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Households Health Cost from Water Borne Diseases in District Swat, Khyber Pakhtunkhwa, Pakistan

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ABSTRACT

The provision of safe drinking water is a very serious issue in Pakistan, including Swat district. Recently, the effects of unsafe drinking water on the health cost of the local community of district Swat has got their importance. The main objective of the study is to estimate the households' health costs of waterborne diseases. The secondary objective of the study is to determine the factors that affect the household health cost from water borne diseases. The study applied to the health cost function on primary data collated from 433 households through a survey questionnaire in district Swat. Results reveal that typhoid, diarrhea, vomiting, and gastroenteritis (vomiting & diarrhea) are the most common waterborne diseases in the District. In rural areas of the district, the prevalence of typhoid and gastroenteritis is higher, whereas in urban areas the prevalence of diarrhea and vomiting is higher. Besides, households who use drinking water from public tube wells mostly suffer from gastroenteritis and vomiting, whereas households who use water from digging wells or from natural springs mostly suffer from gastroenteritis and diarrhea. On average, households bear the highest direct and total health costs of PKR 11685 or USD 52 and PKR 12778 or USD 57 respectively, if their family member suffers from typhoid. Similarly, on average, households bear the highest indirect health cost of PKR 1388 or USD 6, if their family member suffers from diarrhea. Results from the regressions show that household income, disease affected member age, education of household head, the prevalence of typhoid, diarrhea, vomiting, gastroenteritis, and the drinking water sources like tube well and spring significantly affect the direct, indirect, and total health costs of the households. The study recommended that the renovation of the existing drinking water sources and introduction of new safe drinking water schemes can reduce the burden of waterborne diseases and can reduce the health cost of households.

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1. Introduction

Without water, the existence of life on the earth is impossible and nobody can deny the importance of water on the earth, as the earth has covered 71 percent of water, in which 96 percent of water is in the form of oceans, seas and salty lakes etc., which cannot be used for the purpose of drinking. In the remaining 4 percent of water, only 0.5 percent of water is safe for drinking (WHO, 2020). 28 percent of the world population has no access to safe drinking water facilities, which causes different water borne diseases like diarrhea, typhoid, and hepatitis, which has an annual cost of 2.3 billion dollars (Miller et al., 2019). Pakistan is the 6th largest country by population. However, the residents of the country face the threat of low water quality as 20 percent of the population has no access to safe drinking water facilities (Hafzur RM & Rumainul, 2017). Due to these unsafe drinking water facilities, 2.5 million people died in Pakistan because of diarrhea (Daud et al., 2017). For the proper sanitation and for safe drinking water facilities Pakistan has been spend PKR.343.7 billion which is equal to the 3.43 percent of the GDP of Pakistan. However, millions of peoples in the country still have no access to safe drinking water and resultantly the ratio of water borne diseases are still high in the county.

Ground and surface water are the main sources of drinking water in Pakistan. However, due to rapid increases in population and unplanned urbanization, the quality of these drinking water sources has degraded gradually. The mixing of contaminated industrial water with drinking water sources causes water borne diseases like diarrhea, dengue, dysentery and hepatitis in command masses. For the treatment of these waterborne diseases, households spend a huge sum of money (WHO, 2020).

The population of the district is continuously increasing, which also increases the demand for fresh water for agriculture, domestic and industrial purposes. Due to the improper management of waste water in the district, only 7 percent of water is safe for drinking whereas the remaining 93 percent of water is unsafe for drinking. In Mingora city, which is the most populated city in Swat district, only 40 percent of the water is safe for drinking, while the rest of the water is not safe for drinking (Tahir, 2017). Furthermore, water pollution is one of the key environmental issues in the district of Swat, as 1.25 million people directly use surface and ground water for drinking purposes, which is a serious threat to the health of the local community. This drinking water is extremely polluted by fecal coliform and Escherichia coli bacteria, which are the major cause of waterborne diseases like gastroenteritis, dysentery, and diarrhea. The main reasons for water pollution are urbanization, solid waste disposal into the water streams, and the direct discharge of toilets to the main stream of the district (Salam et al., 2021). As the total solid waste produced in Mingora city is 45.59 tons per day, which is directly or indirectly throw to the stream and rivers of the district Swat. This waste material caused different water borne diseases like typhoid, hepatitis, cholera, and diarrhea in the locals of Swat (Khan et al., 2018).

