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SPATIAL ANALYSIS OF SOCIOECONOMIC INEQUALITY OF OPPORTUNITY IN ACCESS TO SKILLED BIRTH ATTENDANT IN PUNJAB, PAKISTAN

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ABSTRACT

Maternal mortality is a critical global public health issue, particularly in developing countries like Pakistan. Interventions to improve mothers' usage of skilled birth attendant (SBA) may reduce maternal mortality. The aim of this work to conduct the spatial analysis of socioeconomic inequality of opportunity in access to SBA in districts of Punjab, Pakistan and explore the circumstance variables that contribute the most to the socioeconomic inequality. The study is conducted by using Punjab's Multiple Indicator Cluster Survey 2017-18 and the data analyzed are taken from women of 15 to 49 years with a live birth in the last 2 years. The Human Opportunity Index is used to measure the coverage rate, inequality, and universal access of opportunity across the districts of Punjab. Further, Shapley Decomposition is utilized to identify the contribution of the circumstance factors to the inequality. It is noted that most of the southern districts of Punjab have poor coverage rates and low universal access to SBA and northern districts have high coverage and universal access for the SBA. There is also higher inequality in southern districts of Punjab. Further, in decomposition analysis, it is found that household wealth status, ANC, birth order, birth interval, household head education, ethnicity, media access and residence were the most significant factors leading to socioeconomic inequality of opportunity across the districts of Punjab. Based on the findings, it is suggested that the government should prioritize equitable resource allocation, particularly in southern Punjab.

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INTRODUCTION

Divergence from the widespread belief on trickledown effect theory emphasizes the role of public policy in the social and economic development of the society through direct intervention by the government. New debate on the global arena to focus on inclusive growth has increased the role of government to ensure the provision of basic services to the population at large. However, it has been found that Pakistan, like many other developing countries, lagging far behind in meeting the target of access to opportunities. Pakistan is 129th country in terms of Sustainable Development Goal Indicators (SDGI) rank with 57.72 SDGI score and it slightly improved since 2000 wherein 140 out of 100,000 women die during live birth or within 42 days of birth (Sachs et al., 2021). It shows the significance of maternal health problems in Pakistan. The growth of provision of the specific facility and timeline to meet sustainable development goals is critically important to provide insight to the public policy makers so that priorities would be aligned accordingly.

Equal access to maternal health services, including prenatal, institutional delivery (ISD), skilled birth attendant (SBA) and postnatal facilities, is one of the most pressing challenges facing the public health system. In Pakistan, there is decrease in maternal mortality rate (MMR) from 276 in 2006-07 to 178 in 207-18 per 100,000 (PDHS 2006-07 and 2017-18) but it is high rate because Pakistan could not achieve goal 5 of MDGs (Improve Maternal Health) by 2015, which aimed to reduce the MMR to 140 by increasing the number of newborns attended by SBA. Following 2015, the SDGs present a revolutionary new agenda for maternal health, intending to lower the global MMR to less than 70 per 100,000 live births by 2030. The WHO encourages using SBA to increase the chance of effectively managing pregnancy problems and thereby lowering the risk of maternal death (World Health Organization, 2016). Several studies have found that nations with high SBA rates had lower maternal mortality rates, while countries with low SBA rates have higher maternal death rates (Betrán et al., 2005; Dunlop et al., 2018; Graham et al., 2001; Ronsmans and Graham 2006). Thus, increasing the use of SBA is presently one of the most critical interventions for lowering maternal mortality to achieve SDG 3, mainly in developing nations.

Punjab with the population of 53.4% is Pakistan's most populous province (Pakistan Bureau of Statistics, 2017).

According to Punjab's multiple indicator cluster survey (MICS) 2017-18, Skilled attendants assist only 76 percent of women in Punjab, which means that nearly every fourth woman in Punjab who delivered a baby in the last two years did not do so with the assistance of skilled health personnel. Assistance by skilled attendant varies across the districts of Punjab and the situation is much worse in southern districts of Punjab because skilled attendant assist only 40.3%, 43.8% and 52.8% in Rajanpur, DG Khan and Muzaffargarh respectively. The highest Skilled birth attendant is provided in district Jhelum (93.9%). It represents that there is huge inequality in access to basic facility of SBA within the province, as can be seen in figure 1, it may be due to coverage or quality of health care provision. Whatever the causes may be, it shows severe concern because improving maternal health and health equity is one of the main targets of the WHO (Marmot et al., 2008) and among the main targets of SDGs (United Nations, 2015).

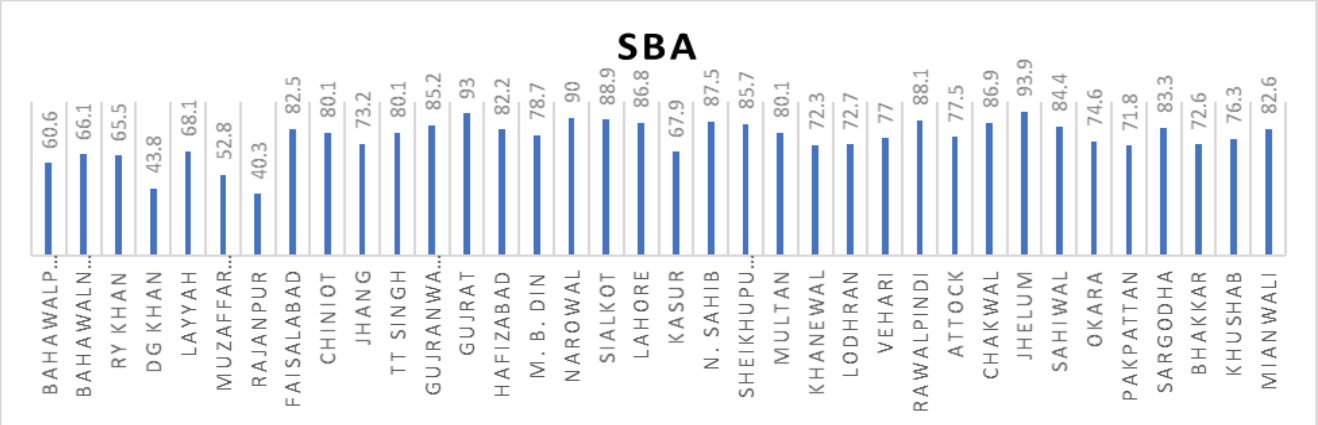

Figure 1. Scenario of SBA Across the Districts of Punjab (Source: Bureau of Statistics Punjab, 2018).

