# Economic cost of primary prevention of cardiovascular diseases in Tanzania

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Tanzania is facing a double burden of disease, with non-communicable diseases being an increasingly important contributor. Evidence-based preventive measures are important to limit the growing financial burden. This article aims to estimate the cost of providing medical primary prevention interventions for cardiovascular disease (CVD) among at-risk patients, reflecting actual resource use and if the World Health Organization (WHO)'s CVD medical preventive guidelines are implemented in Tanzania. In addition, we estimate and explore the cost to patients of receiving these services. Cost data were collected in four health facilities located in both urban and rural settings. Providers' costs were identified and measured using ingredients approach to costing and resource valuation followed the opportunity cost method. Unit costs were estimated using activity-based and step-down costing methodologies. The patient costs were obtained through a structured questionnaire. The unit cost of providing CVD medical primary prevention services ranged from US$30–41 to US$52–71 per patient per year at the health centre and hospital levels, respectively. Employing the WHO's absolute risk approach guidelines will substantially increase these costs. The annual patient cost of receiving these services as currently practised was estimated to be US$118 and US$127 for urban and rural patients, respectively. Providers' costs were estimated from two main viewpoints: 'what is', that is the current practice, and 'what if', reflecting a WHO guidelines scenario. The higher cost of implementing the WHO guidelines suggests the need for further evaluation of whether these added costs are reasonable relative to the added benefits. We also found considerably higher patient costs, implying that distributive and equity implications of access to care require more consideration. Facility location surfaced as the main explanatory variable for both direct and indirect patient costs in the regression analysis; further research on the influence of other provider characteristics on these costs is important.

**Keywords**  Cardiovascular disease, cost analysis, diabetes, direct and indirect cost, hypertension, primary prevention, sub-Saharan Africa, Tanzania

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## KEY MESSAGES

- Evidence-based preventive measures are crucial to limit the growing financial burden of cardiovascular disease on the already constrained health care systems of low income countries.

- The costs of medical primary prevention of cardiovascular disease as currently delivered in Tanzania ranges from US$30–71 per patient per year depending on urban/rural location and health care delivery level.

- Implementing the WHO's primary prevention guidelines for cardiovascular disease will increase these costs substantially, warranting further evaluation of whether this approach is worth the cost.

- The high financial burden falling on patients receiving these services suggests that the distributive and equity implications of access need further consideration.

## Introduction

For more than a decade, deaths and disability related to cardiovascular disease (CVD) in developing countries have been overshadowed by the high burden of communicable diseases such as HIV/AIDS (Reddy 2004). In 2010, stroke and ischaemic heart disease accounted for about 5 million disability-adjusted life years in the eastern, sub-Saharan region (Murray *et al*. 2012). Likewise, CVD deaths are increasing, currently accounting for 11.6% of total deaths and projected to increase to 13.4% by 2015 (Mathers *et al*. 2008). The common risk factors for CVD are well known and have been shown to be highly prevalent in sub-Saharan Africa, including Tanzania (Dalal *et al*. 2011). The overall prevalence of hypertension in the region was reported to be 16.2% (Twagirumukiza *et al*. 2011) and that of diabetes has reached 2–3% in many countries (Gill *et al*. 2009), including frequencies of 3–10% in urban settings (Mbanya *et al*. 2010; Hall *et al*. 2011). Smoking prevalence is on average 25% and the prevalence of obesity shows a large variance, with rates between 4% and 43% (Dalal *et al*. 2011). Studies published after the year 2000 confirm the high and rising prevalence of CVD risk factors in Tanzanian populations (Aspray *et al*. 2000; Edwards *et al*. 2000; Njelekela *et al*. 2001, 2009; Bovet *et al*. 2002; Hendriks *et al*. 2012).

The burden of CVD has major social and economic consequences, such as depriving families of parents and the loss of productive lives. In 2010, the total cost attributable to CVD in the World Health Organization (WHO) African region E region was estimated at about US$5.7 billion (Bloom *et al*. 2011). In South Africa, the overall cost of stroke and heart diseases in 2007 was estimated to be US$1250 million (Gaziano 2008). With this compelling evidence of the rising prevalence of risk factors for CVD, failure to act now by implementing evidence-centred preventive measures will result in large increases of avoidable CVD, placing enormous pressures on the constrained health care systems of low income countries.

Preventive cardiology in the region not only receives low priority but is also practised with a non-holistic approach (Gaziano *et al*. 2005; Gaziano 2007; Sanderson *et al*. 2007). These practices of focusing on single risk factors have been shown to be less effective and more costly than management based on the absolute risk approach advocated in the WHO guidelines and elsewhere (Gaziano *et al*. 2005; Gaziano 2007; Jackson *et al*. 2005; WHO 2007). In Tanzania, only implicit and non-specific guidelines exist, with small segments addressing the prevention of CVD (see Supplementary Appendix S1) (Ministry of Health and Social Welfare 2000, 2008; Association of Physicians of Tanzania 2003). Standard practice for CVD medical primary prevention is that patients visit health facilities (dispensary, health centre or hospital) either through referral from a lower to a higher level of care or through self-referral. At these facilities, depending on the level of care (see Supplementary Appendix S1), patients are seen by physicians, medical doctors or assistant medical officers, with each visit entailing a routine blood pressure check, laboratory tests including urine analysis, blood glucose and blood chemistry and drug prescription when necessary. Follow-up is usually every month or every 2 weeks depending on the patient's condition and the availability of drugs.

Planning and implementation of preventive strategies is hindered by a lack of evidence on the cost of different interventions. A literature search did not yield any cost analyses pertaining to preventive cardiology in the region; rather, we found an article detailing cost of diabetes studies (Mbanya and Mbanya 2003). This article therefore aims to estimate the cost, reflecting actual resource use, of providing outpatient medical primary prevention measures for CVD among at-risk patients. For the reasons highlighted above, we also aimed to estimate the provider costs if the WHO's medical primary prevention guidelines (designed for low resource settings and incorporating low levels of health facility care) were implemented in Tanzania. In addition, the cost to patients of receiving these services was evaluated and further explored to determine which factors explain the main cost drivers.

