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Spatial patterns and prevalence of Hepatitis C virus in Punjab during 2010-2017

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Abstract

The upsurge of contemporary urbanization has created potential risks for the emergence of infectious diseases like HCV affecting millions of people around the globe. The present research studied the spatial patterns of HCV and its prevalence in the Punjab province for the years 2010, 2013 and 2017. Secondary data sources were used, and district-wise figures of HCV patients were obtained from Directorate of General Health Services Punjab, Health Department Lahore (DGHSP). The data for population was attained from Punjab Bureau of Statistics, Lahore. The collected data were processed and analysed in Microsoft Excel 365 and SPSS 22 for calculating HCV prevalence rate. The spread and major clusters of HCV were shown through maps using ArcGIS 10.5. The results show that HCV has gradually increased in number and expanded in spatial spread within the study area since 2010 and the concentration of disease is found in the north eastern, eastern and central districts of Punjab. Most affected districts are Multan, Lahore, Faisalabad, Toba Tek Singh, Bahawalpur, Sahiwal and Gujranwala. Highest prevalence rate of HCV is found in Multan district with 3.39% hence, all other districts have HCV prevalence rate less than 1%. The study suggests future studies to identify the possible environmental risk factors responsible for the spread of disease in the highly affected districts of Punjab and examine the disease pattern through popular mapping techniques like using hot spot analysis and interpolation method.

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Introduction

The world has witnessed a very fast pace of urbanization since the advent of industrial revolution. So far, the rapid urban advancement resulted in many negative impacts on the human environment. The growing urbanism has imposed serious impacts on global health patterns and resulted in the spread of serious infectious diseases like hepatitis C virus (HCV) (Alirol, 2011). It is a worldwide public health burden, instigating an increased level of liver-related morbidity and mortality due to the disease progression. It has been estimated that approximately 170-200 million individuals are infected with HCV all over the world (Alter, 2011). According to World Health Organization (WHO), approximately 1.75 million new HCV cases were reported in year 2015 meaning that 23.7 new HCV infections per 100,000 people. At present the global HCV prevalence is estimated to be 2.5%   rather more precisely, 177.5 million of HCV infected adults (Khan *et al.,* 2014; Petruzziello *et al.,* 2016).

HCV is endemic in many countries and its incidence and prevalence is gradually   increasing in the developing world (Mujeeb *et al.,* 2000). Pakistan ranks second highest among the nations of world with HCV prevalence of 5%, after Egypt and possesses second highest number of HCV patients after China. According to a survey report, during 2007 nearly 7% of people living in Punjab province were suffering from HCV while currently 10 million Pakistanis are victim of HCV (WHO, 2017). This huge disease burden is a major cause of morbidity and mortality within the country which is likely to grow in coming years mainly due to unsafe practices of medical procedures (Umer and Iqbal, 2016). The province wise situation of HCV prevalence is Baluchistan 25.77%, Khyber Pakhtunkhwa 6.07%, Punjab 5.46% and Sindh 2.55% (Arshad and Ashfaq, 2017).

Geospatial analysis has been widely used in the fields of health sciences, medical geography and spatial epidemiology to identify and measure the patterns of disease distribution. Maps express direct graphical information on the spatial distribution of infection and can recognize clear patterns which may be neglected in tabular presentations (Waller and Gotway, 2004). Spatial analysis has been widely used by various researchers for the identification of high risk areas for HCV and other associated infections. For instance, Daw *et al.* (2018) studied the spatio-temporal variations found in HCV distribution in Libya by using disease mapping and cluster analysis technique. Kauhl *et al.* (2015) studied the spatial distribution of HCV in European cities through geographically weighted Poisson regression. Spatial cluster analysis was used by Caudros *et al.* (2014) to understand the epidemiological patterns of HCV in Egypt. Another study was done by Wang *et al.* (2011) to examine the spatio-temporal patterns of HCV in China during 2005 to 2011 through thematic distributional mapping technique. Mujeeb *et al.* (2000) prepared choropleth maps through Geographic Information System (GIS) for showing prevalence of HCV in Karachi city of Pakistan.

