



Willingness to Pay for Cataract Surgeries Among Patients Visiting Eye Care Facilities in Dhaka, Bangladesh

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Abstract

Background Cataract is the leading cause of avoidable blindness globally. It is estimated that 89% of people with visual impairment live in low- and middle-income countries where the cost of cataract surgery represents a major barrier for accessing these services. Developing self-sustaining healthcare programs to cater the unmet demands warrants a better understanding of patients' willingness to pay (WTP) for their services.

Objectives Using a sample of patients visiting eye care facilities in Dhaka, Bangladesh, we estimate WTP for two different cataract extraction techniques, namely small incision cataract surgery (SICS) and phacoemulsification.

Methods We used contingent valuation (CV) approach and elicited WTP through double-bounded dichotomous choice experiments. We interviewed 556 randomly selected patients (283 for SICS and 273 for phacoemulsification) from five different eye care hospitals of Dhaka. In this paper, we estimated the mean and marginal WTP using interval regression models. We also compared the estimated WTP and stated demand for cataract surgeries against the prevailing market prices of SICS and phacoemulsification.

Results We found the mean WTP of BDT 7579 (US\$93) for SICS and BDT 10,208 (US\$126) for phacoemulsification are equivalent to 12 and 16 days of household income, respectively. Household income and assets appeared as the major determinants of WTP for cataract surgeries. However, we did not find any significant association with gender, occupation, and household size among other socioeconomic characteristics. Comparisons between market prices and average WTP suggest it is possible to have a viable market for SICS, but a subsidy-based model for phacoemulsification will be financially challenging because of low WTP and high costs.

Conclusion Our findings suggest lower-cost SICS can potentially provide patients access to surgeries to treat cataract conditions. Moreover, price discrimination and cross-subsidization could be a viable strategy to increase the service-uptake as well as ensure financial sustainability.

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1 Introduction

Globally, about 253 million people remain visually impaired, including 36 million who are blind and 217 million with moderate or severe visual impairments [1]. Cataract remains the leading cause of blindness globally, and the second leading cause of severe and moderate visual impairment after uncorrected refractive error. The burden of visual impairment disproportionately affects low- and middle-income countries as 89% of people with visual impairment live in these countries [2]. In South Asia alone, more than 17.4 million people are visually impaired from cataract, a condition that can be treated with surgery [3]. According to the last National Blindness and Low Vision Survey, cataract is the predominant cause for bilateral blindness (79.6%) and low vision (74.2%) among people aged ≥ 30 years in Bangladesh [4].

Key Points for Decision Makers

Despite being cost effective, the uptake of cataract surgery is low in developing countries.

Understanding the demand and WTP for cataract surgery can help design more accessible and sustainable program for low- and middle-income countries where the burden of visual impairment is high.

Our study finds mean WTP of BDT 7579 (US\$93) for SICS and BDT 10,208 (US\$126) for phacoemulsification surgery with income and wealth as important determinants for WTP for such surgeries.

The lower cost of SICS can potentially provide patients with access to surgeries to treat cataract conditions and market segmentation can allow cross-subsidization to provide essential and otherwise cost-effective eyecare solutions such as cataract surgeries in low-resource settings.

While treatment for cataract requires trained surgeons and adequately equipped operative environments, cataract surgery is considered to be a safe and cost-effective surgical procedure [5, 6]. However, the uptake of cataract surgery remains low and it is estimated that only half of the patients in need of cataract surgeries access these services [7, 8]. Financial barriers, doubt over the efficacy of treatment, lack of information, fatalism, fear of surgery, and reliance on informal care are often identified as factors associated with patients' low uptake of cataract surgeries [9, 10]. Although non-financial barriers may be overcome through awareness campaigns and education, the cost of cataract surgery can still be prohibitive for patients from the poorer households [8, 11]. Understanding the demand and willingness to pay (WTP) for cataract surgical services can help design more accessible and sustainable programs to facilitate the uptake of cataract services in low- and middle-income countries.

Few studies have been published on the WTP for cataract surgery in low- and middle-income countries. A study carried out in China shows that hospitals can charge up to US\$62.5 for cataract surgery with additional supplementary services to make the services more financially viable [12]. In South West Ethiopia, 70% of the participants were willing to pay less than US\$9.2 for cataract surgery on one eye, the highest bid being US\$46 [13]. Another study in Nepal found that potential beneficiaries are willing to pay only US\$2.3 for cataract surgery, with a similar finding for Tanzania [11, 14]. Low income and poverty among the targeted population are one of the major reasons behind low WTP for cataract surgery [9, 11, 15, 16]. Provision of free cataract surgeries

in some settings can also explain the low WTP for cataract surgical services in low-income countries [14, 17]. Free cataract surgeries can crowd out payment-based services and render eye health programs financially less sustainable [8]. Eliciting WTP for cataract surgical services can help to design pricing strategies that optimize service uptake and income generated from cataract programs. WTP studies can also help to identify sub-population who are less likely to demand eye care services and target subsidy more efficiently [13].

