A systematic review and meta-analysis of WTP for prevention and treatment of malaria

Trapero-Bertran M[1], Mistry H[1], Shen J[2], Fox-Rushby J[1]

[1]Health Economics Research Group, Brunel University

[2]Newcastle University

Contact Details

Marta Trapero-Bertran, HERG, Brunel University, Uxbridge, Middlesex, UB8 3PH Tel +44 (0)1895 265443 Email: Marta.Trapero-Bertran@Brunel.ac.uk

Abstract

Predictions of the demand for or perceived benefits of, health interventions tend to be made from the results of a single study. This has prompted researchers to explore alternative approaches to derive parameter estimates. The increasing use of willingness to pay (WTP) in malaria control interventions offers an opportunity to explore such methods and findings for a relatively similarly defined set of interventions. The empirical results also have policy relevance as Governments consider cost recovery options and strategies to influence the demand for treated mosquito nets.

The paper attempts to review the evidence on the WTP for malaria prevention and treatment in endemic areas, to determine what has been studied and how, provide a summary mean WTP by type of intervention, consider how and why WTP estimates vary, and advice on future reporting of WTP studies.

Meta-analysis of WTP for malaria prevention and treatment can help to compare results using different elicitation methods and facilitate the transfer of data across space and time. In practice, this analysis has shortcomings that may limit the validity of results such as the lack of specified information in some publications. However, the analysis also suggests ways in which future reporting and analysis of individual WTP papers could improve the validity and usefulness of WTP data as well as informing methods for benefit transfer method in the future.

Key words: willingness to pay, malaria, meta analysis, prevention, treatment, benefit transfer

Introduction

The estimation of a household's demand for malaria prevention and treatment is important for several reasons. It allows policy makers to balance the goal of cost recovery and potential need for government subsidies against the desire to guarantee that a certain fraction of the population is protected from this disease (Poulos et at., 2006). Secondly, it is necessary to consider what influences elasticities of demand and therefore how to influence demand. Thirdly, estimating values can facilitiate use of cost-benefit analysis (CBA) to help decision-makers prioritise limited health care resources (Brouwer and Bateman, 2005).

The interest of many governmental institutions in developing relevant malaria policies has led to a plethora of studies that try to establish the mean willingness to pay (WTP) for malaria prevention and treatment. To date each study has been conducted largely independently and these studies vary widely in methodology, underlying models, and, not surprisingly, could leave policy makers in disarray regarding which policy to implement (Kremers et al., 1999). WTP studies can also be costly and may take too long to implement and analyse for policy decisions. Therefore a synthesis of literature could feed into policy decisions in a variety of contexts and meta-analysis may offer a useful analytical framework.

Systematic reviews of effectiveness and cost-effectiveness analysis are relatively common in the health sector, although this is not the case with WTP studies – perhaps because it would present a very partial view of efficiency. However, we noticed that this is not the case outside of health economics, for instance the environmental field, where meta-analysis (Brouver et al., 1999) and benefit transfer (Bateman et al., 2005) studies have been applied.

Relative to the range of other health interventions assessed using WTP (Diener et al 1998; Olsen and Smith, 2001) studies of malaria control interventions have been unusually common and therefore offer a potentially natural route to exploring some issues of practice within health economics. Secondly, within malaria control, WTP for insecticide treated nets (ITNs) have been more frequent and could be argued to be more likely to be similar across countries (albeit we expect both size, colour, material and insectide could vary) relative to spraying programmes and that therefore differences in WTP may be less likely to be due to differences in the nature of the intervention.

Our aim in this study was threefold. First, to find out: what is known about WTP for malaria control; what has been studied; how these WTP studies have been conducted; and what mean WTP is. The secondary aim was to find out: how and why mean WTP varies. Finally, we wanted to reflect on the process and consider implications for future reporting of WTP studies both for malaria control and beyond.

Methods

Five databases (MEDLINE, Ingenta, BIDS (Bath Information and Data Services), IBSS (International Bibliography of the Social Sciences) and Econlit) were searched from their inception to August 2006 using the following search terms (1) willing or willingness AND pay

crossed with malaria; (2) contingent AND value or valuation with malaria[1]. In addition, an internet search was undertaken using the same search terms in English and Spanish[2]. Papers were excluded if they: were not WTP studies; used observed rather than stated preferences for WTP; did not contribute to useful information for descriptive and quantitative analysis; were inaccessible; reported WTP for malaria specific sources of goods which could not be extracted from other services or goods; focussed on treatment access or duplicated results.

Each abstract and paper selected was double reviewed, with a third reviewer consulted for any unresolved issues. The data extraction form included questions on; context, study question and design, type of good/service valued, sampling and characteristics of sample, statistical distribution of WTP, methods of analysing WTP, as well as strengths and weaknesses (see authors for full details).

Three types of analysis were undertaken: descriptive statistics to provide an overview of the literature in terms of the location, context, and study design; meta-analysis to summarise mean WTP; and meta-regression to explain variation in mean WTP. For the quantitative analysis, mean WTP and its standard deviation was converted to Int$ 2006 using country-specific gross domestic product deflators (World Bank, IMF, 2006) and World Bank purchasing power parities (Mulligan et al., 2003). Meta-analysis was based on the fixed-effects procedure described by Petitti (2000). Effect size is measured on a continuous scale and calculated as the sum of the product of the inverse of the variance per mean of each study, divided by the sum of the inverse of the variance (Petitti, 2000). The mean is weighted by sample size. 95% confidence intervals for the summary mean were also calculated. Summary valuation results are grouped by type of good (insecticide treated nets (ITNs), prevention and treatment goods) and survey design characteristics (elicitation format, country and area) and reported for the inclusion and exclusion of zero values. Mean WTP was assumed to include zero values, unless otherwise stated[3]. The next step determined whether differences in effect size existed as a function of other variables and considered which variables should be included in a meta-regression to control for heterogeneity.