Very little information was available on the geographical distribution of HCV in Punjab province, where the infection is endemic and gradually rising. The present study aimed to examine the distribution patterns and prevalence of HCV in the districts of Punjab from 2010 to 2017.

Material and methods

Selection of study area

The Punjab province of Pakistan was selected for the present study (Fig. 1). The province is located between 27°40' to 34°01' north latitudes and 69°20' to 75°20' east longitudes. It is bordered by Federal Capital territory of Islamabad and Azad Jammu and Kashmir in the north, by Khyber Pakhtunkhwa province to the west, by Baluchistan to the southwest, Sindh province on the south and by India on the east.

It is the second largest province by area after Baluchistan with an area of 205,344 Km² and the most densely populated province of the country with approx. 110 million inhabitants (GOP, 2017). Administratively, the province comprises of 08 administrative divisions and 36 districts.
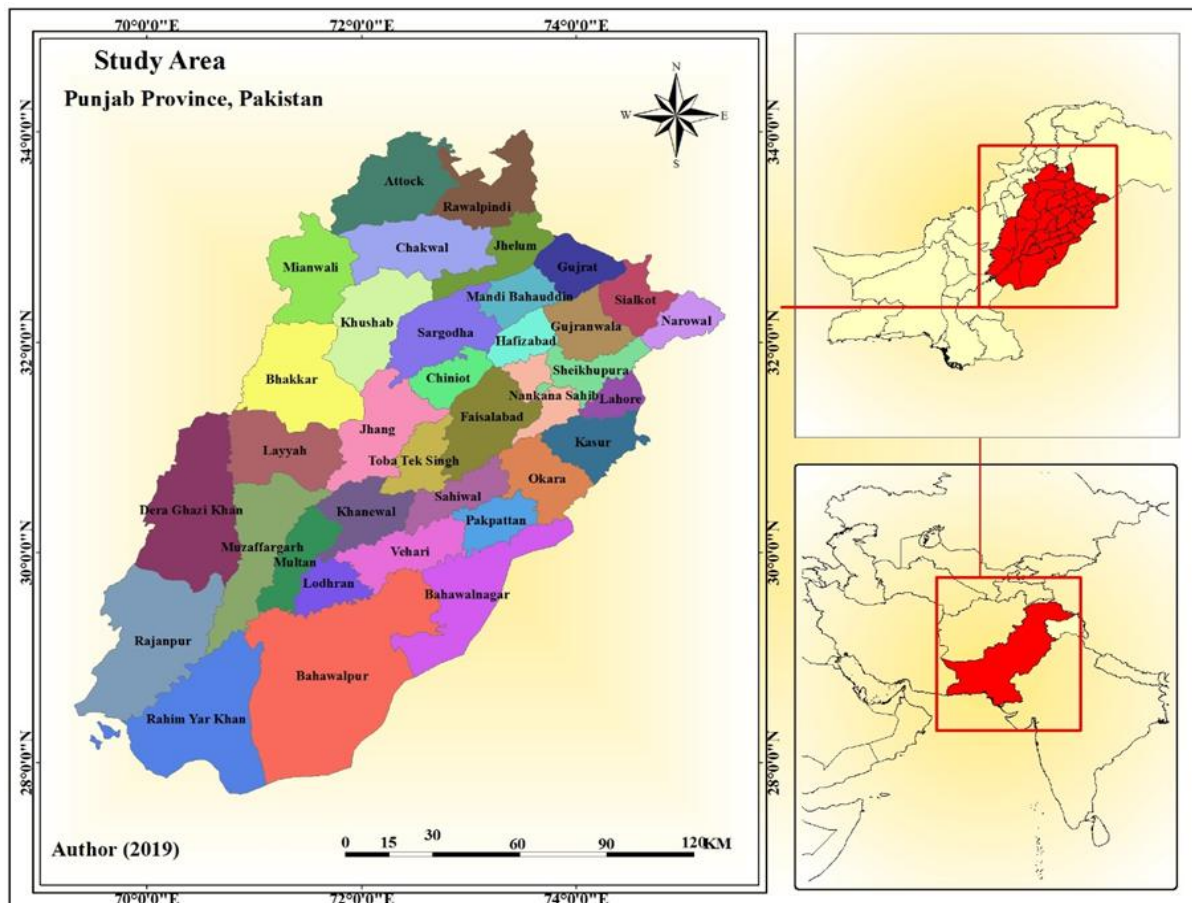
Fig. 1. The study area.

