

Predicting Antenatal Care Utilization in the Philippines: A CHAID Analysis

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Abstract— Complications associated with pregnancy and childbirth are still considered as leading causes of deaths in the reproductive age group of women in many developing countries. This problem may be addressed when expectant mothers utilize antenatal care services. However, despite the benefits of this service to the mother and child, it is not fully utilized in the Philippines. Using the exhaustive chi-squared automatic interaction detector to 2013 National Demographic and Health Survey data, the predictors of antenatal care (ANC) utilization of reproductive women age 15 to 49 in the Philippines one birth. Findings reveal that the most significant predictor of ANC use was the region where a woman resides. Women who were living in NCR, CAR, Ilocos Region, Cagayan Valley, Central Luzon, CALABARZON, Bicol, Western and Central Visayas, Davao and Caraga had the highest likelihood of utilizing ANC than those who lived in MIMAROPA, Eastern Visayas, Zamboanga, Northern Mindanao and SOCCSKSARGEN with the lowest in ARRM. The second most influential factor is the woman's religious affiliation. If a woman is a Muslim, her utilization is lower than a Christian, regardless of what her socio-economic status is or in what wealth quintile she belongs. The result further shows that wealth quintile and educational attainment are also significant predictors. Policy makers and health providers should intensify their efforts to address differentials between these groups of women and to widen the campaign of at least four antenatal visits during pregnancy as a requirement in all parts of the country.

Keywords—Antenatal Care Utilization, E-CHAID, National Demographic and Health Survey, Philippines, Women

I. INTRODUCTION

Over the past decades, the world has seen the tremendous efforts to increase the utilization of antenatal care (ANC) because of its potential benefits to the health of the mother and the child (Gayawan, 2013). The attention given to an expectant mother known as ANC is a major component of a reproductive health care that will reduce unnecessary maternal and child mortality (UN, 2014; USAID, 2015). ANC services provide pregnant women an entry point to the healthcare system, offering appropriate screening, intervention and treatment throughout pregnancy, and encouraging women to seek a skilled birth attendant for their delivery (Lincetto et al. 2006). Furthermore, using ANC provides women information about improving maternal health through proper nutrition and self-care during pregnancy; and throughout the postpartum period, such as the benefits of exclusive breastfeeding and counseling on family planning methods (WHO 2007). Hence, the World Health Organization (WHO) recommends that each

woman receives a minimum of four ANC visits as this will ensure better results for both parties.

There have been numerous studies of the determinants of ANC use in low- and middle-income countries. Melese, Darak and Tefera (2015) for instance, contended that utilizing maternal health care services, such as antenatal, professionals' assistance during delivery and postnatal care contributes to a significant role in the reduction of maternal and child mortality. These findings of their study indicated that utilization of said services was influenced by place of residence, wealth status, women's and husband's education and parity. Also, both religious affiliation and age of women were also prominent predictors of utilization of the ANC and skilled assistance during delivery. Sharma, Shawangdee and Sirirassamee (2007) examined the association of access to health and women's status with the use of prenatal, delivery, and postnatal care during the Safe Motherhood Program period in Nepal. Multiple logistic regression analysis indicated that the utilization of maternal health services increased over a period. Program interventions such as outreach worker's visits, radio information disseminated through various mass media sources and raising women's status through education were able to explain the observed change in utilization. Health worker's visits and educational status of women showed a large association, but radio programmes and other mass media information were only partially successful in increasing use of maternal health services. Also, socioeconomic and demographic variables such as household economic status, number of living children and place of residence showed stronger association with use of maternal health services than did intervention programmes. In another study, Nzioki, Onyango & Ombaka (2015) assessed the influence of socio-demographic characteristics on MCH service utilization. Results indicated that women with secondary education and above, women in households earning more than 1 US Dollar in a day and women in employment or operating a business were more likely to utilize MCH services.

