

# Telemedicine: An Innovative Twist to Primary Health Care in Rural Bangladesh

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## Abstract

**Background:** Health care service is worsening in the remote villages due to less complete and further away of healthcare facilities and service and makes this service costs compared to those of urban people. Telemedicine service provides a potential solution regarding this particular issue. This study provides empirical evidence of the benefits package consists of hypothetical telemedicine service and evaluates the economic benefit of telemedicine service.

**Methods:** The study measures marginal willingness-to-pay (MWTP) responses to policy change on a sample (n=203) observations. A randomized conjoint experiment has conducted in 7 remote villages of 3 coastal districts of the southwest coastal region of Bangladesh. Each respondent ranks 3 options-two hypothetical alternatives and the telemedicine status quo scheme. The level of attributes-payment for telemedicine service, sample collection from home, medicine delivery to home, capitation through online technology, service delivery frequency, and blood pressure and glucose measure at home-are randomly and jointly assigned to the 2 alternatives.

**Results and Conclusions:** Coastal villagers would like to pay more in option 4 and above. The lower payment for telemedicine service does not necessarily imply low demand for telemedicine, as the findings from MWTP illustrate potential demand for telemedicine in coastal villages in Bangladesh.

## Keywords

health economics, rural health care, primary care, cost effectiveness, universal health coverage

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## Introduction

Health care facilities such as service availability, accessibility of service, utilization of service, adequate coverage, and sufficient coverage in the rural area of Bangladesh are below standard. This situation is worsening in the remote villages due to less complete and further away of health care facilities and service and makes this service costs compared to those of urban people.<sup>1,2</sup> The shortage of strong political commitment and the role of non-government organizations (NGOs) and inadequate qualified and specialized doctors and practitioners have also resulted in further backwardness of the villages' health care facilities. Insufficient health care facilities and financial constraints motivate village people to herbal medicine, homeopathy medicine, indigenous medicine, and treatment from *Kobiraj* (occupational title found in Indian subcontinent traditionally practices Ayurveda), religious leader, quake doctor and drug seller. Telemedicine or distance medicine or e-medicine offers increased health care benefits in terms of affordability, accessibility, quality, fairness, equality, and efficiency.<sup>3,4</sup> It plays a vital role in reducing the gap between demand for and supply of healthcare facilities. It is an effective means

of health care over a distance where the provider (doctor) and receiver (patient) interact with each other through telecommunication technology.<sup>5</sup> Table 1 highlights the possible impacts of the telemedicine network.

Telemedicine programs have been in existence since the 1960s. However, in the 1990s they have begun to proliferate, both in the number of systems and the volume of images transmitted.<sup>5</sup> Innovation of necessary medical devices and teleradiology suited to capture images and other data in the form of digital electronics and the development and installation of high speed and high bandwidth telecommunication systems.<sup>6</sup> Teleradiology is the virtual application of telemedicine followed by cardiology, dermatology, psychiatry, pathology and oncology, blood glucose levels, and x-rays.<sup>5</sup> It is also suitable for medical support and monitoring of patients such as remote fetal, aging people, and patients

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**Table 1.** Possible Impacts of Telemedicine Network.

	Effects of telemedicine in terms of			
	Accessibility	Acceptability	Quality	Cost/benefits
For patient care	Access to Health	Confidence	Quality of Care	Low Transfer Cost
For doctors	Access to Data via ICT	Utilization	Quality of Life	Low Displacement Cost
For hospital	Better Offer	Well-being	Goodwill	Low Health Care Cost
For state	Better Access	Support for Telemedicine	Coordination	Cost control

which chronic conditions living at home.<sup>7</sup> In that viewpoint, telemedicine's virtual application is defined as the application of technologies linked in the health care of patients through real-time video conferencing and store and forward applications.<sup>8</sup> Video conferencing has 2 building blocks, such as sound and picture. Likewise, the store and forward applications have 1 building block such as the asynchronous transmission of medical data for example, video films (ultrasound), still-images (x-rays, photographs of skin lesions, and other static images), and sound files (heart murmurs).<sup>9</sup>

Economic evaluation is highly required for households, policymakers, health care programs, and service managers to purchase, plan, monitor, and modify the service and application of telemedicine.<sup>10</sup> It is a domain of formal analytical techniques. It provides systematic information about the cost and benefits of alternative options and support tools, which are essential for priority setting and decision making.<sup>11</sup> An economic evaluation of telemedicine compares the costs and other consequences of delivering specific health care services by telemedicine versus alternative means. The conventional approaches of the economic evaluation of telemedicine are cost-minimization analysis, cost-effectiveness analysis, cost-utility analysis, and cost-benefit analysis. Existing literature used sophisticated analytical approaches such as statistical simulation methods (eg, bootstrapping method, bootstrap-resampled incremental cost-effectiveness ratios (ICERs) and the MOSAIK-M model), cost-effectiveness analysis, cost-benefit analysis, and cost-minimizing analysis for proper empirical investigation of the effectiveness of telemedicine in terms of economic evaluation.<sup>3</sup> A very few studies used cost-utility analysis (eg, willingness-to-pay (WTP), bidding game, hedonic price, and travel cost) for evaluation of telemedicine.