## Methods

This study was conducted in Arusha region, located in northern Tanzania. Four health facilities representing different health delivery levels (one regional hospital, one district hospital and two health centres) were purposively selected. Two facilities were located in Arusha municipality and the other two in Monduli district, signifying urban and rural settings, respectively. All these facilities are government owned apart from the rural health centre which is 'designated', meaning that it is partly government and partly faith-based managed. The costing period was the Tanzanian financial year (July 2011 to June 2012).

### Cost methodology

We adopted a 'narrow' societal perspective whereby only health care provider and patient costs were included (Mogyorosy and Smith 2005). Due to the lack of costing guidelines in the area of preventive cardiology, 'Cost Analysis in Primary Health Care' and 'Costing Guidelines for HIV Services' (UNAIDS 2000, 2011) were modified and used as a costing guide for the provider perspective part of the study. We used an ingredients approach to costing to identify and measure all providers' resource use.

Detailed interviews were held with key personnel at the outpatient and other supporting departments in each health

facility in order to identify the standard service pathways for patients at risk of CVD. In addition, we also inspected order books, inventory records, issue vouchers and delivery notes so as to record all the equipment and supplies consumed. Administrators and hospital accounts were consulted to determine resources used at the administrative level and overhead costs. Whenever necessary, physical counting of equipment and supplies was performed. Health Management and Information Systems (HMIS) books and other relevant hospital records were used to collect data on the number of patients and visits, laboratory tests done and drugs dispensed during the costing period.

Cost valuation followed the economic (opportunity) costs approach (Gold *et al*. 1996; Drummond *et al*. 2005), whereby all resources are valued at the cost of their best alternative use. Data on the cost of medical supplies and equipment were based on the Tanzania Medical Stores Department (MSD) price catalogue (Medical Stores Department and Tanzania 2011\2012). We used the Tanzania Government Procurement Services Agency tender prices for other non-medical equipment and supplies. Rental charges for buildings were calculated according to National Housing Corporation (NHC) rates. The prevailing market price was used as proxy for items whose prices were unavailable from the data sources named above. All costs were estimated in Tanzanian shillings (TSh) and converted to US$ using a mean exchange rate of 1609 TSh/US$ (Bank of Tanzania 2012a) for the financial year 2011/2012.

Exit interviews were conducted to a total of 100 patients from the 4 study facilities using a structured questionnaire (see Supplementary Appendix S2) to obtain patient costs. These were adults aged ≥30 years who had been diagnosed with hypertension and/or diabetes at least 6 months prior to the interview. After probing for patients' alternative time use, market prices for agriculture and livestock products and Tanzanian minimum wages were used to value lost productive working hours during which patients are at health facilities receiving CVD preventive services. Finally, regression models were built to explore the relationships between relevant dependent and independent patient cost variables.

## Cost analysis

Providers' cost analysis was performed using Excel. All relevant health facility departments were grouped into direct, intermediate, supporting and administration service centres depending on whether they had direct patient contact or facilitated, supported or provided services necessary for a facility to function. Resource use was then classified as financial and economic costs and later grouped under capital or recurrent costs. Capital costs consist of items like buildings and equipment whose useful life exceeds a year, while recurrent costs include salaries and supplies.

Capital costs were annuitized using a rate of 9.6%, which was the average interest rate for the year 2011/12 reported by the Bank of Tanzania (2012b) and their useful life years were based on WHO assumptions (WHO 2012a). Capital items costing less than US$62 (TSh100 000) were treated as recurrent costs.

For each direct service centre, total financial and economic costs were calculated and apportioned to the intervention of interest using personnel time. Subsequently, a three-stage, step-down costing methodology (Conteh and Walker 2004; Drummond *et al*. 2005; Fleßa 2009) was used to allocate shared and overhead costs to the different service centres. First, costs were estimated and apportioned using an activity-based approach reflecting actual resource use (UNAIDS 2000, 2011); second, overhead service centre costs were allocated to supporting, intermediate and direct service centres. The accrued costs of the indirect service centres were then apportioned in the same manner until all costs were assigned to direct service centres (see Supplementary Appendix S3). Depending on the service centre being apportioned to, the total number of health facility visits, outpatient visits, CVD outpatient visits or CVD outpatients was used as the allocation keys. Finally, the total cost of the direct service centres was divided by the total number of CVD outpatients seen and total number of CVD visits made to derive the unit cost per patient and per visit.

Uncertainty was managed by performing sensitivity analysis assuming ±20% change around input prices (Mogyorosy and Smith 2005). In line with variability around drug prices, scenario analysis was performed to test changes in providers' unit cost when other valuation sources are applied.

Table 1 summarizes the recommendations of the WHO primary prevention of CVD guidelines after applying the risk prediction charts (WHO 2007). To estimate the cost required for its medical interventions implementation, we made the following assumptions in addition to these basic recommendations (Table 1). First, we assumed the same facility setup will be used and that upgrading of infrastructure is not required.

Second, health centre levels were deemed incapable of performing cholesterol tests or managing patients with a 10-year risk of CVD above 20% and thus these tests and patients were not included in the costing at this level. This is in accordance with the structure and capabilities of facility levels in Tanzania.

Third, for simplicity, two anti-hypertensives—thiazide diuretics as monotherapy and thiazide diuretics and angiotensin-converting enzyme inhibitors (ACEI) as duotherapy—are considered in the cost estimates (Wright and Musini 2009). However, for CVD risk patients with diabetes, ACEI and calcium channel blockers are costed due to contraindications for thiazide diuretics (Lemogoum *et al*. 2003; Grossman and Messerli 2011). Fourth, although glibenclamide is not directly recommended in the WHO guidelines it is considered in combination with metformin as duotherapy. This is because this drug is very likely to be available in low resource settings and it is mentioned in the pocket version of the WHO guidelines and elsewhere in the subsequent WHO reports for non-communicable disease management and control (WHO 2012b).