Meta regression is used to synthesize research findings, test hypotheses and lead to interpretation for policy. To establish the range of independent variables for inclusion in the meta regression, results from all published regression analyses were compared with respect to

[1] In MEDLINE willing$ and valu$ was used instead, and in addition to a search using malaria as a MESH term with all subheadings.
[2] (1) 'capacidad' 'Y' 'pagar' crossed with malaria, (2) 'contingente' 'Y' 'valor' or 'valoracion' with malaria
[3] The only papers not to clarify whether zeros had been included were references 71 and 76 (Appendix A).

the type and number of variables as well as the level and direction of significance. From our findings we had the choice to include study specific data or to collect new data to explain variance. Where possible we used study specific data directly (e.g. % males in sample) or by recoding study specific data (e.g. type of education, to account for different categorisations in publications). However, some data was collected in too heterogeneous way or not reported in a usable way by enough papers (e.g. income). In such cases, alternative data was sought e.g. GNI per capita. As it has also been demonstrated that endemicity of malaria is likely to be an important explanator (Onwujekwe, 2004) but is not reported, as studies are undertaken in a limited number of locations, additional data on malaria incidence was also collected (World Bank, UNICEF, 2005; Korenromp, 2005).

Ordinary least squares (OLS) was used with log-transformed continuous variables, based on standard error estimates weighted by sample size and corrected by clustering with respect to the relationship between studies and individual papers. Then, WTP estimates based on larger samples are given more weight (van Houtven et al, 2006). We expected that more education, a higher percentage of male respondents, married people, knowledge of ITNs, GNI per capita and studies excluding zero values would be positively associated with mean WTP. We also expected WTP to be negatively related with the use of open-ended elicitation methods. A series of regression diagnostics were undertaken (Chen et al, n.d): the presence of outliers, using 'iqr', and Shapiro-Wilk W test to test for normality; Breusch-Pagan / Cook-Weisberg test and White's general test statistic to assess the null hypothesis that the variance of the residuals is homogeneous (Chen, [n.d.]); the Variance Inflation Factor (VIF) and Condition Number (CN) to assess collinearity; and the RAMSEY reset test to test for omitted variable bias. All statistical analyses were undertaken using Stata version 9.2 (StataCorp, 2003).

Results

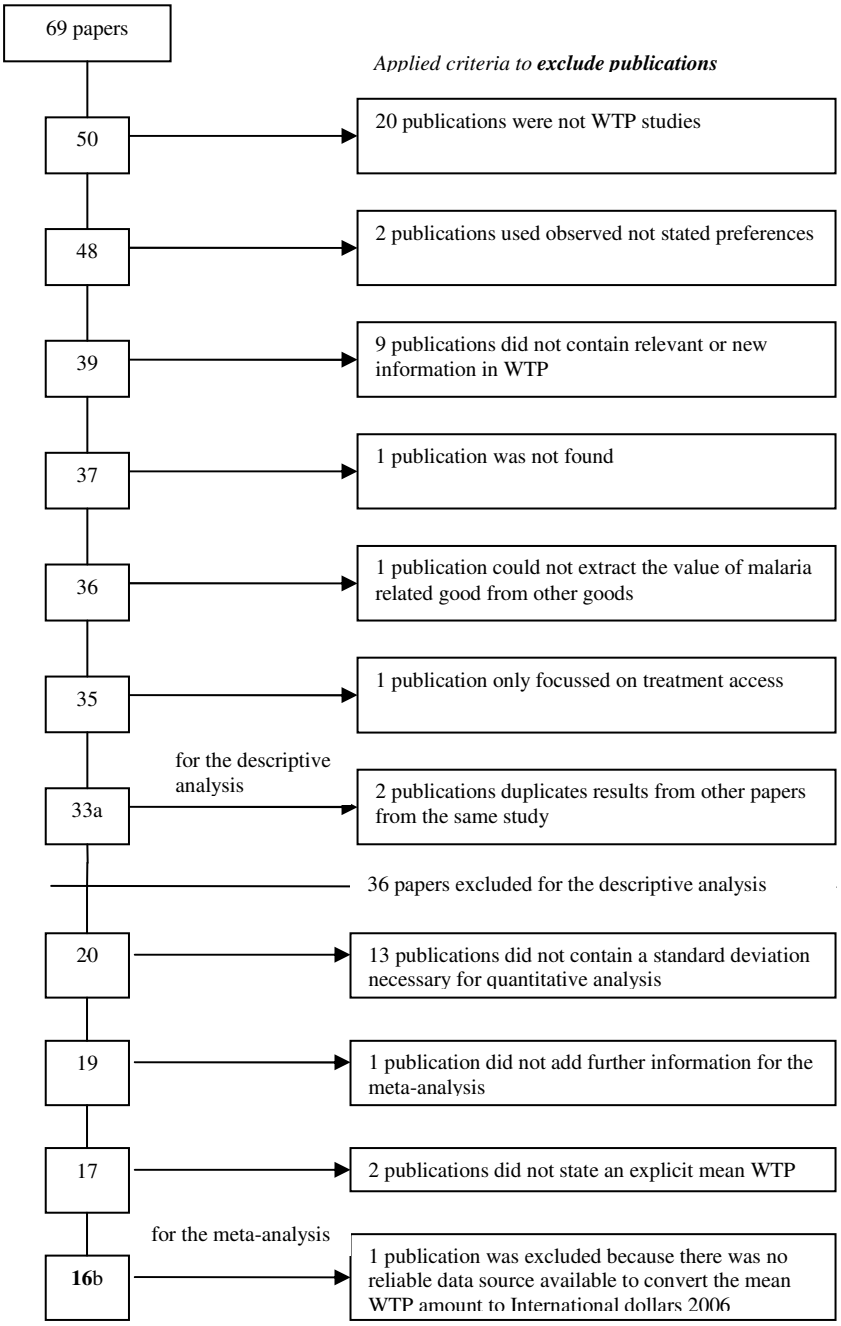
Papers selected

Figure 1 documents the flow of papers through the study and the hierarchical exclusion criteria applied by number of papers excluded. It shows that from the sample of 69 abstracts found, 33 met all the inclusion criteria for the descriptive analysis and, from those, only 16 could be included in the meta-analysis.