District Swat is also the victim of low quality of drinking water, as the poor water sanitation system, unsafe drinking water sources, logging of water pipes, poor wash room system, leakages in the water pipes directly affect the health of the local community. Therefore, the local community needs to treat the victims of waterborne diseases in local and non-local government and private hospitals, private clinics and dispensaries, which leads to increase the household health costs. Due to the importance of the issue under consideration, the main objective of this study is to estimate the household’s health cost from water borne diseases. The secondary objective of the study is to determine the factors that affect the household health cost from water borne diseases. The results of this study will provide important information to policymakers regarding the waterborne diseases caused by different drinking water sources and the associated health costs bear by the locals for the treatment of these diseases. The results of the study will also help the policymakers to revisit all the drinking water schemes in the district and to take some serious measures to protect the drinking water sources from contamination.

2. Literature Review

Since water borne diseases leads to a significant increase in the health cost of households, therefore a number of researchers carried out their studies on this issue for an instant, Dare, Ayinde, Shittu, Sam-Wobo, and Akinbode (2019) studied the health cost of water borne diseases in the rural areas of Nigeria and found that on average each household had earned 80,717.52 Naira (160 USD) quarterly, out of this amount, they used 28571 Naira as a cost of illness from water borne diseases. In the next year, Jabeen, Mahmood, and Nawab (2020) extended the same issue to Pakistan and focused on the impact of unsafe drinking water on the health cost of households. The study found that households in the rural area spent 18% of their incomes on treatment of water borne diseases whereas urban households spent 8% of their incomes to treat the same diseases.

In similar fashion, Ali, Bashir, Abbas, and Murtaza (2021) extended the same issue to Faisalabad, Punjab, Pakistan. The study found that the cost of illness from water borne disease are $10.79 USD in pre-urban and urban areas of Punjab. Some researchers focused on water quality and the prevalence of waterborne diseases. For an instant, Mukate, Wagh, Panaskar, Jacobs, and Sawant (2019) used integrated water quality index (IWQI) to find the quality of ground water in India. Results of the study showed that 2% of drinking water in India is excellent while 8% drinking water is unsafe. Moreover, 39% of good water and 43% of normal water had marginal characteristics.

Solangi, Siyal, Babar, and Siyal (2020) construct the same index and checked the drinking water quality in district Sujawal, Pakistan. Results of the study showed that 2.13% of water in the district is excellent for drinking, 6.38% of water is good for drinking, 13.38% of water is unsuitable for drinking, 22.34% of water is poor for drinking, and 55.32% of water is very dangerous for drinking. Jehan et al. (2020) extended the same issue to District Swat, Khyber Pakhtunkhwa, Pakistan and constructed water quality index for checking the water quality. Results from the constructed index showed that that 77% of the collected water sample in the district had poor water quality and hence cause of water borne diseases in the locals.

Salam et al. (2021) studied the drinking water quality of district Swat Pakistan, for this purpose, they selected the wells of 40 school and colleges randomly from Mingora city of district Swat. For the estimation of the quality of drinking water of Mingora city, they used laboratory test and found that the pH of the water is 6.3, TDS was 410.7 mg/l, EC was 709.7, temperature was 25.83 °C, alkalinity was 104.8 mg/l and the total hardness was 348.15 mg/l and compared it with the values of World Health Organization and the American Public Health Association. The study also found that the mean value of total fecal, and coliform bacteria was (0.32) with standard deviation; (0.572). This study also found that the drinking water sources of Mingora Swat was vary contaminated by fecal coliform bacteria, including Escherichia coli, which is the main cause of waterborne diseases such as gastroenteritis, dysentery, hepatitis and diarrhea.

Going through the previous studies, we conclude that a number of researchers estimated the health cost of waterborne diseases in African countries. Some researchers used similar approaches and estimated the health cost of waterborne diseases in different cities and regions in Pakistan. However, the researchers did not focus to estimate the health cost of waterborne diseases in Northern areas of Pakistan.

Similarly, some researchers in the past constructed a water quality index for the water quality in India and Pakistan (Sarker et al., 2018; Solangi et al., 2020). However, they missed analyzing the effect of unsafe drinking water on household health costs. Therefore, this study estimates the household direct, indirect, and total health cost from four different waterborne diseases (typhoid, diarrhea, vomiting, and gastroenteritis) and from unsafe drinking water.

3. Material and Method

3.1 Study Area

District Swat is the 15th largest district of Khyber Pakhtunkhwa, Pakistan which is divided into seven tehsils namely, Babozai, Kabal, Barikot, khwazakela, Matta, Charbagh, and Behrain respectively. It has a total area of 5,337 square kilometer and a population of 2,309,570 with an average density of 248 persons per kilometer (Khan et al., 2013).

3.2 Sample Size

For accomplishing the study objectives, we have selected 433 households from all the tehsils of district Swat excluding tehsil Matta and khwazakela.