Patient cost data entry was done using EpiData software version 3.1. Descriptive and regression analyses were carried out using STATA 12. For descriptive analysis, summary statistics such as mean and standard deviation were computed and the Wilcoxon–Mann–Whitney rank sum test done. This non-parametric rank test was necessary due to positively skewed cost data. Two types of regression models were applied: multiple linear regression and logistic regression, with the outcome variables of choice being those which showed significant differences between facility locations. These were: cost of

**Table 1** WHO CVD primary prevention management and risk profile monitoring recommendations

| Ten-year risk level for a CVD event | Anti-hypertensive drugs | Lipid-lowering drugs | Hypoglycaemic drugs | Anti-platelet drugs | Risk profile monitoring |
|---|---|---|---|---|---|
| <10% | Lifestyle management[a] | Lifestyle management[a] | Lifestyle management[a] | None | Every 12 months |
| 10% to <19.9% | | | Metformin | | |
| 20 to 29.9% | Thiazide diuretics, angiotensin-converting enzyme inhibitors, calcium channel blockers | Lipid-lowering drugs (simvastatin[b]) | | | Every 6 months |
| >30% | | | | Soluble aspirin | Every 3 months |

*Source*: WHO (2007).

[a]Lifestyle management entails advice on diet, exercise and lifestyle, including smoking and alcohol intake.

[b]Simvastatin is the only off-patent lipid-lowering drug available at the MSD of Tanzania.

food, laboratory test and prescribed drugs and travel and waiting time. The remaining cost items, named cost of travel and consultation, total costs and loss of income, were considered as secondary outcome variables.

We hypothesized that the cost of receiving health care depends on several factors, including socioeconomic factors, CVD risk duration, household location and the facility's geographical location. These were therefore examined as explanatory variables. Our descriptive regression analysis started by examining the statistical association of each independent variable on the outcome variables (Model 1). We also tested for normality of residuals and in many instances, a log transformation of variables was necessary due to the non-normality of residuals.

After testing for multicollinearity, we included into the multiple regression analysis only those variables that were independently associated with the outcome variables (Model 2). Some outcome variables with obvious relevance to other outcome variables were included directly as regressors, e.g. travel time and cost of travel. We then ran a backward stepwise regression beginning with a full model, as a means of variable selection into the final model, in which we include significant and exclude insignificant independent variables according to the inclusion and exclusion criteria set at significance levels of 5% and 10%, respectively.

## Results

### Health facility cost of preventive cardiology

Tables 2–4 present total facility costs, unit costs and some key output statistics for CVD primary prevention as it is currently delivered at these four Tanzanian health facilities (Excel sheets presenting quantities of resource use and their unit prices are available from the authors upon request).

The observed annual costs of providing these services were higher at the hospital level than the health facility level. The cost per patient ranged from US$30–41 to US$52–71 per patient per year at the health centre and hospital levels, respectively. We did not observe marked differences in the unit cost per visit for urban facilities.

Outpatient departments were shown to be the main contributors to the total costs (59–86%), and in all facilities except the rural hospital, laboratory services were the second largest.

No substantial differences were noted in the distribution between capital and recurrent cost categories. In all the facilities, recurrent costs represented about three quarters of the total costs, with personnel representing the main cost driver.

Mixed results were observed in the case of unit cost estimates, whereby cost per visit was higher (US$8.8 vs US$7.8) and cost per patient lower (US$52 vs US$71) in rural facilities compared with urban facilities.

### Cost estimates of providing medical primary prevention of CVD according to the WHO guidelines

From Table 5, absolute risk management according to the WHO guidelines will require an addition of US$71 for very high-risk patients at the hospital level and US$4 for low-risk patients at the health centre level. Assuming that very high-risk and high-risk patients are managed at hospital level, this translates, on average, to almost double the cost per patient compared with current practice if other cost items except laboratory monitoring and drugs remain constant. However, the additional cost required for this strategy is not substantial for low-risk patients if managed at the health centre level.

### Sensitivity and scenario analyses

Cost per patient ranged from US$28–43 to US$49–74 for health centre and hospital level, respectively, when input prices varied by 20%. Both unit cost per patient and per visit estimates were robust to changes in drug valuation source from the Tanzanian MSD to median supplier drug prices of the International Drug Price Indicator Guide (Management Science for Health 2012). In all health facilities, unit costs decreased by 0.3% except in the urban health centre which saw a 0.5% increase when the latter was used. Implementing the WHO's CVD medical preventive guidelines will require on average US$39 more per patient—a 2% increase from the estimates seen when the Tanzanian MSD was used.

### Direct patient costs

Table 6 displays the costs incurred by patients in receiving medical treatment to prevent CVD. Reported below are the results for health facilities paired in their respective urban/rural settings since no major differences in costs were observed between facility levels in the same region. The main cost drivers differed depending on the facility's location, with the cost of

**Table 2** Annual hospital costs of providing primary prevention services for CVD as currently delivered in Tanzania, 2012 (US$)

| | Urban | | | | | Rural | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | OPD | Lab | Pharm | Other | Total | OPD | Lab | Pharm | Other | Total |
| Capital costs | | | | | | | | | | |
| Buildings | 6147 | 544 | 1126 | 1027 | 8844 | 543 | 54 | 54 | 43 | 694 |
| Equipment | 697 | 311 | 105 | 115 | 1228 | 116 | 21 | 11 | 12 | 160 |
| Training | 2944 | 0 | 0 | 0 | 2944 | 1650 | 0 | 0 | 0 | 1650 |
| Total capital costs | 9788 | 855 | 1231 | 1142 | 13 016 | 2309 | 75 | 65 | 55 | 2504 |
| Recurrent costs | | | | | | | | | | |
| Personnel | 19 866 | 4555 | 1943 | 3940 | 30 304 | 3449 | 559 | 496 | 528 | 5032 |
| Drugs[a] | 0 | 0 | 3120 | 0 | 3120 | 0 | 0 | 797 | 0 | 797 |
| Lab consumables | 0 | 3888 | 0 | 0 | 3888 | 0 | 218 | 0 | 0 | 218 |
| Supplies | 1062 | 135 | 74 | 394 | 1665 | 181 | 55 | 31 | 141 | 408 |
| Building operations | 0 | 0 | 0 | 2049 | 2049 | 0 | 0 | 0 | 61 | 61 |
| IEC materials | 2844 | 0 | 0 | 0 | 2844 | 2371 | 0 | 0 | 0 | 2371 |
| Total recurrent costs | 23 772 | 8578 | 5137 | 6383 | 43 870 | 6001 | 832 | 1324 | 730 | 8887 |
| Total | 33 560 | 9433 | 6368 | 7525 | 56 886 | 8310 | 907 | 1389 | 785 | 11 391 |

*Notes:* Exchange rate 1US$ = 1609 TSh.