Indeed, one of the main targets of public health initiatives is to guarantee the equity in the usage of health care services irrespective of socioeconomic status (Wagstaff and Van Doorslaer, 2000). Surprisingly, less research has been done on assessing health disparity in developing countries, partly due to a lack of relevant data (Braveman and Tarimo, 2002; Rannan-Eliya and Somanathan, 2006; Gwatkin, 2009).

There are numerous factors that affect SBA, but this study is just looking at the ones that are out of a woman's control, known as circumstance factors. Many studies emphasize that use of ANC promotes SBA and is the source of inequality (Gage and Guirlène Calixte, 2006; Efendi et al., 2019; Pongpanich et al., 2016). Circumstance factors in urban and rural locations are so dissimilar, significant disparities in the use of SBA are expected. Women from rural regions were less likely to use SBA than those from urban areas in Baluchistan (Pongpanich et al., 2016). The household wealth index has been used to determine socioeconomic class. The wealth index is a regularly used gauge of a household's economic situation when income or spending figures are unavailable (O'Donnell et al., 2008) and it is essential component of disparities in the access of SBA (Channon et al., 2013; Ahmed et al., 2010; Pongpanich et al., 2016).

There are many other factors contribute in IOP in access of SBA through different channels which are explained in different settings like Family size (Duong et al., 2004; Babalola and Fatusi, 2009), sex of household head (Matsumura and Gubhaju, 2001), education of household head (Vallières et al., 2013), ethnicity (Glei et al., 2003; Çalışkan et al., 2015), maternal age at birth (Birmeta et al., 2013; Gabrysch and Campbell, 2009), wantedness (Burgard, 2004), media exposure (Mills et al., 2008), birth order and interval (Stephenson and Tsui, 2002; Pongpanich et al., 2016), and lady health worker (LHW) (World Health Organization, 2012; Lassi et al., 2013).

Inequality of opportunity (IOP) is always perceived as unfair, and policy actions such as compensation or other aggressive measures may be required. Any policy response, however, can only take place if the degree of the inequality can be quantified in a systematic way. In this perspective, statistical tool that can guide the government to make it a reality is Human Opportunity Index (HOI) which is the pioneer conceptualization of linking IOP with human development. This was introduced by De Barros et al. (2009) and is the most recent development in the literature. In addition, the decomposition method suggested by Shorrocks (2013) is used to calculate the contributions of various circumstance factors to the IOP. It's worth noting that there's a lot of literature on IOP in maternal health all over the world. However, in the context of Pakistan generally and Punjab in particularly, the research is scarce and confined to the following: IOP for household head's income, labour wages, and household income per capita (Pervaiz and Akram, 2018; shaheen et al., 2016). Most of the research are focused on determining the factors that influence maternal and child health in Pakistan, including as, Agha (2000), Bhutta et al. (2013), Nisar and Dibley (2014), Bugvi et al. (2014), Di Cesare et al. (2015), Bhutta and Hafeez (2015), Tariq et al. (2018). There is hardly any study that measured the IOP in access to SBA across the districts of Punjab. Therefore, this study adds significant value to existing literature on subject matter.

The objectives of this study are (i) to measure the socioeconomic IOP in access to SBA by using the HOI for all districts of Punjab and perform the spatial analysis. (ii) to decompose the relative contribution of circumstance factors to socioeconomic inequality by using the Shapley Decomposition.

METHODOLOGY

The Lorenz curve is commonly used in economic literature for comparing geographical and temporal inequalities, however it is vulnerable to welfare inequalities (Anand 1983; Chakravarty 1990). Analysts advocated disparity interventions by Theil (1967) and Atkinson (1970) to create social action initiatives. Lambert and Aronson (1993), Silber (1999), Atkinson and Bourguignon (2000), and, most recently, De Barros et al. (2009) have created novel methodologies for examining differences between the groups. The application of the Human Opportunity Index in public health studies has recently gained traction.

The HOI measures overall provision of social resources and rejects inequitable resource distribution among the people. This is done by estimating the coverage rate (C-Rate) of a given service and then adjusting it along with how equitably the services available are distributed between groups of circumstances. Empirically, the HOI of a given basic service or opportunity is the C-Rate ($\bar{P}$), adjusted for difference in its access:

$$HOI = \bar{P}(1 - \hat{D}) \quad (1)$$

Where $\hat{D}$ is a dissimilarity index (DI) that calculates inequalities in access to a given specific service for groups identified by circumstances compared to the average access rate for the same service for the population (De Barros et al., 2009). The first component of HOI is $\bar{P}$, the C-Rate, can be calculated using household survey data. $\hat{D}$ can be interpreted as a share of the overall amount of opportunities that need to be reallocated between groups of circumstances in order to assure fair access. $(1 - \hat{D})$ will be equal to 1 if access to opportunity is independent of the circumstances, in which case HOI will be equal to the average C-Rate ($\bar{P}$).