Such an analytical tool has a more significant advantage to highlight households' preferences, ability, choice, and desires about telemedicine. This study's objective is to broaden the scope and rigor of the economic evaluation of telemedicine through WTP of cost-utility analysis. The first empirical result of the WTP was successfully achieved in a study that assessed demand for voluntary community-based health insurance improvement in rural Lao People's Democratic Republic.<sup>12</sup> Existing studies have not previously applied this approach to assess the effectiveness of

telemedicine with a highlight on improving well-being and health care financing policy. This study estimates WTP by randomization design for conjoint analysis and simple linear regression and considers no functional assumptions and extreme value type1 or Gumbel distribution. Therefore, it is predicted that estimated results are more valid than those of discrete choice experiments (DCEs).

## Methods

This study followed the "research onion" framework consisting of research philosophies, approaches, strategies, methods, time horizons, and techniques and procedures to fulfill the research objectives. Two research philosophies (positivism and interpretivism) will be used in the study. Positivism is the philosophy of science that provides positive facts and information and interpreted through rational or logical treatments from the exclusive source of all authoritative knowledge. The empirical investigation is performed well under this research philosophy. On the other hand, interpretivism involves the researcher to interpret elements of the study. It integrates human interest in a study. The mixed (blending of inductive and deductive) approach will be used for proper and better judgment and investigation. The inductive approach covers the qualitative research technique, and the deductive approach covers surveys through questionnaires or quantitative techniques. A mixed approach helps to blend qualitative and quantitative methods. A blending of these 2 methods provides more flexibility to the researcher by offering alternative techniques and useful combinations of methods to obtain optimal results, and it reduces the adverse effect of any particular method. Cross-sectional data will be used for analysis to detect the significant contributors to telemedicine in rural Bangladesh.

### Focus Group Discussion

Customization is an issue in the selection of the pecuniary attribute and its level. Under this process, it should attempt to make the choice alternative more realistic by relating pecuniary attribute and its level. There is a rule of thumb that each higher pecuniary alternative directly relates to its actual level proposed by Focus Group Discussion (FGD). The levels for visibility could be set 15% higher than the

proposed or actual level.<sup>13</sup> This study organized 4 FGDs, which consists of (7-8) participants of each occurred on 17 to 22 December 2017 at Jorshing Patakhali, Burburia, Sonailtola, and Kultali in Koyra, Mongla, and Shyamnagar sub-districts of Khulna, Bagerhat, and Satkhira districts. The objective of FGD was to set a base payment for telemedicine services in rural Bangladesh.

### **Design of Conjoint Experiment, Survey, and Questionnaire**

The traditional theory of welfare economics state that the value of a good or service arises from its utility, which can be classified into 3 main categories: the bequest or altruism value, the option value, and the existence value.<sup>14</sup> The quasi-option value is another form of non-use value, which is closely associated with the option value. The option value is applicable when we predict a little use of service in the future but not use it at the current time (eg, telemedicine service, and service from universal health coverage).<sup>15</sup> If it is not possible to predict the use or irreversibility of good at present, then the quasi-option value is more applicable. The nature and feature of existence value differ from a bequest, option, and quasi option values. The existence value generates from the utility and perception of the existing good, even in the absence of any expectation or unpredictable use.<sup>16</sup> The option value, hypothetical stated preference data, and conjoint analysis are highly correlated with each other and essential to valuing telemedicine service through WTP, and all are effective for developing strategies for service design.<sup>17</sup>

The conjoint analysis aims for greater realism, grounds attributes in concrete descriptions, which provide better discrimination among attribute importance.<sup>18</sup> It assumes that all services are equally available in the market. Results from conjoint analysis reflect the potential market acceptance of services.<sup>19</sup> For the necessary and fundamental steps in designing the conjoint experiment, this study needed some relevant attributes. These attributes are highly correlated with the provision of telemedicine. Findings from FGD and reviewed literature are the sources of selected attributes. In this study, the hypothetical telemedicine-based health care package is described accordingly to 6 attributes such as *payment for telemedicine service, sample collection from home, medicine delivery to home, capitation (managed health care contracts with physicians) through online technology, service delivery frequency, and blood pressure and glucose measure at home*. The first 3 attributes are selected from the findings of FGD. The rest attributes such as capitation through online technology,<sup>20</sup> service delivery frequency from doctor and telemedicine center,<sup>21</sup> and blood pressure, and glucose measure at home<sup>22</sup> are selected from existing literature on telemedicine. According to a systematic review of contributors

affecting telemedicine, capitation through online technology has been widely and effectively utilized in different areas of medical practice, such as diagnosis and treatment of pathological conditions.<sup>23,24</sup> The other 2 studies found that frequency of service delivery is an essential contributor to the development of intervention aimed at facilitating doctor and patient interaction.<sup>25,26</sup> Furthermore, other studies reported that blood pressure and glucose measures at home under the provision of home telemedicine consultation have significantly control diabetes.<sup>27</sup> Hence, this study hypothesizes that all the proposed attributes discussed above are the potential contributors to telemedicine.

