

## Mathematical Modeling of Women Empowerment in Bangladesh

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**Abstract:** The aim of the present study is to estimate the women empowerment index value in Bangladesh since, women's empowerment is a matter of basic human rights which has during the last decade become a panacea for third world development. For this purpose, BDHS-2004 data have been used which reveals that empowerment level of women increases with age except the age group 45-49. Moreover, a mathematical model has been fitted to the mean score of women empowerment index which shows that women empowerment index follows a quadratic polynomial model.

**Key words:** Women empowerment, polynomial model, cross validity prediction power test, Bangladesh

### INTRODUCTION

Bangladesh is the 7th most populous nation in the world with 159 million people and the population density is remarkable (United Nations ESCAP, 2007). Despite sustained domestic and international efforts to improve economic and demographic prospects. Bangladesh remains a developing nation, in part due to its large population (UNFPA, 2007). Its per capita income in 2006 was US\$ 2340 (on purchasing power parity basis) compared to the world average of US\$ 9,940 (Population Reference Bureau, 2007). Yet, as the World Bank notes in its July 2005 Country Brief, the country has made significant progress in human development in the areas of literacy, gender parity in schooling and reduction of population growth (World Bank, 2005).

Like many other developing countries it needs poverty alleviation and empowering women as well. Since, the empowerment of women is an essential precondition for the elimination of world poverty and the upholding of human rights (DFID, 2000). Keller and Mbwewe (1991) describe Women's empowerment as a process whereby women become able to organize themselves to increase their own self-reliance, to assert their independent right to make choices and to control resources which will assist in challenging and eliminating their own subordination. According to ICPD there are 5 components of women's empowerment: women's sense of self worth, their right to determine choices, their right to have access to opportunities and resources, their right to have the power to control their own lives, both within and outside the home and their ability to influence the direction of social

change to create a more just social and economic order, nationally and internationally. Hashemi *et al.* (1996) defined the empowerment of women through the use of 6 spheres: sense of self and a vision of the future, including resisting negative behaviors of the husband, mobility and visibility, including how women are treated when they are traveling; economic security, including cash income, new skills and knowledge; status and decision-making power within the household, including making purchases on their own; ability to interact effectively in the public sphere, such as joining credit programs and participation in non-family groups, such as credit programs and solidarity movements.

Women's empowerment is a matter of basic human rights. Interest in women's empowerment among demographers and population policy makers was heightened during the 1994 International Conference on Population and Development (ICPD) held in Cairo, at which the empowerment of women was legitimated as a social goal and enshrined as a necessary condition for population stabilization (Hodgson and Watkins, 1997). Since then, critiques of demographers' views of gender and women (Presser, 1997; Watkins, 1993) have grown apace with the wealth of empirical studies investigating women's empowerment and its demographic consequences (Amin *et al.*, 1994; Balk, 1994, 1997; Chowdhury and Trovato, 1994; Dharmalingam and Morgan, 1996; Greenhalgh and Li, 1995; Jejeebhoy, 1995; Malhotra *et al.*, 1995; Morgan and Niraula, 1995; Schuler and Hashemi, 1994). Thus, here efforts have been made to measure the women empowerment index (WEI) score for Bangladeshi women and to find out which types

of models is more applicable to WEI score. Thus, the specific objectives of this study are:

- To measure the WEI score by age.
- To build up mathematical models to WEI score.
- To apply CVPP to the model to verify the validity of the model.

**MATERIALS AND METHODS**

Women empowerment is multidimensional and is very difficult to measure. For constructing WEI and other analysis, a nationally representative survey, Bangladesh Demographic and Health Survey (BDHS)-2004 data of 11,440 women of age 10-49 is used. The survey was conducted under the authority of the National Institute for Population Research and Training (NIPORT) over a 5 month period from 1 January to 25 May 2004 using multistage cluster sampling.

In this study, we have tried to measure women empowerment in the domestic sphere by making women empowerment index using the dimensions in accordance with Mason and Smith (2003). The particular aspects or dimensions of domestic empowerment we take are:

- Women’s economic decision making power.
- Their household decision making power.
- Their physical freedom of movement.

The detailed description of these 3 dimensions with their relevant indicators is given in Table 1. Then the index of each dimension was constructed where minimum and maximum values were chosen for each underlying indicator. Performance in each indicator is expressed as the minimum and maximum value between 0 and 1 in accordance with the construction method of the Human Development Index (UNDP, 2005) as follows:

$$IV_{ij} = \frac{(X_{ij}) - \text{Min}(X_{ij})}{\text{Max}(X_{ij}) - \text{Min}(X_{ij})}$$

where,  $(X_{ij})$ ,  $\text{Min}(X_{ij})$ ,  $\text{Max}(X_{ij})$  and  $IV_{ij}$  are, respectively, the actual, minimum, maximum and dimension index.

