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Research Article

Incidence of Dengue in the Highland District Swat, Pakistan: A Major Shift in the Geographical Prevalence of the Disease

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Abstract: Dengue disease has been known as a major public health problem in recent years throughout the world including Pakistan. During 2013 out-break in Pakistan it has shown wider spread to areas which were never endemic to it: more importantly spreading in higher latitude and altitude. To understand its expansion, particularly in the northern mountainous belt we conducted a study in Swat District of Pakistan. Aim of this study was to investigate the factors of this unexpected spread and epidemiology of dengue disease in newly hit area, District Swat. A sample of 180 households was selected for questionnaire survey from the hospital patients' records. Among total population of the selected households around quarter of people endured from disease during last spell. Male were the highest victims particularly between ages of 16-45 years, as they were the most mobile people carrying the virus from other urban centers of Pakistan such as Karachi, Lahore and Peshawar. The result further specified that increased movement into the district from historically endemic region was the igniting factor.

Keywords: Northern Mountains of Pakistan, Swat, Dengue expansion, Epidemiology, Mobility.

1. INTRODUCTION

Historically epidemics of infectious diseases resulted in calamities and have caused large scale mortality of human being in many parts of the world. However, with the advancement of science and technology in health care and medicines during nineteenth century, we were hopeful that infectious diseases will be eradicated soon [1, 2]. Unfortunately, we met with serious challenges of emergence and reemergence of infectious diseases both old and new and some of these diseases are still a major cause of mortality around the World [3, 4]. Dengue is one among the dangerous emerging and fast growing infectious diseases of tropics [5–9]. Various estimates have been reported regarding dengue infections at world level but most widely stated and currently used figure of 50-100 million infections per year is used by WHO [10]. It is now endemic in more than 110 countries, particularly in Asia, the Pacific regions, the Americas, Africa and the Caribbean [11]. This arboviral disease grow faster in urban population in tropical and sub-tropical regions [12, 13], imposing a heavy toll on economy and health [14, 15].

In developing world, the trend of re-emergence of infectious diseases in epidemic form has been accelerated by changes in environmental conditions particularly climatic elements, socioeconomic conditions, and demographic factors [16–18]. The virus of dengue transmission is climate sensitive for several reasons, i.e. temperature affects the vector born disease through vectors reproductive rate. It can also shift a vector's geographical range or distribution, changing vector-pathogen-host interaction and affecting host susceptibility [19]. The rainfall has a direct relation with density of adult female mosquitoes and availability of breeding sites. An increase in the number of adult female mosquitoes increases the spread of the disease [20]. Lastly the seasonal outline for dengue outbreaks is also important. Areas on both sides of equator particularly in regions, where Asiatic

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monsoon weather is dominant, and incidence of dengue fluctuates with the rainy period [21, 22].

Besides the climatic factors, cultural and socioeconomic factors also play an important role in the prevalence of the dengue disease. The close proximity and poor construction of houses and buildings in the cities, use of natural ventilation instead of air conditioning, low access to health services and health education interrelate to support dengue diffusion [23]. Most dengue endemic countries have poor surveillance for dengue, this is especially true in those countries where clinical management of the disease is not up to standard, and where there is lack of accurate data about dengue patients [16, 24].

First dengue case in Pakistan was registered in 1984-85 [25, 26]. Afterwards different outbreaks have been reported from various parts of the country [26, 27]. The first major outbreak was reported in Karachi in 1994-95 [24, 28] the southernmost, coastal city of the country. In 2003 episode cases were reported from other parts of the country including Haripur district of Khyber Pakhtunkhwa (KP). During 2005 to 2006, there was an unexpected spread of this virus in the country [29]. In 2006, over a period of about six months, it affected more than four thousand people and 50 deaths were reported only from Karachi [30]. Since then it became a regular phenomenon with variations in frequency and concentration in various areas of Pakistan. In 2011, the outbreak hit the Punjab province with a total of 21597 cases of DF and 365 death tolls, making it the world's largest epidemic of DF [31]. During that year it also entered into many districts of the KP, the Northern Province, with total suspected cases of 907. This was for the first time when sporadic dengue cases were reported from the mountainous belt of northern Pakistan.