Although the present telemedicine status quo scheme consists of payment and medical consultation, this study intentionally includes the attributes mentioned above in its experiment to observe how households' trade-off between them and other hypothetical attributes. Table 2 outlines the proposed attributes and their associate levels attached in the experiment. The number of attributes and levels produce a total of  $4^1 \times 2^5 = 4 \times 2 \times 2 \times 2 \times 2 = 128$  possible outcomes excluding the status quo scenario. These possible outcomes consist of 65 536 possible pairs where 128 pair from 16 choice sets are randomly selected to maintain the simplicity and condition of uncorrelated attributes. Each respondent presented with a set of 3 choice tasks; therefore, the causal effects are estimated using 16 choice sets.

The common objective of the conjoint experiment is the derivation of measures designed to determine the amount of money where participants are willing to forfeit to obtain benefits from the undertaking of some specific action and such measures are known as WTP.<sup>28</sup> The study assumes that the service of telemedicine is not only to the actions and efforts of the government. It also requires collective efforts or actions requiring data from different households to elicit WTP for proper empirical investigation of telemedicine. Improper application of conjoint experiment and its related questionnaire may hamper the whole survey and data collection process. To avoid such situation, questionnaire of the study designs to explain the purpose of the survey, attitudes of respondents toward proposed and existing telemedicine service, respondents' background information (e.g., age, monthly income, level of education, distance [km.] of health care centre from home, and household composition), and lastly, it covers 3 choice tasks. Respondents who completed the first session of the questionnaire were proceeding to the last session (experimental session). Before starting the experimental session, the assigned data collectors meet face-to-face with the respondents and explain the imagery scenario of the proposed telemedicine service and the rules of the experiment. In each choice task, the respondents compared 3 policy alternatives, 2 hypothetical policies, and the status quo scheme for telemedicine and rank the policies based on which scheme will maximize their well-being (1, 2, and 3 indicate the most, moderate and least preferred

**Table 2.** Attributes and Their Levels.

Attributes	No	Levels	Description
Payment for telemedicine service	1	2000 Tk. (3 months)	Payment per person in Bangladeshi currency Taka (Tk.) at different monthly options.
		3800 Tk. (6 months)	
		4000 Tk. (9 months)	
		5000 Tk. (12 months)	
	2	2300 Tk. (3 months)	Payment per person in Bangladeshi currency Taka (Tk.). It is higher than level 1.
		4370 Tk. (6 months)	
		5060 Tk. (9 months)	
	3	5750 Tk. (12 months)	Payment per person in Bangladeshi currency Taka (Tk.). It is higher than level 2.
		2645 Tk. (3 months)	
		5026 Tk. (6 months)	
	4	5819 Tk. (9 months)	Payment per person in Bangladeshi currency (Taka). It is higher than level 3.
		6613 Tk. (12 months)	
3042 Tk. (3 months)			
5780 Tk. (6 months)			
Sample collection from home	5	7605 Tk. (12 months)	Telemedicine service covers sample collection such as blood, urine, stool, and saliva.
		Yes	
Medicine delivery to home	6	No	Telemedicine service does not cover sample collection such as blood, urine, stool, and saliva.
		Yes	Telemedicine service covers medicine delivery to home.
Capitation through online technology	7	No	Telemedicine service does not cover medicine delivery to home.
		25% discount	Telemedicine service offers 25% discount of per capitation.
Service delivery frequency	9	30% discount	Telemedicine service offers 30% discount of per capitation.
		Within 3 days	Telemedicine service covers prompt delivery of medicine and diagnosis report within three days.
Blood pressure and glucose measure at home	11	Within 10 days	Telemedicine service does not cover delivery of medicine and diagnosis report within 10 days.
		Yes	Telemedicine covers blood pressure and glucose measure at home
	13	No	Telemedicine does not cover blood pressure and glucose measure at home

policy). To forgo bias resulting from the order in which attributes were given, the position order was randomized. For simplicity, every respondent received the identical attribute order across the 3 choice tasks.

