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Determinants of the Households' Choice of Drinking Water Sources in Pakistan: Evidence from PSLM 2014-15.

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Abstract

The study analyzed the socioeconomic determinants of the household choice of drinking water sources in Pakistan. The study uses multinomial logit model and the results indicate that education status of the head of the household, which is also the significant factor to capture awareness, plays an important role in the choice of water source. As the level of education increases then there are more chances that a head of the household will prefer improved source of drinking water i.e piped water, covered sources or others (filtration plants and bottled water). Besides education, higher income quartiles, occupational status of the head of the household, distance to water source, number of rooms are important determinants of preference for improved sources of drinking water in Pakistan.

Key words: Water Choices, Drinking Water, Multinomial Model

JEL Classification: Q25, Q50

1. Introduction

Water in general and sources of drinking water in particular are significant factors ensuring sustainable development. Increase in demand of water due to growing population coupled with climate change has caused massive stress on water resources in developing countries (Nauges and Whittington 2010) including Pakistan. Consequently per capita water availability is decreasing to critical levels in developed and developing world and it is expected to decline even more substantially in the near future too. Issues of inequitable distribution across head and tail ends of canals and system losses make the situation worse. In such circumstances, a scarcity pricing system can address the issue while considering the optimal price inversely related to storage levels. This means increasing the price when demand is high and decreasing it in times of supply augmentation (Hughes

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et.al 2009). Poor quality of drinking water is another important area of concern for policymakers as it causes different waterborne diseases in developing countries (Khan 2010).

Household obtain drinking water from different sources that include hand pumps, inside or outside tap, open wells, streams, filtration plants etc. (Mu et al 1990) and therefore the level of services for example price, distance from source, quality, reliability, etc also vary depending on water source and access. Consequently households' choice of drinking water depends on different factors i.e household size, no of children, time to reach the source, levels of education, awareness, exposure to print and mass media, income, input prices, and taste (Hidman 2002). In Pakistan only 65% of the households have access to improved water sources (LEAD 2016).Thus, a larger part of the population is exposed to unsafe and polluted drinking water (Mahmood and Maqbool 2006).

In Pakistan there are very few studies that examined socio economic and demographic factors, that are affecting the households' choice of drinking water source, that too for a single city (Khan *et.al* 2010, Kausar *et.al.* 2009, Ahmad 2010). Keeping in mind the severity of issues related to drinking water and lack of systematic understanding of household choices for drinking water at the provincial level, it is important to fill the information gap and provide scientific studies for policy makers in this area. This study aims to analyze household choices for drinking water sources in Pakistan by using Pakistan Social and Living Standard Measurement (PSLM) Survey 2014-15 data. It also examines factors that are affecting a household's choice of drinking water sources. This study will contribute to the existing literature on the choice of drinking water sources in Pakistan by analyzing the decisions of households in choosing water sources using a multinomial logit model. Results of the study provide insights for policymakers for more accurately targeting initiatives that can result in better availability of quality drinking water to households.

The layout of the study as is follows. Section 2 presents the review of previous literature on the issue. Section 3 discusses the methodology and variable construction. Whereas section 4 presents the empirical results and in section 5 we will conclude the study and provide policy implications.

2. Literature Review

Hindman (2002) conducted a study on the household water choices in Philippines. The study analyzes the effects of water prices, taste (it is use as a proxy for income) and household size on the probability to choose a specific water supply source. The results indicate that the time taken to collect water (proxy of water price) has a statistically significant effect to choose a particular water source. Household size only affects demand for connection while surprisingly taste has ambiguous effects on household choice of a drinking water source.

Bukenya (2006) estimated a simultaneous probit model and identified the socio economic and demographic determinants of the choice of a specific water purification method that is either boiling of water or buying of bottled water or both. The study found out that there is a significant relationship between levels of education and income, household size, specially the number of children, area of residence, and the opinion about water quality. The study indicated that boiling of water decrease the demand for bottled water but it is not true for the other way round, that is demand for bottled water does not decrease the use of boiled water.

Jalan*et.al.* (2009) estimated the effects of awareness (the study used education and exposure to mass media and their occupation as proxies for awareness to choose improved water sources) on the purification behavior of households in urban India. The study concluded that all these measures of awareness have a significant effect on water purification behavior of urban households.