IEC, information, education and communication; Lab, laboratory; OPD, outpatient department; Other, supporting departments (medical stores, medical records and laundry) and administration; Pharm, pharmacy.

[a]Drugs included here are oral anti-hypertensives and oral hypoglycaemic drugs; statins and low-dose aspirin were not consumed.

**Table 3** Annual health centre costs of providing primary prevention of CVD as currently delivered in Tanzania, 2012 (US$)

| | Urban | | | | | Rural | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | OPD | Lab | Pharm | Other | Total | OPD | Lab | Pharm | Other | Total |
| Capital costs | | | | | | | | | | |
| Buildings | 198 | 30 | 13 | 81 | 322 | 113 | 66 | 61 | 59 | 299 |
| Equipment | 18 | 2 | 1 | 4 | 25 | 16 | 6 | 7 | 13 | 42 |
| Training | 821 | 0 | 0 | 0 | 821 | 732 | 0 | 0 | 0 | 732 |
| Total capital costs | 1037 | 32 | 14 | 85 | 1168 | 861 | 72 | 68 | 72 | 1073 |
| Recurrent costs | | | | | | | | | | |
| Personnel | 1451 | 80 | 54 | 153 | 1738 | 606 | 303 | 170 | 425 | 1504 |
| Drugs[a] | 0 | 0 | 38 | 0 | 38 | 0 | 0 | 98 | 0 | 98 |
| Lab consumables | 0 | 129 | 0 | 0 | 129 | 0 | 140 | 0 | 0 | 140 |
| Supplies | 127 | 21 | 1 | 10 | 159 | 49 | 32 | 7 | 68 | 156 |
| Building operations | 0 | 0 | 0 | 23 | 23 | 0 | 0 | 0 | 20 | 20 |
| IEC materials | 1422 | 0 | 0 | 0 | 1422 | 949 | 0 | 0 | 0 | 949 |
| Total recurrent costs | 3000 | 230 | 93 | 186 | 3509 | 1604 | 475 | 275 | 513 | 2867 |
| Total | 4037 | 262 | 107 | 271 | 4677 | 2465 | 547 | 343 | 585 | 3940 |

*Notes:* Exchange rate 1US$ = 1609 TSh.

IEC, Information, education and communication; Lab, laboratory; OPD, outpatient department; Other, supporting departments (medical stores, medical records and laundry) and administration; Pharm, pharmacy.

[a]Drugs included here are oral anti-hypertensives and oral hypoglycaemic drugs; statins and low-dose aspirin were not consumed.

prescribed medication being prominent in the urban facilities while the cost of food recorded highest in rural facilities. The differences in cost were shown to be statistically significant at the 5% level, except for travel and consultation costs.

### Indirect patient costs

Presented in Table 6 are estimates of income loss due to working hours lost while receiving medical preventive services.

Fifty-five per cent of all patients in our sample reported that their income had been affected as a result of receiving these health services. Rural residents lost more income due to absence from productive work, although this difference was not statistically significant. As for the indirect costs of waiting and travel time, patients attending urban facilities had to wait twice as long (mean waiting time of 4 h for urban facilities) compared with those in rural facilities ($P = 0.0001$).[1] Even

**Table 4** Annual health facility output statistics and unit costs of providing primary prevention of CVD as currently delivered in Tanzania (service units in parentheses)

| | Urban | | Rural | |
|---|---|---|---|---|
| | Hospital | Health centre | Hospital | Health centre |
| Facility output by department | Number | | | |
| Outpatient department (CVD visits) | 7 323 | 631 | 1 298 | 558 |
| Outpatient department (CVD patients) | 802 | 158 | 217 | 95 |
| Outpatient department (all visits) | 75 435 | 87 923 | 47 906 | 11 638 |
| Laboratory department (tests) | 26 443 | 3 946 | 1 722 | 4 004 |
| Total health facility (visits) | 114 828 | 87 923 | 55 390 | 12 622 |
| Unit costs by service centre (patients) | | 2012, US$ | | |
| Outpatient department | 41.8 | 25.5 | 38.3 | 25.9 |
| Laboratory department | 11.8 | 1.7 | 4.2 | 5.8 |
| Pharmacy department | 7.9 | 1.1 | 6.4 | 3.6 |
| Supporting department and administration | 9.4 | 1.8 | 3.6 | 6.2 |
| Unit costs per patient/visit—all service centres | | 2012, US$ | | |
| Cost per patient | 71 | 30 | 52 | 41 |
| Cost per visit | 7.8 | 7.4 | 8.8 | 7.1 |

**Table 5** Estimated additional annual cost per patient of implementing WHO primary prevention of CVD guidelines, 2012 (US$)

| Ten-year CVD risk | Hospital level | | Heath centre level | |
|---|---|---|---|---|
| | Very high risk >30% | High risk 20–29.9% | Moderate risk 10–19.9% | Low risk <10% |
| Cost of medication | 55 | 36 | 29 | — |
| Cost of laboratory risk profile monitoring | 16 | 8 | 4 | 4 |
| Total | 71 | 44 | 33 | 4 |

*Notes:* Exchange rate: 1US$ = 1609 TSh.

though travel costs were higher in the rural region, travel time was significantly shorter $(P = 0.015)$[1] compared with the urban region, by an average of 20 min.

### Patient cost regression analysis results

Stepwise regression analysis results for each of the six outcome variables, with insignificant variables omitted (see Supplementary Appendix S4), shows that younger patients (<40 years old) paid 50% more for drugs $(P = 0.042)$ compared with other age groups (40–59 and >60 years old). The cost of drugs was also significantly higher for patients attending urban facilities, by 55% $(P = 0.001)$. CVD risk duration and socioeconomic status did not significantly explain the cost of drugs. Even though respondents stated a preference for more hospital visits as a reason to avoid buying drugs, the model results showed an insignificant contribution from this explanatory variable (Table 7).