After identification of circumstances, woman's predicted probability of access to an opportunity is obtained after estimating the logistic model as preliminary step for DI. Then $\bar{P}$ and $\hat{D}$ are computed for final step as following:

$$\bar{P} = \sum_1^n W_i \hat{P}_i \quad (2)$$

and

$$\hat{D} = \frac{1}{2\bar{P}} \sum_{i=1}^n W_i |\hat{P}_i - \bar{P}| \quad (3)$$

It is worth remembering that both the DI ($\hat{D}$) and HOI vary between 0 and 100.

Decomposition methods are employed in many areas of economics to help disentangle and measure the effect of multiple causal factors. No attempt has been made to integrate the various strategies into a similar overall framework. We use the decomposition method of Shorrocks (2013), who introduced a single common paradigm, centered on the concept of Shapley value in cooperative games, to calculate the contribution of various circumstance factors to the IOP. To explain the method, we relate it to the maternal health care (MHC) service of SBA and approximate the relative contributions to each circumstance to the reported variation in MHC service.

The DI ($\hat{D}$), as defined in equation 3, measures the IOP following the De Barros et al. (2009). The value of $\hat{D}$ is dependent on considered set of circumstances. In addition, they have the essential property which always increases the value of ($\hat{D}$) by including further circumstances. The effect of adding a circumstance A is given by:

$$D_{A=\sum_{S \subseteq N \setminus \{A\}} \frac{|S|!(n-|S|-1)!}{n!} [D(S \cup \{A\}) - D(S)]} \quad (4)$$

and the contribution of circumstance A to the dissimilarity index is defined as:

$$\emptyset_A = \frac{D_A}{D(N)} \quad (5)$$

Where $\sum_{i \in N} \emptyset_i = 1$

In other terms, the total of all circumstances' contributions to the index of dissimilarity adds up to 100 per cent, a crucial property achieved by the Shapley decomposition.

Data Sources

The study breakdown the analysis on the district level in Punjab and used the data from Punjab's MICS, 2017-18, which is very rich data set in terms of the variables to be used in the study. In MICS 2017-18, 53,840 sample of household were selected, and 51,660 household were interviewed. The data analyzed are taken from women of 15 to 49 years with a live birth in the last 2 years in this study. The mentioned variables in introduction section are utilized for the purpose of analysis. Detailed description of the variables is provided in Appendix A.

RESULTS AND DISCUSSION

MICS Punjab 2017-18 was used to calculate the C-Rate, DI, and HOI of SBA for each district in Punjab (Pakistan). It can be observed in Appendix B that districts are ranked in tabular form based on assessed C-Rate, DI, and HOI. Figures 2, 3 and 4 depict the findings of the C-Rate, DI, and HOI of SBA in the form of Punjab shapefiles, which are utilized to provide spatial analysis of these findings in a unique color scheme, such as whether the patterns of these indices are similar in adjacent districts or not, further, values of these indices are attached on shapefiles for clear understanding. The results in the districts of Punjab are unique and instructive. As shown in Figure 2, the C-Rate of SBA is low in the southern belt (Rajanpur, D G Khan, and Muzaffargarh) of the Punjab province and high in the north and central districts of the Punjab (Gujrat, Jhelum, Rawalpindi, Sialkot, Chakwal, and Lahore etc.). It can be seen in 2nd column of Appendix B that C-Rate varies among the districts of Punjab from 45.67% (Rajanpur) to 94.22% (Gujrat).

DI tells us whether the opportunity is distributed equitably among the various circumstance groups. Based on DI value, it can be inferred that a certain share of opportunity must be reallocated among women from various circumstance groups to restore equal opportunity for all women. The districts are ranked based on DI in the fourth column of Appendix B, which shows a separate ranking of the districts based on SBA inequality of opportunity. DI findings are also presented in Punjab shapefile for the purpose of spatial analysis and values are attached in shapefile for further clarification (Figure 3). The distinct color scheme is meant to highlight disparities and distinguish across districts, with a darker area of the map indicating more inequalities.