Nketiah-Amponsah *etal.* (2009) used multinomial logit model to identify socioeconomic determinants of household choice of source of drinking water in Ghana. The study uses data from a survey conducted in three Districts in Ghana (A cross-section of 531 households was interviewed using stratified random sampling technique). The results confirm the influence of factors such as income, residence (rural or urban), education level of the head of the household and the distance between the residence and water source on household choices of drinking water sources.

Using data on 301 households of Dakar (Senegal), Briand *et.al.* (2010) estimate a bivariate probit model to explain household's decision to rely on a private water connection at home or/and to get water from the public standpipe. The bivariate probit model takes in consideration the fact that there is interdependence between household's decision to rely on a private water connection at home or/and to get water from the public standpipe. The findings show that the household head status

(being a widow) as well as the quality of the supply service has a significant impact on households' choices. Findings also indicate that the household welfare, the education of household head, time cost, access to alternatives sources, are strong determinants of household decision to rely on private connection.

Arouna and Dabbert (2010) highlighted the determinants of domestic water use in the rural Benin. The study found that household size, access to different sources of drinking water, income level, and time cost are important determinants to choose for a particular water source for a household.

Fotue (2013) described the determinants of the demand of improved drinking water sources in Camroon by using Multiple Cluster Indicators Survey. The study applied bivariate probit model and the results showed that the awareness (indicated by education level of the head of the household and possession of TV or radio) positively affect the choice of an improved water source. So if a household is educated then there are more chances that he will be choosing an improved water source. Owning a TV or/and a radio also affecting positively the household choice of an improved water source in Camroon.

Rauf *et al.* (2015) observed the determinants of drinking water sources for province Punjab, Pakistan by using micro data set of Household Integrated Economic Survey 2010-11. The study applied multinomial logit model and found out that family size, total numbers of rooms, region (rural or urban) have a significant effect on the choice of drinking water source. There is negative relationship is observed between mode of transport and ownership of hand and motor pumps.

Irianti *et al.* (2016) analyzed the choice of drinking water source in Indonesia by using Indonesian Family Life survey 2007. The study categorizes the drinking water sources into three groups: unimproved, improved and piped water. The results indicated that household with unimproved sanitation facility have more chances to use either improved or piped water source. If a household is living in urban areas then there are more chances that either he is using improved or pied water sources as compared to his rural counterparts. Besides all these other socio economic and demographic factors including marital status, sex of the head of the household, number of internal migration of the internal household members, education, employment status and income level are significantly affecting the choice of drinking water sources.

3. Data and Methodology

We will use multinomial logit model to assess the households' drinking water preferences in Pakistan by using micro data form PSLM survey 2014-15. Generally multinomial model is applied when dependent variable have more than two categories. In the multinomial logit model, one category of dependent variable is selected as base category. Assuming that dependent variable Y derives from j nominal outcome, categories are numbered from 1 to i. Let the likelihood of observing outcome m on the basis of given x is:

$$\Pr\left(Y = \frac{m}{x}\right) \quad (1)$$

Then the probability model is constructed as follows (Greene, 2003):

$$\Pr\left(Y_i = {}^{m}/_{x_i}\right) = \frac{e^{\beta j' x}}{1 + \sum_{i=1}^{1} e^{\beta k' x}} \text{m>1} \quad (2)$$

For a meaningful interpretation we will obtain the marginal effects that are the derivatives of the equation 2 with respect to the explanatory variables. The data used in the study is obtained from Pakistan Social & Living Standard Measurement (PSLM) Survey 2014-15. The PSLM survey have detailed information on the individual's level of education, monthly wages, employment status, health, type of dwelling, sources of drinking water, type of fuel for cooking, type of toilet and sanitation facilities. By following Irianti *et.al.* (2016) our model will be:

$$w_i = \beta_0 + \sum_{j=1}^{J} \beta_i X_{j,i} + \varepsilon_i \quad (3)$$

Drinking water sources are the dependent variables. These are unordered variables for which there is no natural ranking of the alternatives is required. These water sources are divided into five categories i.e. piped water sources, hand pumps, covered water sources, uncovered sources (base category) and other water sources. The detail of each category is given in Table 1.