The objective of this study is to estimate the WTP for cataract surgeries using a double-bounded dichotomous choice contingent valuation method from a sample of patients visiting eye care facilities in Dhaka, Bangladesh. This method of eliciting WTP has been used in several other contexts [18–21]. We investigate WTP for two different cataract surgical techniques commonly used in low- and middle-income countries, namely, manual small incision cataract surgery (SICS) and phacoemulsification. We believe this study will contribute to the evidence base for designing differential pricing strategies, improving cost recovery systems, and contributing to optimal uptake for cataract surgery.

2 Methods

2.1 Sampling

Dhaka, the capital city of Bangladesh, has a population of about 16 million (as of 2013), which is expected to grow to 24 million by 2025 [22]. There are seven specialized hospitals and 111 general hospitals with eye care services currently operating within the metropolitan area of Dhaka [23]. We chose to work at five different facilities. The chosen facilities are well-established hospitals providing eye care services to a relatively large number of patients. These chosen hospitals have provided formal consents to conduct the survey. The facilities were located in different parts of the city—two were public hospitals and three were private not-for-profit hospitals (see Online Appendix Table 4 for the list of sampled facilities).

Evidence from different empirical studies suggest that individual utility varies across different health states [24–26]. Moreover, lack of experiences about the health state makes preferences unstable, which may generate considerable doubt on the WTP estimates [25, 27]. Hence, in this study, instead of concentrating on general population, we elicited WTP of patients who were suffering from different eye diseases. To elicit WTP, each respondent was randomly assigned for either SICS or phacoemulsification.

We selected the respondents based on a systematic random sampling approach. Considering patients' flow for each healthcare facility and the time required to complete

the interview, we selected every fourth to sixth patient after randomly selecting the first patient of the day. However, for a specific healthcare facility, the sampling interval was constant and set based on its average daily patient flow. The survey was conducted in November 2014 for a period of about 3 weeks. Over this period, we interviewed 556 respondents. However, we interviewed the accompanying adult guardians for 36 respondents who were minors (i.e. aged < 18 years) at the time of the survey. We used a structured questionnaire to collect individual and household information and a separate module to elicit WTP (see the questionnaire submitted as supplementary material). The interview took an average of 35 min to complete. A team of six trained enumerators collected the data using CSPro (Version 6.0).

2.2 WTP Elicitation Approach

We applied a commonly used contingent valuation (CV) approach, namely the double-bounded dichotomous choice contingent valuation method to elicit WTP for cataract surgeries, typically considered more efficient estimates of WTP compared to the single-bounded approach, especially in finite samples [18, 28, 29]. We followed a two-by-two experimental design with two surgery types (i.e. SICS and phacoemulsification) and two starting bids (i.e. high and low). Respondents were randomly assigned to one of the four contingent valuations (e.g. SICS with lower starting bid). The elicitation began with a brief introduction (common to all groups), in which the respondents were informed about cataract and its treatments. However, respondents were briefed with additional details on SICS or phacoemulsification procedures based on their respective questionnaire types (see the questionnaire submitted as supplementary material). Then, enumerators asked the respondents a series of dichotomous choice questions to progressively narrow down their WTP. Respondents were offered two rounds of bidding: the first bidding with a pre-specified amount; and a follow-up question where the proposed amount was increased or decreased depending on the response to the first bidding question (see Fig. 1). Moreover, to check the internal consistency of the bidding responses, we also asked the respondents to report their maximum WTP.

We varied the starting bids to reflect the higher cost of phacoemulsification surgeries compared to manual SICS. Although both techniques have similar outcomes in terms of visual outcome and complication rates, phacoemulsification surgeries are more expensive because of longer average surgery time and higher costs of phacoemulsification equipment and consumables [30–32]. To reduce possible anchoring effect, we also randomly varied the starting bids [33]. Respondents were randomly assigned to WTP questionnaires with starting bids of Bangladeshi Taka (BDT) 5000 (US\$62) or BDT 8000 (US\$98) for SICS and BDT 20,000

(US\$246) or BDT 30,000 (US\$369) for phacoemulsification. We increased the follow-up bids in case of acceptance and decreased in case of rejection by an amount equivalent to BDT 1500 (US\$19) for SICS and BDT 5000 (US\$62) for phacoemulsification (see Fig. 1 for schematic description).