The Women Empowerment Index (WEI) is then computed by averaging these 3 indices.

**Model fitting:** We plotted the women empowerment index value by the respondent’s current age in Fig. 1 which depicts that the empowerment of women increases as age of women increases. But to fit a specific mathematical model to WEI score, we plotted the mean score of WEI by

age groups which showed that mean score of WEI can be distributed by polynomial model for different ages. Therefore, a polynomial is briefly discussed as an expression of the form (Waerden, 1948):

$$Y = f(X) = a_0 + a_1X + a_2X^2 + \dots + a_nX^n, (a_n \neq 0)$$

where,

- x = Age group.
- y = Mean score of WEI.
- a<sub>0</sub> = The constant.
- a<sub>i</sub> = The coefficient of x<sup>i</sup> (i=1, 2, 3, …, n).

If n = 0 then it becomes constant function. If n = 1 then, it is polynomial of 1<sup>o</sup> i.e., simple linear function. If n = 2 then it is polynomial of degree 2 i.e., quadratic polynomial etc. (Spiegel, 1992; Gupta and Kapoor, 1997).

**Model validation technique:** To test the stability of the model, the cross validity prediction power (CVPP),  $\rho_{cv}^2$  is applied here. The method for CVPP is given by:

$$\rho_{cv}^2 = 1 - \frac{(n-1)(n-2)(n+1)}{n(n-k-1)(n-k-2)}(1-R^2)$$

where,

- n = The number of cases.
- k = The number of predictors in the model and the cross-validated.
- R = The correlation between observed and predicted values of the dependent variable.

The shrinkage of the model is the absolute value of the difference between  $\rho_{cv}^2$  and  $R^2$ . Moreover, the stability of  $R^2$  of the model is equal to (1-shrinkage) (Stevens, 1996).

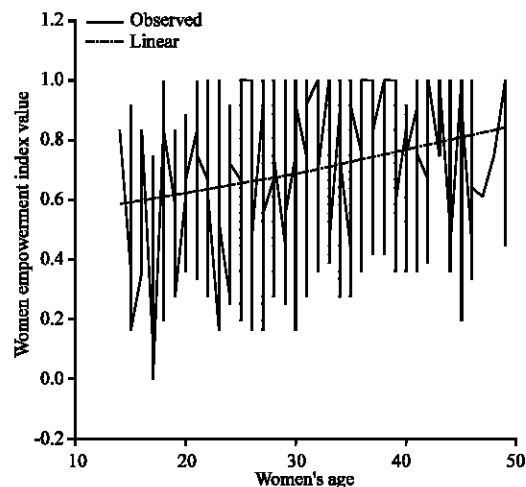


Fig. 1: Graphical representation of WEI by age

**Table 1: Description of dimensions and indicators with their measurement**

Component	Description	Coding	Measurement scale
Economic decision making index	Who decides how to spend money	1 = Respondent alone 2 = Respondent and husband/partner 3 = Respondent and other person 4 = Husband/partner alone 5 = Someone else	1, 2, 3 = 1 4, 5 = 0
	Final say on large household purchases	1 = Respondent alone 2 = Respondent and husband/partner 3 = Respondent and other person 4 = Husband/partner alone 5 = Someone else 6 = Decision not made/not applicable	1, 2, 3 = 1 4, 5, 6 = 0
	Final say on making household purchases for daily needs	1 = Respondent alone 2 = Respondent and husband/partner 3 = Respondent and other person 4 = Husband/partner alone 5 = Someone else 6 = Decision not made/not applicable	1, 2, 3 = 1 4, 5, 6 = 0
Household decision making index	Final say on own health care	1 = Respondent alone 2 = Respondent and husband/partner 3 = Respondent and other person 4 = Husband/partner alone 5 = Someone else 6 = Decision not made/not applicable	1, 2, 3 = 1 4, 5, 6 = 0
	Final say on child health care	1 = Respondent alone 2 = Respondent and husband/partner 3 = Respondent and other person 4 = Husband/partner alone 5 = Someone else 6 = Decision not made/not applicable 7 = Not applicable/no child	1, 2, 3 = 1 4, 5, 6, 7 = 0
	Final say on food to be cooked each day	1 = Respondent alone 2 = Respondent and husband/partner 3 = Respondent and other person 4 = Husband/partner alone 5 = Someone else 6 = Decision not made/not applicable	1, 2, 3 = 1 4, 5, 6 = 0
	Discussed about family planning with partner	1 = Mainly respondent 2 = Mainly husband 3 = Joint decision 4 = Others	1, 3 = 1 2, 6 = 0
Freedom of movement index	Final say on visits to family or relatives	1 = Respondent alone 2 = Respondent and husband/partner 3 = Respondent and other person 4 = Husband/partner alone 5 = Someone else 6 = Decision not made/not applicable	1, 2, 3 = 1 4, 5, 6 = 0
	Goes outside the village/town/city alone	0 = No 1 = Alone 2 = With children 6 = Others	1 = 1 0, 2, 6 = 0
	Goes to a health centre or hospital alone	0 = No 1 = Alone 2 = With children 3 = With husband 6 = Others	1 = 1 2, 3, 6 = 0
	Goes shopping alone or with somebody else	1 = Alone 2 = With children 3 = With husband 4 = With relatives	1 = 1 2, 3, 4 = 0