Of the 33 papers reviewed, most were journal papers (82%), followed by technical reports (12%) and most published papers were in medical (n=16) rather than social science journals (48%). More than two thirds were published between 2000 and 2005, with only one paper

was published in the 1990s (see Appendix 1). The 33 publications were drawn from 22 different studies. Two studies from Nigeria each had five publications each and three other studies (from India, Ethiopia and Tanzania) had two publications each.

Figure 1. Screening and selection method of the papers (Table available from authors)



a Number of publications included in the descriptive analysis (Table available from authors)

b Number of publications included in the meta-analysis

Background to studies

56% of papers were from Nigeria, with the remainder from other African countries, India, Myanmar and Sri Lanka (see Appendix 1). 39% of the papers were undertaken in highly endemic areas, 24% in holoendemic (high levels in early years of life), 3% in an area of low

endemicity but 34% did not give such information. 61% of papers were based on interviews of households in rural areas, 12% in urban areas and 21% in both rural and urban areas.

6% of publications interviewed only the household head whereas 73% opted for either household head or a household representative. However, 21% of papers provided no information about whose views were solicited. Most (67%) papers used randomly selected samples but only 12% provided any statistical justification for the sample size used and three papers (9%) did not state the method of sampling. With respect to characterising the samples; half did not contain the mean age of respondents, half did not give mean household income and one third did not state the percentages of gender.

13 out of 33 papers were focused in ITNs, and 8 on treatment with the rest (24%) of a variety of preventions methods including net re-treatment, malaria vaccine and insurance. Whilst many of the products asked are often bought on the open market in some form (e.g. untreated mosquito nets, malaraquin tablets), we noted that 70% of papers gave no indication of the market price of the most approximate good or service.

Methods of eliciting WTP

Appendix 1 shows the elicitation format(s) used in each study and that eight different types of questions to elicit WTP were used. The most frequently used was the bidding game (55%), which was used singly or combined with another method. This was followed by the binary with follow-up and the open-ended question approaches. The lowest starting bid was offered in Myanmar for a test kit (Int$ 1.004) and the highest starting bid in Ghana for treatment of malaria (Int$ 50.31). The mean lower bid value was Int$7.45 and the mean upper bid value used was Int $19.42.

In four papers, it was not possible to identify the elicitation method. Three studies (covering six papers) tested the effects of different elicitation formats and statistically significantly effects on stated WTP, with open-ended formats producing lower estimates than the bidding game and binary with follow-up.

As 30/33 papers did not state the percentage of ‘do not know’ responses, it is not clear whether the majority of papers provided this option to respondents.

WTP values

There was often more than one mean WTP estimate per publication due as researchers asked about different goods, different populations and used more than one approach to asking WTP questions. Infact, 56% of publications had four or more mean estimates. 16 out of 33 papers, from nine studies, provided 59 observations of mean WTP for the meta-analysis. Table 1 categorises types of goods into the three main types and sets out the results of the meta-analyses.

Table 1. Results from the meta-analysis (Int$ 2006)

		Zeros included?	Mean WTP	Median WTP	Standard error	Lower 95% CI [a]	Upper 95% CI[a]	N=59
Type of good	ITNs[4]	yes	3.38	3.29	2.08	0.32	7.17	24
		no	8.94	9.23	2.03	6.02	12.84	13
	Prevention	yes	6.97	1.06	16.27	0.14	50.25	9
		no	12.33	158.36	24.48	1.09	56.12	5
	Treatment	yes	3.10	1.68	2.54	1.14	7.83	7
		no	2.84	2.84	-	-	-	1
	Overall WTP for malaria goods/services	yes	4.14	2.79	7.76	0.14	50.25	40
		no	9.51	9.00	11.87	1.09	56.12	19
Elicitation format	Bidding game	yes	3.64	2.90	2.47	0.66	7.17	12
		no	6.44	9.07	4.95	1.09	12.84	9
	Binary with follow-up	yes	2.22	2.61	1.44	0.32	3.49	6
		no	7.91	7.74	1.88	6.17	10	4
	Structured Haggling	yes	3.88	3.40	2.89	0.88	7.83	4
	Open-ended question	yes	1.60	1.32	0.90	0.38	3.21	7
	Dichotomous Choice	yes	3.57	3.57	4.86	0.14	7.00	2
	Bidding game + Open ended question	yes	3.10	3.05	1.42	1.06	5.40	7
	Bidding game + Binary with follow-up	no	8.03	8.36	1.59	6.02	9.37	4
	Not specified	yes	26.47	26.47	33.64	2.68	50.25	2
		no	29.48	29.48	37.67	2.84	56.12	2
Country	India	yes	6.52	6.64	0.75	5.62	7.17	4
		no	9.07	9.07	-	-	-	1
	Nigeria	yes	2.52	2.21	1.82	0.32	7.83	24
		no	7.04	8.24	3.83	1.09	12.84	16
	Sri Lanka	yes	26.47	26.47	33.64	2.68	50.25	2
		no	29.48	29.48	37.67	2.84	56.12	2
	Sudan	yes	3.27	3.32	0.77	2.32	4.11	4
	Tanzania	yes	1.90	1.27	2.57	0.14	7.00	6
Area	rural	yes	4.45	2.79	8.90	0.14	50.25	30
		No	11.68	9.23	12.54	2.84	56.12	15
	both	No	1.38	1.40	0.30	1.09	1.65	4
	urban	yes	3.21	2.69	2.12	1.14	7.83	10

[a] CI: Confidence Interval

For the type of good valued, 40 out of 59 estimates included zero values, of which 63% focussed on ITNs and a further 24% on other forms of prevention. WTP per household, including zeros, for prevention goods or services is more than twice that for ITNs and for treatment. However, the overall average WTP for malaria goods or services, including and excluding zeros, has a large 95% confidence interval and a long right hand tail (except for ITNs). Despite these potential differences, it is of concern that 76% of papers did not reveal the percentage of non-responses.