Data collection and analysis

Keeping in view the nature of study, secondary data sources were utilized. Firstly, the district-wise reported cases of HCV for the year 2010, 2013, 2017 were collected from the Directorate of General Health Services Punjab, Health Department Lahore (DGHSP). Secondly, district-wise population data for year 2017 were attained from Punjab Bureau of Statistics (PBS), Lahore. The collected information was afterwards organised and tabulated in Microsoft Excel 365 and SPSS Version 22.

Cluster detection has increased the capacity of spatial analysis in health research and medical geography because it enables the rapid identification of areas that represent either high or low disease risk (Arden, 2008). An attempt was made in the present study to identify disease clusters of HCV in the study area. For this purpose, the districts were categorized into 5 classes according to the number of HCV patients as used by Daw *et al.* (2018) (see Table 1). The data was

arranged accordingly in attribute tables to show the main clusters of disease within the study area with the help of ArcGIS 10.5. Furthermore, distributional maps were also prepared for year 2010, 2013, and 2017. The aim was to show the extent of HCV spread and compare the gradual increase in the incidence of HCV within the study area. Finally, to check the regional variations, district wise disease prevalence rate was calculated for the year 2017 by using the following formula:

$$\text{Disease Prevalence} = \frac{\text{Number of persons infected with disease in sample population}}{\text{Total no. of Population during reference period}} \times 1000$$

Results and discussion

A total number of 56,372 cases of HCV were reported in Punjab during eight-year period from 2010 to 2017. Great regional varaiations were obeserved in the incidence of identified HCV cases among the districts of the study area (Table 2).

Table 1. Classification of districts according to HCV patients.

Class	Patients	Districts
I	1 – 50	Least affected districts
II	51 – 100	Less affected districts
III	101- 500	Moderately affected districts
IV	501- 1000	Highly affected districts
V	> 1000	Extremely high affected districts

Source: Author, 2019.

Table 2. HCV Patients in Punjab during 2010-2017.

Sr.	Districts	2010	2013	2017	2010-17
1	Multan	50	405	16,097	16,552
2	Faisalabad	104	9,794	2,903	12,801
3	Lahore	11	1,059	3,704	4,774
4	Gujranwala	230	1,315	938	2,483
5	Rawalpindi	8	1,012	735	1,755
6	Bahawalpur	18	617	1,129	1,764
7	Toba Tek Singh	792	144	1,157	2,093
8	Sialkot	616	268	416	1,300
9	Okara	113	152	773	1,038
10	Rahim Yar Khan	13	481	415	909
11	Khanewal	230	278	310	818
12	Dera Ghazi Khan	124	75	948	1,147
13	Sahiwal	262	68	1,156	1,486
14	Gujrat	872	162	159	1,193
15	Vehari	175	529	115	819
16	Narowal	23	126	441	590
17	Bahawalnagar	139	190	164	493
18	Hafizabad	51	74	630	755
19	Jhelum	164	162	188	514
20	Attock	144	160	97	401
21	Sargodha	34	59	375	468
22	Layyah	39	173	151	363
23	Khushab	19	101	135	255
24	Bhakkar	7	37	49	93
25	Kasur	2	7	442	451
26	Muzaffargarh	110	35	66	211
27	Mandi Bahauddin	25	16	13	54
28	Sheikhupura	0	1	162	163
29	Pakpatan	36	35	64	135
30	Nankana Sahib	20	20	91	131
31	Lodhran	15	16	60	91
32	Chakwal	43	6	79	128
33	Rajnapur	57	7	6	70
34	Chiniot	1	14	23	38
35	Mianwali	1	27	3	31
36	Jhang	5	0	0	5
	Total	4,553	17,625	34,194	56,372

Source:DGHSP, 2017.

