7**	**0.58***	**1383**	**100***

*Indicates percentage of the total malaria episodes

Table 4: Households average treatment expenditure by action and action number

Action taken	Number of action First US$	Second US$	Third US$	Overall US$
Self medication				
Transport	0.05	0.17	0.03	0.06
Medication	0.55	1.44	0.70	0.62
Other costs	0.25	1.02	0.33	0.32
Average overall expenditure per case*	**0.81**	**2.56**	**1.05**	**1.00**
Clinic / hospital				
Transport to and from clinic/hospital	0.74	0.63	1.48	0.73
Registration fee	0.09	0.15	0.51	0.11
Consultation fee	0.17	0.24	0.02	0.18
Laboratory cost	0.18	0.16	0.07	0.18
Total drugs cost at clinic	1.07	1.32	0.38	1.10
Treatment cost	2.14	2.05	0.53	2.10
Total drugs cost at drug store	0.39	0.18	0.40	0.36
Transport cost to and from purchasing drugs at a drug store	0.01	0.04	0	0.03
Average overall expenditure per case*	**4.05**	**4.30**	**3.17**	**4.8**

**Overall average expenditures were based on total cases within each action number.*

Table 5: Percent distribution of households by mode of protection against mosquito bites

Protection against mosquitoes	DISTRICT				
	Kabale	**Kamuli**	**Mubende**	**Tororo**	**Total**
Nothing	37.9	21.6	1.9	1.7	16.4
Sleep under bed nets	10.9	13.8	5.6	26.3	14.3
Sleep under treated bed nets	2.4	2.2	0.9	7.1	3.2
Have door/window nets	0.4	0.4	0	0.4	0.3
Indoor residual spraying	1.6	0.4	0	1.7	0.9
Use of mosquito repellents	8.4	16.7	6.5	31.6	16
Other modes of protection*	48	4.5	3.7	10	16.8
Number of households**	**248**	**269**	**216**	**240**	**973**

Note: Other methods include clearing bush and stagnant water around the home, closing windows and door early and burning of leaves. Percentages were computed basing on number households within each district

Table 6: Average annual household expenditure on protective measures by district

Protection measure	District								Total	
	Kabale		**Kamuli**		**Mubende**		**Tororo**			
	n*	**US$**	**n***	**US$**	**n***	**US$**	**N***	**US$**	**n***	**US$**
Bed nets	35	6.50	61	5.33	22	6.93	67	5.94	185	5.96
Sprays	15	60.15	3	120.37	7	37.30	17	62.24	42	61.49
Repellants	1	33.33	0	0	1	16.67	4	11.67	6	16.11
Mosquito coils	1	2.89	64	33.59	12	28.62	69	22.90	146	27.92
Other protection methods	3	29.55	0	0	3	5.55	2	1.67	8	13.58
Totals	**55**	**132.43**	**128**	**159.30**	**45**	**95.07**	**159**	**104.42**	**387**	**125.07**

Note: n is number of households that spent on a given protection measure

Table 7: Average waiting time (minutes) for obtaining various services

District	Service					
	Obtaining card	**Consultation**	**Lab services**	**Injection**	**Dispensary**	**Total**
Kabale	21.8	24.1	12.1	5.7	16.4	80
Kamuli	26.7	31.1	12	15.2	21.2	106
Mubende	11.7	18.9	4.7	8.7	13.4	57
Tororo	28.5	17.8	8	16.3	13.1	84
Average	22.175	22.975	9.2	11.475	16.025	

Table 8: Average monthly and annual household loss in earnings due to absence from work by district

District	No. of Households*	Total loss US$	Average monthly loss per household US$	Average annual loss per household US$
Kabale	96	245.97	2.56	30.75
Kamuli	81	206.96	2.55	30.66
Mubende	68	402.30	5.91	80
Tororo	102	575.26	5.64	67.68
Total	347	1,430.50	4.12	49.47