3.3 Sampling Techniques

The data have been collected from the site through cluster sampling from the Months of June to November 2022 via a self-administrative questionnaire. The data was collected randomly from every 5th household and if the household refused to give its opinions so the next household was selected for the survey. After the approval of the household to participate in the survey, the questionnaire was translated to the household head in his local language. To draw the sample size from a population, we use the solvin's formula (Cochran, 1977).

$$S = \frac{z^2 c(1-c)}{I^2} \quad (1)$$

Where, S is sample size, z is confidence level c is choice of sample and I is the confidence interval. For the estimation of sample size of each tehsil the following formula was used:

$$T = (N/n)_{x} S \quad (2)$$

Where, T is the tehsil wise sample data N is total population of district Swat, n is the population of each tehsil and S is total sample size, which is estimated through solvin,'s formula (Jehan et al., 2020). Using the above sample formula, keeping the confidence level 99% with 5% margin of error, and the respondent rate 50%, we get the total sample size of 433 households. The sample size is proportionally distributed among five tehsils of district Swat.

3.4 Health Cost Function

For estimating the economic cost of waterborne diseases, we follow the methodology of Ali et al. (2021). They estimated the household total health cost (THC) and used it as a proxy for household economic cost from waterborne diseases. They further divided the household health cost into two categories namely, direct health cost (DHC) and indirect health cost (IHC). The DHC compose of the doctor consultation fee, medicine cost, laboratory fee, and hospital expenditures whereas the IHC is composed of loss of work timing captured by daily wage loss either for the patient or for the person who looks after the patient. Therefore,

$$THC = DHC + IHC \quad (3)$$

For the identification of factors effecting the health cost, we follow Park et al. (2015) and specify the following regression model:

$$HC_i = \gamma_0 + \gamma_1 Income_i + \gamma_2 Age_i + \gamma_3 Education_i + \gamma_{4k} Wdisease_i + \gamma_{5k} Wsource_i + \gamma_6 Location_i + \epsilon_i \quad (4)$$

Where, HC_i is direct health cost or indirect health cost or total health cost of the ith household in PKR (Ali et al., 2021; Dare et al., 2019; Jabeen et al., 2020; Mukate et al., 2019;

Solangi et al., 2020), $Income_i$ is the household monthly income, Age_i is the age of the disease effected member of the ith household, $Education_i$ is the education of the of ith household head, $Wdisease_i$ is the set of waterborne disease as specified as dummies, the value of each dummy is 1 if the member of the ith household suffer from a kth waterborne disease, 0 otherwise (Sajjad et al., 2022), $Wsource_i$ is the set of source of water specified as dummies the value is 1 if the ith household have a kth water source, 0 otherwise (Ali et al., 2021), $Location_i$ is the location of household the value is 1 if the household living in urban area, 0 otherwise, , and ϵ_i is the error term. The model given in (4) is estimated using ordinary least square with rebuts standard errors.

4. Results and Discussion

4.1 Prevalence of Waterborne Diseases and Household Health Cost

The direct, indirect, and total health cost of different waterborne disease, from different sources of drinking water and different region of district Swat, has been mentioned in Table 1. From Table 1 we observed the highest average direct cost for the treatment of typhoid disease (PKR 11685 or USD 52), followed by gastroenteritis (PKR 7045 or USD 32), diarrhea (PKR 6236 or USD 28), and vomiting (PKR 5672 or USD 25). Similarly, the highest average indirect health cost is observed for diarrhea (PKR 1388 or USD 6), followed by vomiting (PKR 1254), typhoid (PKR 1093), and gastroenteritis (PKR 1020). As expected, the highest average total health cost is observed for the treatment of typhoid (PKR 12778), followed by gastroenteritis (PKR 8065), diarrhea (PKR 7624), and vomiting (PKR 6926). The treatment of typhoid is so costly because it needs proper consultation with the doctor, expensive medicine, more bed rest, and deep care. Therefore, the households on average spend more for the treatment of typhoid as compared to other waterborne diseases.

Comparing the health costs from different water sources, we observed that those households who use water from natural springs on average bear the highest direct health costs (PKR 10043), followed by the households who use drinking water from a tube well (PKR 6516), and those households who use drinking water from own well (PKR 6060). The treatment of typhoid is so costly because it needs proper consultation with the doctor, expensive medicine, more bed rest, and deep care. Therefore, the households on average spend more for the treatment of typhoid as compared to other waterborne diseases. Comparing the health costs from different water sources, we observed that those households who use water from natural springs on average bear the highest direct health costs (PKR 10043), followed by the households who use drinking water from tube well (PKR 6516), and those households who use drinking water from their own well (PKR 6060). Similarly, the highest indirect health cost is observed for households who use own well water for drinking (PKR 1179), followed by households who use tube well water for drinking (PKR 1078, and households who use drinking water from spring (PKR 1017). Accordingly, highest total health cost is observed for the households who use spring water (PKR 11060), followed by the households who use drinking water from tube well (PKR 7594), and those households who use drinking water from own well (PKR 7238). District swat is famous for its natural spring and thus majority of the households use water from these springs for drinking. Majority of the households in the district has common perception that the water from springs are safer than other water sources. However, this is not true because the spring water causes various waterborne diseases in the locals and hence they spend a huge sum of money for the treatment of these diseases.