Facility's geographical location was not a significant explanatory variable for cost of food or laboratory tests, in contrast to the rank test results in Table 6. Waiting time was not significantly explained by travel time. Patients attending urban facilities had to wait and travel longer than rural facility attendees (Table 7). Patients attending urban facilities and

those having had CVD risk factors for more than 2 years decreased the log odds of frequent clinic visits compared to patients attending rural facilities and newly diagnosed. This probability of more visits was increased in patients younger than 40 years. The model results did not reveal a negative influence from cost of drugs, waiting or travel time on frequency of clinic visits.

### Patient cost uncertainty

Patient costs seem to be uncertain, with long 95% confidence intervals for total cost. According to the standard deviations presented in Table 6, total annual cost per patient ranged from US$14–223 to US$10–245 in the urban and rural settings, respectively.

## Discussion

This work sets out to estimate the cost of primary medical prevention of CVD from two perspectives, the providers' and the patients'. The providers' viewpoint was first analyzed according to current practice and then, additionally, we estimated costs assuming a scenario in which the WHO's medical primary prevention of CVD guidelines are being followed. To the best of our knowledge, this is the first study in the sub-Saharan context to evaluate the cost of primary medical interventions to prevent CVD.

Several main findings emerged from this study. First, utilization rates and bypassing of the health referral system drive the unit costs. Second, cost estimates indicate that implementing the WHO's medical primary preventive guidelines more than doubles the costs of current practice—assuming other cost items remain constant—warranting further evaluation. Third, even though health services are free at the point of use for patients with chronic diseases in Tanzania, the cost of medication is shown to be among the main patient cost drivers. Additionally, the geographical location of health facilities

**Table 6** Annual direct and indirect patient costs, 2012 (US$)

| | Urban facilities | | | | Rural facilities | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number of observations = 65 | | | | Number of observations = 35 | | | | *P* value[a] | Probability (rural > urban) |
| | Mean | SD | Minimum | Maximum | Mean | SD | Minimum | Maximum | | |
| Direct costs | | | | | | | | | | |
| One-way travel cost[b] | 14.0 | 16.2 | 0.0 | 74.6 | 24.6 | 32.9 | 0.0 | 139.2 | 0.4409 | 0.549 |
| Cost of food | 27.3 | 19.8 | 5.0 | 89.5 | 39.6 | 18.1 | 14.9 | 89.5 | 0.0003 | 0.720 |
| Medical consultation cost[c] | 1.3 | 3.4 | 0.0 | 14.9 | 0.9 | 2.3 | 0.0 | 7.5 | 0.6749 | 0.484 |
| Cost of laboratory tests | 1.1 | 3.0 | 0.0 | 12.4 | 2.8 | 3.1 | 0.0 | 7.5 | 0.0004 | 0.667 |
| Cost of prescribed drugs | 51.1 | 34.7 | 0.0 | 139.2 | 28.8 | 24.8 | 0.0 | 101.4 | 0.0013 | 0.305 |
| Indirect costs | | | | | | | | | | |
| Loss of income | 23.3 | 26.3 | 0.0 | 79.6 | 30.3 | 28.5 | 0.0 | 74.6 | 0.2120 | 0.572 |
| Total costs | 118.2 | 53.3 | 31.4 | 307.6 | 127.3 | 59.8 | 44.7 | 245.1 | 0.3292 | 0.559 |

*Notes:* Exchange rate 1US$ = 1609 TSh.

SD = standard deviation.

[a]*P* value of Mann–Whitney *U* test due to a non-normal data distribution.

[b]Travel costs for 13 patients residing in the rural region but attending urban facilities were omitted as these were outliers, including them makes the mean cost for urban facilities 20.9.

[c]All diabetic patients and patients over 60 years of age are exempted.

**Table 7** Patient cost regression model results

| Explanatory variables | Primary outcome variables | | |
|---|---|---|---|
| | *β* coefficient | *P* value | Confidence interval |
| Cost of drugs (*n* = 87) | | | |
| Age ≤ 40 years | 0.500 | 0.042 | 0.018 to 0.981 |
| Urban facilities[a] | 0.553 | 0.001 | 0.277 to 0.829 |
| Cost of food (*n* = 100) | | | |
| Frequent clinic visits[b] | 0.695 | 0.001 | 0.466 to 0.923 |
| Cost of laboratory tests (*n* = 27) | | | |
| Time to diagnosis[c] | −0.455 | 0.009 | −0.785 to −0.125 |
| Formal education[d] | −0.447 | 0.016 | −0.900 to −0.006 |
| Waiting time (*n* = 100) | | | |
| Urban facilities[a] | 1.630 | 0.001 | 1.135 to 2.124 |
| Travel time (*n* = 100) | | | |
| Travel cost | 0.173 | 0.007 | 0.048 to 0.297 |
| Frequent clinic visits[e] (*n* = 72) | | | |
| Age < 40 years | 2.169 | 0.032 | −4.877 to −0.499 |
| Time to diagnosis[c] | −2.680 | 0.005 | −4.534 to −0.825 |
| Urban facilities[a] | −2.793 | 0.001 | −4.132 to −1.454 |

[a]Urban relative to rural facilities.

[b]Frequent (≥7) relative to infrequent (≤6) clinic visits.

[c]Two years or more since diagnosis relative to less than 1 year.

[d]Formal relative to informal education.

[e]Binary outcome variable: frequent visits is 7 to maximum and infrequent visits is 6 to minimum.

influenced most of the patients' costs, indicating the need for further research into the role of other provider characteristics in explaining these costs.