In 2013, KP was hard hit by dengue epidemic for the first time and around 94% cases of total cases from KP were reported from one of the northern mountainous district of the province – Swat – where previously this disease was almost unknown (Fig. 1). The main objective of this research is to investigate the factors of sudden outbreak and high concentration of dengue in geographically remote locality.

2. MATERIALS AND METHODS

2.1. Study Area

Swat, one of the northern districts of North-west Pakistan, falls in the Hindukush mountain system, and roughly follows the boundary of Swat valley. It covers more than 5 thousands km2 area [32] stretching between 34° 34′ to 35° 55′ North latitude

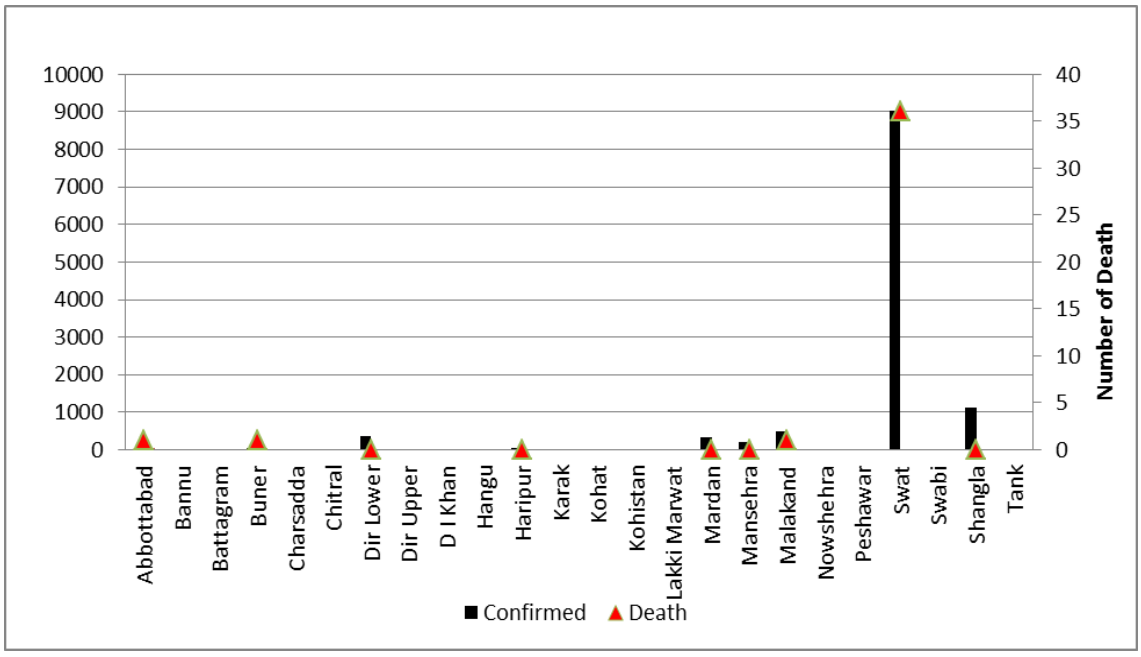

Fig. 1. District wise dengue cases in Khyber Pakhtunkhwa 2013

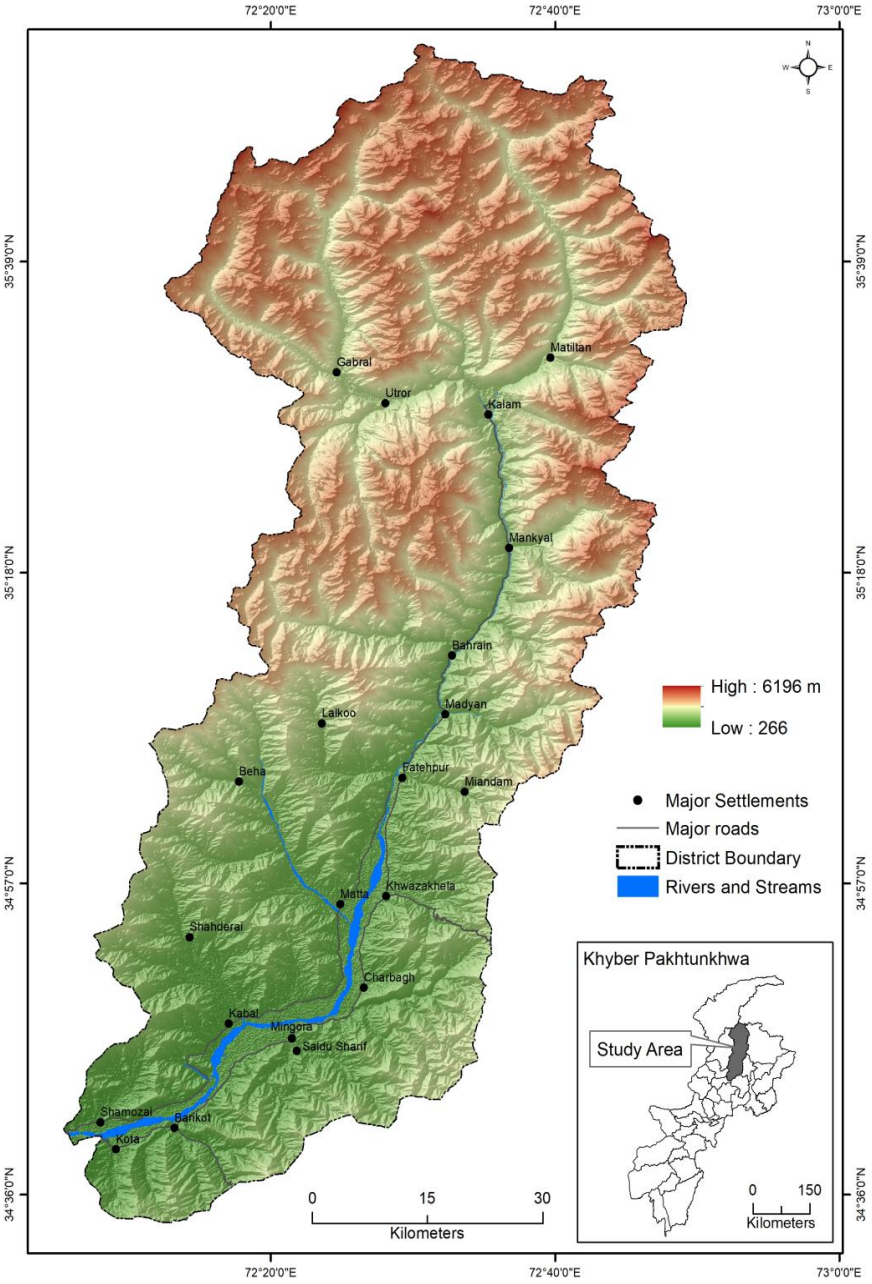

Fig. 2. Location and Elevation map of the Study Area.

and 72° 10′ to 72° 50′ East longitude (Fig. 2). It is surrounded by mountains, reaching to around 6000m elevation in the north and in the south to720 m giving out let to River Swat (Fig. 2). River Swat, a 3–6 km wide and almost 70 km long, originates Ushu and Gabral glaciers in the north and enters into Swat basin, where most thickly populated settlements are located. According to 2017 census, District Swat has a total population of 2,309,570 with 274,620 households [33].

Climatically, Swat district has long winters and short summers. The highest mean temperature 33° C is recorded in the month of June at Saidu shareef, while lowest temperature is recorded in January with mean maximum of 11°C and minimum temperature -2°C. The amount of rainfall is highest in March, followed by April, August, February and July (Fig. 3).