In summary, the above studies and many others have identified the predictors for low utilization of maternal health care services employing inferential statistics specifically using regression analyses. The advent of powerful computers and the emergence of internet and e-commerce have made the pattern recognition an important research tool (Chan et al. 2006), particularly among business and marketing researchers (Nong, 2003). Pattern recognition, popularly known as data mining (DM) is the extraction of hidden predictive information from large databases ((Han, Kamber& Pei, 2011). With the increasingly significant amount of scientific, medical, demographic and financial data stored in databases, DM techniques that can intelligently assist people in transforming

these data into something that will benefit a company, an institution or industry (Han, Kamber, & Pei, 2011) becomes a necessity. One commonly used DM technique is chi-squared automatic interaction detector (CHAID), which has been used to segment a heterogeneous population into homogeneous subgroups. However, little is known about the utilization of these techniques on this significant issue and concern- maternal and child health. No previous study, to the researcher's knowledge, has examined utilization of ANC using the National Demographic and Health Survey (NDHS) data using data mining.

The present study utilized the Anderson's Behavioral Model for Healthcare Use. This model has been used to understand utilization in different health care settings (Babitsch, 2012). Several studies have made use of this conceptual model to explain the determinants of antenatal care utilization (Beeckman 2010, Guliani H 2014, Babitsch 2012, Chakraborty 2003).

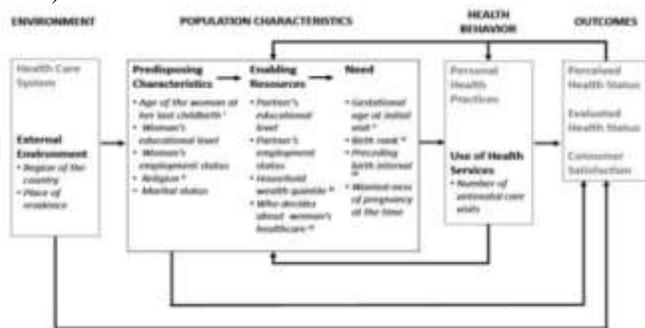


Figure 1

The conceptual framework based on Anderson's Behavioral Model of Healthcare Use and the corresponding determinants used in our secondary analysis (Hodgins, 2014). Source: Anderson 1995 (Hodgins, 2014).

This paper investigated the factors influencing the ANC utilization of reproductive women in the Philippines using a Chi-squared Automatic Interaction Detector. The aim was to divide the heterogeneous group of women of reproductive age in the country to groups of similar characteristics thereby addressing their specific needs.

II. MATERIALS AND METHODS

Participants of the Study

Five thousand three-hundred one women were selected as participants of the study. These women had births for the past five years before the survey. This number represents 33% of the total number of women surveyed.

Of the 5,301 women over half of the women aged 15-49 (50.4%) are under 30. Two out three (65.3%) women are married, over a quarter (26.4%) are living together with a man while the remaining 8.3% are either never in a union, widowed or separated. Regarding the women's education, almost one in two women (48.9%) have secondary education, over a quarter (28.1%) have a higher education while one-fifth (21.1%) have some form of primary education. Approximately 2% of the women have no formal education. With regards to religion, about 4 out of 5 women (82.1%) are Christians; much lower proportions are Muslims (9.4%) and 7.7% from other religion. More than half of the women are living in rural areas (58%)

while the remaining number of women are living in rural areas. The majority of the respondents (28.8%) belong to the lowest quintile while 13% belong to the highest quintile.

Source of Data and Collection Procedures

The data set of this study was obtained from the 2013 National Demographic and Health Survey (NDHS) of the Philippines carried out by the Philippine Statistics Authority (PSA). The NDHS is part of the worldwide MEASURE Demographic and Health Surveys program, which is designed to gather information on a variety of health-related topics including fertility, family planning, and maternal and child health (PSA and ICF International, 2014). Information about the DHS Program was obtained from ICF International, 530 Gaither Road, Suite 500, Rockville, MD 20850, USA. The researcher communicated first to the DHS Program using <http://www.dhsprogram.com> to avail of the said data. After she had registered and after she provided the Program with the description of the study, evaluation by the committee was done, and approval was granted to the researcher. She was then given access to download the zipped data in different formats.