Comparing the health costs of urban and rural households, we observed that the rural household on average bear highest direct, indirect, and total health costs (PKR 8204, PKR 1076, and PKR 9280), respectively for the treatment of waterborne diseases as compared to the urban households (PKR 5541, PKR 1063, and PKR 6604). Better health facilities and comparatively safe drinking water sources are available in the urban areas of district swat. On the other hand, the health facilities in the rural areas of the district is scarce. The rural population heavily dependent on the health center situated in the urban areas. Similarly, they have no access to public water schemes, which is relatively safer than spring water sources. Therefore, the rural households are mostly suffering from the waterborne diseases and for the treatment of these diseases they move to urban health centers which consequently increase their health cost.

Table 1
Household Health Costs for Waterborne Diseases

Waterborne disease	**Direct health cost (PKR)**	**Indirect health cost (PKR)**	**Total health cost (PKR)**
Typhoid	11685	1093	12778
Diarrhea	6236	1388	7624
Vomiting	5672	1254	6926
Gastroenteritis	7045	1020	8065
Water Source			
Tube well	6516	1078	7594
Own well	6060	1179	7238
Spring	10043	1017	11060
Region			
Urban	5541	1063	6604
Rural	8204	1076	9280

Source: Authors estimation based on primary data collected from district Swat.

Figure 1 show the drinking water sources and the prevalence of waterborne diseases. From the figure, it is observed that, the households who use drinking water from public tube wells mostly suffer from gastroenteritis (35%), vomiting (16%), and diarrhea (15%). Similarly, the households who use water from own dig wells mostly suffer from gastroenteritis (22%), diarrhea (19%), and vomiting (13%). On the other hand, the households who use water from natural springs mostly suffer from gastroenteritis (35%), diarrhea (19%), and typhoid (16%). This is alarming that the spring water causes serious and costly waterborne diseases in the locals. The awareness among the locals that the spring water is not safe for drinking is needed immediately. The water safety techniques at the house and an alternative water supply schemes against the spring water can reduce the prevalence and health costs of waterborne diseases.

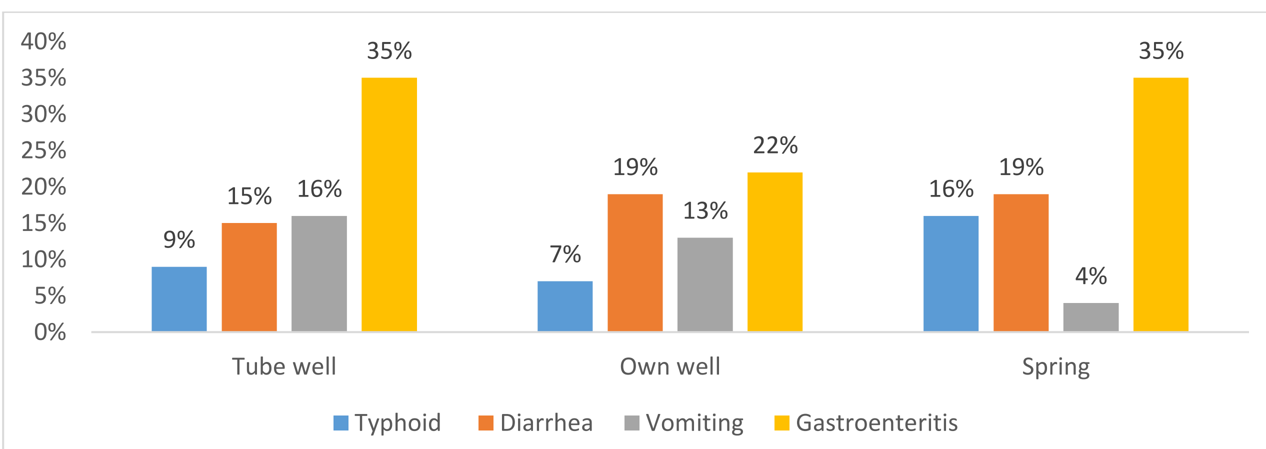

Figure 1: Water Source and Prevalence of Waterborne Diseases
Source: Authors estimation based on primary data collected from district Swat.

From Figure 2, we observed that in rural areas of the district the prevalence of typhoid (13%) and gastroenteritis (32%) is higher. On the other hand, in urban areas the prevalence of diarrhea (25%) and vomiting (22%) is higher. The rural households having unsafe drinking water sources, low awareness about the waterborne diseases, and limited health facilities are suffering from serious and costly waterborne diseases like typhoid and gastroenteritis. This does not mean that the urban households are safe from waterborne diseases, they also frequently affecting from the waterborne diseases because their drinking water sources are also contaminated.