The largest number of identified cases were found in the districts of Multan with 16,552, Faisalabad 12,801, Lahore 4,774, Gujranwala 2,483, and Toba Tek Singh with 2,093 HCV patients. However, very few HCV cases were reported from Jhang with 05, Mianwali 31, Chiniot 38 and Mandi Bahauddin 54 HCV patients during 2010-2017 (Fig. 2). It was also observed that during 2010 to 2017, around 52% of the total HCV cases were exclusively reported from only two districts i.e. Multan and Faisalabad , while all other districts shared less than 10 %. Furthermore, the distribution of HCV was also examined for the years

2010, 2013 and 2017 to figure out the spatial extent and gradual increase in HCV incidence in Punjab (Fig. 3). The results depicted that total 4,553 HCV cases were reported in 2010 within the study area. The concentration of HCV incidence was observed in the north-eastern and central parts of the province. Highest concentration in north eastern part was seen at Gujrat and Sialkot with 872 and 616 patients respectively. In the central part, districts of Toba Tek Singh and Sahiwal exhibited thick spread of HCV with 792 and 262 cases respectively. Less than 05 patients were found at Mianwali, Chiniot and Kasur districts while no patient was reported from Sheikhupura district.

Table 3. Class-wise intensity of HCV prevalence in Punjab, 2010-2017.

Class	Category	2010		2013		2017	
		No. of districts	% Cases	No. of districts	% Cases	No. of districts	% Cases
I	Least affected districts	20	8.13	13	1.25	6	0.27
II	Less affected districts	2	2.37	4	1.57	6	1.34
III	Moderately affected districts	11	39.42	13	15.90	13	10.16
IV	Highly affected districts	3	50.08	2	6.50	5	11.77
V	Extremely high affected districts	0	0.00	4	74.78	6	76.46
	Total	36	100.00	36	100.00	36	100.00

Source: Author, 2019.

Table 4. District-wise HCV prevalence rate in Punjab, 2017.

Sr	Districts	HCV cases 2017	Population 2017	*Disease Prevalence Rate %	Sr	Districts	HCV cases 2017	Population 2017	*Disease Prevalence Rate %
1	Multan	16097	4745109	3.39	19	Jehlum	188	1222650	0.15
2	Faisalabad	2903	7873910	0.36	20	Attock	97	1883556	0.05
3	Lahore	3704	11126285	0.33	21	Sargodha	375	2517560	0.14
4	Gujranwala	938	5014196	0.18	22	Layyah	151	1824230	0.08
5	Rawalpindi	735	5405633	0.13	23	Khushab	135	1281299	0.1
6	Bahawalpur	1129	3668106	0.3	24	Bhakkar	49	1650518	0.02
7	Toba Tek Singh	1157	2190015	0.52	25	Kasur	442	3454996	0.12
8	Sialkot	416	3893672	0.1	26	Muzaffargarh	66	4322009	0.01
9	Okara	773	3039139	0.25	27	M.Bahauddin	13	1593292	0
10	Rahim Y. Khan	415	4814006	0.08	28	Sheikhupura	162	3460426	0.04
11	Khanewal	310	2921986	0.1	29	Pakpatan	64	1823687	0.03
12	Dera G. Khan	948	2872201	0.33	30	Nankana Sahib	91	1356374	0.06
13	Sahiwal	1156	2517560	0.45	31	Lodhran	60	1700620	0.03
14	Gujrat	159	2756110	0.57	32	Chakwal	79	1495982	0.05
15	Vehari	115	2897446	0.03	33	Rajnapur	6	1995958	0
16	Narowal	441	1709757	0.25	34	Chiniot	23	1369740	0.01
17	Bahawalnagar	164	2981919	0.05	35	Mianwali	3	1546094	0
18	Hafizabad	630	1156957	0.54	36	Jhang	0	2743416	0

Source: DGHSP and PBS (2017)

*Disease prevalence calculated by author.