Between different elicitation format, average WTP per household varied betwee Int$1.60-26.47 when zeros are included and between Int$6.44-29.48 when excluded. The open-ended elicitation format appears to result in much lower mean WTP values compared with all other formats. The structured haggling, bidding game and dichotomous choice format show the higher average WTP, followed by the binary with follow up, but the structured haggling approach has the largest standard error. It is also notable that the highest mean values appear when the elicitation method is not specified, although these notably also came from one country.

Mean WTP appears to vary by country. For example, Tanzania has the lowest mean WTP amounts and Sri Lanka the highest. However, there appears to be no major differences between mean willingness to pay in rural and urban areas when zeros values are included, although there are when excluded.

Explaining variation in WTP

Appendix 2 summarises the results from published regression models and show that six potential variables explain variation in mean WTP for goods/services to control malarial;

1) Gender - with 28 coefficients available to study from 17 papers, 12 are statistically significant with a strong positive relation between being male and higher mean WTP;
2) Marital status - of 24 coefficients from 16 papers, 5 out of 6 statistically significant coefficients are negative, indicating being married reduces WTP;
3) Age – of the 23 coefficients from 14 papers, 39% provide strong evidence for older people being less willing to pay.
4) Education - with 24 coefficients from 13 publications, 48% are positive and statistically significant, thus more years of education is associated with a higher WTP;

[4] Although ITNs is a preventive measure it was treated separately due to the quantity of observations

5) Household size - of the 20 coefficients from 9 papers, 25% are positively significant and 9% significant negatively related indicating a rather mixed result overall.
6) Socio economic status - of the 18 coefficients from 5 different publications, 88% of the coefficients show a positive relation between status and WTP.
7) Household savings (as a proxy of wealth) – all 4 coefficients from 3 papers are statistically significantly positive. Those with more savings have a higher WTP.
8) Household income and average annual expenditures (a proxy for income) – of the 12 coefficients from 7 publications, 42% are positively correlated with WTP.

The summary in Appendix 2 was repeated for prevention goods or services, ITNs and treatment separately. Most results above were confirmed. However, studying the prevention goods or services separately, it could be added the price of the good or service such as a significant variable, which seems to have a clear evidence of negative relation with mean WTP, lower the price of the good or service, higher the amount willing to pay.

Three meta-regressions were performed where log mean WTP: included zero values (in estimating mean WTP) (n=49); excluded zero values (n=10); and both (n=56). The inclusive method dropped to avoid double-counting as three papers calculated WTP with and without zeros in the same paper. A base case and a reduced model were produced for each of the three cases. Due to lack of information, it was not possible to incorporate all the desired independent variables in the base model. Table 2 presents all the variables specified in the base model.

Table 2. Descriptions of variables used in base model of meta-regression

Variables	Description
MEAN_WTP	Mean WTP for malaria control (in 2006 Int $)
STUD_NUM	Study number used to classify the papers included in the meta-analysis (9 studies)
%MALE	Percent male
EDUCMEAN	Mean education years
INCIDEN	Malaria basic incidence rate
GNI_PC	Gross National Income per capita used as a proxy of income (in 2006 Int $)
NIGERIA	=1 if paper was conducted in Nigeria; 0= otherwise
IN_EX_0	=1 if mean WTP amount was including zero values; 0=otherwise
RURAL	=1 if paper was conducted in a rural area
BOTH	=2 if paper was conducted in a rural or urban area
URBAN	=3 if paper was conducted in an urban area
ITNs	=1 if the good/service of malaria control were ITNs
PREVEN	=2 if the good/service of malaria control were preventive, excluding ITNs
TREAT	=3 if the good/service of malaria control were for treatment
BID_GAME	=1 if a bidding game elicitation method was used

BIN_WFUP	=2 if a binary with follow up value elicitation method was used
STRU_HAG	=3 if a structured haggling value elicitation method was used
OPEN_ENDED	=4 if a open-ended value elicitation method was used
DICH_CHO	=5 if a dichotomous choice value elicitation method was used
BG+OPE	=6 if a bidding game plus an open ended question value elicitation method was used
BG+BWFUP	=7 if bidding game plus binary with follow up value elicitation method was used
NOT_SPEC	=8 if a not specified value elicitation method was used
SAMPLE	Number of respondents used to estimate the WTP value

The results of the meta-regression are presented in Table 3. Due to problems of multi-collinearity, incidence and the gender were dropped from all models and GNI_PC also had to be dropped in the model excluding zeros. The regression including zero observations seems not to have collinearity problems (VIF=4.97). Both the Shapiro-Wilk W test (p=0.36) and White test (p=0.72) indicated homoscedastic residuals. However, RAMSEY test was indicated the possibility of omitted variables (p=0.02). The regression with excluding zeros observations appears to have no collinearity problems (VIF=5.20) and was sufficiently specficed (RAMSEY test; p=0.97). However, the Shapiro-Wilk W test (p=0.004) and White test (p=0.63) gave conflicting results, suggesting that there may be some problems with heteroscedasticity. Finally, the regression that included all values, regardless of inclusion of zero seems to have no problem with collinearity (VIF=4.85) or heteroscedasticity (Shapiro-Wilk W; p=0.03; White test; p=0.75) and the model is sufficiently specified (RAMSEY test; p=0.09).