Statistical Analysis

The filtered data was analyzed using the decision tree technique, a data mining approach. The decision tree technique generates rules for the classification of a dataset and uses a tree-shaped structure to represent sets of decisions. In this present study, Exhaustive CHAID algorithm analysis performed using IBM SPSS version 21 was utilized to build the decision tree models. CHAID decision trees are nonparametric procedures that make no assumptions about the underlying data. Moreover, this technique uses a systematic algorithm to detect the strongest association between predictors and outcome variables (i.e., health outcomes) through a comprehensive search of the predictors and the level of predictors from the entire set that show the most differentiation on the outcome variable. The degree of differentiation is depicted sequentially in a decision tree format to show the optimally split predictors. Thus, homogeneous groups could be identified regarding their observed levels on the outcome variable. The alpha level for all statistical tests was 0.05, corrected for the number statistical tests within each predictor using a Bonferroni correction.

III. RESULTS AND DISCUSSION

Results

The analysis of this research is based on 5,301 women respondents who had given at least one birth within five years preceding the survey.

Table 1 shows the summary model of the ANC utilization. The Specification section provides information on the settings used to generate the tree model. The Results section displays information on the number of total and terminal nodes, depth of the tree (number of levels below the root node), and independent variables included in the final model.

Of the ten independent variables specified only region, religion, wealth quintile, educational level were included in the final model.

The tree diagram (Figure 2) shows that out of 5,301 sampled women in the country, 5,031 (94.9%) have received/utilized ANC services while only 270 (5.1%) have not received it.

The most significant predictor of ANC utilization in the Philippines was the region where a woman resides. Women who were living in NCR, CAR, Ilocos Region, Cagayan Valley, Central Luzon, CALABARZON, Bicol, Western and Central Visayas, Davao and Caraga had the highest likelihood of utilizing ANC (97.9%) than those who lived in MIMAROPA, Eastern Visayas, Zamboanga, Northern Mindanao and SOCCSKSARGEN (94.1%). The lowest is in ARMM with only 64.8% chance of utilization. Among this first group of women, the second most influential factor was related to woman's religious affiliation. If a woman is a Christian, this significantly increased chances of higher ANC utilization (98.2%). If a woman is a Muslim, her utilization is lower (94.7%) than a Christian, regardless of what her socio-economic status is or what wealth quintile she belongs. The third factor was wealth quintile. If a woman resides either in NCR, CAR, Ilocos Region, Cagayan Valley, Central Luzon, CALABARZON, Bicol, Western and Central Visayas, Davao and Caraga, a Christian, and belongs to either richer, poorer, richest, or middle wealth quintile, the likelihood of a successful utilization of ANC was 98.6%. However, if a woman was in the same group of regions, a Christian yet belonging to the poorest quintile, the likelihood of successful ANC utilization is 96.6%.

For women who were living in MIMAROPA, Eastern Visayas, Zamboanga Peninsula, Northern Mindanao and SOCCSKSARGEN, the second predictor to ANC use was educational level. A woman would have a higher likelihood of successful ANC visits if she attained at least secondary level.

A woman who resides in the Autonomous Region in Muslim Mindanao has a significantly decreased chance for a successful ANC utilization of 64.8%.

Successful ANC Utilization

Table 2 shows the subgroups sorted by a gain score (successful ANC utilization rate) revealing from highest to lowest the top three successful groups that have a significantly higher competitive ANC utilization rates than the competitive ANC utilization rate (94.9%) of the overall sample. The following is a brief description of these three homogeneous subgroups with higher than average competitive ANC utilization rates:

Group 1. This group represents the 2,728 women who resided either in NCR, CAR, Ilocos Region, Cagayan Valley, Central Luzon, CALABARZON, Bicol, Western and Central Visayas, Davao and Caraga. These women were Christians, and they belong to either to richest, poorer, richer and middle wealth quintile. These 2,728 women represent 51.5% of the overall women sample while 2,690 women represent 53.5% of all women who received ANC services in the overall sample. The competitive utilization rate for these women was 98.6%. An index score of the ratio of these two percentages indicates the comparison between the proportion of women who utilized ANC in this group as compared to the proportion of women who utilized ANC in the overall sample. For this group, the index score was 104% (53.5/51.5) and reveals that the proportion of

women who found competitive ANC utilization in this group is approximately 104% better than the competitive utilization rate for the overall sample.