Note: Only households whose members were sick and reported their earnings were included

Table 9: Average monthly and annual loss in earnings of caregivers by occupation (US$)

	Unemployed	Peasant	Self-employed	Employee	House wife	total monthly loss	No. of care givers	Overall monthly average loss	Overall annual average loss
Amount caregiver paid someone	2.21	2.22	3.26	2.50	2.00	12.19	6	2.10	25.25
Loss in earnings due to absence from work	1.95	1.90	15.32	8.11	0.53	27.82	10	2.67	32.09

Total	4.17	4.12	18.58	10.61	2.53	40	16	2.50	30.0

Table 10: Direct and indirect costs of malaria morbidity in Uganda

Cost components		**Cost (US$)**	**Percentage of total**
Direct costs:			
Annual institutional expenditures on malaria control (ISC)	Ministry of health	247,222	0.0%
	National medical stores	1,592,288	0.2%
	Development partners	5,074,059	0.8%
Annual total household expenditure on malaria prevention (HEP)		553,101	0.1%
Annual total household cost of treatment (ADCT)	Self-medication	4,813,930	0.7%
	Admission	4,314,392	0.7%
	Outpatient department care	32,527,357	4.9%
Subtotal direct costs		**49,122,349**	
Indirect costs:			
Annual patients total loss of income due to travel and waiting time (AYL_{TW})		13,824,620	2.1%
Annual patients total loss of income due to malaria sickness (APL_S)		317,526,842	48.2%
Annual total productivity losses incurred by relatives accompanying and visiting patients (L_{CG})		277,726,747	42.2%
Subtotal indirect costs		**609,078,209**	
TOTAL COST		**658,200,558**	**100**