Total cost and unit costs at hospital level were expected to be higher than those of health centres. This is because hospitals are planned for the management of severe and complex cases and therefore requires sophisticated diagnostic services and equipment, specialized clinical experts and they generally have higher over heads than low-level facilities. However, it is worth noting that cost per visit estimates were not so different at the two delivery levels for the urban facilities. One plausible explanation could be the common phenomenon of the bypassing of lower level facilities, with the most cited reason being the perceived higher quality of care, for instance, availability of drugs at higher level facilities (Harpham and Molyneux 2001; Klemick *et al.* 2009). This implies that health centres may be underutilized, and the hospital level is likely to be managing low-risk patients instead of concentrating on those at high risk, hence decreasing efficiency and increasing costs for these facilities. More space for resource saving is therefore possible if patients with moderate-to-low CVD risk levels are attended at lower level facilities.

The availability of many and highly qualified personnel (Munga and Mæstad 2009), advanced equipment and functional laboratories makes it probable that total costs will be higher in urban than in rural facilities, as is shown in our study results. For example, laboratory costs for the urban hospital are seven times higher than those of its rural counterpart. Unit costs, on the other hand, portrayed mixed results in this case. This could again be explained by the factors of referral bypass for urban facilities highlighted above, meaning that these hospitals are receiving many visits from patients who could be managed at health centres, hence driving down the cost per visit. Dissimilarities in the organization of the health centres costed here (purely public in the case of the urban health centre compared with a designated facility—church owned—for the rural health centre) may make comparisons challenging in our case. Designated facilities have higher standards of care (reflected here in their higher laboratory and drug costs) than is usual in public facilities.

The structured medical management of patients according to the WHO's guidelines will require more resources to implement

than those currently allocated. More resources are dedicated to patients with a 10-year CVD risk level above 20% due to their high drug requirements and frequent risk profile monitoring. As will be pointed out in the limitations later, part of the cost estimates of current practice may be explained by inefficiencies and so, assuming that implementing such guidelines will reduce inefficiencies by, among other things, minimizing unnecessary visits, then the extra amount needed could be lower than the annual US\$38 per patient estimated by this work. If this scenario is partly or wholly absorbed by government facilities, it will decrease part of the patients' financial burden, especially private expenditure on drugs. It is worth noting that if public facilities are frequently out of drugs—as is currently observed—the discrepancies between drug availability and demand will increase.

In Tanzania, public health care services are 'free' for patients >60 years of age, those with chronic diseases and the poor. However, our study results suggest that financial protection from such costs by public health facilities seems to be a far cry from reality, especially for non-communicable diseases, which are traditionally not prioritized in low-income countries. This study has shown that private expenditure on medication surfaces as one of the main drivers of direct patient costs for urban residents (an average of US\$51 per patient per year) and second highest for rural residents (at US\$29 per patient per year). The obvious reason for the high out-of-pocket (OOP) expenditure on drugs in this setting is the frequently empty drug shelves in government facilities. The easy accessibility of newer drug classes in private pharmacies in urban areas may explain the high expenditure on drugs by urban patients. Moreover, it was found that pharmaceutical marketing personnel have an influence on the prescription patterns of drugs, making it probable that prescribed medications are not selected from the cheaper national essential drug list, and hence impacting on the high cost of drugs to patients (Mori *et al*. 2013).

In rural areas, travel and food costs contributed substantially to direct patient costs; this finding is similar to those of other studies reporting such costs to be the greatest barriers to obtaining health services (Ensor and Cooper 2004; Peters *et al*. 2008). Lost income was also higher in this location (although the difference was statistically insignificant) and this could be due to having more patients engaged in agriculture and/or working with livestock, whose sales depend on specific market days which might fall on clinic days, compared with employed work or daily market days in the urban region.

The current gross domestic product per capita for Arusha region is US\$413 (National Bureau of Statistics 2011), implying that patients in this study spend on average 30% of their annual income on receiving CVD preventive services. It can be argued that our (hospital rather than community) patient sample may be assumed to have a higher than average health-seeking behaviour and hence their expenditure per capita on medical care is high, making this percentage likely to be lower in the general population. Nevertheless, the fact that patients are spending more than 10% of their annual income on CVD prevention alone is alarming. Such a high financial burden on patients might have an impact on their health-seeking behaviour and hence lead to low utilization of health services and poor compliance with treatment for these chronic illnesses (Mendis *et al*. 2004; Bovet *et al*. 2008).

Of all the outcome variables in the patient costs regression analysis, facility location has been shown to significantly explain most of these costs. Interestingly, urban facility location has both a positive and a negative effect (Table 7). The positive influence on cost of drugs and waiting time may be explained by the influence of pharmaceutical marketing on observed prescription patterns and the bypassing of the health referral system highlighted above. Its negative effect on the frequency of clinic visits may indicate that issues of perceived poor health care quality in rural areas (Harpham and Molyneux 2001; Klemick *et al*. 2009) and problems with the full implementation of decentralization in Tanzania's health sector (Munga *et al*. 2009; Maluka *et al*. 2011) are important contributors. The resource management mandate from central government to district councils is not substantial enough to allow them to make practical decisions about, for example, drug stocking. Further research on the possible role of other provider characteristics in explaining both facility and, importantly, patient costs needs to be explored.

Uncertainty around patient costs is startling. Annual cost incurred per patient was as little as US\$10 and US\$14 to as high as US\$245 and US\$223 for rural and urban facilities, respectively. Outliers, especially in travel and accommodation costs for patients residing in the rural areas but attending urban facilities, could partly explain this. More so though, these huge differences could be motivated by recall bias. Use of better methodology, like diaries to record costs incurred, could be more useful in estimating more accurate values.

## Strengths and limitations

Several strengths can be noted in this work. First, we took both provider and patient perspectives, a viewpoint which enables a reflection on the distribution of the financial burden and helps to detect cost shifting between different segments of society. Second, the ingredients approach to costing employed in this study is considered to be more informative than other methods, for example reference costing, due to its detailed primary data on actual resource use. Finally, since chronic patients do not usually pay user fees and OOP drug payments were mainly made in private pharmacies, double counting was largely avoided.