Table 1: Drinking Water categories Description

Drinking Water Source		**Frequency**	**Percentages**
1	Piped water	13,549	17.28
2	Hand pumps	26,351	33.6
3	Covered sources	23,942	30.53
4	Uncovered sources (base category)*	12,974	16.54
5	Others^	1,609	2.05
Total		78,425	100

Source: Authors' calculations from PSLM survey 2014-15.

**As per WHO standard base category includes open well, river, water tanker.*

^ It includes filtration plant, mineral water and others.

Whereas X is a vector of different individual and household characteristics that are affecting the choice of a particular water source. In order to make our results more valid we also checked the assumptions of multinomial logit model before we did the empirical estimation. Our dependent variable is measured at the nominal level. We also included continuous explanatory variables in our analysis. Our dependent variable has mutually exclusive and exhaustive categories. There is no problem of multicollinearity and or outliers in our data. Explanatory variables are explained in Table 2:

Table 2: List of Explanatory Variables

Head of the Household (HH) Personal Characteristics:	
Household size	Household size
35-49 yrs	=1 if the age of HH is 35-49, & 0 otherwise
50 yrs& above	=1 if age of HH is 50 yrs and above, & 0 otherwise (35 yrs& younger is the base category)
Illiterate	=1 if head of HH has no formal education, & 0 otherwise
Middle	=1 if head of HH's highest level of completed education is middle, & 0 otherwise
Matric	=1 if head of HH's highest level of completed education is matric, & 0 otherwise
Graduate	=1 if head of HH's highest level of completed education is graduate, & 0 otherwise
Higher	=1 if head of HH's highest level of completed education is above graduation, & 0 otherwise
Professional	=1 if head of HH's highest level of completed education is professional, & 0 otherwise (Primary level of education is the base category)
Not working	=1 if head of HH is unemployed, & 0 otherwise
Managers	=1 if head of HH is working as a manager, & 0 otherwise
Professionals	=1 if head of HH is working as professional, & 0 otherwise
Technicians & Associate Professionals	=1 if head of HH is technician/associate, & 0 otherwise
Clerical Support workers	=1 if head of HH belongs to clerical staff, & 0 otherwise

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(continued) Table 2: List of Explanatory Variables

Head of the Household (HH) Personal Characteristics:	
Service & sales workers	=1 if head of HH is a salesman, & 0 otherwise
Skilled agri. Forestry & fishery workers	=1 if head of HH is engaged in agricultural field, & 0 otherwise
Variables	**Explanation**
Craft & related trade workers	=1 if head of HH is a trade worker, & 0 otherwise
Plant & machine operators & assemblers	=1 if head of HH is a mechanic, & 0 otherwise (Group of elementary occupations is the base category)
Total monthly income 2nd 25%	=1 if head of HH belongs to 2nd income quartile, & 0 otherwise
Total monthly income3rd 25%	=1 if head of HH belongs to 3rd income quartile, & 0 otherwise
Total monthly income 4th 25%	=1 if head of HH belongs to 4th income quartile, & 0 otherwise (Total monthly income 1st 25% is the base category)
Dwelling Status and Structure:	
No. of rooms	Number of rooms in the house
RCC	=1 if head of HH has modern style of roofs, & 0 otherwise
Iron	=1 if head of HH have used ironic material in roofs, & 0 otherwise (Wood roof is the base category)
Septic toilet	=1 if head of the household has modern toilets, & 0 otherwise
Non septic toilet	=1 if head of the household has old cultured toilets, & 0 otherwise (No toilet facility is the base category)
Distance to water source	=1 if distance to water source is 0-14 minutes, & 0 otherwise (Distance > 14 minutes is the base category)
Region:	
Urban	=1 if head of HH is settled in urban areas, & 0 otherwise (Rural is the base category)
KPK	=1 if head of HH belongs to KPK, & 0 otherwise
Punjab	=1 if head of HH belongs to Punjab, & 0 otherwise
Variables	**Explanation**
Sind	=1 if head of HH belongs to Sind, & 0 otherwiseBalochistan is the base category)

Source: PSLM survey 2014-15.