The pre-test was conducted to validate and understand the experimental setup where 15 respondents (5 farmers, 3 small traders, 2 rickshaw pullers, 3 service holders, and 2 fishermen) took part in the pre-test. These 15 respondents were omitted from the main survey results. The pre-test results' assured that the proposed attributes and their associated levels were significant and relevant in terms of validity of the experiment and understandability of respondents.

As much as possible, the selection of respondents is random, but there is a possibility to occur sampling error. The

following procedures were taken to reduce the bias of the conjoint experiment. Four trained data collectors conducted all survey interviews. All respondents during the survey time have briefed the importance of telemedicine service. The interview of respondents was taken care of for a long time. The data collectors did not indulge in any personal and irrelevant gossiping to avoid anchoring or influencing the respondents' answers and choice tasks.

### Sampling

This study depends on stated preference (SP) data of rural households in few selected coastal villages in Khulna, Bagerhat, and Satkhira districts of Bangladesh. These



villages are all remote in that they are isolated from the nearby district and sub-district and adjacent to Sundarbans mangrove forest and the Bay of Bengal. Boat, bike, and bicycle are the only means of transportation to reach the destination. People of these villages are away from proper health care services due to poverty, and distance of hospitals, clinics, and health care centers.

This study has chosen 7 remote villages of 3 districts purposely for sample selection, but the representative households were randomly sampled. For sample random samples (SRS), the minimum acceptable sample size,  $n$ , was determined by applying the following formula.

$$n \geq \frac{q}{pa^2} [\Phi^{-1}(1 - \frac{\alpha}{2})]^2 \quad (1)$$

where  $p$  is the true choice proportion of the accuracy of the estimated probabilities,  $q$  is defined as  $1-p$ ,  $\Phi^{-1}(1 - \frac{\alpha}{2})$  is the inverse cumulative distribution function of a standard normal (i.e.,  $N \sim (0,1)$ ) taken at  $(1 - \frac{\alpha}{2})$  and  $\alpha$  is the level of accuracy. Estimated probabilities at a 95% level of accuracy and  $Z^2$  (calculated by Microsoft Excel) determine sample size 214 in the study area. Two villages (Jorshing Patakhali and Jaigirmahal in Koyra sub-district) of Khulna district, 4 villages (Joymony Ghol, Burburia, Joymony Sankirchar, and Sonaitola in Mongla sub-districts) of Bagerhat district, and 1 village (Kultali in Shyamnagor sub-district) of Satkhira district were selected for sample selection.

In this study, a household is defined as a group of people in a housing unit living together as a family and sharing the same kitchen.<sup>29</sup> All head of households (permanently live in these villages and have land, and business, occupation) got eligibility to be respondents of the study. The head of the household (father or elder son or in certain case mother) is defined as the person making the major economic, social, and household decisions irrespective of age.<sup>30</sup> Out of estimated 214 respondents, 203 (94.86%) respondents were agreed to participate in the survey and conjoint experiment, and the rest 11 (5.14%) respondents were refused the request to participate in the survey and conjoint experiment. Among all respondents, 116 (57%) were farmers, 57 (28%) were fishermen, 20 (10%) were businessmen, and the rest 10 (5%) were service holders. For the proper empirical investigation, FGD and pre-test were conducted by the author along with other collaborators. The author collected the survey data and data from the choice experiment and paid 4 data collectors, 1 principal investigator, and 3 graduate students with data collection experience and household surveys. The household surveys were conducted in 7 remote villages from 14 to 27 February 2018. On average, 2 days were spent in each village to collect data.

## Analysis

This study applies a full randomization design for the conjoint experiment. It is a respondents' preference-based approach in which each respondent faces a set of choices with several alternatives where every respondent is asked to state rather than reveal and rank the alternatives based on preferences. For instance, the conjoint experiment of the study randomly generates 2 hypothetical telemedicine alternatives such as payment for telemedicine service and non-monetized or non-pecuniary attributes for example, sample collection from home, medicine delivery to home, capitation through online technology, service delivery frequency, and blood pressure and glucose measure at home. Every respondent is requested to rank the preference-based alternatives.

The telemedicine status quo scheme as one of the important alternatives is initially included in the choice experiment. Therefore, every choice task has 3 alternatives. Two of them are hypothetical telemedicine alternatives, and the other is the telemedicine status quo scheme. Consequently, 2 kinds of results can be seen jointly, such as endogenous (preference 1 alternative to another alternative) and exogenous (preference to the status quo) choice probabilities.