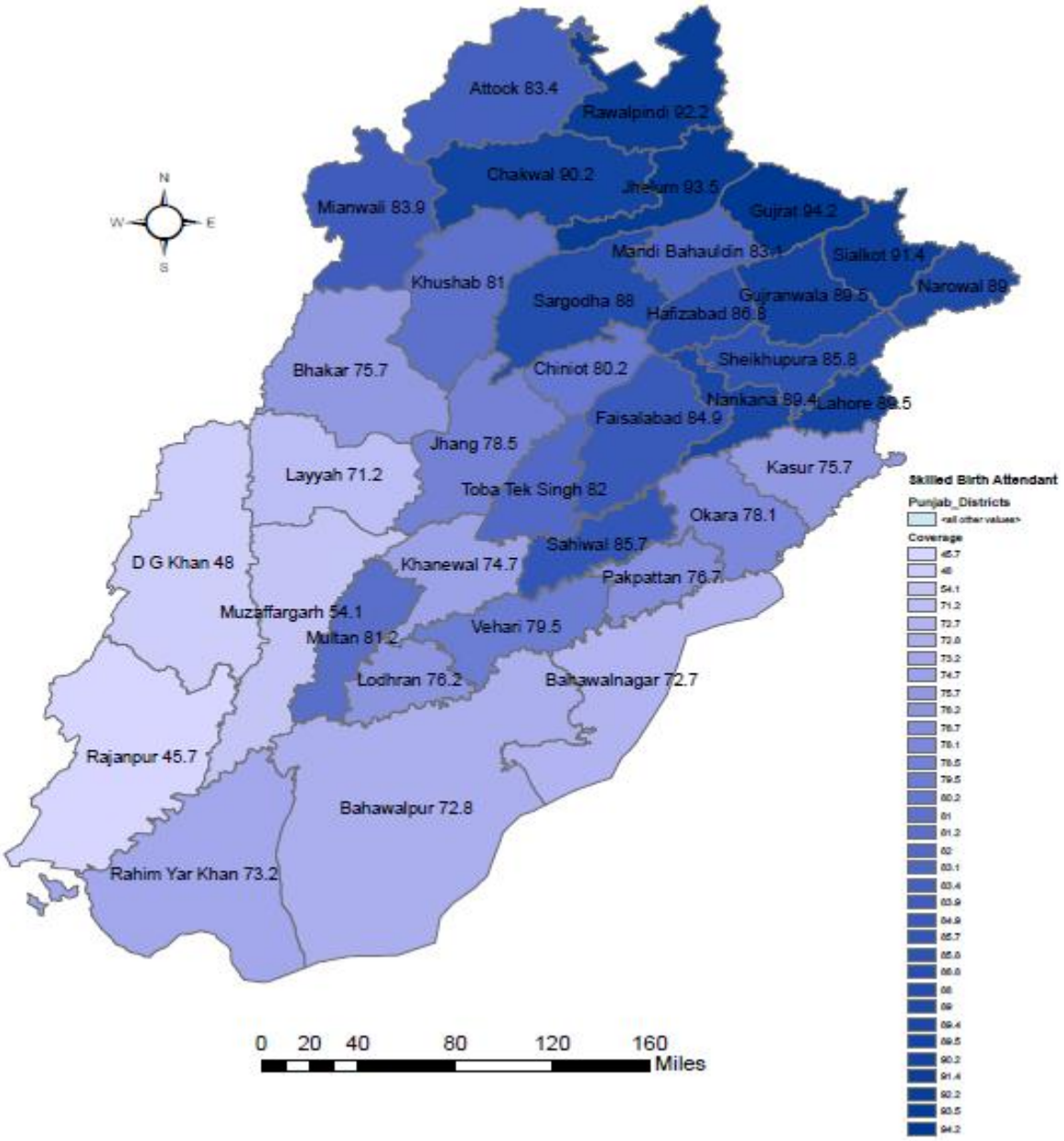

Figure 2. Coverage Rate of SBA across the Districts of Punjab (By using the ArcGIS 10.3.1).

It is observed that DI have rising trend in most of the southern districts of Punjab like Rajanpur (21.30%), D G Khan (19.60%), Muzaffargarh (14.39%), Layyah (14.28%) and Rahim Yar Khan (12.57%) etc. while decreasing trend in most of the northern and central districts of Punjab like Gujrat and Rawalpindi (3.55%) etc. it can be inferred from this inequality pattern that southern districts are more neglected belt of the province as the inequality score is highest in these districts. According to the interpretation of inequality, 21.30% of the particular opportunity must be reallocated among the different groups of women in the district of Rajanpur to restore equal opportunity of SBA for all women, while only 3.55% of the particular opportunity must be reallocated among the various groups of women in the Gujrat and Rawalpindi districts to restore equal opportunity of SBA for all women. The HOI is a composite indicator that assesses both basic service coverage and distribution of access to the service (equality of opportunity). It explains how much opportunity coverage is discounted by opportunity disparity and informs about the decline rate of access to certain opportunities. In simple words, we can say that HOI is coverage corrected for equity. The HOI ranging from 0 to 100, with 100 representing a society that has achieved universal coverage of a certain service. In the sixth column of the Appendix B, the districts are also ranked in terms of HOI, from highest to lowest access to SBA. In addition, the Punjab shapefile (figure 4) is also used to show the HOI (universal access) for SBA across the districts of Punjab for spatial analysis and A distinct color scheme is used again to define the HOI level across Punjab's districts, and HOI values are attached to the shapefile to help better grasp the differences between districts in term of access to SBA.