During 2013, the incidence of HCV cases had increased more than three times as the number of identified HCV patients reached to 17,625. The disease had spread not only in number but also in spatial extent thus by affecting the north eastern, south eastern and central parts of Punjab. Highest concentration of HCV incidence was found at Faisalabad, Gujranwala, Lahore and Rawalpindi districts with thousands of reported cases. However, least number of cases were reported from Sheikhupura, Chakwal, Rajanpur, Kasur and Chiniot districts.
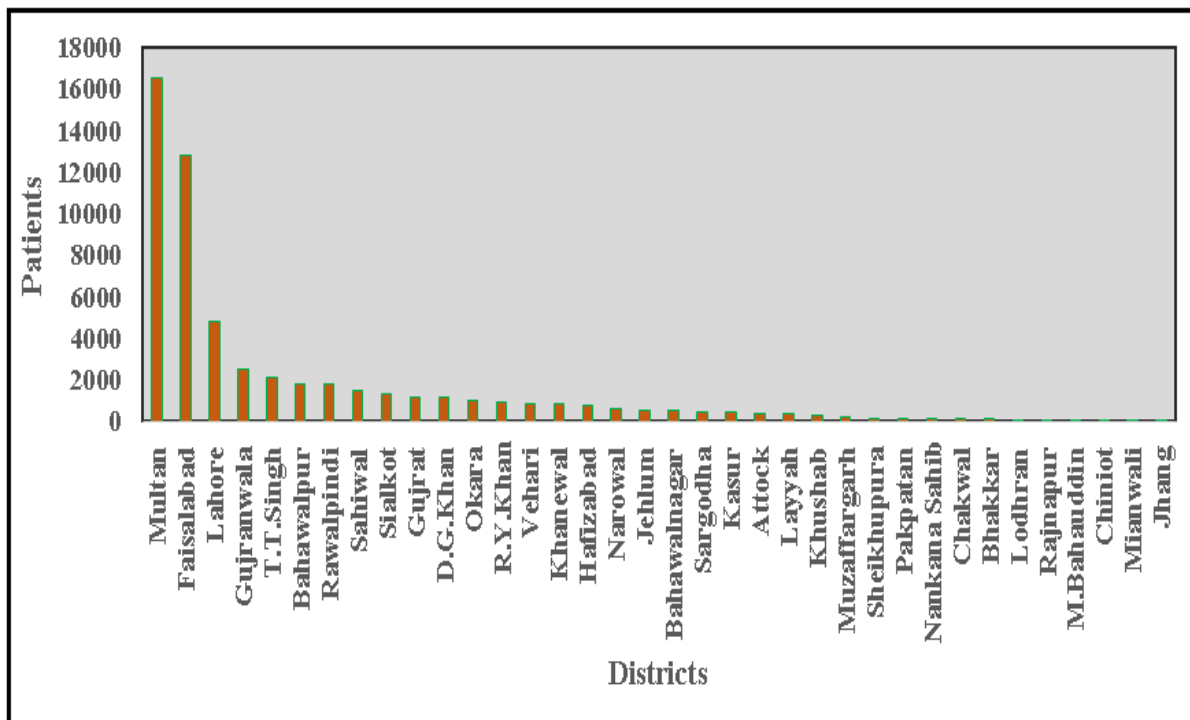
Fig. 2. Reported cases of HCV in Punjab during 2010-2017.