The formal structure of the conjoint experiment was articulated by Hninn et al.<sup>31</sup> Suppose  $C = \{c_1, c_2, \dots, c_m\}$  is a set of choice tasks of telemedicine alternatives where  $T_{ijk} = \{T_{jk1}, T_{jk2}, \dots, T_{jkn}\}$  covers annual payment for telemedicine service and  $\bar{T}_{ijk} = \{\bar{T}_{jk1}, \bar{T}_{jk2}, \dots, \bar{T}_{jkn}\}$  covers non-monetize attributes for the  $i^{\text{th}}$  individual in the  $j^{\text{th}}$  alternative of the  $k^{\text{th}}$  choice task and  $n$  indicates the number of attributes. Therefore, associated attributes of telemedicine are defined by  $T_{ijk}$  and  $\bar{T}_{ijk}$ . Respondent  $i$  can choice between  $j^1$  and  $j^2$  or, simple  $J (=2)$  hypothetical telemedicine alternatives and the telemedicine status quo scheme in every  $K$  choice task. The variable  $Y_{ijk}$  indicates the individual choice outcome in the scenario where subscript  $i^{\text{th}}$  respondent prefers alternative  $j^{\text{th}}$  in the choice task over the status quo or, over another alternative for endogenous choice probabilities. In that particular case, it is possible to write  $Y_{ijk} = 1$  and 0 otherwise. Two assumptions are highly required for better functioning of this approach. The first includes the independence assumption and the second covers the randomization assumption. The independence assumption highlights the round of the choice task, and the sequences of alternatives do not influence the individual choice outcome. Therefore, it is possible to omit subscript  $k$  and write  $Y_{ij}$ ,  $T_{ij}$ , and  $\bar{T}_{ij}$ . The randomization assumption works as a facilitator to define the telemedicine detection of changes the level of proposed attribute  $l$  from  $p_0$  to  $p_1$ . Mathematically it can be written as:

$$\tilde{\pi}_1 = (a_1, a_0) = Y_{ij/P_{ij}=p, \bar{P}_{ij}=p_1}^* - Y_{ij/P_{ij}=p, \bar{P}_{ij}=p_0}^* \quad (2)$$

Where  $P$ ,  $P_1$ , and  $P_0$  are the levels of payment for telemedicine service ( $T_{ij}$ ) and attribute  $l(I_{ijl})$  for the hypothetical telemedicine alternative. The components  $Y_{ij/P_i=p, \bar{P}_{ij1}=a_1}^*$  and  $Y_{ij/P_i=p, \bar{P}_{ij1}=a_0}^*$  indicate the conditional averages of the observed choice outcome. Proposed attributes of the telemedicine can be estimated by using conjoint experiment data, and the following ordinary least square (OLS) method guided linear regression model:

$$E[Y_{ij}] = \beta_0 + \beta_p I_{ijp} + \sum_{l=1}^6 \beta_l I_{ijl} \quad (3)$$

where  $E[Y_{ij}]$  is the expected binary choice indicator of the  $i^{\text{th}}$  respondent for telemedicine service alternative  $j$ .  $I_{ijp}$  and  $I_{ijl}$  present the vectors of dummy for the levels of payment and the  $l^{\text{th}}$  attribute.  $\beta_p$  and  $\beta_l$  are vectors of the estimates of the telemedicine service. Equation (3) can be estimated by the cluster robust standard error method under the condition of the rank of 3 alternatives in several choice tasks.

For the analysis of WTP, the study mimics the methodology of Sydavong, Goto, Kawata, Kaneko, and Ichihashi<sup>12</sup> and Hninn et al.<sup>31</sup> Monotonicity, continuity, boundary, and rationality of the utility function is required to identify the marginal distribution of willingness to pay (WTP). Mathematically, it can be written as:

$$\check{F}(P) = 1 - \check{Y}_{ij/P_i=p} \quad (4)$$

where  $\check{F}(P)$  is the detected result of the distribution of marginal WTP or the share of attributes having a WTP value of  $P$  or lower.<sup>12</sup> The boundary assumption of utility function only assumes the lower bound of WTP at zero and has not assumed the upper bound, which implies that non monetize attributes have higher relative to the levels of telemedicine status quo scheme.<sup>31</sup> Only the lower bound of the mean WTP from the conjoint data can be detected using the following form:

$$\check{\mu} = \sum_{i=0}^n P_i [\check{F}(P_{i+1}) - \check{F}(P_i)] \quad (5)$$

where  $P_i$  indicates the lower payment for the telemedicine service in the  $i^{\text{th}}$  household, and  $n$  is the number of threshold levels. Payment for medical care or telemedicine service varies across the household size. The hypothetical payment levels for telemedicine services are also may vary accordingly in the study (see the following 4 matrixes for more details).