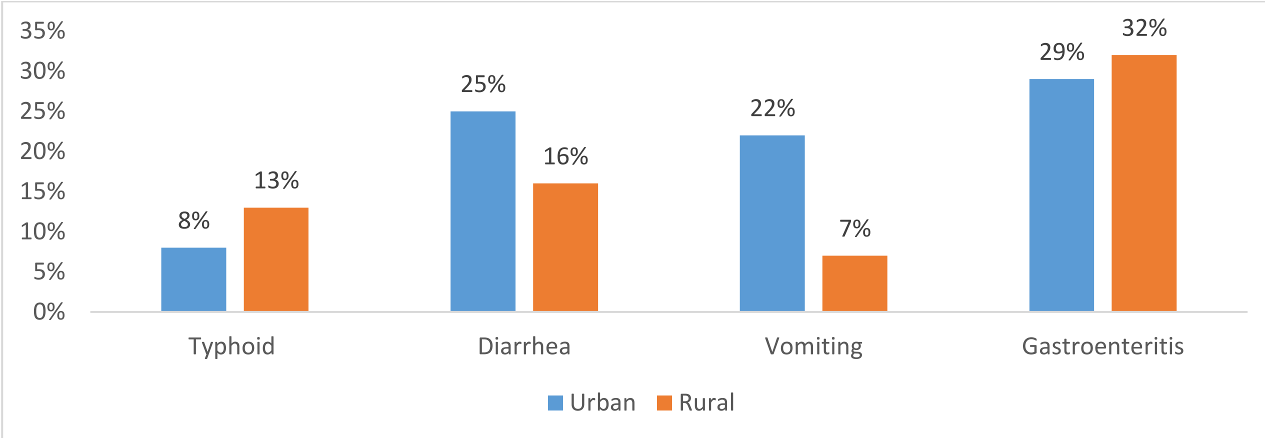

Figure 2: Region Wise Prevalence of Waterborne Diseases
Source: Authors estimation based on primary data collected from district Swat.

4.2 Descriptive Statistics

Table 2
Descriptive Statistics

Variables	Definition	Mean	Standard deviation
Dependent			
Direct health cost	Direct health cost of the ith household (consultation fee, medicine fee, laboratory fee) for waterborne diseases in PKR	7435.254	8058.557
Indirect health cost	Indirect health cost of the ith household captured by loss of work timing captured by daily wage loss either of the patient or for the person who look after the waterborne disease affected patient in PKR	1072.402	1350.877
Total health cost	Summation of the direct and indirect health costs of the ith household whose member suffered from waterborne disease in PKR	8508	8267
Explanatory			
Household income	Monthly income of the ith household in PKR	59369.33	58389.83
Age	Age of the waterborne disease effected member of the ith household	19.03695	17.86727
Education	Education of the of ith household head in years	10.75982	4.783996
Typhoid	1 if the member of the ith household suffer from typhoid, 0 otherwise	0.1154734	0.3199621
Diarrhea	1 if the member of the ith household suffer from diarrhea, 0 otherwise	0.187067	0.3904164
Vomiting	1 if the member of the ith household suffer from vomiting, 0 otherwise	0.1154734	0.3199621
Gastroenteritis	1 if the member of the ith household suffer from gastroenteritis, 0 otherwise	0.3117783	0.4637556
Tube well	1 if the ith household use tube well water for drinking, 0 otherwise	0.3972286	0.4898901
Own well	1 if the ith household use his own well water for drinking, 0 otherwise	0.3094688	0.4628094
Spring	1 if the ith household use natural spring water for drinking, 0 otherwise	0.1778291	0.3828111
Urban	1 if the ith household living in urban area, 0 otherwise	0.2886836	0. 4536747

Source: Authors estimation based on primary data collected from district Swat.

Descriptive statistics of the important variables used in the study are given in Table 2. It is observed that the average monthly income of the ith household is PKR 59369. Out of this monthly income the household on average spend PKR 8508 for treatment of waterborne disease affected member. Further, in this total health cost the household pay on average PKR 7435 or 32.52 USD as direct health cost whereas PKR 1072 as indirect health cost. Moreover, the average age of the waterborne disease effected member of the ith household is 19 years. This show that mostly young household members are suffer from waterborne diseases. The average education of the of ith household head is 11 years. Furthermore, 12 percent of the household members are suffered from typhoid, 19 percent of the household members are suffered from diarrhea, 12 percent of the household members are suffered from vomiting, and 31 percent of the household members are suffered from gastroenteritis. Similarly, 40 percent households use tube well water for drinking, 31 percent of the households use their own well water for drinking, and 18 percent of the households use natural spring water for drinking. Finally, out of the total 433 households 29 percent of the households living in urban areas while the remaining household live in rural areas.