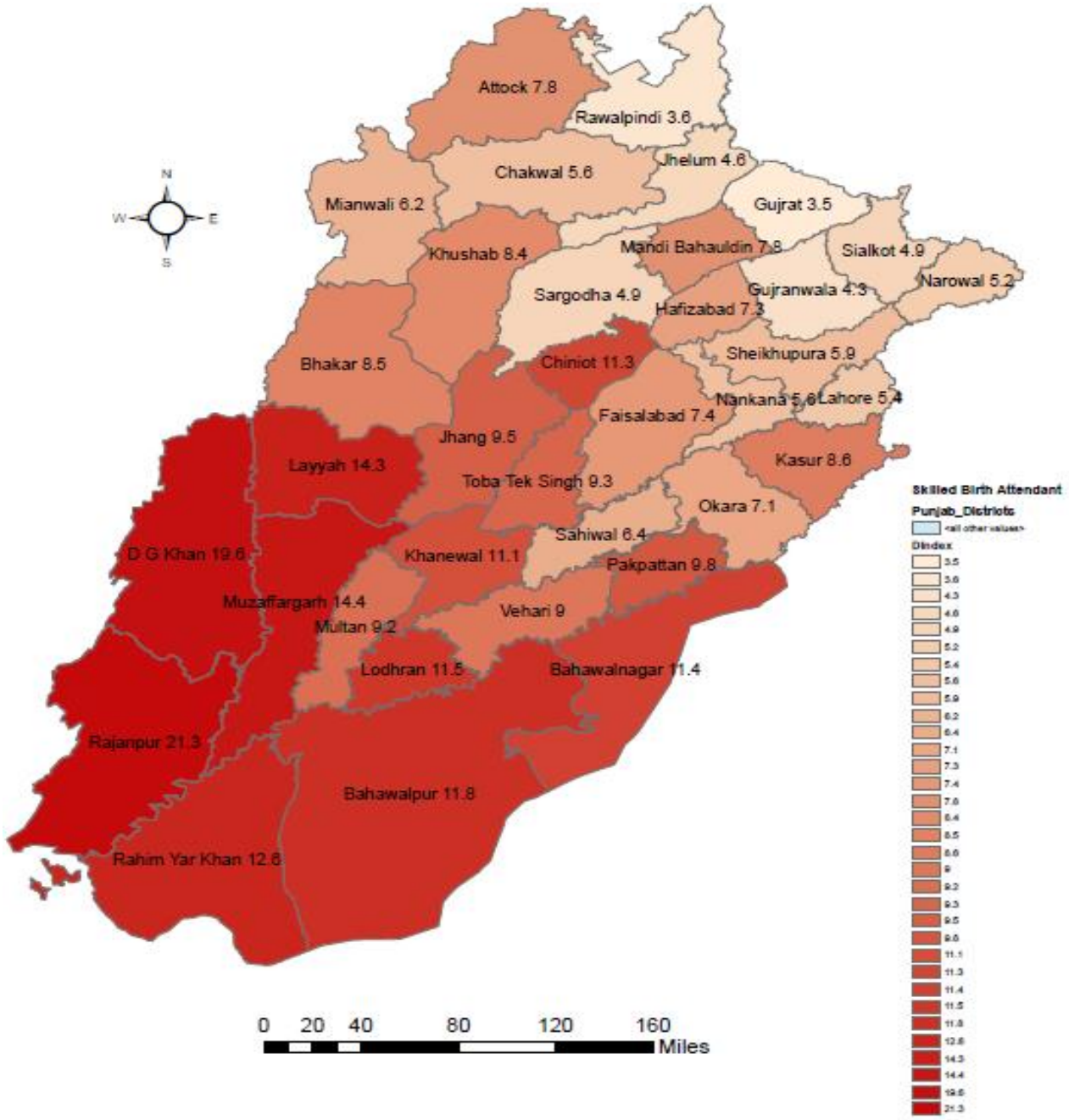

Figure 3. IOP of SBA across the Districts of Punjab (By using the ArcGIS 10.3.1).

It has been discovered that almost the whole south belt of the Punjab has a low HOI value, implying less universal access to SBA and the lowest value of HOI exist in southern districts of Rajanpur (35.95%), D G Khan (38.63%) and Muzaffargarh (46.35%) etc. Most of the northern and central districts have high HOI values like Gujrat (90.88%), Jhelum (89.17%), Rawalpindi (88.92%) and Sialkot (86.93%) etc. we can interpret that district Rajanpur have 35.95 % access to the SBA services means this district around 64% far away from universal access of SBA while district Gujrat have 90.88 % access to the SBA services means this district only around 09% far away from universal access of SBA. The rest of the districts lie between these two figures and can be interpreted similarly.

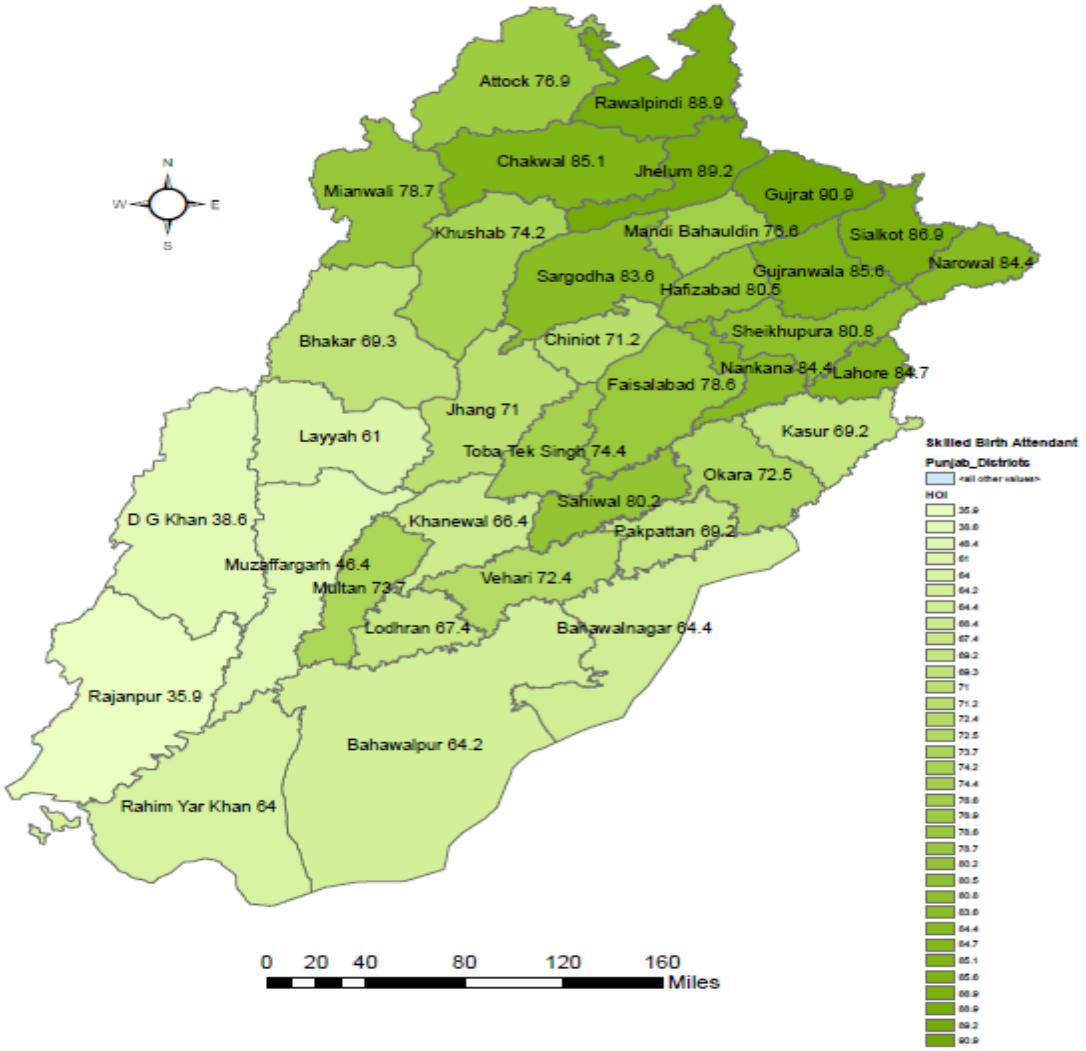

Figure 4. HOI for SBA across the Districts of Punjab (By using the ArcGIS 10.3.1).