$$P_1 = \left\{ \begin{array}{ll} 2,000Tk. & 3\text{ Months} \\ 3,800Tk. & 6\text{ Months} \\ 4,400Tk. & 9\text{ Months} \\ 5,000Tk. & 12\text{ Months} \end{array} \right\}$$

$$P_2 = \left\{ \begin{array}{ll} 2,300Tk. & 3\text{ Months} \\ 4,370Tk. & 6\text{ Months} \\ 5,060Tk. & 9\text{ Months} \\ 5,750Tk. & 12\text{ Months} \end{array} \right\}$$

$$P_3 = \left\{ \begin{array}{ll} 2,645Tk. & 3\text{ Months} \\ 5,026Tk. & 6\text{ Months} \\ 5,819Tk. & 9\text{ Months} \\ 6,613Tk. & 12\text{ Months} \end{array} \right\}$$

$$P_4 = \left\{ \begin{array}{ll} 3,042Tk. & 3\text{ Months} \\ 5,780Tk. & 6\text{ Months} \\ 6,692Tk. & 9\text{ Months} \\ 7,605Tk. & 12\text{ Months} \end{array} \right\}$$

There is a rule of thumb that the level of pecuniary attribute could be set 15% higher or 15% lower than the existing or current level.<sup>13</sup> The study also followed this rule to differentiate each month group at a 15% level. From equation (4), the probability intervals of distribution of marginal WTP can be rewritten as:

$$\begin{aligned} \check{F}(P_1) &= 1 - \check{Y}_{ij/P_i=p_1} \\ \check{F}(P_2) - \check{P}(P_1) &= \check{Y}_{ij/P_i=p_1} - \check{Y}_{ij/P_i=p_2} \\ \check{F}(P_3) - \check{P}(P_2) &= \check{Y}_{ij/P_i=p_2} - \check{Y}_{ij/P_i=p_3} \\ \check{F}(P_4) - \check{P}(P_3) &= \check{Y}_{ij/P_i=p_3} - \check{Y}_{ij/P_i=p_4} \\ 1 - \check{F}(P_4) &= \check{Y}_{ij/P_i=p_4} \end{aligned} \quad (6)$$

The boundary assumption helps to identify 5 threshold payment levels for telemedicine services such as  $(0, P_1)$ ;  $(P_1, P_2)$ ;  $(P_2, P_3)$ ;  $(P_3, P_4)$ ; and  $(P_4, \alpha)$ . Hence, the lower bound of the mean WTP in equation (4) can be estimated as follows:

$$\check{\mu} = \begin{pmatrix} 2,000_{m_3} & 2,300_{m_3} & 2,645_{m_3} & 3,042_{m_3} \\ 3,800_{m_6} & 4,370_{m_6} & 5,026_{m_6} & 5,780_{m_6} \\ 4,400_{m_9} & 5,060_{m_9} & 5,819_{m_9} & 6,692_{m_9} \\ 5,000_{m_{12}} & 5,750_{m_{12}} & 6,613_{m_{12}} & 7,606_{m_{12}} \\ \check{F}(P_2) - \check{P}(P_1) \\ \check{F}(P_3) - \check{P}(P_2) \\ \check{F}(P_4) - \check{P}(P_3) \\ 1 - \check{F}(P_4) \end{pmatrix} \quad (7)$$

Contact basis telemedicine service is proposed for the villagers. Each recipient of the village can renew the contract after completion of the tenure of telemedicine service. Three months ( $m_3$ ), 6 months ( $m_6$ ), 9 months ( $m_9$ ), and 12 months ( $m_{12}$ ) telemedicine service scheme are proposed

**Table 3.** Brief Descriptive Statistics of the Variables.

Variables	Mean	Minimum	Maximum	Standard deviation
Age (years)	32.38	15	71	13.13
Monthly income (Tk.)	9000.09	5000	42000	1192.94
Education (years of schooling)	5.12	0	17	4.02
Household composition	5.54	3	12	1.78
Distance (km.) of health care centre	42.71	33	60	27.34

Authors' calculation based on survey data, 2019.

for the villagers in coastal Bangladesh. The proposed telemedicine service is contacted in local currency Bangladeshi Taka (Tk.), equivalent to US\$ using a conversion rate of BDT 82 to US\$ 1 corresponding to May 2019.

The orthogonal matrix designed choice sets in IBM SPSS Statistics Data Editor (version 20). The collected data were compiled, tabulated, coded, and analyzed according to the study's objectives. All collected data were input into the *NLOGIT* software and run by linear regression model at the convenient 1% (0.01), 5% (0.05), and 10% (0.10) level of significance. In this process, all the responses were given a numerical code. When the data entries were completed, the aggregate data were cleaned by producing frequency figures and examining the outliers.

### Ethics Statement

The ethical committee of the centre for higher studies and research, Bangladesh University of Professionals (BUP) approved this study. The consent form has consisted of specific expectations in terms of clear commitments to anonymity and confidentiality. This form has also presented the details about the collection of data. This form offered a range of concepts and ideas in which consent was sought, and every participant was requested to provide support, information, and data. Oral informed consent was obtained from all the respondents after the survey objectives and procedures were explained. The respondents were assured that their participation was voluntary, and they could withdraw from the survey at any time. They were also assured that they were not identifiable in any resulting presentations or publications that arose from the study. It was made clear to respondents that non-participation has no adverse consequences. This study assigned a unique ID code to each respondent's data and separated personal identification information from the response data to maintain the data's high confidentiality and protect the respondents' anonymity. All sets of data were password protected and saved in different places.