During last decade, Swat has suffered heavy loss of various economic sectors like trade, agriculture and tourism during militancy and military operation (2007-2009) and following the super flood of 2010. Beside heavy economic disruption, large numbers of inhabitants of the district were dislocated by

these events. Many of them were forced to live in camps established for Internally Displaced Persons (IDP) in different parts of the province while huge number of inhabitants migrated to other parts of the country including areas endemic to dengue disease. In many cases these migrants were living in very poor conditions and were exposed to a number of risks including this infection. After reinstatement of peace in the area most of the internally displaced persons (IDPs) returned to Swat in 2012 and 2013 and majority of them settled in Mingora and Saidu Sharif.

2.2. Methodology

For the identification of samples and sampling design, basic information was collected from Public Health Office (PHO) Swat (KP) between August-November 2013. That information included the details (name, age, sex and address) of all reported, suspected or serologically confirmed DF/DHF cases in the study area. Based on the addresses of patients a total number of Dengue cases for each Mouza (Revenue Village) were linked with Mouza map (polygon layer) which was shown by Proportional Circles (Fig. 4). With the help of this data, three zones i.e. high, medium and low disease concentrated were identified in Swat district. Saidu Sharif and Mingora were selected from urban areas which fall in high concentration zone with very high rate of incidences. Two villages were selected from medium concentration zone that is Nawe Kaley and Takhtaband. Rest of the district from where even single case was reported was identified as low disease concentration zone. Large numbers of such villages were spread over Swat district in all directions; therefore, four villages Kanjo, Sangota, Charbagh and Manglawar, were selected as sample villages to understand the spread and diffusion of disease (Fig. 4).

For an in-depth analysis at household level, all the identified cases were geo-referenced, using global positioning system (GPS). Out of total affected houseseholds, 180 households were randomly selected for self-administered questionnaires. Household with disease and patients were identified from hospital record while other variables like their age structure and gender, profession, movement history and other related material were collected through questionnaire. Housing and environmental conditions were also recorded.

Focus Group Discussions, each consisting of 8 to 10 persons, were arranged in community places like markets and educational institutes at least two in each sample site. In these FGDs, history of the disease, probable causes of spread and changing environmental conditions of area were discussed. Besides these issues, discussions were of great help on matters like role of government and non-government organizations in awareness campaigns and provision of health facilities. Future risks of the disease were also highlighted in these discussions and interviews with health officials.

Secondary data were obtained from various official and non-official organizations. Projected data of demographic variables for the year, 2013

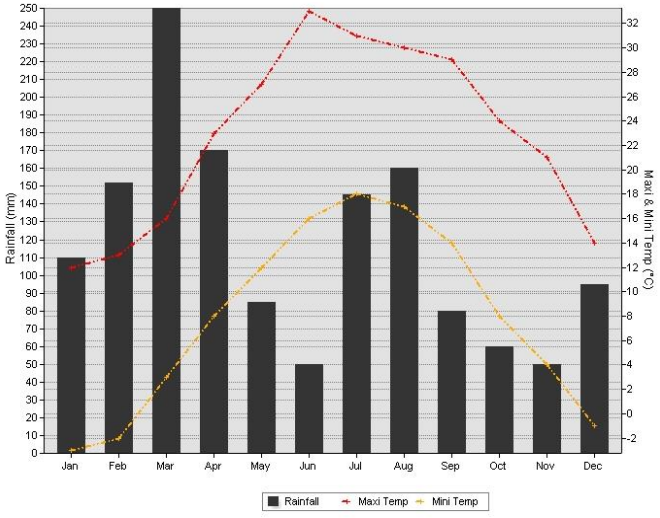

Fig. 3. Climatic conditions of Swat (1974-1995)