Table 3. Weighted least squares meta-regression results

Explanatory variable	Dependent variable: ln(mean_wtp)			Dependent variable: ln(mean_wtp)		
	Base model			Reduced model		
	Coefficient (Robust standard errors)			Coefficient (Robust standard errors)		
	IN 0	EX 0	IN and EX 0	IN 0	EX 0	IN and EX 0
ln(EDUCMEAN)	-0.04 (0.61)	0.63 (7.92e-15)***	0.13 (0.45)		0.63 (3.82e-15)***	
ln(GNI_PC)	4.95 (1.29)***	dropped	5.08 (1.09)***	6.23 (0.31)***		6.22 (0.24)***
NIGERIA	0.39 (0.44)	-1.54 (1.48e-15)***	0.41 (0.35)		-1.55 (1.86e-15)***	
IN_EX_0			-0.68 (0.24)**			-1.14 (0.04)***
RURAL	-2.38 (1.01)**	base	-2.39 (0.93)**	-0.91 (0.19)***	Base	-0.86 (0.19)***
BOTH		-2.23 (5.01e-15)***	-2.38 (0.90)**		-2.23 (4.29e-15)***	-2.22 (0.11)***
URBAN	base		base	base		base
ITNs	2.37 (1.56)	1.78 (6.38e-15)***	2.35 (1.39)		1.78 (4.98e-15)***	
PREVEN	0.87 (1.45)	2.51 (1.11e-14)***	0.85 (1.29)		2.51 (9.04e-15)***	
TREAT	base	base	base		Base	
BID_GAME	base	base	base	base	base	base
BIN_WFUP	-0.50 (0.50)	-0.79 (5.13e-16)***	-0.56 (0.34)	-0.11 (0.15)	-0.79 (4.24e-16)***	-0.26 (0.22)
STRU_HAG	0.05 (0.32)		-0.04 (0.28)	0.09 (0.15)		0.03 (0.15)
OPEN_ENDED	-0.61 (0.50)		-0.63 (0.36)	0.04 (0.13)		-0.03 (0.11)
DICH_CHO	2.91 (1.37)*		2.98 (1.27)**	3.06 (1.68)		2.99 (1.68)

BG+OPE	-0.42 (0.75)		-0.42 (0.63)	-0.10 (0.18)		-0.13 (0.12)
BG+BWFUP		2.01 (2.80e-15)***	2.05 (0.14)***		2.01 (2.61e-15)***	2.18 (0.11)***
NOT_SPEC	0.68 (1.66)	dropped	0.56 (1.44)	-1.93 (0.27)***	dropped	-1.99 (0.16)***
CONSTANT	-34.85 (8.04)***	-3.52 (7.92e-15)***	-35.24 (6.45)***	-42.43 (1.84)***	-3.52 (7.08e-15)***	-41.18 (1.44)***
n=	40	19	56	40	19	56
R-squared=	77.38	84.07	80.54	65.13	84.07	72.58
Root MSE=	82.39	76.55	78.84	95.46	76.55	89.24
N clusters=	9	3	9	9	3	9

Significance of parameters: *≤0,10, **≤0,05, ***≤0,01

The including zero and inclusive models met expectations regarding the impact of income at a 1% significance level. The higher the income of the household, the higher mean WTP. Compared with WTP among respondents in urban areas WTP is statistically significantly lower (at the 1% level) in rural areas in both models and, in samples that combine respondents from rural and urban areas only in the inclusive model.

In the inclusive model, the bidding game plus binary with follow up method is positively related to mean WTP compared with the bidding game alone whereas studies not specifying elicitation method give statistically significantly lower values than those elicited using the bidding game. The impact of not accounting for zero responses in WTP values provides, not surprisingly, statistically significantly lower mean WTP values (at 1% level). The findings from the including zeros model differ because these factors were not represented within studies.

The results from the model excluding zeros show that, when variables are included, the signs for variables match those in the inclusive model. The main difference is that a number of variables enter the regression for this model that are in neither of the other reduced models. For example, years of education is statistically significant and positive, values from Nigeria are statistically significantly lower than the mean of all other countries and the nature of the good is an important explanatory of variation in mean values with WTP for treatment and for ITNs being statistically significantly higher than for other forms of prevention. However, the impact of clustering, presence of outliers and non-normality in the residuals, raises questions about the validity of these findings despite the R-squared.

Discussion

Malaria can affect diverse features of human existence including mobility, investment choices, and even fertility decisions (Malaney, 2005). The cost of the numerous measures that can reduce or eliminate the threat posed by malaria need to be balanced against estimates of

benefit given limited resources available. WTP is one route to providing such an estimate. This paper provides the first attempt to compare contingent valuation (CV) results for prevention and treatment of malaria prevention and treatment goods. It is also unusual in the development of a meta-regression to explore and control for the effects of heterogeneity in WTP values within the health sector, despite the existence of applications with environmental and transport economics (e.g. Brouwer et al., 1999, Kremers et al., 1999).

WTP has mainly been used to estimate the value attributed to ITNs, followed by drugs (as mono- and combination therapy), a hypothetical vaccine and re-treatment of nets. After this one or two papers each consider a test kit, insurance, and general improvements to treatment facilities with one paper only considering the WTP for spraying, larviciding and fogging. Thus WTP tends to be focussed on newer rather than existing methods for controlling malaria. No values have been provided for prevention such as sheets, screens or repellents, probably because these are available readily in local markets. However, no values are available for government-provided environmental or biological control or for different approaches to spraying in terms of choice of chemical or focus of spraying.