In year 2017, the incidence of HCV was almost doubled in number from year 2013 as 34,194 cases were reported in Punjab. A visible increase was noticed in the spatial extent of disease which had greatly expanded thereby extensively covering the north-eastern, eastern, and central and to some extent, the southern parts of Punjab as well (Fig. 3).

The districts with highest HCV incidence were Multan, Lahore, Faisalabad, Toba Tek Singh, Sahiwal and Bahawalpur. While as less HCV incidence was reported from Mianwali, Rajanpur, Mandi Bahauddin and Chiniot districts. Moreover, a sudden increase was seen at Dera Gazi Khan District with 948 cases which was negligible in previous years. Broadly speaking, the incidence pattern of HCV was found somehow similar as reported by Khan *et al.* (2014) and Arshad and Ashfaq (2017) within the study area.

The results of cluster detection of identified HCV cases revealed many interesting facts regarding the intensity of disease prevalence within Punjab during 2010 to 2017 (Table 3). It is obvious from Table 2 that the intensity of disease prevalence was low in year 2010 as most of the districts i.e. 20 were in class I, 11 districts were in class III.

Only 03 districts were found in class IV which were Gujrat, Toba Tek Singh and Sialkot with 50.08% of the total HCV cases of 2010. However, no district was found in class V. The major clusters of HCV were detected in the north eastern and central parts of Punjab (Fig. 4).

Some changes were observed in the intensity of HCV prevalence in year 2013 as the number of districts decreased in class I, while slightly increased in class II

and III. Interestingly, 04 districts were found in class V namely Faisalabad, Gujranwala, Lahore and Rawalpindi with 74.48% of identified HCV cases during 2013. The major clusters were progressively moving from north-east to eastern, central and southern parts of the study area. Finally, in 2017, noticeable changes were observed in the intensity of HCV prevalence within Punjab as majority of the districts were now falling in last three classes. Only 06 districts were found in class I with less than 1% of total HCV reported cases of 2017. On the other hand, 06 districts were found in class V with 76.46% of the total reported cases.
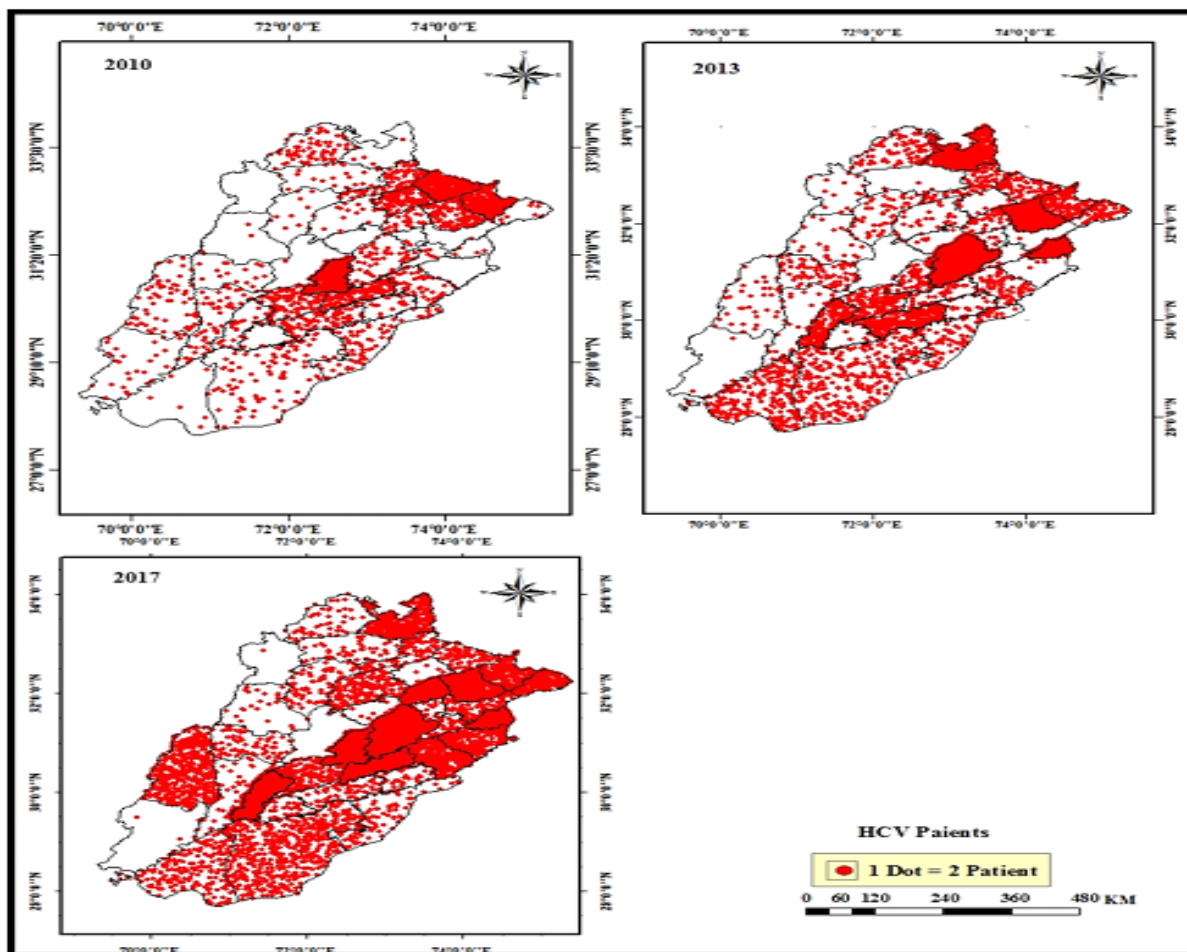