**RESULTS AND DISCUSSION**

Though BDHS-2004 collected data from 11 440 women of age 10-49, we get only one women’s relevant data for constructing WEI in age group 10-14. That is why, mean scores of WEI are presented in Table 2 excepting score of age group 10-14.

We observe from Table 2 that there is an upward trend in the mean score of WEI from age 15-44 years. That is in average the women who are under 20 years of age are much lower empowered than the women who are in 40-44 age group.

Now for fitting more appropriate model to the WEI score, we utilize usual models such as Makehams,

Table 2: Mean score of WEI by selected demographic variables

Variables	Mean score of WEI
15-19	0.5095
20-24	0.6615
25-29	0.6786
30-34	0.7473
35-39	0.7569
40-44	0.7845
45-49	0.6797

Table 3: Information of model fitting

Model	n	k	R <sup>2</sup>	$\rho^2_{cv}$	Shrinkage	Parameters	Significant probability (p)
(A)	7	3	0.92613	0.57788	0.34824	a <sub>0</sub>	0.41778
						a <sub>1</sub>	0.00542
						a <sub>2</sub>	0.00845

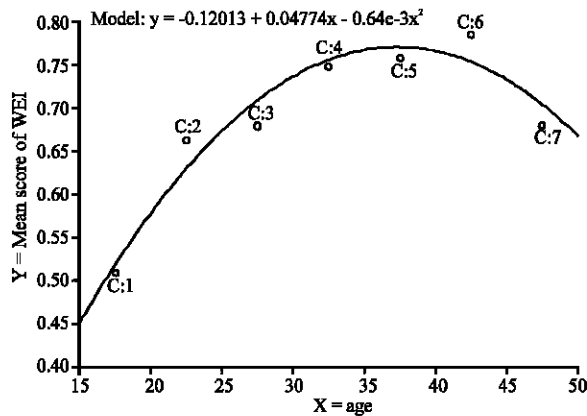


Fig. 2: Graphical representation observed and fitted mean score of WEI, Note: C presents observed values

Logistic, Gompertz, log-linear and semi-log linear. Among them, polynomial model of order 2 best fits according to its shrinkages. So, only the outputs of the polynomial model are exhibited in Table 3 and Fig. 2.

The polynomial model for WEI in Bangladesh is:

$$y = -0.12013 + 0.04774x - 0.64e-3x^2 \quad (A)$$

which is the polynomial of degree 2 i.e., quadratic polynomial.

From Table 3, it is shown that 2 parameters of the fitted model are statistically significant with 93% of variance explained and the model's shrinkage is 0.34824. This model will be stable more than 57%.

### CONCLUSION

The level of women's empowerment in Bangladesh is not satisfactory for any of the age group. Older women have more independence and empowerment than younger women because they have more experience with life, a better understanding of how to get what they want or

need, a closer relationship with the husband, or because they have fulfilled certain social obligations to the husband and his family (for example, bearing children or sons) and thus, are more trusted than are young wives, over whom tighter controls are maintained (Tareque *et al.*, 2007) and the mathematical model of WEI score in Bangladesh follows a quadratic polynomial model.

### FURTHER SCOPE

Table 2 and Fig. 2 show that not all women in Bangladesh are equally empowered i.e., young aged women are less empowered than their older counterparts. Now some questions will be arisen-why it is happened and what the consequences are.

On average, girls who marry as adolescents attain lower schooling levels, which cause lower self confidence, bargaining power, freedom of choices etc. as a result they have less reproductive control and suffer higher rates of maternal mortality and domestic violence and thereafter less empowerment. We guess some other causes like early female marriage make women low empowered. Thus, further research is needed to find out the rationale behind the above questions.

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