We set the starting bids based on an exploratory study where a number of cataract patients and cataract surgeons are interviewed to collect data on the cost of cataract surgery and how prices are set for SICS and phacoemulsification. Before eliciting their WTP, we conditioned the respondents by providing information about cataract and the cataract surgical technique for which their WTP is elicited (i.e. SICS or phacoemulsification). For SICS, respondents are informed that the surgeon manually removes the cloudy natural lens and replaces it with an artificial intraocular lens. For phacoemulsification, we informed the respondents about more advanced technology used in phacoemulsification to break up the cloudy natural lens with ultrasonic frequency before aspirating it from the eye and replacing it by an artificial intraocular lens.

2.3 Statistical Analyses

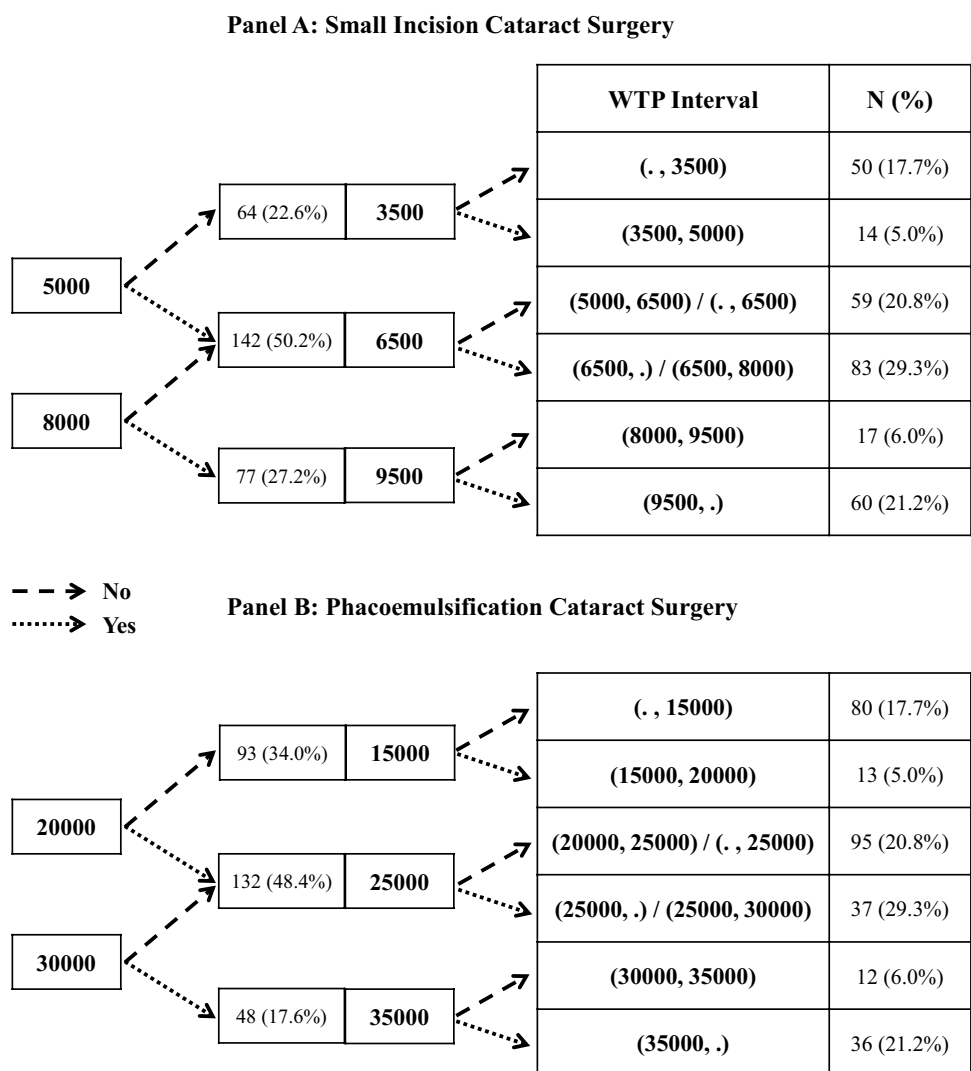
The econometric analysis relies on the assumption that “true” WTP (Y_i^*) of the consumer is not directly observable by the researchers. However, we assume that it is linear in nature with the following functional form:

$$Y_i^* = \beta X_i + \varepsilon_i$$

where X_i is a vector of observable characteristics that determine the true latent WTP for the individual respondent. We also have an unobservable component, ε_i . This component may or may not be known to the respondent and we assume an independent and identical distribution for ε_i . As observable characteristics we include gender, age, occupations, household size, asset ownership, income and prior experience with eye care services and knowledge, among others. For a full list of characteristics included in our models, see Table 1.