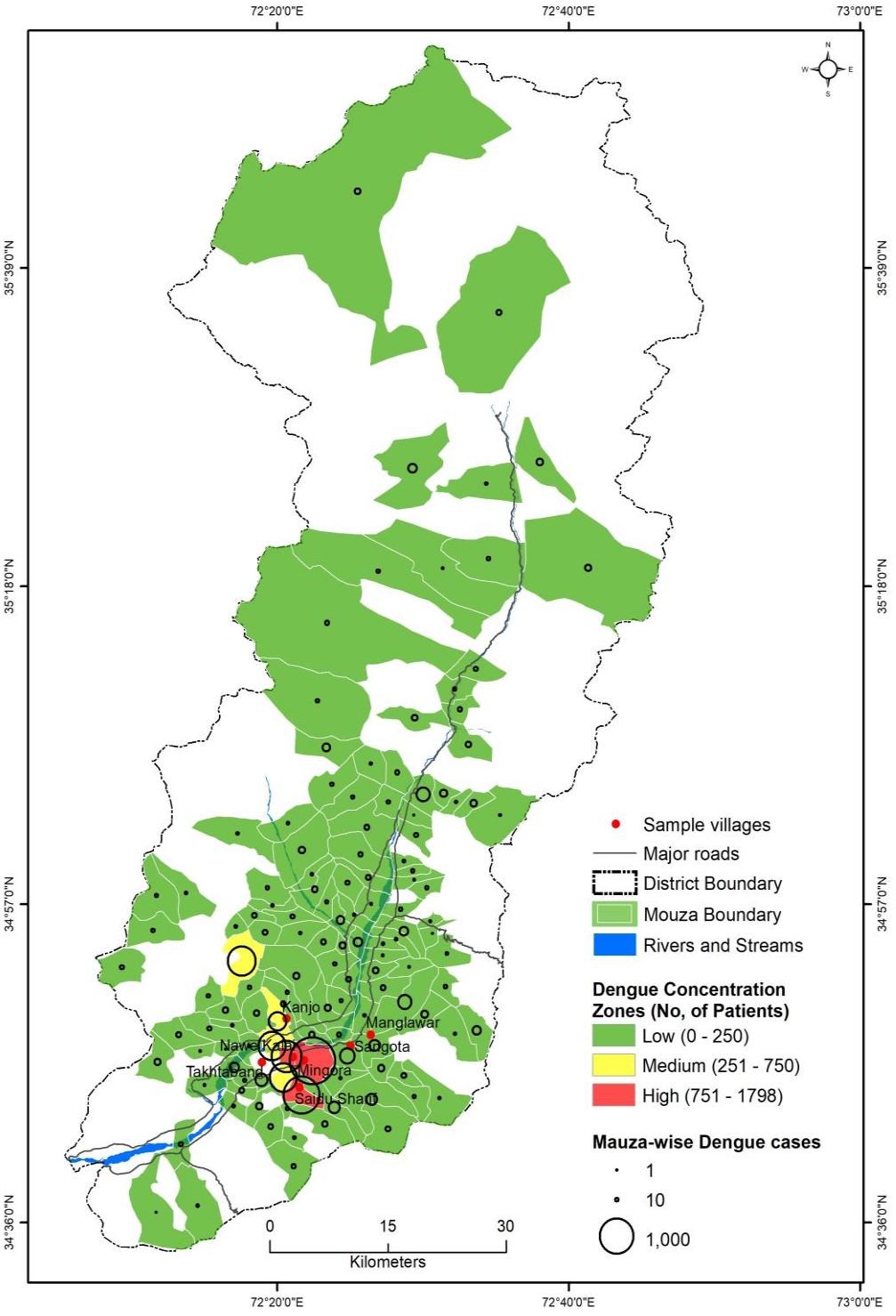

Fig. 4. Concentration zones of dengue disease

were obtained from census office. Information about incidences and characteristics of patients and disease were provided by hospitals and directorate of health KP. Regional center Peshawar of Pakistan Meteorological Office, provided data for climatic elements like rainfall, temperature and humidity data.