Shapley Decomposition Analysis of Skilled Birth Attendant

The Shapley decomposition approach is used to decompose the socioeconomic IOP of SBA, which provides percentage contributions of various circumstances to the DI. We discovered that several factors had a substantial contribution to IOP throughout Punjab's districts. Table 1 shows that education of the household head, wealth status, ANC, birth order, birth interval, and media access are the most important factors influencing IOP of SBA across the districts of Punjab. Ethnicity, place of residence, visit of LHW, and maternal age at birth all contribute to IOP in few distinct Punjab districts, however family size, wantedness, and sex of household head do not contribute substantially in Punjab districts. It is worth noting that there is variation in the contributions of these factors to inequality throughout the districts of Punjab, implying that a single circumstance factor has a different influence in different districts. Table 1 presents comprehensive information on the contribution of each element of circumstance to the disparity of SBA in all districts of Punjab.

All factors are classified into five categories: household characteristics, women characteristics, perceived quality of care as measured by ANC, perceived accessibility as assessed by residence, and demographic factors. Amongst the household characteristics, it is found that education of household head and household wealth status had played very significant role in contribution to IOP of SBA across all districts of Punjab. Table 1 shows that education of household heads contributes 23.29 percent to IOP of SBA in Rahim Yar Khan and Chakwal, and 20.49 percent, 19.95 percent, 19.26 percent, 19.17 percent, and 17.60 percent in Khanewal, Nankana, Gujranwala, Hafizabad, and Lahore, respectively, while it is not a source of inequality in Muzaffargarh, Pakpattan, Jhang, Khushab and many others. It can be noted that household wealth status contributes significantly to IOP of SBA in districts Mandi Bahauddin (35.23 %), Sargodha (33.74 %), Lahore (32.90 %), while lowest contribution is in district Narowal (9.01 %). It demonstrates that the contribution to IOP of SBA varies greatly between Punjab districts, ranging from 9.01 % (Narowal) to 35.23 % (Mandi Bahauddin), indicating that this factor impacts various districts differently. Ethnicity played a significant influence in a few Punjab districts, including Rawalpindi (13.05 %), Multan (12.53 %), Rahim Yar Khan (12.13 %), and Bhakkar (11.30 %) while it is not a significant source of inequality in other districts of Punjab. Except in Pakpattan district, the gender of the household head did not significantly contribute to the IOP of SBA, and family size did not have a major role in contributing to the disparity of SBA among Punjab districts.

Table 1. Contribution of Circumstance Factors in socioeconomic IOP in access to SBA in all Districts of Punjab.