While we do not observe the latent WTP (Y_i^*) directly, our double-bounded dichotomous choice contingent valuation design allows us to restrict the latent WTP within an interval, or $Y_i^* \in [Y_i^l, Y_i^h]$. We assume the error term in the linear utility function or ε_i is normally distributed with a mean of 0 and standard deviation of σ , hence, Y_i^* follows the stronger assumptions of classical linear regression models. The probability of lying within an interval, $\Pr(Y_i^l \leq Y_i^* < Y_i^h)$ then can be modeled using the standard normal cumulative function. Replacing the equation for the WTP for cataract surgery, the probability function can be expressed as $\Pr(Y_i^l \leq X_i\beta + \varepsilon_i < Y_i^h)$. The joint probability of the observations is maximized using a log-likelihood function by

Fig. 1 Schematic description of the choice experiments. In total 283 and 273 individuals were randomly selected to elicit WTP for SICS and phacoemulsification respectively. Prior to the experiment, respondents were briefed about cataract and their respective surgical procedures (see Online Appendix). Then they were asked if they would pay the amount (stated in each node) for SICS/phacoemulsification surgery if they were cataract patients. The second consecutive bids were increased (decreased) based on the acceptance (rejection) of the random initial bid. Final intervals of the respondent's WTP contain both censored (e.g. [., 3500] and [35,000,.) and interval-coded observations (e.g. [5000, 6000], [30,000, 35,000])



choosing the appropriate β . The maximum likelihood function is estimated using interval regression techniques.

To check the robustness of the coefficients from our preferred interval regression models, we re-estimate the models using ordinary least square (OLS) techniques, where respondents' maximum WTP (asked after the second bidding) is used as the outcome variable instead of the interval-coded WTP outcomes (see Online Appendix Table 5). All analyses were carried out in Stata[®] versions 13.1 and 15.

3 Findings

3.1 Summary Statistics

We present the key socio-economic characteristics of the respondents in Table 1. The mean age is 46.5 years and 51% of the respondents were female. Almost 63% of respondents reported having less than primary level of schooling

suggesting a fairly low level of formal education. The average household monthly income is about BDT 19,000 (about US\$234). About 1% of respondents reported having cataract problems and only about 6% of the respondents reported knowing about cataract surgeries. Although the survey was conducted in various hospitals in Dhaka, about 60% of the respondents were reported to be living outside the city.

A total number of 556 individuals participated in the study. Of these, 283 respondents were randomly assigned to the SICS group and the remaining 273 to the phacoemulsification group. We did not find any statistically significant differences between the SICS and phacoemulsification groups in terms of socio-economic characteristics, except that a higher proportion of respondents in the phacoemulsification group had completed primary or higher education (about 42% in phacoemulsification as opposed to 33% in SICS; p value = 0.04). We further validated the balance between the two groups with a joint orthogonality test using a multivariate model. We found that, except for education and

Table 1 Sample characteristics

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Total sample (<i>N</i> = 556)		Small incision cataract surgery (<i>N</i> = 283)		Phacoemulsifi- cation surgery (<i>N</i> = 273)		<i>p</i> value
	Mean	SD	Mean	SD	Mean	SD	
Continuous							
Age (years)	46.5	19.0	46.5	18.9	46.6	19.1	0.96
Total monthly household income (BDT)	18,805	18,978	18,658	18,881	18,960	19,193	0.85
Land ownership (decimal)	250	540.6	285.3	565.7	217.1	516.8	0.37
Costs already incurred before visiting this hospital (BDT)	10,697	58,084	13,617	76,615	7420	24,000	0.38
Categorical							
= 1 if female	0.51		0.54		0.49		0.21
Educational status							
None	0.39		0.40		0.38		0.04**
Some primary	0.24		0.27		0.20		
Primary or more	0.37		0.33		0.42		
Occupation							
Wage workers	0.23		0.25		0.21		0.23
Self-employed	0.14		0.12		0.17		
Homemakers	0.35		0.35		0.34		
Students	0.06		0.08		0.05		
Others	0.22		0.20		0.23		
Family size							
1–2 members	0.10		0.10		0.11		0.50
3–4 members	0.36		0.34		0.38		
≥5 members	0.54		0.56		0.51		
Starting bid							
Higher	0.49	0.50	0.49	0.50	0.50	0.50	0.87
= 1 if household has television	0.70	0.46	0.71	0.45	0.68	0.47	0.36
= 1 if household has mobile phone	0.94	0.24	0.95	0.21	0.93	0.26	0.17
= 1 if cataract patient	0.01	0.09	0.01	0.08	0.01	0.09	0.97
= 1 if informed about cataract surgery	0.06	0.23	0.07	0.25	0.05	0.21	0.32
= 1 if from outside Dhaka City	0.58	0.50	0.60	0.49	0.55	0.50	0.29