3. RESULTS

3.1 Age and Sex Composition of Sample Population

Total population in surveyed households; was 2198 persons. Among these 463 cases of dengue patients

were reported, indicated that 21% of people in the sample households have suffered from disease during last spell. More than one patient was reported from most of these households (Table 1).

Male were affected relatively in higher numbers particularly at the age of 16-30 year and 31-45year as compared to female. Female patients in all ages make 7% and highest were in the same age group as male. Mean age of the patients is 31 with standard deviation of 11.67.

3.2 Occupation of the dengue affected persons

Data revealed that majority of the affected people were students constituting around 40% of all reported cases. This was followed by employed persons (18%) and daily wagers (17%). Least number of cases was reported by house wives (Fig. 5).

3.3 Housing Characteristics of Sample Households

Data about house profile shows that more than 70% the houses were single storey houses while only 29% of the houses were multistory. House structure in small number (20%) was from local material i.e. stones, mud and wood while rest of the houses were built with concrete. Use of air conditioners was very limited and 90% of households did not have air conditioners. Before this out break people were hardly using mosquitoes net (21%) but afterwards more than 90% of people were using nets. Isolated trees were found in the courtyards but most of the trees were located outside the houses. Many of these trees were planted on field boundaries located at some distance from houses. Livestock keeping was reported by around 40% of households and most of houses (76%) had animal shed inside or attached to the house (Table 2).

3.4 Mobility of People in Dengue Affected Households

Epidemiological questions such as travel history, incubation period, and first day of illness were evaluated to identify the possible origin of dengue infection. According to the field survey most of the patients were mobile. More than 90% of male moved out of their place of origin and around 7% of female had mobility history in that context.

Around 4 % patients, all males were having travel history to Lahore and last trip before two weeks of their illness. These were among those who normally have to visit Lahore at least once a month for business pursuits. Most of them (12 out 20 persons) are involved in used tyer tire business. Further 12% of the patients were recently returned back from different parts of the country and they were among the first registered patients at Saidu Teaching Hospital. Around half of male and 5% female patients were not the bonafide resident of Mingora. Many of them were students and few of them were working in these areas. Forty-seven (47) dengue patients were found having no history of mobility prior to the attack of the disease (Table 3).

4. DISCUSSION

A complex relationship exists between socioeconomic factors like age and sex of patients and occurrences of dengue cases in different environmental settings [34]. Age and sex wise distribution of dengue disease has significant role

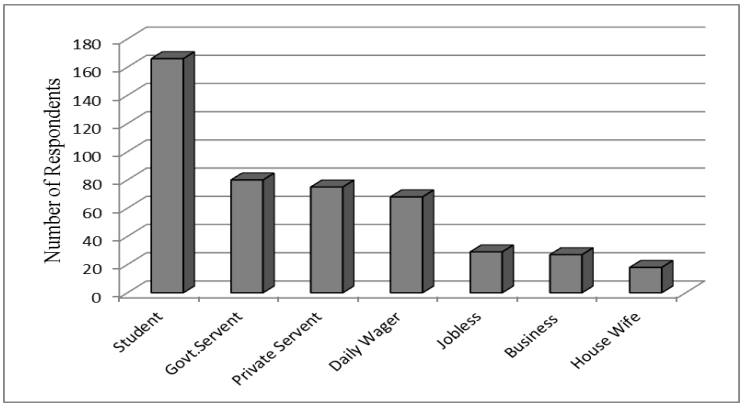

Fig. 5. Occupation of the dengue affected person

Table 1. District Swat: Age and sex composition of sample households

Sex	Age in Years					Total	Mean age	Std. Deviation
	1-15	16-30	31-45	46-59	60+			
Male	404 (11)	298 (177)	273 (152)	164 (85)	80 (6)	1219 (431)	31.2	11.67
Female	340 (1)	203 (16)	193 (9)	183(5)	60 (1)	979 (32)		
Both	744	501	466	347	140	2198 (463)		