This study also has some limitations. First, because of the small number of facilities, which were not randomly selected, the results cannot be used to make broad generalizations about urban/rural differences or differences in costing structures between levels of health service delivery. More research is needed to better predict the cost implications at different service levels if preventive cardiology is scaled up in Tanzania and to better understand how costs may influence service utilization by different groups within the population. Nonetheless, given that these facilities are public and resource inputs are centrally purchased within government-owned bodies (MSD, NHC, government salary scales, etc.), regional and zonal generalizations can cautiously be made. Second, part of the provider perspective costing was based on current practices; these could be inefficient, leading to an overestimation of costs. However, given the African context of resource-constrained health systems, overestimation may be unlikely. Third, blunt interpretation of the unit cost results are

discouraged since information from the HMIS books—from which unit costs are based—is expected to be of mixed quality. To minimize this uncertainty, we cross-checked these data using other HMIS books and patient log books present at each patient care service centre.

Finally, the stepwise regression method used in the patient cost data is not without problems (Campbell 2008), as such, results need to be interpreted with caution since some variables coded as dummies may be lost in the model fitting, changing the interpretation of other controlled variables; however, as stated above, the analysis was undertaken for descriptive and not confirmatory purposes.

## Conclusion

This study estimated providers' costs of CVD medical primary prevention services from two main viewpoints: what is, that is the current practice, and what if, reflecting the WHO guidelines scenario, in four health facilities. We further determined the direct and indirect costs to patients of receiving such services in Tanzania. Utilization rates appear to influence the current practice cost estimates, suggesting that appropriate use of lower level facilities is important to ensure proper resource allocation and more efficient CVD prevention. At this point, implementing the WHO guidelines is more costly than the current Tanzanian practice for patients at all risk levels except lowest and so it is important to answer questions about whether it is worth pursuing this approach relative to its additional benefits. The study results also reveal considerably high patient costs, indicating that the distributive and equity implications of access to care need further consideration. A substantial under estimation of the total cost of these interventions at the societal level is likely when patient costs are ignored. The geographical location of facilities is an important determinant of patient costs, and further research is required to better understand the influence of other provider characteristics on these costs and how best to scale up these interventions in Tanzania.

## Ethical Approval

Ethical clearance was provided by the Ethical Review Committee of the Tanzania National Institute of Medical Research, Ref. No. NIMR/HQ/R.8a/Vol. IX/1364. Respondents from the four facilities costed were asked for their consent to participate in the study and written permission was obtained before the interviews.

## Supplementary Data

Supplementary data are available at *HEAPOL* online.

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## Endnote

[1] *P* value of Wilcoxon–Mann–Whitney *U* test.

## References

Aspray TJ, Mugusi F, Rashid S *et al.* 2000. Rural and urban differences in diabetes prevalence in Tanzania: the role of obesity, physical inactivity and urban living. *Transactions of the Royal Society of Tropical Medicine and Hygiene* **94**: 637–44.

Association of Physicians of Tanzania. 2003. *Guidelines for the Management of Hypertension*. Dar es Salaam: Association of Physicians of Tanzania.

Bank of Tanzania. 2012a. *Financial Markets; Interbank Foreign Exchange Market (IFEM) Summaries*. http://www.bot-tz.org/FinancialMarkets/IFEMsummaries/IFEMsummaries.asp, accessed September 2012.

Bank of Tanzania. 2012b. *Interest Rate Structure*. http://www.bot-tz.org/Publications/InterestRates.htm, accessed September 2012.

Bloom DE, Cafiero ET, Jané-Llopis E, Abrahams-Gessel S. 2011. *The Global Economic Burden of Noncommunicable Diseases*. Geneva: World Economic Forum.

Bovet P, Gervasoni JP, Mkamba M *et al.* 2008. Low utilization of health care services following screening for hypertension in Dar es Salaam (Tanzania): a prospective population-based study. *BMC Public Health* **8**: 407.

Bovet P, Ross AG, Gervasoni JP *et al.* 2002. Distribution of blood pressure, body mass index and smoking habits in the urban population of Dar es Salaam, Tanzania, and associations with socioeconomic status. *International Journal of Epidemiology* **31**: 240–7.

Campbell MJ. 2008. *Statistics at Square Two: Understanding Modern Statistical Applications in Medicine*, JohnWiley & Sons.

Connor MD, Walker R, Modi G, Warlow CP. 2007. Burden of stroke in black populations in sub-Saharan Africa. *Lancet Neurology* **6**: 269–78.

Conteh L, Walker D. 2004. Cost and unit cost calculations using step-down accounting. *Health Policy and Planning* **19**: 127–35.

Dalal S, Beunza JJ, Volmink J *et al.* 2011. Non-communicable diseases in sub-Saharan Africa: what we know now. *International Journal of Epidemiology* **40**: 885–901.

Drummond MF, Sculpher MJ, Torrance GW, O'Brien BJ, Stoddart GL. 2005. *Methods for the Economic Evaluation of Health Care Programmes*, Oxford University Press, Oxford.

Edwards R, Unwin N, Mugusi F *et al.* 2000. Hypertension prevalence and care in an urban and rural area of Tanzania. *Journal of Hypertension* **18**: 145–52.

Ensor T, Cooper S. 2004. Overcoming barriers to health service access: influencing the demand side. *Health Policy and Planning* **19**: 69–79.

Fleßa S. 2009. *Costing of Health Care Services in Developing Countries: A Prerequisite for Affordability, Sustainability and Efficiency*. Lang: Frankfurt am Main.

Gaziano T. 2008. Economic burden and the cost-effectiveness of treatment of cardiovascular diseases in Africa. *Heart* **94**: 140–4.

Gaziano TA. 2007. Reducing the growing burden of cardiovascular disease in the developing world. *Health Affairs* **26**: 13–24.

Gaziano TA, Steyn K, Cohen DJ, Weinstein MC, Opie LH. 2005. Cost-effectiveness analysis of hypertension guidelines in South Africa: absolute risk versus blood pressure level. *Circulation* **112**: 3569–76.

Gill GV, Mbanya JC, Ramaiya KL, Tesfaye S. 2009. A sub-Saharan African perspective of diabetes. *Diabetologia* **52**: 8–16.

Gold MR, Siegel JE, Russell LB, Weinstein MC. 1996. *Cost-Effectiveness in Health and Medicine*. Oxford University Press, Oxford.

Grossman E, Messerli FH. 2011. Management of blood pressure in patients with diabetes. *American Journal of Hypertension* **24**: 863–75.