Most papers (67%) focus on the WTP for a single intervention or one combination intervention (12%) rather than WTP for several single or packages of interventions. However, 27% of studies did ask for the WTP for more than one intervention. It is possible that stated values are subject to an order effect or 'position bias', with the largest value given to the first good (Payne et al, 2004) and this does not appear to have been investigated, suggesting mean WTP values from studies may be biased. If information on ordering was provided in all studies, it could have been included as an additional regressand. Other design effects that would be interesting to compare across studies include the choice of type of respondent, the impact of including a 'don't know' option and sampling methodology. In many cases we could not ascertain what had happened and this would have confounded interpretation of coefficients if included in our model.

The advantages of the model are that not only that variation in WTP can be explained across settings but that the impact of particular characteristics can be predicted in different settings. An increment of a 1% in our GNI per capita will lead to a 6.22% of increment in the expected mean WTP amount, holding all the other variables constant. We do, however, note that the model stretches data beyond existing knowledge. For example the structured haggling approach has not yet been used outside of Nigeria and yet using the coefficient to predict

values suggests this might be appropriate. Predictions should be tested in practice and the meta-regression re-run with the additional findings.

One of the problems of our model is that the reduced model excludes the type of good valued. Re-inserting the type of good variable back into the model gives an increase in the mean WTP for ITNs of 245%, and for other prevention goods/services a decrease in the mean WTP of 10.34%. The type of good was only statistically significant in the model that excluded zeros and this may be because it used data from only 3 studies, more than 50% of which asked about ITNs. One of the possible reasons for the lack of significance in the more inclusive models is because the interventions within the treatment and other prevention categories were too diffuse and this could be experimented with further in the future as could a regression of just mean WTP for ITNs.

There was a difference in the hierarchy of WTP values for type of good between the meta-analysis and meta-regression. The meta-analysis suggested that average WTP was highest for prevention goods and services, followed by ITNs whereas the meta regression, which controlled for heterogeneity, showed WTP to be highest for ITNs followed by other prevention goods/services and treatment (see base model), although we note this variable did not reach the 10% significance level in the reduced model. There were also some significant differences in the ranking of WTP between the meta-analysis and meta-regression. The meta-regression showed WTP by method increased in the following order; non-specified method, BWFU, BG+OE, OE, BG, SH, BG+BWFU, DC. However, statistically, the clearest message is that values for the BG were significantly lower than the BG+BWFU and significantly higher than those using unspecified methods. After controlling for heterogeneity, the main differences in ranking occurred where the non-specified values fell from the highest to lowest value, that open-ended responses moved from the lowest to the middle and dichotomous choice rose from a middle to the top rank – all others maintained their ranked position.

Three different meta-regressions were undertaken to maximize useful data and account for the possibility that different factors might influence market entry. However, the model that excludes zeros is dominated by only 3 studies, excludes income and despite accounting for clustering still suffers from heteroscedasticity. Including a variable that controls for inclusion of zero values therefore, in this sample, appears to be a better approach. Explanators in the inclusive model introduces variables from both smaller models and most follow expected relationships including GNI per capita, a 1% of increment of which leads to a 6% increase in

mean WTP. The results clearly demonstrate an elicitation effect and highlight the importance of researchers specifying elicitation questions. It also supports similar findings from environmental economics (Brouwer et al., 1999) but indicates that elicitation effects may also extend to interventions with more defined property rights. Further research, with larger samples, is required to test the impact of malaria incidence and impact of gender.

Marital status, age, household size, socio-economic status, wealth and household income were all potential variables for explaining mean WTP. However, many could not been explored simply due to the reporting of studies. The consistency of results from within studies and our review suggests it is very important for authors to specify income, rurality, and elicitation mechanism. Our results also suggest that it may also be important to report years of education, and type of good to facilitate future meta-regressions. Beyond this, there is lack of information and agreement about study content that may affect the summary mean WTP variation and we would therefore point towards the results of our qualitative review of regression models to guide additional reporting.

How reliable are these results for transferring findings across countries? Do we still have to do more WTP studies? In environmental and transport economics two techniques have been used to transfer across settings; meta-analytic regression and, more recently, 'benefit transfer' (BT). BT predictions from parameter estimates that are directly obtained from a single source study but the potentially misleading predictions has prompted use of meta-regression models (Rosenberger and Loomis, 2000, Shrestha, 2001, Engel, 2002, Johnston et al., 2005, Johnston et al., forthcoming, in Moeltner et al., 2006). The disadvantage of meta-regression in this instance has been the reliance on poorly reported data and suggests that meta-regression at present must rely on contact with authors which often proves difficult in practice. Nevertheless these regressions tend to have relatively good explanatory power and have still enabled inclusion of variables not often considered within one study, such as a broad range of elicitation mechanisms and types of goods. What also remains debatable is whether people's stated WTP remains constant in time, as implied by transferring to current value without accounting for time period. Further research on WTP is required alongside an improvement in reporting.

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Appendix 1. Characteristics from the papers included in the descriptive analysis