Source: Field Survey 2014 Note: Figures in parenthesis show dengue patients

Table 2. District Swat: Housing characteristics of sample households

Housing characteristics		Frequency	Percentage
House type	Single storey	129	71
	Double storey	051	29
House structure	Kacha	037	20
	Pacca	087	49
	Semi pacca	056	31
Air conditioners	Yes	019	10
	No	161	90
Use of mosquitoes net	Before this episode	21	12
	After this episode	164	91
Vegetation	Inside house	56	31
	Outside house	124	69
Fields	Adjacent to house	52	29
	Away from house	128	71
Animal shed (74)	Inside house	56	76
	Outside house	18	24
Water tanks	In court yard	023	13
	On rooftop	157	87
Water utensils	Covered	164	91
	Uncovered	016	09
Remove water from flower pots	Yes	011	06
	No	169	94

Table 3. District Swat: Movement of the sample population

Place of Movement	Purposes of Movement				
	Business	Daily Wager	Education	Employment	Total
Lahore	20	0	0	0	20
Mingora	5	38	86	79	208
Saidu Sharif	2	30	80	76	188
Total	27	68	166	155	416

in epidemiological studies more particularly for identification of population at higher risk. Higher number of cases reported by male in Swat in 2013 episode has shown similar trend as in other areas of Pakistan [25, 29] as well as the world [35]. However, the ratio of male female cases is very high in this study. In some studies slightly more women were affected particularly in Brazil and other countries of Latin America [36]. The probable reasons could be vector's indoor characteristics as well as greater use of health services by women in those areas. In our study the situation is different and reasons could be contrary as women in the area have restricted mobility, higher body coverage and are less visible in seeking health services. This also could be due to involvement of twin vectors Aedes albopictus outdoor prevalence and Aedes aegypti indoor prevalence in this episode [37]. Nadeeka, [38] reported that gender is not a significant variable and younger population (under 18 years) has higher vulnerability.

Dengue in many countries is known as childhood disease like Thailand [39], Colombia [40], Philippines [41] and Mexico [42]. Initially dengue was considered as disease of children but in many countries it has shown higher trend in adult age [43]. The general pattern for age distribution in the present study shows that cases were relatively low in the children as well as aged. Median age of this study (31) is located in the range of age 24-32 shown by number of studies [44]. The higher number of adult males as compared to the female and children and the elderly people is probably due to greater exposure of male to vector during day time at work place or while travelling to and from work, more specifically movement of adult male to endemic areas. As highest number of cases were reported in adult age group, thus the economically active group was affected by disease which could have damaged the already stressed local and household economy of the district. This has also been supported by prevalence of disease in students as the education institutions are located in Mingora and Saidu Sharif, the high concentration zones mobility to these areas has caused the spread. Occupation, age and sex composition clearly indicate that infection has spread through host. Those who were immobile and stayed home like elderly, children and housewives were very few in numbers.

In the study area mixed agriculture is practiced and the presence of vegetable farms, fruit trees and mixed cropland increase the chance of Aedes mosquito development [45, 46]. In higher altitude of Swat, Pines trees, Dewdar, Dedar, Beyar are common, while in plain areas where temperature is relatively high, plants of broad leaves like Bakyan, Poplar and Willow are found. Holes and axils of these trees also provides sites for the growth of Aedes mosquitos larva. About 70% of the households were having plants and fields around the houses. This increases the chances of out door dominence of vector.

Housing factors in the study area were classified on the basis of structure and type. Majority of the houses were Semi pacca (made of wood, stones and concreate material) and single storey. Use of air conditioners and mosquito nets was very limitted. However, after this episode NGOs working in the area have distributed nets in large quantities and as a result of awareness campaigns, use of nets became common. Storage tanks were mosly on roof tops and water utensils were covered. All these factors could have resulted in low risk of indoor vector. The only factor favouring vector inside houses was the presence of water in flower pots.