4.3 Regression Results

The results of the estimated ordinary least square regression with rebuts standard errors are presented in Table 2. We use three categories of health costs. Therefore, we estimate the regression model for each of these three health cost categories: direct health cost (Model 1), indirect health cost (Model 2), and total health cost (Model 3), presented in Table 3. The results of the diagnostic check of the three models are reported in the last panel of Table 3. In the three regression models, the R squared is in the range of 0.13 to 0.26, while root mean square error (Root MSE) is in the range of 0.42 to 1.09. Results of the F statistics show that the regression models are overall statistically significant at 1 percent level for each of the three regressions.

Results of Model 1 show that household income, disease affected member age, and the prevalence of typhoid positively and significantly affect the direct health cost of the households while education of household head, the prevalence of diarrhea, vomiting, and gastroenteritis negatively and significantly affect the direct health cost. Similarly, results of Model 2 show that household income, education of household head, the prevalence of typhoid, diarrhea, vomiting, and gastroenteritis, and the drinking water sources like tube well and spring positively and significantly affect the indirect health cost of the households. Finally, results of Model 3 show that household income, disease affected member age, and the prevalence of typhoid positively and significantly affect the total health cost of the households while education of household head, the prevalence of diarrhea, vomiting, and gastroenteritis negatively and significantly affect the total health cost.

In all the three models the estimated coefficients of household income are positive and significant at 1 percent level. This shows that a one percent point increase in household income increase the household direct health cost by 18 percent points, the indirect health cost by 28 percent points, and the total health cost by 21 percent points. These results are consistent with the results of Abrahams, Hubbell, and Jordan (2000); Ali et al. (2021); Dasgupta (2004); Mukate et al. (2019) and Solangi et al. (2020). The positive relationship between the health cost and the income of the household has in interesting fact. This is not a surprise, according to the rule of thumb, whenever a household observed a positive shift in his monthly income, they spend more on their family health (Ali et al., 2021).

In Model 1 and Model 3 the estimated coefficients of disease affected member age are positive and significant at 5 and 1 percent level, respectively. This shows that a one-year increase in the disease affected member age increase the household direct health cost by 15 percent points and the total health cost by 14 percent points. The studies carried out in the past like the study of Mintz, Bartram, Lochery, and Wegelin (2001) and Solangi et al. (2020) supporting the above results. The diseases effected member age of the household and the health cost of the household are positively correlated. This is because the aged household members are drinking more water as compared to children and thus they are expose directly to waterborne diseases.

In all the three models the estimated coefficients of education of household head are significant at 1 and 5 percent level, respectively. However, in Model 2 the estimated coefficient is positive whereas in Model 1 and Model 3 the estimated coefficients are negative. This shows that a one-year increase in education of household head increase the household indirect health cost by 5 percent points whereas a one-year increase in education of household head decrease the household direct health cost by 21 percent points and total health cost by 13 percent points. These results are in line with the results of Abrahams et al. (2000); Haq, Mustafa, and Ahmad (2007) and Zulfiqar, Abbas, Raza, and Ali (2016). It is a common factor that the household head with high level of education lead to have a healthy life, as he spends more on its family health. The educated household head provides good nutrition, safe drinking water, and better health facilities to its family members, which resultantly reduce the chance of waterborne diseases.

In all the three models the estimated coefficients of typhoid are positive and significant at 5 and 1 percent level, respectively. This shows that if the household member suffers from typhoid then household direct and total health cost increases by 34 percent points while their indirect health cost increases by 32 percent points. The results of our study also in line with the results of Kaljee et al. (2018); Mejia et al. (2020) and WHO (2020). Typhoid is a disease, which is mostly effecting the low income families in district Swat, as they have no access to the safe drinking water facilities. Therefore, when the households observed signs of typhoid in the suspected patient, they consult with doctor for diagnosis of the diseases the doctor recommend laboratory tests. Once the diseases diagnose, the doctor recommend medicine and bed rest. In all this process households have to pay doctor and laboratory test fees, purchasing medicine and wage loss due to bed rest. Consequently, the direct, indirect and total health costs for the treatment of typhoid patient increases.