(a) *p* value for comparison between SICS and Phacoemulsification groups: using *t* test of difference in means for quantitative variables or Chi-square test of independence for categorical variables; (b) asterisks indicate statistical significance (***) $p < 0.01$, (**) $p < 0.05$, (*) $p < 0.1$)

occupation, none of the factors systematically predicts being selected for one of the two samples (see Online Appendix Table 6). We also examined the within-group balance in terms of assigning respondents to the initial bid categories (i.e. higher or lower). The joint orthogonality tests for both SICS and phacoemulsification groups showed no strong evidence of selection bias (see Online Appendix Table 7).

We made further comparisons between the observed characteristics of our sample and a nationally representative sample from a household income and expenditure survey [34]. In comparison with our study, the general population are comparatively younger (about 27 years on average), have about the same level of formal education (50%), earn a lower monthly household income (about BDT 13,000; equivalent

to US\$160), own less land (about 70 decimals) and belong to a comparatively smaller family (see Online Appendix Table 8).

During the choice experiments, 48 of the 556 respondents (i.e. 8.6%) reported non-positive WTP for the cataract surgeries. Respondents with non-positive WTP were comparatively older, had less formal education and a lower monthly family income. We included their responses as left-censored intervals and estimated the models. However, as a robustness check, we further estimated our models by both including and excluding the respondents with no positive WTP. Our models were not sensitive to exclusion of these respondents (see columns 1–2 and 4–5 of Online Appendix Table 5) from the analyses. Moreover, we included 36 accompanying adult

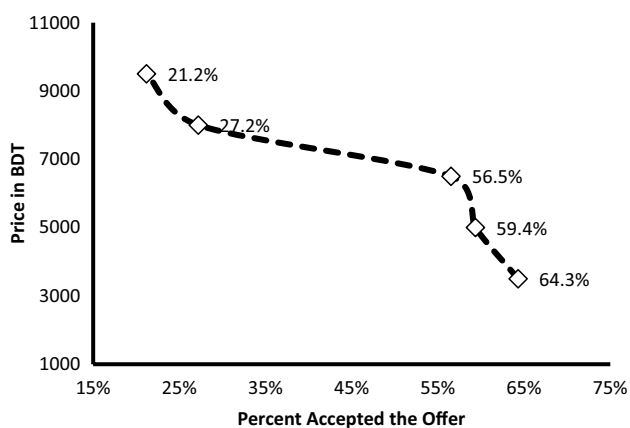


Fig. 2 Estimated demand curve for SICS

guardians (i.e. interviewed if the selected respondent was aged < 18 years) in our analyses. We did not find any systematic association between being a guardian and eliciting WTP (p value = 0.312 for SICS and p value = 0.919 for phacoemulsification).

3.2 Demand for Cataract Surgery and Price Sensitivity

Figure 2 shows the estimated demand curve for SICS surgery. At the lowest price point of BDT 3500 (US\$43), 64% of the respondents were willing to pay for the surgery. The demand dropped by 5 percentage points when the price was increased to BDT 5000 (US\$62) and another 3 percentage points when further increased to BDT 6500 (US\$80). The demand dropped by 29 percentage points as we increased the offered price from BDT 6500 (US\$80) to BDT 8000 (US\$98), which suggests a more elastic demand for this segment. When we increased the price by another BDT 1500 (US\$19) to the highest price bound of BDT 9500 (US\$117), the demand fell by additional 6 percentage points suggesting only one-fifth of the potential consumers would be willing to have SICS surgery at that price.

For phacoemulsification surgery, we found that at the lowest price point of BDT 15,000 (US\$185) about 39% of the respondents were willing to pay that price (see Fig. 3). The demand fell by 5 percentage points when the price was increased to BDT 20,000 (US\$246) and another 3 percentage points when the price was increased further to BDT 25,000 (US\$308). Similar to SICS, we found a more elastic demand as we increased the offered price from BDT 25,000 (US\$308) to BDT 30,000 (US\$369), the demand fell by 13.5 percentage points. Last, at the highest price point of BDT 35,000 (US\$431), we found that only 13.2% of respondents were willing to pay for phacoemulsification surgery.