In Table 3 we present the descriptive statistics. Examining household heads' age distribution we found that 28% head of the households are lying under age 35 years, 38% in the age interval 35–49 years and 35% are in the category of age 50 years and above. As to their educational status, 50% are illiterate, 16% are primary, 10% middle school and 13% matric, while 8% are graduates and 22% have higher level of education. As to their occupation 14% of household heads are not working, 4% are top level managers, 4% are professionals, 2% are technical and associate professionals, 2% are clerical and support workers, 12% are service and sales workers, 33% are skilled agricultural, forestry and fishery works, 8% are in crafts and related trades workers group, 6% are working as plant and machine operatives and assemblers. 6% head of the households are in elementary occupations.

Table 3: Descriptive Statics:

Variables	**Mean**	**Std. Dev.**
No. of rooms	2.29	1.30
Household size	6.54	3.07
Age of the Head of the Household		
35 yrs& younger (base category)	0.28	0.45
35-49 yrs	0.38	0.48
50 yrs& above	0.35	0.48
Educational Categories		
Illiterate	0.50	0.50
Primary (base category)	0.16	0.37
Middle	0.10	0.31
Matric	0.13	0.34
Graduate	0.08	0.27
Higher	0.02	0.15
Professional	0.01	0.09
Occupational Groups		
Not working	0.14	0.35
Managers	0.04	0.20
Professionals	0.04	0.20
Technicians & Associate Professionals	0.02	0.15
Clerical Support workers	0.02	0.13
Service & sales workers	0.12	0.32
Skilled agri. Forestry & fishery workers	0.33	0.47

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(continued) Table 3: Descriptive Statistics

Craft & related trade workers	**0.08**	**0.26**
Plant & machine operators & assemblers	0.06	0.23
Elementary occupations (base category)	0.6	0.37
Income Quintiles:		
1st 25% (base category)	0.26	0.44
2nd 25%	0.24	0.43
3rd 25%	0.24	0.41
4th 25%	0.26	0.44
Residence		
Urban	0.18	0.38
Rural (base category)	0.82	0.38
Distance to Basic Facilities:		
Distance to water source (1 to 14 Mints)	0.90	0.30
Roof Structure:		
RCC	0.14	0.35
Wood roof	0.41	0.50
Iron	0.45	0.50
Type of Toilet:		
No toilet facility	0.20	0.40
Septic toilet	0.41	0.49
Non septic toilet	0.40	0.49
Provinces		
KPK	0.17	0.37
Punjab	0.47	0.50
Sind	0.24	0.43
Balochistan (base category)	0.13	0.34

Source: PSLM Survey 2014-15

We took log of the monthly income of the head of the household and then divided it into four equal parts. First quartile is the minimum income, second and third quartiles are considered to be median income and fourth quartile is the maximum income. Of households' heads, 1st 25% people have total income 26%, while 2nd 25% people have total income 24%, 3rd 25% people have total income 24% and 4th 25% people have total income 26%. 82% are in rural areas and 18% are residing in urban areas. 14% of households have made their roofs with RCC material, 41% of people have wooden material roofs whereas 45% people have roof made of iron. 20% of heads of the household have no toilet facility, 41% are using septic facility

while 40% are using open drain type of toilets. Numbers of heads of households included in our analysis from Punjab are 47%, from KPK are 17%, from Baluchistan are 13% and from Sind are 24%.

4. Empirical Results

In this section we will discuss the empirical results. The results are presented in Table 4, it also reports the relative risk ratio[1]. Total numbers of rooms in a house is representing the size of the house and generally considered to be better if a house has a large number of rooms. As the no of rooms increase then there are more chances that the head of the household will opt for covered sources and it is highly significant. Household size is negatively associated with improved drinking water sources except hand pump. As compared to age group 35 and younger as the age increases then there are more chances that a head of the household will prefer to use improved water sources.

Education used as proxy for awareness in different studies and it is normally seen if a person is educated then he will prefer to use improved sources of drinking water. The marginal effects are 0.99 and 0.11 for covered water sources and others (includes filtration plants and mineral water) respectively. The present study also supports this fact in case of Pakistan too. As the level of education increase then there are less chances that the head of the household will prefer to opt hand pump as compared to unimproved sources of drinking water (McConnell and Rosado, 2000; Jalan*et.al.* 2009; Ahmad *et.al.*, 2010).

As compared to elementary occupation, working as a professional is more likely to use piped water as compared to unimproved drinking water sources. Whereas being a skilled agriculture worker it is more likely to use hand pump for drinking water. As the level of income increases then there are more chances that a head of the household will use either hand pump or covered sources or others.