Publication Authors	Publication year	Type of good	Elicitation format	Country	Regression Model	Dependent Variable
Alaii et al.	2003	bed net	open ended question	Kenya		No regression
Ankomah-Asante and Asenso-Okyere	2003	Malaria prevention treatment[5]	Bidding game	Ghana	Probit	Qualitative choice of amount an individual is willing to pay
Asafu-Adjaye and Dzator	2003	malaria insurance	Bidding game	Ghana	Probit	WTP for malaria insurance
Attanayake	undated	curative care / preventive care	not specified	Sri Lanka	Not specified	WTP for curative care and WTP for ITNs
Bhatia	2005	ITNs	Bidding game + open ended	India		No regression
Bhatia and Fox-Rushby	2002	ITNs	Bidding game	India		No regression
Cho-Min-Naing et al.	2000	test kit	Bidding game	Myanmar	OLS	WTP for test kit
Cropper et al.	2000	malaria vaccine / ITNs	single-bounded dichotomous choice	Ethiopia	Truncated Poisson	WTP for all vaccines for next year and WTP for ITNs
Dgedge	2000	ITNs	bidding game + open ended question	Mozambique	Logistic	WTP for ITNs
Guyatt et al.	2002	ITNs	single-bounded, dichotomous choice + open ended question	Kenya		No regression
Kilian et al.	2003	monotherapy drugs	not specified	Uganda		No regression
Lampietti	1999	bed net / hypothetical vaccine	not specified	Ethiopia	Probit	Differences between husbands and wives with respect to the decision to purchase preventive health care
Masiye and Rehnberg	2005	Improved malaria treatment[7]	Payment card	Zambia	Interval regression	WTP for malaria improved treatment
Mujinja et al.	2004	ITNs	single-bounded dichotomous choice	Tanzania		No regression
Okrah et al.	2002	net treatment	not specified	Burkina Faso		No regression
Onwujekwe	2004	ITNs	bidding game, binary with follow-up and structured haggling	Nigeria		No regression
Onwujekwe	2001	ITNs	bidding game, binary with follow-up	Nigeria	OLS	Variation in WTP for ITNs (in general)
Onwujekwe and Nwagbo	2002	ITNs / re-treatment	bidding game + open ended question	Nigeria	Tobit	WTP for small and large nets and WTP for re-treatment
Onwujekwe and Uzochukwu	2004	ITNs	binary with follow up, open ended question	Nigeria	Logistic and Heckman model	Altruistic WTP (in both models)
Onwujekwe et al. (3)[a]	2004	ITNs / re-treatment	bidding game, binary with follow-up, structured haggling	Nigeria	OLS	WTP for re-treatment
Onwujekwe et al. (10)[a]	2004	ITNs	bidding game + binary with follow-up + structured haggling	Nigeria	OLS	WTP for ITN
Onwujekwe et al. (22)[a]	2005	ITNs	bidding game, binary with follow-up and structured haggling	Nigeria		No regression
Onwujekwe et al. (4)[a]	2002	ITNs	open-ended question	Nigeria	Tobit	Altruistic WTP for ITN (for nets for other people combined for 4 different areas)
Onwujekwe et al. (9)[a]	2001	ITNs	bidding game + binary with follow up[8]	Nigeria	OLS	WTP for personal and for other's ITNs
Onwujekwe et al. (13)[a]	2000	re-treatment	bidding game	Nigeria	OLS	WTP for re-treatment
Onwujekwe et al. (21)[a]	2004	combination therapy drugs	bidding game, structured haggling	Nigeria	Logistic and OLS	WTP for combination therapy
Onwujekwe et al. (76)[a8]	2005	ITNs, IRS, LWC and SS[9]	bidding game + open ended question	Sudan	Tobit	WTP for ITNs, IRHS, LWC and SS
Poulos	2000	malaria vaccine	single-bounded dichotomous choice	Tanzania	Probit	Probability of purchasing vaccines for the household
Sauerborn et al.	2005	malaria vaccine	bidding game	Burkina Faso	OLS	WTP for maternal and childhood malaria vaccine
Weaver et al.	1993	drugs to treat malaria	single-bounded dichotomous choice	Central African Republic	Logistic regression	WTP for drugs to treat malaria
Weaver et al.	1996	drugs to treat malaria	single-bounded dichotomous choice	Central African Republic		No regression
Whittington et al.	2003	malaria vaccine	single-bounded dichotomous choice	Mozambique	Probit	Probability that a respondent will choose to pay for the hypothetical malaria vaccine
Wiseman et al.	2005	Three combination therapy and monotherapy[10]	bidding game	Tanzania		No regression

[a] Publication number

[5] This study determines willingness to pay for malaria treatment and prevention at the same time. It has been classified as a prevention paper because the treatment was not well specified.
[6] Improved malaria treatment is based on access to a qualified doctor, nursing care, laboratory and other diagnostic services, access to all necessary anti-malarial medicines and hospitalization costs, such as food, laundry etc as deemed necessary by clinicians and health facility managers.
[7] The binary with follow up method is only used in this study to calculate the mean willingness to pay for one area from Nigeria (called Orba).
[9] IRS (Indoor residual spraying), LWC (Larvidicing with chemicals) and SS (Space spraying-fogging).
[10] This includes; Artemether-lumefantrine, Amodiaquine+sulfadoxine-pyrimethamine and Amodiaquine+artesunate. The monetherapy is based in Amodiaquine.

Appendix 2. Summary of regressions' variables for the overall goods and services for malaria control (complete summary table available from the authors).