Districts / Variables	Family Size	Edu of HH Head	Sex of HH Head	Ethnicity	Wanted-ness	ANC	Maternal Age at Birth	Birth order	Birth Interval	Media Access	HH Wealth Status	Resid-ence	Visit of LHW
Attock	1.10	13.04	0.12	4.40	1.63	18.59	6.76	15.08	15.52	6.01	12.71	2.33	2.71
Bahawalnagar	3.65	14.48	0.38	3.97	2.16	21.03	6.57	8.52	10.41	2.30	20.27	1.82	4.44
Bahawalpur	0.29	6.70	1.03	6.04	2.12	12.63	3.99	6.78	2.02	21.96	19.64	10.83	5.96
Bhakkar	1.10	11.90	0.11	11.30	3.19	8.29	4.55	10.37	8.78	10.83	19.29	6.61	3.68
Chakwal	1.91	23.29	2.41	8.36	1.16	6.45	6.77	11.59	15.07	2.30	18.55	0.93	1.21
Chiniot	1.07	5.75	0.98	2.33	6.84	4.83	11.01	6.10	12.73	17.48	17.75	6.55	6.59
D G Khan	0.64	6.85	1.44	2.95	1.10	18.89	3.15	8.40	13.48	12.50	22.15	6.66	1.80
Faisalabad	1.33	16.39	0.72	1.40	1.13	25.00	0.45	7.31	7.30	3.48	20.84	13.46	1.20
Gujranwala	3.63	19.26	1.24	6.25	5.50	13.14	8.61	7.52	9.54	6.07	13.51	1.58	4.14
Gujrat	1.49	16.35	3.84	3.47	0.33	9.24	2.73	13.88	22.01	2.40	19.37	3.67	1.20
Hafizabad	1.68	19.17	1.02	5.69	3.11	2.03	8.24	10.13	21.02	0.45	17.04	6.51	3.90
Jhang	2.35	5.08	4.15	3.65	5.20	32.25	2.06	9.38	9.56	9.25	13.15	2.10	1.81
jhelum	0.76	16.48	5.28	1.02	7.28	17.07	4.42	7.02	16.57	7.38	10.45	4.51	1.77
Kasur	6.34	5.29	0.12	7.11	0.77	40.04	5.75	1.27	8.97	2.80	17.94	2.66	0.94
Khanewal	0.72	20.49	1.58	9.23	1.40	17.04	8.38	3.80	8.92	5.65	20.13	0.67	1.98
Khushab	0.75	5.12	0.67	2.36	4.09	19.30	3.38	17.39	13.32	6.03	25.62	1.62	0.33
Lahore	0.13	17.60	0.66	8.13	3.16	16.99	1.34	7.52	10.11	0.97	32.90	NA	0.48
Layyah	3.96	11.90	2.32	7.29	0.66	10.85	2.40	15.46	10.55	5.70	24.11	2.77	2.02
Lodharan	0.95	14.57	1.67	2.20	0.47	12.52	7.69	25.14	13.57	3.44	14.94	1.06	1.77
Mandi Bahauddin	0.73	6.28	3.61	2.79	1.28	22.38	2.08	10.06	4.10	1.37	35.23	7.05	3.04
Mianwali	2.78	9.44	5.27	4.22	1.84	22.53	1.29	8.88	8.38	9.01	21.26	4.87	0.21
Multan	2.73	14.11	0.17	12.53	1.34	15.69	0.45	4.04	4.23	10.13	21.60	11.03	1.93
MuzaffarGarh	0.68	4.35	1.89	2.12	0.17	47.46	2.78	6.12	5.54	3.25	17.70	1.65	6.29
Nankana	1.69	19.95	0.45	1.67	0.03	12.39	9.32	10.80	14.13	1.78	19.80	7.42	0.58
Narowal	2.15	5.90	0.52	2.06	1.52	30.37	13.72	14.04	15.64	2.63	9.01	2.01	0.43
Okara	0.33	12.19	3.49	1.24	0.22	21.29	5.28	8.91	19.32	9.19	15.90	0.96	1.68
Pakpattan	1.73	4.90	11.43	3.36	1.40	18.70	7.22	14.33	6.31	3.05	13.28	13.77	0.51
Rahim Yar Khan	0.09	23.29	0.13	12.13	0.74	19.47	1.76	3.64	5.14	4.88	13.51	1.91	13.30
Rajanpur	4.27	8.31	0.30	7.64	7.91	17.73	1.27	7.72	4.67	13.87	18.89	4.16	3.25
Rawalpindi	0.59	10.99	0.40	13.05	0.63	22.81	1.44	9.33	9.88	14.75	14.00	1.56	0.56
Sahiwal	4.69	6.88	1.16	0.94	0.65	27.93	4.07	20.82	9.07	6.57	14.56	2.33	0.31
Sargodha	4.59	10.63	1.04	3.95	3.04	6.76	7.75	6.73	3.29	0.42	33.74	4.27	13.79
Sheikhupura	0.44	7.56	0.33	2.47	5.97	27.93	3.22	11.98	9.39	0.80	23.27	4.18	2.45
Sialkot	4.69	8.11	5.51	7.10	1.80	18.39	4.78	17.44	9.55	2.59	13.02	5.79	1.22
Toba Tek Singh	0.46	10.29	2.08	3.13	0.88	22.59	5.81	7.71	12.26	2.31	22.39	2.35	7.74
Vehari	1.16	5.83	0.42	7.28	2.56	26.12	4.75	15.94	4.63	0.70	25.81	2.55	2.26

Source: Authors' own estimations by using STATA 14.2.

Among the women characteristics, media access significantly contribute in IOP of SBA in most of the districts and highly contributing in Bahawalpur, Chiniot, Rawalpindi, Rajanpur, D G Khan Bhakkar and Multan with the contribution value of 21.96 %, 17.48 %, 14.75 %, 13.87 %, 12.50%, 10.83% and 10.13 % respectively. It is not a substantial source of inequality in many of the districts and ranges from 0.42 % to 21.96 % throughout the districts of Punjab. Maternal age at birth contributes variably in different districts, ranging from 0.45 percent to 13.72 percent, and it contributes considerably to IOP of SBA in a few districts of Punjab like Narowal (13.72 %), Chiniot (11.01 %) and Nankana (9.32 %). Wantedness is not a significant contributor to IOP of SBA in any district of Punjab.

Demographic factors also played substantial role in the contribution of IOP of SBA. The results about contribution of these factors are mix regarding the contribution in south, north and center of the province. Birth order of child have significantly contributed to inequality of SBA in most of the northern and central districts of Punjab, but highest contribution is in district Lodharan which is southern district. The contribution of birth order in IOP of SBA ranged from 1.27 % (Kasur) to 25.14 % (Lodharan), with the remainder of the districts falling somewhere in between. Birth interval has also played an important role in contributing to SBA inequality, ranging from 2.02 % (Bahawalpur) to 22.01 % (Gujrat), and highest contribution of birth interval in IOP of SBA in most of the central districts of Punjab like Gujrat (22.01 %), Hafizabad (21.02 %), Okara (19.32 %) etc. as can be seen in table 1. LHW visits effectively contribute to SBA disparity in few districts, including Sargodha (13.79 %) and Rahim Yar Khan (13.30 %).

Place of residence[1] (perceived accessibility) had a substantial impact in influencing SBA disparity in a few districts, including Pakpattan (13.77 %), Faisalabad (13.46 %) Multan (11.03 %) and Bahawalpur (10.83 %). ANC (Perceived quality of care) significantly contributes to SBA inequality across the districts of Punjab, and it ranges from 2.03 % to 47.46 %. It is highly contributing in most of the districts like Muzaffargarh (47.46 %), Kasur (40.04 %) Jhang (32.25 %), Narowal (30.37 %) and many others. This factor is contributing more than 10 % in IOP of SBA in 30 districts of Punjab.