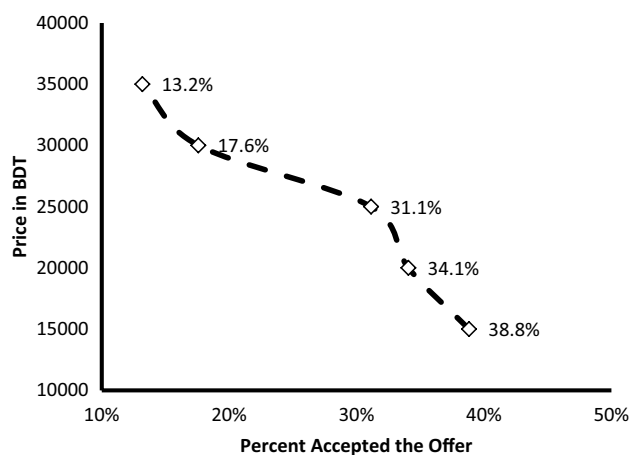


Fig. 3 Estimated demand curve for phacoemulsification Source: Authors' calculations using double-bounded dichotomous choice contingent valuation experiments

3.3 Multivariable Analysis

Table 2 shows the interval regression results for SICS and phacoemulsification surgeries, respectively. In the model without any explanatory variables, the constant term gives the mean maximum WTP for each cataract surgical procedure (see columns 1 and 3 of Table 2). For SICS, the mean WTP is BDT 7579 (US\$93). By comparing it with the average monthly household income (as reported in Table 1), we found that this is about 41% of the average monthly household income or equivalent to about 12 days of income for respondents in our sample. Similarly, for phacoemulsification surgery, we found that the average WTP is about BDT 10,208 (US\$126), which is about 54% of average monthly household income, or equivalent to 16 days of income for the sampled respondents (see column 3 of Table 2).

We found a strong association between household income and WTP for cataract surgery. The mean WTP increases by BDT 2642 (US\$33) for SICS and BDT 6502 (US\$80) for phacoemulsification for one standard deviation increment in household income. We also found that ownership of durable assets is associated with WTP for cataract surgery. Respondents without any land ownership were willing to pay on average BDT 2308 (US\$28) less for SICS (p value = 0.02) and BDT 11,427 (US\$141) less for phacoemulsification (p value = 0.03) compared with respondents who own land. Ownership of television and mobile phone are found to be associated with a higher WTP for both types of cataract surgeries. However, the associations were statistically weaker (p value = 0.06) and not significant for SICS. Other factors such as gender, occupation, and household size were not significantly associated with WTP for SICS or phacoemulsification surgery (see Table 2).

Table 2 Interval regression results—WTP for SICS and phacoemulsification

Variables	SICS		Phacoemulsification	
	(1)	(2)	(3)	(4)
Constant	7578.63*** (0.00)		10,207.86*** (0.00)	
= 1 if female		1955.02 (0.10)		2,034.25 (0.74)
Age (years)		-73.95** (0.01)		-14.84 (0.90)
Education level				
None		Base		Base
Some primary		149.08 (0.89)		1740.57 (0.77)
Primary or more		805.96 (0.49)		10,413.98* (0.05)
Occupation				
Wage worker		Base		Base
Self employed		1,009.53 (0.53)		-3,083.96 (0.65)
Homemaker		-1554.85 (0.28)		-1462.10 (0.84)
Students		-1749.03 (0.35)		-7451.18 (0.43)
Others		-167.31 (0.90)		1834.48 (0.78)
Family size (number)				
1-2		Base		Base
3-4		44.01 (0.98)		4713.37 (0.50)
5 or more		1772.78 (0.26)		-398.32 (0.95)
= 1 if higher starting bid		2613.16*** (0.00)		4554.65 (0.26)
Household total income (standardized)		2641.62*** (0.00)		6502.43*** (0.00)
Didn't own land		-2308.26** (0.02)		-11,427.25** (0.03)
Household land (standardized)		-17.80 (0.98)		16,225.89** (0.04)
= 1 if household has television		1,552.06 (0.12)		9369.27* (0.06)
= 1 if household has mobile phone		345.46 (0.88)		23,187.16* (0.06)
= 1 if informed about cataract surgery		3278.70 (0.13)		-5172.84 (0.54)
= 1 if no costs incurred before elicitation		-2870.19*** (0.00)		-1214.12 (0.76)
Costs already incurred before visiting this hospital (Standardized)		4775.00 (0.14)		14,192.04 (0.17)
= 1 if visiting from outside of Dhaka City		-1861.68* (0.07)		-4548.71 (0.34)
Observations	283	283	273	273