Water availability in the study area becomes a serious problem in summer; therefore, almost all houses were having water storage tanks. Most of these tanks were placed at roof tops and were properly covered. Water utensils particularly those used for drinking purposes were clean and covered. In small number of houses flower pots were present. However, water from these pots was not regularly removed.

Mobility record of people has confirmed that imported dengue cases have played vital role spread of this disease in Swat resulting in epidemics of 2013. This in line with study conducted by Garcia et al. [47] which stated that human movement have serious impacts on spatial spread of infectious disease and on outbreak dynamics. Although, reasons for current dengue outbreak in Pakistan are multi-factorial [48] but long distance importations like in present study is attributed to the involvement of Aedes aegypti in spread of dengue [49]. Imported dengue cases are defined as laboratory-confirmed dengue cases with travel history to endemic area

within 14 days before the date of onset of dengue (based on Taiwan-CDC's definition).

Due to the internal conflict in Swat District, most of the inhabitants were displaced. To accommodate these Internally Dispersed Persons (IDPs), the government had set up camps in Peshawar, Mardan and Swabi districts of Khyber Pakhtunkhwa. Military operation was started against Taliban groups in Swat district in April 2009. The operation was lunched due to law and order situation resulted from the failure of two agreements of the provisional government [50]. All sectors of life were badly affected and majority of the inhabitants lost their livelihood assets. Prior to the conflict, Swat was the hub of tourism and large number of tourists from all over the country used to come to this area. Large numbers of people in Swat were therefore employed in tourism related business. This sector was totally devastated by unrest in the area leaving thousands of locals as jobless. Another huge chunk of skilled labour force was left without jobs due to the declination of industries. All these people were forced to migrate to other districts of the country. Many of them, IDPs, shifted to larger urban centers like Lahore and Karachi for jobs as well started business over there.

After the reinforcement of law and order situation in 2012 the inhabitants started to move back to Swat. Majority of these families settled in Mingora and Saidu Shareef being the District Head Quarter or established their businesses in Mingora which increased intra district mobility. During 2012 and 2013 tourism industry was also encouraged as festivals and programs were initiated by Pakistan Army to boost the economy as well as moral of the local inhabitants.

5. CONCLUSIONS

Though Dengue virus has caused many epidemics since 1994 till 2011 in Pakistan, almost all of these outbreaks were in relatively low lying plain of southern and central parts of the country. However, in 2013 for the very first time the northern mountainous belt experienced unusual Dengue outbreak. According to available literature dengue endemic belt lies between 35^0 N to 35^0 S and the study area lies at the outer margins of latitudinal limits. Nevertheless, the ceiling for this disease has been delimited up to 2000 meters at 19^0 North latitude for Mexico and 2,200 m for Colombia (4^0 North latitude). In the present study dengue cases were reported from altitude and that has never been reported in the relevant literature around happened in the world.

This study reveals that mobility of the people has played a significant role in the outbreak and unusual spread of dengue in the remote mountainous area. Economic disruption due to conflicts resulted in dislocation of large number of inhabitants. Many of them were forced to live in camps established for Internally Displaced Persons (IDP) in different parts of the province while huge number of inhabitants migrated to other parts of the country including areas endemic to dengue disease. In many cases these migrants were living in very poor conditions and were exposed to a number of risks including this infection. After reinstatement of peace in the area most of the internally displaced persons (IDPs) returned to Swat in 2012 and 2013 and majority of them settled in Mingora and Saidu Sharif and ignited dengue disease in the area.

The local environmental conditions also favored for the long-term survival of the vector from August through November in this geographically unique milieu. Large scale movement between Swat and endemic cities and within the district for the search of improved socioeconomic conditions and opportunities were accelerated by years of conflict and followed by devastating flood. This population mobility has been identified as an important contributing factor to the explosive nature of the outbreak.

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