Fig. 3. Spatial spread of HCV in Punjab.

These included Multan, Lahore, and Faisalabad, Toba Tek Singh, Sahiwal and Bahawalpur districts. Lastly, district-wise disease prevalence rate was calculated to understand the current situation of disease burden faced by Punjab due to HCV (Table 4).

Disease prevalence rate is a good measure to find the disease frequency and quantifying disease burden of a disease in a given population at a given time (Mujeeb *et al.,* 2000; Wang *et al.,* 2014; Daw *et al.,* 2018). The results for HCV prevalence rate revealed the fact that highest prevalence rate were found at Multan district with 3.39% per 1000 persons during 2017. Gujrat district was on second with 0.57% followed by Hafizabad with 0.54%, Toba Tek Singh 0.52% and Sahiwal with 0.45% per 1000 persons. Faisalabad and Lahore districts exhibited comparatively less prevalence rate as 0.36% and 0.33% respectively. Moreover, 0.33% and 0.3% HCV prevalence rate were seen at Dera Ghazi Khan and Bahawalpur districts. However, the districts with zero prevalence rate were Jhang, Mianwali, Rajanpur and Mandi Bahauddin either due to absence of HCV or very few reported cases during 2017.
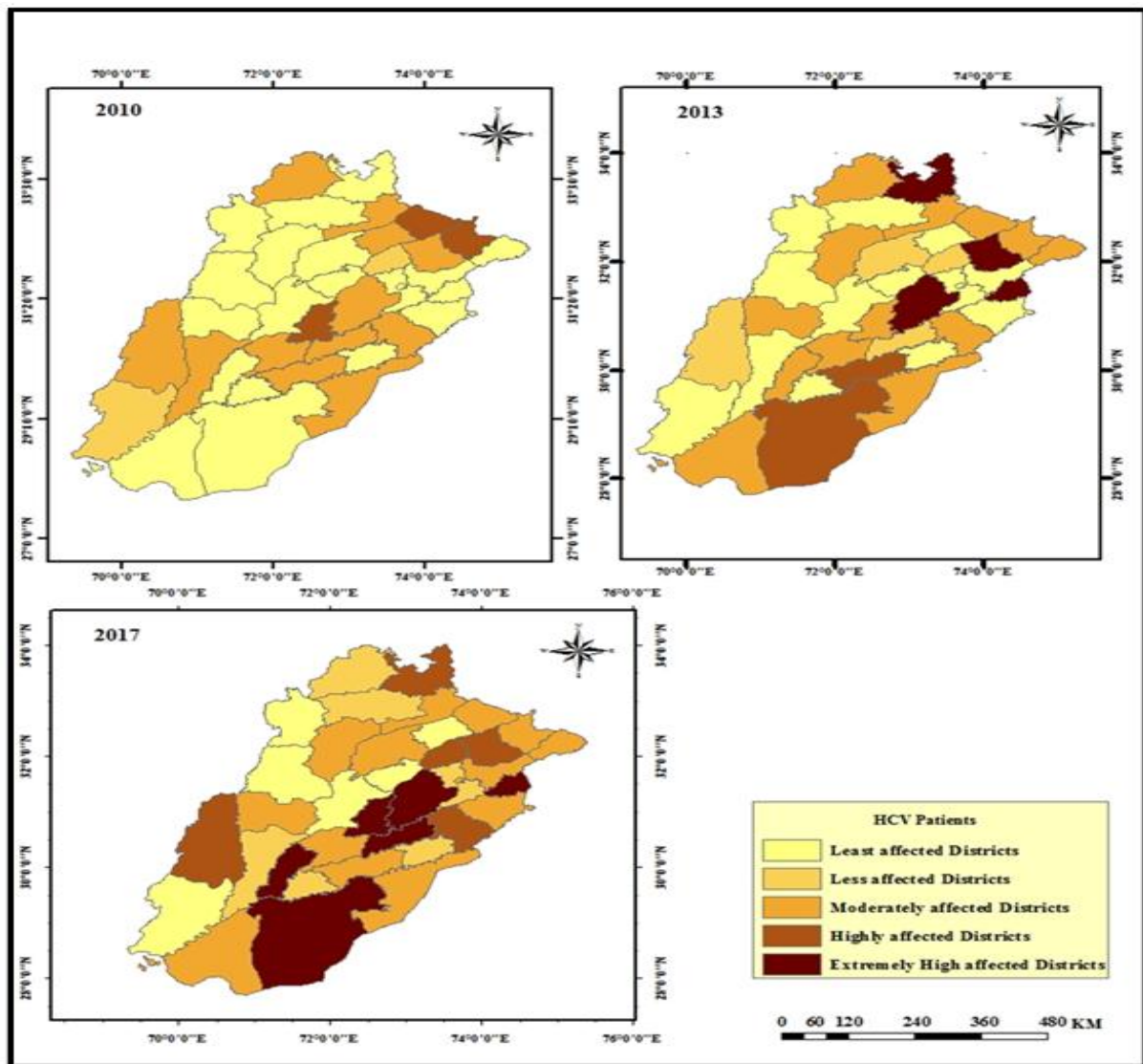
Fig. 4. Major Clusters of HCV in Punjab during 2010-2017.

Conclusion

The present study concludes that Punjab province has witnessed a substantial growth in the incidence and prevalence HCV during 2010-2017. The disease has not only increased in number but also in its areal extent and spatial spread.

The concentration of the disease is in the north-eastern, central and to some extent, the southern districts of Punjab, where pace of urbanization is fast. The badly affected districts are Multan, Faisalabad, Lahore, Toba Tek Singh, Gujrat, Sahiwal and Dera Ghazi Khan where high HCV prevalence rate has been detected during 2017. There is a great need for serious action to be taken by the responsible public health authorities to control the further transmission of disease in Punjab. The Future studies should examine the spatial spread of HCV through modern mapping techniques as hot spot analysis, interpolation, and disease modelling to identify possible risk factors and so on.

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