Group 2. This group represents 841 women who resided either in MIMAROPA, Eastern Visayas, Zamboanga Peninsula, Northern Mindanao and SOCCSKSARGEN and who have an educational background in high school or some higher education. Of this number, 819 utilized ANC. The competitive utilization rate for this group was 97%, and the index score was approximately 103% indicating that the utilization rate of the women in this group is 103% better than the utilization rate of the overall sample.

Group 3. This group represents 680 women who resided either in NCR, CAR, Ilocos Region, Cagayan Valley, Central Luzon, CALABARZON, Bicol, Western and Central Visayas, Davao and Caraga. These women were Christians, and they belong to the poorest wealth quintile. There were 658 who had at least four ANC visits during their pregnancy. The competition utilization rate for this group was 97%, and the index score was approximately 102% which means that the successful utilization rate of this group was 102% better than the ANC utilization rate of the overall sample.

Unsuccessful ANC Utilization

Subgroups sorted by a gain score (unsuccessful ANC utilization rate) are the following:

Group 1. Group 1 represents 344 women who were residing in Autonomous and Muslim Mindanao. This 344 is 6.5% of the overall women sample. One hundred twenty-one of these women have not utilized ANC services which represent 44.8% of all women sample who have not also used ANC. The competitive unsuccessful utilization rate was 35.2%, and the index score was 690% indicating that their unsuccessful utilization rate was 6.9 times higher than the average of the overall sample.

Group 2. This group represents 370 women residing at either MIMAROPA, Eastern Visayas, Zamboanga Peninsula, Northern Mindanao and SOCCSKSARGEN, who have no education or have attained some primary schooling. This figure represents 7% of the overall women sample, and the unsuccessful competitive utilization rate was 13%. The index score was 260% indicating that their unsuccessful ANC utilization rate was 2.6% times higher than the average of the overall sample.

Group 3. This group represents 338 women who lived either in NCR, CAR, Ilocos Region, Cagayan Valley, Central Luzon, CALABARZON, Bicol, Western and Central Visayas, Davao and Caraga. These individuals were either from Islam and other religious affiliation different from Christianity. The successful competitive ANC utilization rate for this group is 95%, and the index score was 104% indicating that their unsuccessful utilization rate for this particular maternal health service is 1.04 times higher than the average of the overall sample.

Discussion

The data mining approach provides detailed information and insight about the relationship among demographic, socio-economic and cultural variables and maternal health service utilization through the segmentation of a sample into mutually exclusive subgroups. In this study, the results of the Exhaustive CHAID analyses revealed that the utilization of maternal health care services of Filipino women of reproductive age is influenced by many factors.

In this study, the results of the Exhaustive CHAID analysis revealed that antenatal care utilization is influenced by women's residence as to region, religion, wealth quintile and education. Women had the highest probability of ANC utilization when she lived in either NCR, CAR, Ilocos Region, Cagayan Valley, Central Luzon, CALABARZON, Bicol, Western Visayas Central Visayas, Davao or Caraga, a Christian and belonging to either poorer, middle, richer or richest wealth quintile. For women who were living in either MIMAROPA, Eastern Visayas, Zamboanga Peninsula, Northern Mindanao and SOCCSKSARGEN, they have a higher likelihood of successful ANC utilization if they attained at least secondary level of education. A woman who lived in the Autonomous Region in Muslim Mindanao has a significantly decreased chance for a successful ANC utilization.