Figure 1: Years of education for household members

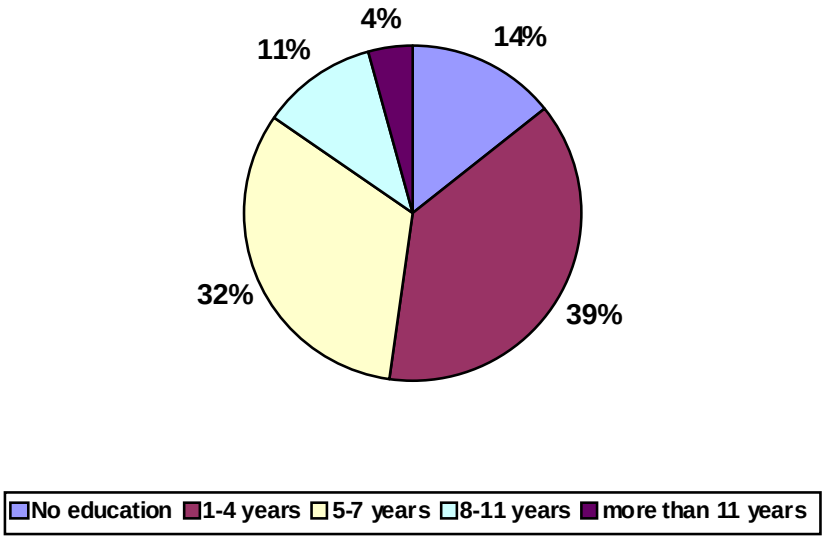

Figure 2: Primary occupation of household members

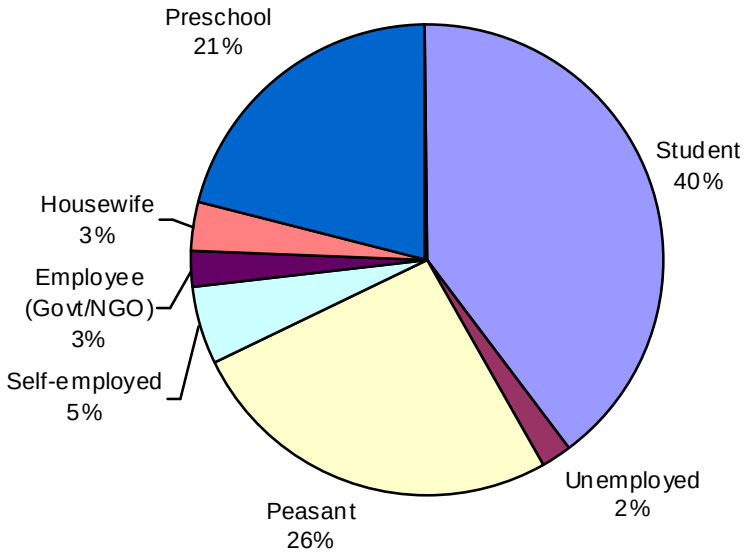

Figure 3: Percent distribution of households by reasons for using different modes of protection