Hall V, Thomsen RW, Henriksen O, Lohse N. 2011. Diabetes in sub Saharan Africa 1999-2011: epidemiology and public health implications. A systematic review. *BMC Public Health* **11**: 564.

Harpham T, Molyneux C. 2001. Urban health in developing countries: a review. *Progress in Development Studies* **1**: 113–37.

Hendriks ME, Wit FW, Roos MT *et al.* 2012. Hypertension in sub-Saharan Africa: cross-sectional surveys in four rural and urban communities. *PloS One* **7**: e32638.

Jackson R, Lawes CM, Bennett DA, Milne RJ, Rodgers A. 2005. Treatment with drugs to lower blood pressure and blood cholesterol based on an individual's absolute cardiovascular risk. *The Lancet* **365**: 434–41.

Klemick H, Leonard KL, Masatu MC. 2009. Defining access to health care: evidence on the importance of quality and distance in rural Tanzania. *American Journal of Agricultural Economics* **91**: 347–58.

Lemogoum D, Seedat YK, Mabadeje AF *et al.* 2003. Recommendations for prevention, diagnosis and management of hypertension and cardiovascular risk factors in sub-Saharan Africa. *Journal of Hypertension* **21**: 1993–2000.

Maluka SO, Hurtig AK, Sebastián MS *et al.* 2011. Decentralization and health care prioritization process in Tanzania: from national rhetoric to local reality. *The International Journal of Health Planning and Management* **26**: e102–20.

Management Science for Health. 2012. *International Drug Price Indicator Guide, 2012*. Arlington, TX: Management Science for Health.

Mathers C, Fat DM, Boerma JT. 2008. *The Global Burden of Disease: 2004 Update*. Geneva: World Health Organization.

Mbanya JC, Mbanya D. 2003. Diabetes cost in sub-Saharan Africa. *Journal of Cardiovascular Risk* **10**: 191–3.

Mbanya JC, Motala AA, Sobngwi E, Assah FK, Enoru ST. 2010. Diabetes in sub-Saharan Africa. *The Lancet* **375**: 2254–66.

Medical Stores Department, Tanzania. 2011\2012. *Price Catalogue of Essential Medicines, Diagnostics and Hospital Supplies*.

Mendis S, Abegunde D, Oladapo O, Celletti F, Nordet P. 2004. Barriers to management of cardiovascular risk in a low-resource setting using hypertension as an entry point. *Journal of Hypertension* **22**: 59–64.

Mensah GA. 2008. Ischemic heart disease in Africa. *Heart* **94**: 836–43.

Ministry of Health and Social Welfare. 2000. *National Package of Essential Health Interventions*. Dar es Salaam: Ministry of Health and Social Welfare.

Ministry of Health and Social Welfare. 2008. *Health Sector Strategic Plan III: ''Partnerships for Delivering the MDGs'' July 2009–June 2015*. Dar es Salaam: Ministry of Health and Social Welfare.

Mogyorosy Z, Smith P. 2005. The main methodological issues in costing health care services: a literature review. *CHE Research Paper 7*.

Mori AT, Kaale EA, Ngalesoni F, Norheim OF, Robberstad B. 2013. The role of evidence in the decision-making process of selecting essential medicines in developing countries: the case of Tanzania. PloS one, 9, e84824.

Msuya J. 2003. *Horizontal and Vertical Delivery of Health Services: What Are the Tradeoffs*. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/2003/01/2593723/horizontal-vertical-delivery-health-services-trade-offs# accessed June 2013.

Munga M, Mæstad O. 2009. Measuring inequalities in the distribution of health workers: the case of Tanzania. *Human Resources for Health* **7**: 4.

Munga MA, Songstad NG, Blystad A, Mæstad O. 2009. The decentralisation-centralisation dilemma: recruitment and distribution of health workers in remote districts of Tanzania. *BMC International Health and Human Rights* **9**: 9.

Murray CJ, Vos T, Lozano R *et al.* 2012. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet* **380**: 2197–223.

National Bureau of Statistics. 2011. *National Accounts of Tanzania Mainland 2000-2010*. Dar es Salaam: National Bureau of Statistics.

Njelekela MA, Mpembeni R, Muhihi A *et al.* 2009. Gender-related differences in the prevalence of cardiovascular disease risk factors and their correlates in urban Tanzania. *BMC Cardiovascular Disorders* **9**: 30.

Njelekela M, Negishi H, Nara Y *et al.* 2001. Cardiovascular risk factors in Tanzania: a revisit. *Acta Tropica* **79**: 231–9.

Peters DH, Garg A, Bloom G *et al.* 2008. Poverty and access to health care in developing countries. *Annals of the New York Academy of Sciences* **1136**: 161–71.

Reddy KS. 2004. Cardiovascular disease in non-Western countries. *New England Journal of Medicine* **350**: 2438–510.

Sanderson JE, Mayosi B, Yusuf S *et al.* 2007. Global burden of cardiovascular disease. *Heart* **93**: 1175.

Twagirumukiza M, De Bacquer D, Kips JG *et al.* 2011. Current and projected prevalence of arterial hypertension in sub-Saharan Africa by sex, age and habitat: an estimate from population studies. *Journal of Hypertension* **29**: 1243–52.

Joint United Nations Programme on HIV/AIDS (UNAIDS). 2000. *Costing Guidelines for HIV Prevention Strategies*. Geneva: UNAIDS.

UNAIDS. 2011. *Manual for Costing HIV Facilities and Services*. Geneva: UNAIDS.

WHO. 2007. *Prevention of Cardiovascular Disease: Guidelines for Assessment and Management of Cardiovascular Risk*. Geneva: WHO.

WHO. 2012a. *CHOosing Interventions that are Cost Effective (WHO-CHOICE)*. http://www.who.int/choice/costs/useful_life/en/index.html, accessed September 2012.

WHO. 2012b. *Prevention and Control of Non-Communicable Diseases: Guidelines for Primary Health Care in Low-Resource Settings*. Geneva: WHO.

Wright JM, Musini VM. 2009. First-line drugs for hypertension. *Cochrane Database of Systematic Reviews*. CD001841.