A significant finding from this analysis is the central role, the **region** a woman resides in predicting her ANC utilization. Specifically, two in the top three successful groups with higher than average competitive ANC utilization rates, came from NCR, CAR, Ilocos Region, Cagayan Valley, Central Luzon, CALABARZON, Bicol, Western Visayas or Central Visayas, Davao or Caraga, whereas two groups from the top three unsuccessful groups with the highest unsuccessful utilization came from regions not mentioned above. Interestingly, NCR, CAR, Ilocos Region, Cagayan Valley, Central Luzon, CALABARZON, Bicol, Western and Central Visayas, Davao and Caraga are regions with developed cities.

Developed cities/urban places have a greater number of health centers, a higher number of skilled health professionals, and bigger budget allocation to health services. The second most influential factor is a woman's religious affiliation. Christian women have a higher likelihood of seeking for antenatal care services than Muslim women. Health-seeking behavior may be influenced by religious law or teaching. For instance, in the Middle East and North Africa, it is necessary for a Muslim woman to have her husband or about go with her outside the home (Newbrander, Natiq, Shahim et al., 2014; Remien, Chowdhury, Mokhbat et al., 2009). In a similar fashion, in Afghanistan, a husband's consent is sought whenever a woman leaves the house even in the case of an emergency (Newbrander, Natiq, Shahim et al., 2014).

The next factors influencing ANC utilization are education and socio-economic status (wealth quintile). This finding is the same with that of Shariff et al. (2002) and Molina, Nakamura, Kizuki & Seino (2013). In their study, they pointed out that the low utilization of maternal services seems to be due to low levels of household income (wealth quintile), high illiteracy and ignorance. In Babar's study (2004), he emphasized that low

literacy level of the mother is one of the major causes of poor utilization of primary health care services.

Strengths and limitations

The current study has some strengths. The data utilized was a national survey data and relatively large sample size with a high response rate. The demographic and health surveys are internationally validated and nationally adapted surveys. Therefore, the current findings are generalizable to the entire country. The analysis accounted for study, design and sampling procedure, which is more likely to yield accurate estimates. This study has also provided knowledge on factors associated with the utilization of antenatal care. However, the present study has several limitations. Cross-sectional nature of NDHS does not allow one to extract causal inferences. Also, considering that this is a retrospective study, participants may not be able to recall significant information during interviews.

IV. CONCLUSIONS

Employing Exhaustive Chi-squared Automatic Interaction Detector (E-CHAID) may be used to predict antenatal care utilization and other maternal health services. In this study, it was found out that region, religion, wealth quintile, educational level are influential factors to ANC utilization in the country. The use of the decision provided information as to the groups of women who are marginalized- women who need greater attention from the government.

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TABLE 1 MODEL SUMMARY FOR ANC UTILIZATION

<i>Specifications</i>	Growing Method	EXHAUSTIVE CHAID
	Dependent Variable	UTILIZATION OF ANTENATAL CARE SERVICES
	Independent Variables	Educational Level, Place of Residence, Region, Sex of Household Head, Wealth quintile, Access to Mass Media, Level of Empowerment, Religion, Occupation, Ethnicity
	Validation	Cross Validation
	Maximum Tree Depth	3
	Minimum Cases in Parent Node	400
	Minimum Cases in Child Node	200
<i>Results</i>	Independent Variables Included	Region, Religion, Wealth quintile, Educational Level
	Number of Nodes	10
	Number of Terminal Nodes	6
	Depth	3

TABLE 2. GAINS CHART OF TOP THREE SUCCESSFUL END GROUPS

Group	Node	n(cases)	Percent (Total Sample)	n(successful)	Percent (successful sample)	Gain (percent) Success rate	Index (%)
1	8	2728	51.50%	2690	53.50%	98.60%	103.90%
2	6	841	15.90%	819	16.30%	97.40%	102.60%
3	9	680	12.80%	658	13.10%	96.80%	102.00%

Note: The gain percent represents successful ANC utilization rate.