## Result

### Descriptive Statistics of the Variables

Based on the collected data obtained from field surveys in 7 coastal villages, basic descriptive statistics of major variables are calculated (see Table 3 for more details).

A total of 203 villagers from 7 villages participated in the survey, where all were male. More than 73% of respondents argued that telemedicine service could play an important role in providing better health care service and well-being, but 17% of respondents were not interested in paying for telemedicine service due to low income, faith and trust, and effective utilization of collected funds. About 97% of respondents strongly agreed that they did not get access to proper health care services. Table 3 outlines the summary statistics of the study. The average age and monthly income of the respondents are 32 years and Tk. 9000 respectively. About 27.8% of the respondents passed secondary school certificate (SSC) examination, higher secondary certificate (HSC) examination, and above 33.6% of respondents had completed primary education, and the rest of 38.6% of respondents were illiterate. The average residential distance of respondents from the health care centre is 42.71 (km.). The majority of the villagers have 5 family members.

### Results of Models and Marginal WTP

Table 4 presents the telemedicine results for the endogenous (hypothetical attributes for and exogenous choice probabilities from estimating from equation (3)). Estimated coefficients of each attribute of telemedicine service indicate the respondents' choice possibility of joining the telemedicine service scheme compared to the baseline level.

The findings show that the signs, significance, and magnitudes levels of the estimates are particularly close between the endogenous and exogenous choices for telemedicine service suggest that respondents' preferences are robust. All estimated coefficients are statistically significant at 1%, 5%, and 10 % levels. Estimated results confirm that telemedicine service's hypothetical attributes have produced more significant benefits than those of the status quo scenario. Thus, it can be said that telemedicine service's proposed attributes have a greater causal effect on choice probability than the existing telemedicine service attributes. This study further explores the distribution of respondents' WTP from endogenous choice for telemedicine service. The results of equation (5) presented in the following section.

The study counts a subsample analysis in which all levels attribute the fulfillment of the boundary assumption to measure the lower bound of the mean WTP, except payment

**Table 4.** Regression Results of the Survey.

Attributes	Exogenous choice for telemedicine service					Endogenous choice
	3 months option	6 months option	9 months option	12 months option	Aggregate option	
Alternative specific constant	27.897** (0.453)	38.072* (0.010)	26.093* (0.003)	34.202 (0.782)	0.531** (0.563)	13.219* (0.002)
Payment for telemedicine	-0.953*** (0.753)	-0.077** (0.653)	-0.212** (0.239)	-0.347*** (0.005)	-0.431* (0.008)	-0.321*** (0.328)
Sample collection	0.020** (0.332)	0.325 (0.863)	0.290*** (0.645)	0.003* (0.572)	0.232*** (0.020)	0.009* (0.628)
Medicine delivery to home	0.006 (0.653)	0.094 (0.741)	0.013** (0.529)	0.008 (0.737)	0.014* (0.110)	0.003 (0.346)
Online capitation	0.085* (0.007)	0.013*** (0.542)	0.053** (0.179)	0.020*** (0.453)	0.006*** (0.673)	-0.003** (0.677)
Service delivery frequency	0.045*** (0.531)	0.087** (0.019)	0.003* (0.162)	0.072 (0.320)	0.036*** (0.001)	0.034* (0.528)
Blood pressure & Glucose measure at home	0.004* (0.033)	0.072*** (0.011)	0.010* (0.122)	0.002** (0.121)	0.035*** (0.109)	0.006* (0.284)
Log-likelihood	-428.243	-541.038	-433.041	-423.732	-696.067	-894.99
Pseudo R <sup>2</sup>	0.347	0.290	0.265	0.398	0.334	0.426
Observations (n)	42	41	57	63	203	203

Authors' calculation based on survey data, 2018.

Robust standard errors in parentheses; \*\*\* $P \leq .01$ , \*\* $P \leq .05$ , and \* $P \leq .1$  indicate 1%, 5%, and 10% level of significance.

**Table 5.** Marginal Share of WTP.

	Estimated value	Standard error	P-value
$P_1$	0.047***	0.362	0.000
$P_2$	0.030***	0.179	0.000
$P_3$	0.182**	0.387	0.023
$P_4$	0.165***	0.429	0.000
$P_5+$	0.835*	0.568	0.101

Authors' calculation based on survey data, 2018.