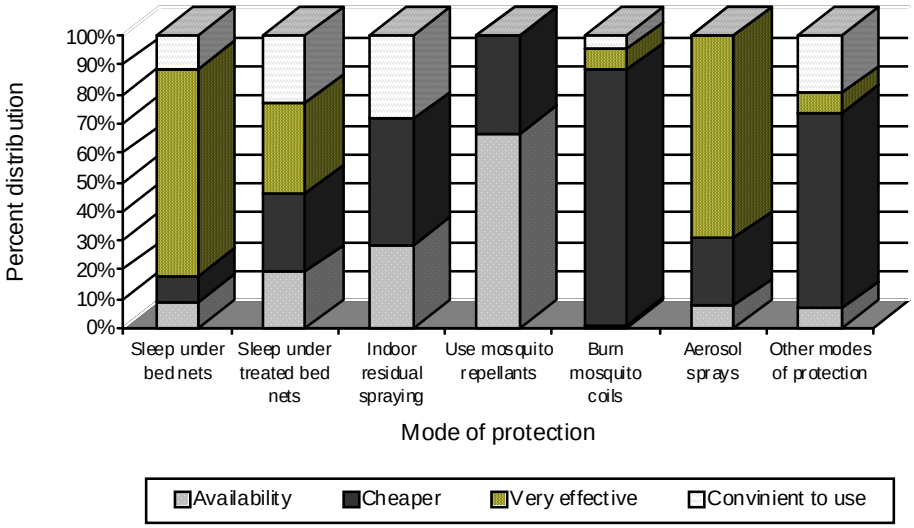

Figure 4: Distance to clinic/hospital by district

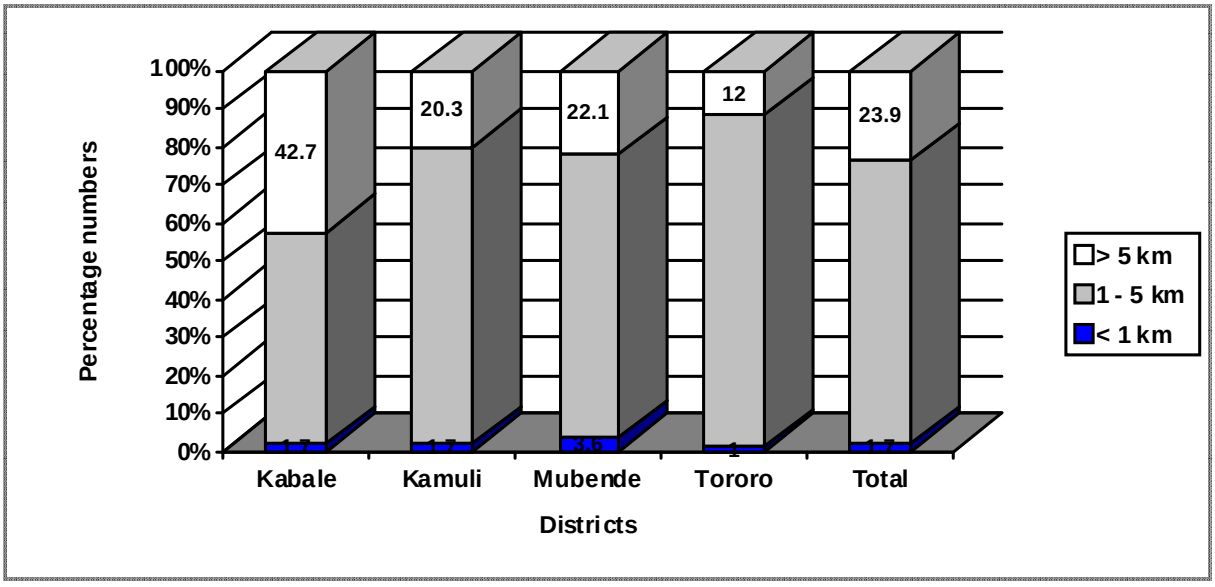

Figure 5: Time taken to reach facility (one-way)

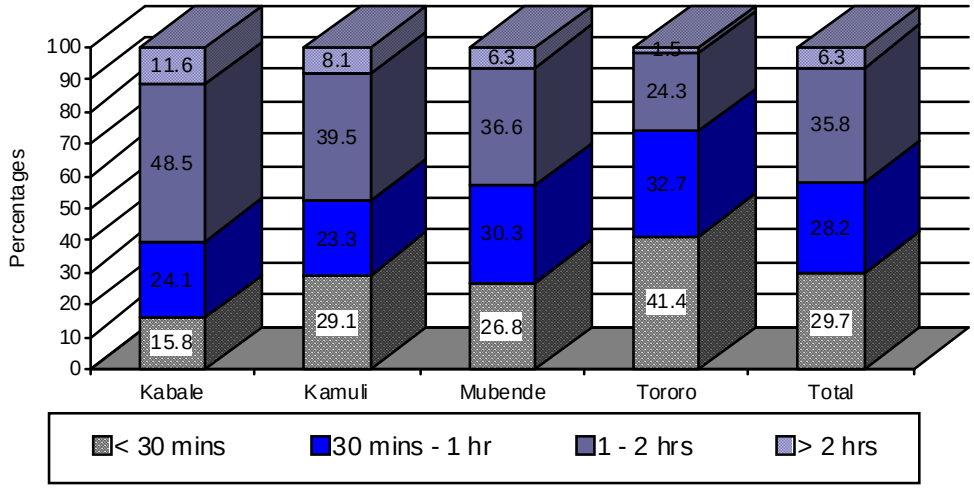

Figure 6: Malaria patient's occupation by district

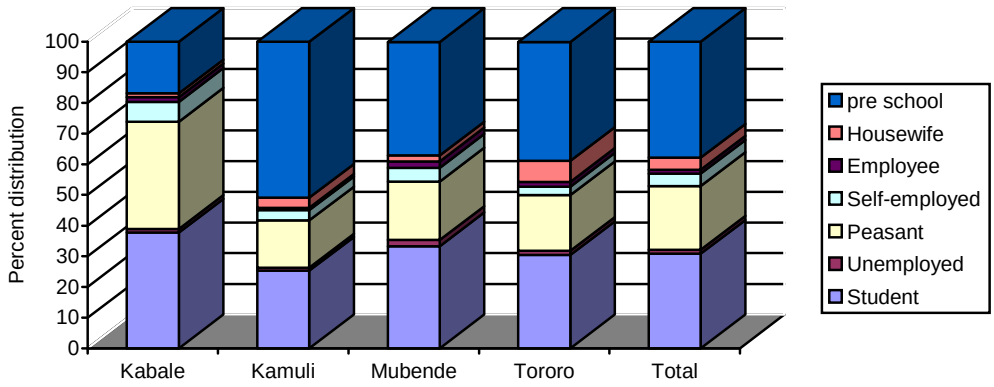

Figure 7: Occupation of caregivers by district