In all the three models the estimated coefficients of diarrhea are significant at 1 and 5 percent level, respectively. However, in Model 2 the estimated coefficient is positive whereas in Model 1 and Model 3 the estimated coefficients are negative. This shows that if the household member suffers from diarrhea then household indirect health cost increases by 32 percent points while their direct and total health cost decreases by 46 and 27 percent points, respectively. The studies of Burke et al. (2013); Sarker et al. (2018) and Sultana et al. (2021) also suporting our result. Dirreaha is highly prevalent and infectious diseases and common in all age groups in district Swat. Dirreaha is a mojor cause of hospitalization, therefore its direct health cost is free for the households in the government hospitals of Swat KPK, Pakistan (The Nation Newspaper, 2022). The indirect health cost of the household is positive as the hospitalized patient required the hospital stay and the caregiver to take time from work. The indirect cost of dirreaha is very high for rural families as the speend more on transportation cost as the have a greater distance from the hospital and clinic.

In all the three models, the estimated coefficients of vomiting are significant at 1 percent level. However, in Model 2 the estimated coefficient is positive, whereas in Model 1 and Model 3 the estimated coefficients are negative. This shows that if the household member suffers from vomiting, then household indirect health cost increases by 33 percent points while their direct and total health cost decreases by 79 and 43 percent points, respectively. These results are also supported by the studies of Jamil (2019); Pavlinac et al. (2018) and Zhang et al. (2020). Since the rapid increase in population and urbanization, lowering down the quality of drinking water in Swat district. Therefore, the unsafe drinking water causes vomiting in the locals. However, vomiting increases the absentees from job, business and other works which further reduces their daily earnings and increases their indirect health cost. On the other hand, most of the direct cost of the vomiting is bear by the provincial government if the patient is treated in government hospitals. Therefore, the prevalence of vomiting reduces the direct and total health costs of households.

In Model 1 and Model 2 the estimated coefficients of gastroenteritis are significant at 10 and 1 percent, respectively. However, in Model 2 the estimated coefficient is positive, whereas in Model 1 the estimated coefficient is negative. This shows that if the household member suffers from gastroenteritis, then household indirect health cost increases by 24 percent points while their direct health cost decreases by 28 percent points. The studies of Burke et al. (2013); Maconachie (2019); Sarker et al. (2018) and Sultana et al. (2021) also supporting our results is well. The indirect health cost of the household from gastroenteritis increases due to the cost of the transportation on every trip to the hospital, the loss of working hours of the household, the cost of food of the related people in hospital, which increased with the increases of days of the patient's stay in the hospital.

Table 3
Regression Results

Model:	**(1)**	**(2)**	**(3)**
Dependent variable:	**Direct Health Cost**	**Indirect Health Cost**	**Total Health Cost**
Explanatory variables:			
Household income (ln)	0.184***	0.281***	0.206***
	(0.0667)	(0.0440)	(0.0524)
Disease affected member age (ln)	0.153**	0.00717	0.143***
	(0.0618)	(0.0238)	(0.0478)
Education of household head (ln)	-0.205***	0.0495**	-0.134***
	(0.0636)	(0.0231)	(0.0488)
Typhoid (Yes =1, No = 0)	0.343**	0.318***	0.344**
	(0.171)	(0.0636)	(0.134)
Diarrhea (Yes =1, No = 0)	-0.463***	0.323***	-0.273**
	(0.164)	(0.0775)	(0.126)
Vomiting (Yes =1, No = 0)	-0.790***	0.326***	-0.425***
	(0.230)	(0.0843)	(0.162)
Gastroenteritis (Yes =1, No = 0)	-0.275*	0.238***	-0.134
	(0.141)	(0.0512)	(0.105)
Tube well (Yes =1, No = 0)	-0.180	0.163***	-0.0998
	(0.191)	(0.0593)	(0.158)
Own well (Yes =1, No = 0)	-0.193	0.0766	-0.152
	(0.198)	(0.0651)	(0.162)
Spring (Yes =1, No = 0)	-0.234	0.101*	-0.0868
	(0.222)	(0.0600)	(0.177)
Urban (Yes =1, No = 0)	-0.0481	-0.0581	-0.0873
	(0.131)	(0.0541)	(0.0961)
Constant	6.893***	3.370***	6.644***
	(0.707)	(0.475)	(0.553)
Observations	433	433	433
R-squared	0.130	0.256	0.140
F-statistics	6.95***	6.79***	7.51***
Root MSE	1.09	0.42	0.82

Source: Authors estimation based on primary data collected from district Swat.
Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

In Model 2, the estimated coefficient of tube well is positive and significant at 1 percent level. This indicates that if the household uses tube well water for drinking, then its indirect health cost increases by 16 percent points. This result is in line with the results of Akram (2018) and Daniel et al. (2019). The local community of district Swat got 24,375 water connections and consumes 140 gallons of water per household per month from 69 tube wells and 47 water tanks in which most of the tube wells are contaminated (WSSC Swat, 2018 and Inter Press Services, 2015). These contaminated drinking water sources increase the indirect health cost of the local community.