[1]Examines the relationships between the dependent variables' categories and variables that are to be predicted. RRR shows the relative risk ratio of one preference to other.

Table 4: Results of Multinomial Logit Model Estimates for Households' Water Preferences

Explanatory Variables	Piped Water		Hand Pump		Covered Sources		Others	
	Coefficients	RRR	Coefficients	RRR	Coefficients	RRR	Coefficients	RRR
No. of Rrooms	.0159***	.954***	-.066***	.704***	.032***	.961***	.001***	.980
HH. Size	-.007***	.997	.015***	1.090***	-.002***	1.030***	-.0006***	.993
Age of the Head of Household (Age less than 35 is the base category)								
35 to 49 years	.017***	1.051	-.037***	.847***	.013***	.998***	.001	1.057
50 and above	.024***	1.109*	-.036***	.865***	.008	1.004	.0013	1.073
Educational Status of the Head of Household (Primary level of education is the base category)								
Illiterate	-.021***	.851***	.041***	1.094	-.024***	.892	-.001	.869
Middle	.013**	1.089	-.028***	.920	.015**	1.059	.002	1.165
Matric	-.0008	.970	-.024***	.895	.018***	1.023	.004*	1.226***
Graduate	.014**	1.079	-.051***	.833***	.026***	1.076	.010***	1.720
Higher	-.006	1.226*	-.078***	.936	.099***	1.612***	.011***	2.278***
Occupational Groups of the Head of Household (Elementary occupation is the base category)								
Professional	.050***	1.347**	-.052**	.880	-.00009	1.068	.011***	1.847**
Not working	-.026***	1.181****	.010	1.418***	.048***	1.552***	.001	1.555***
Managers	-.007	.974	-.034***	.896	.040***	1.121	.002	1.169
Professionals	-.013	.842**	.010	.939	-.008	.884	-.0006	.864
Tech & Assoc. Professionals	.013	1.001	-.028*	.849	.004	.949	.002	1.085
Clerical Support workers	.029**	1.508***	-.032*	1.168	.030*	1.418*	.002	1.533
Service & sales workers	.021***	1.176***	-.026***	.966	.011	1.090	.0009	1.126
Skilled agri. Forestry & fishery workers	-.041***	.864***	.063***	1.324***	-.010	1.048	-.002*	.904

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(continued) Table 4: Results of Multinomial Logit Model Estimates for Households' Water Preferences

Craft & related trade workers	.015**	.925	-.029***	.774***	-.006	.843**	-.0002	.842
Plant & machine operators & assemblers	.011	1.145**	-.011	1.038	.009	1.108	-.0001	1.067
Total Monthly Income of the Head of Household (Bottom 25% is the base category)								
2nd25%	-.038***	.971	.069***	1.494***	-.009	1.168***	.0001	1.215
3rd 25%	-.019***	1.265***	.031***	1.553***	.022***	1.485***	.003*	1.726***
4th 25%	-.026***	1.244***	.003	1.446***	.058***	1.668***	.004***	1.952***
Region of the Head of Household (Rural is the base category)								
Urban	.228***	3.028***	-.209***	.488***	-.012**	1.205***	.018***	3.113***
Distance								
Distance to water source(1-14min)	.069***	4.091***	.1322***	4.628***	.029***	2.905***	-.047***	.548***
House Structure (Wood roof is the base category)								
RCC	.053***	1.779***	-.229***	.449***	.194***	2.165***	.016***	3.124***
Iron	.008**	1.724***	-.040***	1.434***	.098***	2.147***	-.006***	1.018
Toilet Facility (No Toilet facility is the base category)								
Septic toilet	.057***	3.267***	-.135***	1.498***	.175***	3.865***	.001	2.747***
NonSeptic toilets	-.012**	2.013***	-.079***	1.631***	.180***	3.444***	-.001	1.983***
Provinces (Balochistan province is the base category)								
KPK	-.037***	1.080*	.246***	2.587***	-.158***	.7992***	-.018***	.154***
Punjab	-.232***	2.845***	.511***	79.125***	.008	13.189***	-.0001	12.659***
Sind	-.206***	.680***	.674***	22.815***	-.345***	.910	-.012***	1.041

****, **,* significant at 1%, 5% and 10% respectively.*

Our result also confirmed the existing literature on the choice of water sources that income is positively affecting the choice of an improved water source (Nauges and Strand 2007). It is 22 % more likely to use piped water if a person is living in urban area as compared to rural area. The reason is obvious that mostly in urban areas people are using piped water whereas in rural settlement most of the population is depending on hand pumps or wells to get water for household use.