\*\*\* $P \leq .01$ , \*\* $P \leq .05$ , and \* $P \leq .1$  indicate 1%, 5%, and 10% level of significance.

for telemedicine service. According to the 4 levels of payment designed in the conjoint experiment and the boundary assumption, the measured WTP is presented by 5 payment options (see Table 5 for more details).

The findings show that the estimated WTP values are all significant at the acceptable levels of significance. More than 20% of respondents revealed that they would like to pay for telemedicine service if it is equal to or less than  $P_1$ . Interestingly, the payment option  $P_4$  and above have the greater WTP value compared to those of other payment options for telemedicine service. SED characteristics of respondents play an important role in taking telemedicine services in remote villages in coastal Bangladesh. As the proposed or hypothetical attributes of telemedicine service are desirable, Table 6 shows the changes from baseline to the new level for each hypothetical attribute.

The empirically tested evidence generated by this study supports the findings of<sup>32-35</sup> Currell, Urquhart, Wainwright, and Lewis in rural Bangladesh and the USA. These 5 studies employed case study, cost-benefit analysis, content analysis of the interview, gravity model, and randomized controlled trials (RCTs) to assess the impacts of telemedicine. Those studies found that greater sample collection

(blood, urine, stool, and saliva) from home, medicine delivery to home, capitation through online technology, prompt feedback from the doctor, and blood pressure and glucose measure at home coverage significantly influence respondents' choice behavior. Moreover, the findings of the study are causally interpretable. The estimated results reveal that telemedicine service's proposed attributes are important contributors to telemedicine service for all the villagers of remote villages in the southwest coastal region of Bangladesh.

## Discussion

The objective of telemedicine is to protect people from out-of-pocket (OOP) payments and access to healthcare facilities and services by greater enrollment, which is consistent with universal health coverage (UHC). Nobel laureate economists Joseph Stiglitz, Kenneth Arrow, Alvin Roth, Vernon Smith, and Christopher Pissarides argued that health care is an investment, not a cost.<sup>36</sup> The economic case for telemedicine includes the cost of health, driving economic growth, and building well-being and resilience. However, in Bangladesh, the degree of enrolment in the telemedicine services remains far from satisfactory level due to the existence of unstable and higher payment for telemedicine and not the consideration of households' ability to pay option. The payment stands out as the major burden affecting the choice probabilities, ensuring the monotonic effects of the payment support the monotonicity assumption. The preference is more sensitive to a higher payment for telemedicine service than to a lower payment. This result confirms the findings of previous studies,<sup>37-39</sup> and it is also consistent with the self-reported reasons why respondents do not prefer the telemedicine service scheme. Respondents have not a homogeneous level of interest in all proposed payment



**Table 6.** Attribute Change from the Baseline Level to the New Level of Telemedicine Service.

	Baseline level ( $a_0$ )	New level ( $a_1$ )
1	Not cover sample collection from home for diagnosis	Cover sample collection from home for diagnosis
2	Not cover medicine delivery to home	Cover medicine delivery to home
3	Not cover capitation through online technology	Cover capitation through online technology
4	Not measure service delivery frequency	Measure service delivery frequency
5	Not cover blood pressure and glucose measure at home	Cover blood pressure and glucose measure at home

options for telemedicine service. This statement is rational in that a higher payment option may reduce villagers' interest and vice-versa in telemedicine service. The lower payment for telemedicine service does not necessarily imply low demand for telemedicine, as the findings from MWTP illustrate potential demand for telemedicine in coastal villages in Bangladesh.

The existing telemedicine service in Bangladesh is called *Shasthyo Batayon* (Health Window), and it does not meet the demand for healthcare services because of its shorter coverage facilities. Under the current marketization process and the new liberal economy, *Shasthyo Batayon* cannot attract many people by its nature of service. Therefore, to make telemedicine service more attractive, this study explores SP and the distribution of WTP for plans of telemedicine-based on hypothetical attributes such as payment for telemedicine service, sample collection from home, medicine delivery to home, capitation through online technology, service delivery frequency, and blood pressure and glucose measure at home in remote coastal villages of Bangladesh. For the proper empirical investigation, the study develops conjoint analysis using a full randomized experimental design to elicit SP data. The estimates can be interpreted as a causal judgment or inference, and apply a non-parametric WTP distribution for measuring respondents' behavior toward the telemedicine.

Positive values of MWTP for telemedicine make a guarantee that it creates well-being for telemedicine recipients (villagers) and brings a substantial amount of revenues for telemedicine investors. Age, income, household composition, the distance of health care centre, and years of schooling level of education are found to be important contributors to telemedicine. Hence, any policy aiming to undertake telemedicine service is needed to consider these factors for its effective implementation. The study findings can serve as policy inputs not only to telemedicine, but also pave the way for undertaking similar projects like the economic valuation of universal health coverage (UHC), non-communicable diseases (NCDs), and infant and child health.

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