In Model 2, the estimated coefficient of spring is positive and significant at 10 percent. This indicates that if the household uses spring water for drinking, then its indirect health cost increases by 10 percent points. This result is also in line with the study of Akram (2018) and Daniel et al. (2019). The majority of the population in the hilly areas of the district of Swat are using natural spring water sources for drinking without any chemical or physical treatment, which causes 80 % of water borne disease and increases the indirect health cost of households (Daud et al., 2017). Finally, in Model 1 and Model 3, we find insignificant impact of water sources and location on the household direct and total health costs. Similarly, in Model 2, we find insignificant impact of disease affected member age, own well and location on household indirect health cost. Our result is also supported by the results of Akter et al. (2016) and Hasan and Muhammad (2020). As 86.17% of the population live in the rural areas of the district of Swat, Pakistan have less access to safe drinking water sources, as they rely on the river and spring water, which are not safe for drinking. As a result, it affects their health cost because they have to pay more on the medicines, dr. consultation fee and on their stay and foods on the hospitals of the urban areas of district Swat (Hasan & Muhammad, 2020).

5. Conclusion and Recommendations

In this study, we estimate the health cost of different water borne diseases in district Swat. For this purpose, we collected data from 433 households of the local community through a well- organized questioner and applied least square regression with rebuts standard errors. Results of the study reveal that typhoid, diarrhea, vomiting, and gastroenteritis are the most common waterborne diseases in the District. In rural areas of the district, the prevalence of typhoid and gastroenteritis is higher, whereas in urban areas the prevalence of diarrhea and vomiting is higher. Besides, households who use drinking water from public tube wells mostly suffer from gastroenteritis and vomiting, whereas households who use water from digging wells or from natural springs mostly suffer from gastroenteritis and diarrhea. This shows that the all the drinking water sources, especially springs and tube well water in the district swat are heavily contaminated, which causes different waterborne diseases in the locals. In the district, the awareness of the local community about safe drinking water and the prevention measures of such diseases like water boiling, private filters etc. is necessary. The recent campaign of Water and Sanitation Services Company Swat (WSSCS) about the awareness among the masses against purification measures of drinking water in the markets, schools, colleges and universities is a good step. However, the campaign still covers the main city, Mingora. There is a need to extend the same campaign to other areas of the district, especially to rural areas. Programs from the district health department on waterborne diseases and prevention measures against these diseases can reduce the prevalence of these diseases. The planned gravity fall scheme for the provision of safe drinking water for households is another good step taken by WSSCS. However, the scheme will cover only the Mingora city of district swat.

It is suggested to WSSCS to introduce similar schemes for other tehsils of the district. The installation of filtration plants at neighborhood council, village council, and union council level can also improve the drinking water quality and can reduce the burden of waterborne diseases. Moreover, on average, households bear the highest direct and total health costs if their family member suffers from typhoid. Similarly, on average, households bear the highest indirect health cost if their family member suffers from diarrhea. This shows that waterborne diseases cause a significant money loss for households. The provision of the Sehat Insaf Card to households under the Sehat Sahulat Program of the Government of Khyber Pakhtunkhwa (KP) is a good step which not only reduces the household health costs but also for them to have better health facilities at public and private hospitals. However, the card still does not cover the cost of waterborne diseases. Therefore, it is suggested to the KP health Ministry to include the treatment of waterborne diseases in the Sehat Sahulat Program.

Finally, results from the regressions show that household income positively affects the direct, indirect, and total health costs of households. The poverty alleviation and employment generation programs in the district of Swat can increase the income level of the households. A stable and higher income can enable households to install safe drinking water sources and efficiently invest their income in avoiding waterborne disease. This laid responsibility on the Government of KP, Sarhad Rural Support Program, Tehsil Governments Swat, and on donor organizations to increase their effort for poverty alleviation and employment generation in district Swat.

5.1 Limitation and Future Guidelines

This study has numerous limitations, which could be the new research area for the development of research consistency. As this study was limited to only the five tehsils of district Swat, where data was collected from the Months of June to November 2022, which restricted the research generalizability. Therefore, future research can be done by including the sample size of all the details of the district of Swat. Furthermore, the time period for the collection of the data should also be increased. Secondly, this research was conducted in the district of Swat, which is a hilly area of Khyber Pakhtunkhwa and most of the locals use springs, rivers and the lakes for drinking. Therefore, a future study should be conducted in the plain areas of Khyber Pakhtunkhwa where the people use tube wells, their own wells and store water for drinking.

Authors Contribution

Muhammad Rahman: introduction, review of literature, and data collection
Naveed Hayat: research methodology and data analysis
Sher Ali: interpretation, drafting and recommendation

Conflict of Interests/Disclosures

The authors declared no potential conflicts of interest w.r.t the research, authorship and/or publication of this article.

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