Variable	No papers	No total coefficients	No significant coefficients	Total positive coefficients	Significance level positive coefficients by publication number[a]	Total negative coefficients	Significance level negative coefficients by publication number[a]
Sex	17	28	15	21	66.1, 66.2, 89, 76.1***, 76.4*, 3.1, 8.1***, 8.2, 9.1**, 9.2, 10**, 12.1***, 12.2***, 4**, 76.2**, 90.2, 57.2, 90.1, 90.2**, 21.1**, 21.2**	7	57.1**, 23.3***, 3.2, 3.3, 23.1***, 23.2, 75.1
Marital status	16	24	6	10	89, 57.1**, 23.3, 76.4 23.1, 76.2, 12.1, 12.2, 57.2, 90.1	14	3.1, 3.2**, 3.3, 8.1, 8.2, 66.1, 66.2 9.1, 9.2, 10***, 4**, 23.2, 90.2*21.1*
Age	14	23	9	3	66.1, 10, 21.1	20	59, 66.2***, 57.1**, 8.1, 8.2, 23.3***, 76.1**, 76.4, 9.1, 9.2, 12.1***, 12.2, 23.1***, 23.2, 76, 90.2, 57.2, 21.1***, 21.2***, 21.2**
Education	13	24	14	18	66.1***, 66.2, 23.3***, 76.3*, 3.3*, 8.1, 8.2, 23.1***, 23.2, (64.1 x 2)***, (64.2 x 2)***, 10***, 90.1, 90.2***, 60, 21.1**	6	9.1, 9.2, 12.1, 12.2**, 21.2***, 21.2
Household size	9	20	7	18	(59 x 8), 3.3, 4*, 9.1**, 9.2, 10**, 12.1*, 12.2, 75, 21.1*, 21.2	2	8.1***, 8.2***
Status in household	9	16	7	10	23.3, 76.3, 76.4*, 3.2**, 3.3*, 10**, 23.1, 23.2, 76, 90.2,	6	3.1, 9.1, 9.2, 21.1**, 21.2*, 21.1***
Occupation	5	10	5	4	23.3***, 23.1***, 23.2, 10	6	66.1***, 66.2***, 89, 10 x 3
Expenditure to treat malaria	5	9	3	7	3.2, 3.3*, 13, 9.1, 9.2, 12.1, 4***	2	3.1, 12.2*
Socio economic status	5	18	16	18	76.1***, 76.3***, 76.4***,64.1***, 64.1*, 64.2***, 64.2, 76.2***, 10***, 21.2.1**, 21.2.2, 21.2.3*, (21.1 x 3)***, (21.2 x 2)**, 21.2*	0	
Household income log	4	4	3	4	89***, 59***, 57.1**,57.2	0	
Price	4	4	4	0		4	59***, 91*, 57.1**, 57.2**
Actual incidence of malaria	4	7	4	2	3.1, 10***	5	3.2**, 9.1*, 9.2, 12.1, 12.2**
Household children size	3	4	3	1	66.2***	3	59**, 66.1, 57.1**
Average annual expenditures (food, celebrations, clothing, gifts, school fees)	3	8	3	7	13*, 13, 9.1, 9.1***, 9.2 x 2, 12.1	1	12.2***
Household savings	3	4	4	4	13**, 9.1***, 9.2**, 4***	0	
WTP for own ITNs	2	5	5	5	90.1***, 90.2***, 90.1***, 90.2***, 4***	0	
Had malaria	2	2	1	1	21.1**	1	90.1
Value of first bid	2	3	2	2	8.1***, 8.2***	1	23.3
Altitude	2	2	1	1	57.2	1	57.1**
Distance to nearest health facility	2	3	3	1	1.2**	2	8.1***, 8.2**
Distance to nearest health facility log	2	2	0	1	60	1	89
Household direct cost of illness	2	2	1	1	57.1**	1	57.2
Incidence of malaria	2	3	2	1	3.1**	2	3.2*, 10
Missing wage	2	2	0	2	57.1, 57.2	0	
Ownership of electrical appliances (radio, grinding machine)	2	6	3	6	3.1*, 3.2, 3.3*, 3.3, 90.1*, 90.2	0	
Ownership of method of transport (motorcycle, bicycle, motorcar)	2	7	2	3	90.1, 90.2*, 90.2	4	3.1, 90.1***, 90.2, 90.1
Previous purchase of nets	2	2	0	2	3.2, 90.1	0	
Read	2	2	1	1	57.1**	1	57.2
Resident of urban area	2	8	4	1	60	7	8.1, 8.2, (60 x 2)**, (60 x 2)***, 60
Health status of the respondents	2	4	2	3	(75 x 2)**, 75	1	60

Variable	No papers	No total coefficients	No significant coefficients	Total positive coefficients	Significance level positive coefficients by publication number[a]	Total negative coefficients	Significance level negative coefficients by publication number[a]
Food cost log	1	3	2	3	90.1**, 90.1**, 90.2	0	
Had other illnesses	1	2	1	2	90.1**, 90.2	0	
High starting-point	1	2	1	0		2	23.1, 23.2***
Household income log	1	1	0	1		0	
Medium starting-point	1	2	0	1	23.2	1	23.1
Number of children	1	1	0	1	57.2	0	
Number of teenagers	1	1	0	1	57.2	0	
Perceived risk of contracting malaria	1	2	0	2	9.1, 9.2	0	
Purchase of ITNs	1	2	2	2	64.1***, 64.2***	0	
WTP for others ITNs	1	4	4	4	90.1**, 90.2**, 90.1***, 90.2*	0	
Actual incidence of other illnesses	1	1	0	1	3.3	0	
Community in which respondent and his or her household are located	1	2	1	1	66.2***	1	66.1
Dependency status of household members	1	1	0	0		1	89
Dummy of expenditure to treat other illnesses	1	1	0	0		1	3.3
Education log	1	1	0	0		1	89
Health care facility	1	1	1	0		1	89**
Household children size (< 6 years)	1	2	2	2	8.1***, 8.2**	0	
Household female size	1	2	0	2	8.1, 8.2	0	
Household money income	1	2	2	2	66.1***, 66.2***	0	
Household total cost of illness	1	1	0	0		1	59
Households teenagers size	1	1	0	1	57.1	0	
Individual 6-month cash expenditure, log 10	1	2	0	2	8.1, 8.2	0	
Individual 6-month cash income, log 10	1	2	2	2	8.1**, 8.2**	0	

[a] Significance of parameters: *≤0,10, **≤0,05, ***≤0,01

Nº papers	Total number of publications reporting this variable
Nº coefficients	Total number of coefficients reported in all different papers
Total positive coefficients	Total number of positive coefficients reported by all papers
Significance level positive coefficients	Specification of the significance level from positive coefficients
Total negative coefficients	Total number of negative coefficients reported by all papers
Significance level negative coefficients	Specification of the significance level from negative coefficients