(a) *p* value in parentheses; (b) asterisks indicate statistical significance (****p* < 0.01, ***p* < 0.05, **p* < 0.1)

The findings varied for some of the determinants of WTP between the SICS and phacoemulsification groups. We found older people were less willing to pay for SICS surgery and mean WTP decreases by BDT 74 (US\$0.91) for each additional year (*p* value = 0.01); however, this association was not statistically significant for phacoemulsification (*p* value = 0.90). We did not find a significant association between the education level and WTP for SICS, although respondents with primary or higher education level were willing to pay on average BDT 10,414 (US\$128) more for phacoemulsification surgery compared to respondents with no formal education (*p* value = 0.05). Respondents who were residing outside Dhaka or who had not spent money for eye consultation or treatment elsewhere, prior to the survey, had significantly lower WTP for SICS, BDT 1862 (US\$23) (*p* value = 0.07) and BDT 2870 (US\$35) (*p* value < 0.01) less

on average, respectively. These associations between WTP and residence or cost incurred prior to the survey are not statistically significant for phacoemulsification surgery.

Finally, we found that the design of the WTP elicitation approach and the choice of the starting bids, in particular, had an influence on the elicited WTP. For SICS, respondents starting from a bid higher by BDT 1500 (US\$19), were willing to pay about BDT 2613 (US\$32) more on average compared to respondents starting from the lower bid amount (*p* value < 0.01). For phacoemulsification surgery, we found a difference of about BDT 4555 (US\$56), but the association was not statistically significant (*p* value = 0.26). These findings are generally consistent with anchoring effects in the WTP literature [35].

The income earning status of the respondent can allow better intra-household bargaining capacity and can be

Table 3 Prices of cataract surgeries

Description of the surgery	Package price in BDT (equivalent USD)
SICS using PMMA intraocular lens manufactured in India	5000–6500 (US\$62–80)
SICS using PMMA intraocular Lens manufactured in USA	9050–11,000 (US\$111–35)
Phacoemulsification surgery using PMMA intraocular lens manufactured in India	10,000–16,500 (US\$123–203)
Phacoemulsification surgery using PMMA intraocular lens manufactured in USA	12,000–16,500 (US\$148–203)
Phacoemulsification surgery using single/double hepatic-aspheric intraocular lens	12,000–25,000 (US\$148–308)
Phacoemulsification surgery using single piece-clear/yellow-hydrophobic lens	17,000–26,000 (US\$209–320)
Phacoemulsification surgery using multifocal intraocular lens	85,000–90,000 (US\$1046–1107)

(1) Unless explicitly specified, all these lenses are mono-focal; (2) All the price quotations are for cataract surgery of one eye. For both eyes, surgical procedures are conducted separately and the cost doubles; (3) Price figures are from the year 2015. In 2017 prices increased by 14–35%; (4) Surgical Package includes IOL price, Surgery fees, and operation theatre charges; (5) Public facilities charge only for intraocular lens price. These price quotations were collected from all the private specialized eye-care facilities mentioned in Table 4 (see Online Appendix)

associated with higher WTP. Moreover, being exposed to eye-care facilities with different levels of subsidies can also be associated with the WTP. Hence, we checked sensitivity of our models to include income earning status and facility dummies. However, our results were not sensitive to inclusion of these additional controls (see columns 2 and 4 Online Appendix Table 9).

We further checked the robustness of the estimated models using the stated maximum WTP as the outcome variables using simple OLS models. The results from these alternate stated WTP outcomes were found to be similar to the findings from the interval regression models (see Online Appendix Table 5). For example, higher household income and durable assets (i.e. land and television) were found to be associated with higher WTP for SICS; whereas people who were older, living outside Dhaka, and having had no experience of incurring expenditure for eyecare elsewhere were willing to pay less for SICS (see column 3 in Online Appendix Table 5). For the phacoemulsification surgeries, the estimates were less precise (as one would expect), even though the directions of the estimated coefficients remained unchanged for almost all the variables (see column 6 of in Online Appendix Table 5).

3.4 Market Prices of Cataract Surgeries

We have further collected price quotations for cataract surgeries from the selected private (not-for-profit) and public hospitals in Dhaka (see Table 3). Table 3 reports indicative prices for manual SICS and phacoemulsification surgeries available at the selected private (not-for-profit) hospitals (see Online Appendix Table 4). According to our exploratory study, these private hospitals are popular among patients of the lower socio-economic stratum. Results shows that it is possible to get a SICS with mono-focal polymethyl-methacrylate (PMMA) lens made in India at a price of BDT 5000 (US\$62). With the lens with identical features but manufactured in the USA, the price for SICS is as much as

BDT 11,000 (US\$135). Phacoemulsification surgeries have a higher and broader price range, starting at BDT 10,000 (US\$123) and with better quality (i.e. multifocal, single/double hepatic, etc.) lenses prices can be as much as BDT 90,000 (about US\$1107). It should be noted that these prices do not include possible additional non-medical expenditures of food, bed rent, and transportation, among others.