Time cost is represented by distance to water source, the study highlights that as the distance increases then there are more chances that a household will obtain water by hand pump followed by piped water sources. This is true in the sense; in order to decrease the time cost, people prefer to have a water source at their door step either in the form of well or a hand pump. While taking into account the roof material then it is clear that as compared to wood roof if a head of the household have a roof made of RCC then it is more likely that he will be using either covered sources or others (that include filtration plants and bottled water).

Taking into account another important variable type of toilet that is representing the sanitation condition of a household head. It is observed that as compared to no toilet it is more likely for a head of the household to use either pipe water or covered sources. If the head of the household has non septic type of toilet then there are more chances that he is using a covered water source for drinking. Our result is supported by literature that if a person has poor means of sanitation in his house then he try to spend on better source of drinking water (Irianti et al 2016). Finally we used provincial dummies in our analysis and our results indicated that as compared to Balochistan if a head of the household is residing in Punjab or Sind then there are more chances that he will be using hand pump.

5. Conclusions

The present study aims to analyze economic and socio-demographic factors affecting households' water choices in Pakistan with the help of multinomial logit model and by using data from Pakistan Social and Living Standard Measurement (PSLM) Survey 2014-15. The result of the study shows that the household choice for improved water source is significantly related to the income of the head of the household. Increase in income will help the consumers to use better sources of drinking water through wealth effects (Sattar and Ahmed 2007). As far as area or residence is concerned, the most salient characteristic of urban dwellers compared to rural dwellers is their dominant choice of better water source e.g. piped water and improved water while rural dwellers have their choice for more conventional sources. The occupation of household head has a positive and has a statistically

significant effect on water source choice. Household heads in higher income occupation groups prefer to use covered sources and improved water sources to unimproved water sources compared to those engaged in agriculture, forestry, fishery etc. This study concludes that there should be delivery institutions responsible for water supply to come up with projects that ensure a reliable and regular water supply to everyone, irrespective their area of residence. There is a need to make people aware about the importance of clean and purified water and that how unimproved water affect their own and their children's health. Results also show that education is positively correlated with improved water sources, because education creates awareness among people.

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APPENDIX

Table A1: Wald Test

Variables	chi2	df	P>chi2
No. of rooms	974.281	4	0.00
Household size	504.755	4	0.00
Age of the Head of the Household			
35-49 yrs	60.981	4	0.00
50 yrs& above	56.850	4	0.00
Educational Categories		4	0.00
Illiterate	71.110	4	0.00
Middle	18.320	4	0.00
Matric	18.504	4	0.00
Graduate	53.229	4	0.00
Higher	59.030	4	0.00
Professional	17.444	4	0.00
Occupational Groups			
Not working	60.860	4	0.00
Managers	14.382	4	0.00
Professionals	14.735	4	0.00

Continued on next page

(Continued) Table A1: Wald Test

Technicians & Associate Professionals	**14.368**	**4**	**0.00**
Clerical Support workers	13.987	4	0.00
Service & sales workers	20.515	4	0.00
Skilled agri. Forestry & fishery workers	131.963	4	0.00
Craft & related trade workers	21.788	4	0.00
Plant & machine operators & assemblers	15.547	4	0.00
Income Quintiles:			
2nd 25%	130.415	4	0.00
3rd 25%	108.845	4	0.00
4th 25%	127.864	4	0.00
Residence			
Urban	2835.474	4	0.00
Distance to Basic Facilities:			
Distance to water source (1 to 14 Mints)	2073.313	4	0.00
Distance to transport (1 to 14 Mints)	431.110	4	0.00
Roof Structure:			
RCC	1213.158	4	0.00
Iron	664.115	4	0.00
Type of Toilet:			
Septic toilet	1632.733	4	0.00
Non septic toilet	1095.032	4	0.00
Provinces			
KPK	469.683	4	0.00
Punjab	6214.185	4	0.00
Sind	4204.289	4	0.00