4 Discussion

The current study aimed to measure WTP for cataract surgeries in selected tertiary hospitals in Dhaka city. Unlike some of the previous studies, we elicited WTPs separately for two most common types of cataract surgeries, namely SICS and phacoemulsification. We carried out the elicitation for the patients at the major facilities providing different types of eyecare services including cataract surgeries. According to our estimates, the average WTP for SICS is about BDT 7579 (US\$93) and about BDT 10,208 (US\$126) for phacoemulsification. Our results are comparable to elicited WTP from a prior study in China (subject to proper inflation adjustments), but our mean WTP estimates are higher than values previously elicited in studies carried out in a low-income setting [12–14].

We found income level to be one of the most important determinants of WTP for cataract surgery. Respondents from the wealthier households were willing to pay higher prices for both SICS and phacoemulsification, suggesting that market segmentation and differential pricing can play role to optimize cost recovery and increase the number of free or subsidized surgeries for respondents from poorer households, who also have the lowest WTP [36, 37]. Hence, it is important to further understand determinants of WTP in Bangladesh and how much patients are willing to pay for potential enhancements to surgical packages, including non-clinical services such as accommodation or other amenities. Increasing cataract program revenues using differences in

WTP for these services can allow greater cross-subsidization and more equitable access to eye-care services [12, 38].

We acknowledge some of our study limitations. First, our findings rely on the assumption that stated WTP can predict respondent's actual purchasing behavior in case they need a cataract surgery. Given that respondents in our survey are general eye-care patients (who do not necessarily have cataract), the most relevant WTP and preferences may well be health state dependent [24, 25, 27]. Second, it is important to acknowledge that the choice of elicitation format and design of WTP module in a contingent valuation study can have an influence on the elicited WTP [39]. In particular, we found some evidence of starting point bias for initial and follow-up questions [40]. Third, our respondents were selected from patients who were attending a limited number of eye-care facilities in Dhaka and some differences in terms of socio-demographic characteristics were found between respondents in our sample and the general population in Bangladesh (see Online Appendix Table 8). While eliciting WTP may be more relevant to the people who are seeking eye-care services, one needs to be cautious about generalizing our findings to other contexts.

5 Conclusion

The cost of cataract surgery is an important barrier limiting the uptake of cataract surgery in low- and middle-income countries with a high prevalence of cataract blindness and visual impairment. We found that household income is the main determinant of WTP for cataract surgery, with the poorer individuals having the lower WTP. WTP can help programs to rationalize prices so that otherwise underserved clients can access cataract surgeries through more efficient cost-sharing protocols. This strategy is more sustainable and possibly does not cannibalize commercially available services. Our findings suggest that SICS may be a more appropriate method for high volume cataract surgery programs given the lower costs associated with this technique compared to phacoemulsification. Considering that a significant number of respondents expressed a maximum WTP that is below the lower bound of prices typically charged for SICS, it is likely that cataract programs in Bangladesh will need to continue providing surgeries at free or subsidized prices to increase uptake of cataract services. In such context, phacoemulsification can allow an opportunity to increase revenue generated by cataract programs by offering multi-tiered services and targeting the more affluent segments of the population and, allowing for greater subsidization for the poorer patients.

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Author Contributions AR and MS designed the study. AR, MNI, and SH developed the study instruments. MNI and SH managed the data collection. MNI and AR analyzed the data and drafted the manuscript. AR, MS, TE, and MNI critically revised the manuscript. All authors approved the version submitted for publication.

Data Availability Statement The datasets are not currently available. However, it can be made available upon request.

Compliance with Ethical Standards

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Ethical approval The ethical review committee of James P Grant School of Public Health (JPGSPH) at BRAC University, Bangladesh approved the study protocol. Administrative authorization to do the survey in selected hospital premises was obtained from hospital management before the start of data collection activities. Informed verbal consents were also obtained from the participants of this study. All procedures performed in this study involving human participants were in accordance with the ethical standards of JPGSPH, BRAC University and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of interest Muhammed Nazmul Islam, Thomas Engels, Shafayet Hossain, Malabika Sarker, and Atonu Rabbani have no conflict of interest to declare.

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