CONCLUSIONS AND POLICY RECOMMENDATIONS

The purpose of this study to conduct the spatial analysis of socioeconomic IOP in access to SBA in districts of Punjab, Pakistan and explore the circumstance variables that contribute the most to the socioeconomic inequality. The C-Rate, DI and HOI for every district of Punjab is measured in this study by using the data set of MICS Punjab 2017-18 (Pakistan). We have utilized HOI technique by following De Barros et al. (2009), to measure C-Rate and the indices. The results of these three indicators are interesting by keeping in view the scenario of districts of Punjab. It is observed that most of the southern districts of Punjab (Rajanpur, DG Khan, Muzaffargarh, Layyah, and others) have poor coverage rates and low universal access to SBA and northern districts (Gujrat, Jhelum, Rawalpindi, Sialkot and others) have high coverage and universal access to SBA. Rising trend of IOP was also observed in southern Punjab districts like Rajanpur, DG Khan, Muzaffargarh and others.

We can suggest a policy for the Government by bearing in mind these findings that the Government needs to interfere more seriously in the southern belt in order to improve the C-Rate and reallocate resources among the different groups of women to create equitable opportunities for all women to have access to the SBA.

In the second stage of the analysis, we have used the decomposition procedure by following the Shorrocks (2013) to identify the contribution of the circumstance factors to the IOP. It was found that household wealth status, ANC, birth order, birth interval, household head education, media access and residence were the most contributing factors leading to IOP in the accessibility of SBA services across the districts of Punjab.

Contributing factors must be considered when suggesting the policies for government. There is need to raise the socio-economic status of households in all districts of Punjab as there is significant contribution of education of household head and household wealth status in inequality. Secondly, Government needs to emphasis on family planning as the birth order and the birth interval are contributory variables to inequalities in most of the districts. Thirdly, Government needs to concentrate on reforms in health care centers especially in Multan and Rawalpindi so that the actions of health workers based on ethnicity do not discriminate. Fourthly, Government of Punjab needs to enhance the equal ANC access across the districts of Punjab because ANC is more contributing factor throughout the province. Overall, this study emphasizes the government to increase distribution of resources especially in southern Punjab.

[1] This factor is not utilized in the model for Lahore district because complete Lahore district is declared as urban district in population census-2017 of Pakistan.

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Appendix A. Variables description.

Variable	Description
Skilled Birth Attendant	It is binary variable and assumes the value 1 for skilled birth attendant i.e., Doctor, Nurse, Midwife, Lady health Visitor, Community Midwife and 0 otherwise.
ANC Visits during Pregnancy	By integrating the WHO guideline that pregnant women should make at least four ANC visits to a professional provider, a binary variable is created. The responses are grouped into a binary outcome variable based on this criterion, with a value of 0 if ≤3 ANC visits and 1 if > 3 ANC visits.
Sex of Household Head	It is binary variable. It is equal=1 if HH head is male and 0 for female.
Education of Household Head	This variable is based on categories; No education=0, Primary=1, Middle=2, Secondary=3, Higher=4
Ethnicity	This variable is based on categories; it is equal=0 for Urdu, 1 for Punjabi/Potohari, 2 for Saraiki and 3 for otherwise
Birth order	This variable is based on categories; 1 for having first order birth, 2 for having 2-3 order birth, 3 for having 4-6 order birth, and 4 for having 7 and above birth order.
Birth Spacing/interval	It is birth interval with previous birth. It is categorized as = 0 if the birth is first, = 1 if birth interval is less than 2 years, =2 if the interval is 2years, =3 if 3 years and =4 if 4 years and above
Maternal Age	It is age of woman, and it is taken as continuous variable
Wantedness	It is binary variable. It is equal=1 if the mother wanted last child and 0 otherwise.
Media Access	A composite measure that incorporates whether respondents read a newspaper or a magazine, listen to the radio and watch TV. Classified as 0 for having no media access, 1 for having less than once a week, 2 for having medium media access (at least once a week) and 3 for having high media access nearly every day.
Household Wealth Status	A composite index of household possessions, assets, and amenities, derived using principal component analysis, grouped as: Poorest=1; Second=2; Middle=3; Fourth=4 and Richest=5.
Family Size	It is taken as continuous variable and derived from number of households members.
Visit of LHW	A binary variable is generated; If the LHW visit during last month=1, otherwise=0
Residence	It is binary variable. It is equal=1 if the place of residence is urban and 0 if rural.

Appendix B: Ranking of Districts on the base of C-Rate, DI and HOI of SBA.

Ranking	Districts	Coverage Rate ($\bar{P}$)	Districts	DI	Districts	HOI
1	Gujrat	94.22	Gujrat	3.55	Gujrat	90.88
2	Jhelum	93.45	Rawalpindi	3.55	Jhelum	89.17
3	Rawalpindi	92.20	Gujranwala	4.33	Rawalpindi	88.92
4	Sialkot	91.44	Jhelum	4.59	Sialkot	86.93
5	Chakwal	90.20	Sialkot	4.93	Gujranwala	85.64
6	Lahore	89.54	Sargodha	4.93	Chakwal	85.11
7	Gujranwala	89.51	Narowal	5.19	Lahore	84.71
8	Nankana	89.42	Lahore	5.40	Nankana	84.44
9	Narowal	89.04	Nankana	5.56	Narowal	84.42
10	Sargodha	87.96	Chakwal	5.64	Sargodha	83.62
11	Hafizabad	86.76	Sheikhupura	5.87	Sheikhupura	80.80
12	Sheikhupura	85.85	Mianwali	6.18	Hafizabad	80.47
13	Sahiwal	85.67	Sahiwal	6.38	Sahiwal	80.21
14.	Faisalabad	84.90	Okara	7.12	Mianwali	78.72
15	Mianwali	83.90	Hafizabad	7.25	Faisalabad	78.62
16	Attock	83.42	Faisalabad	7.40	Attock	76.92
17	Mandi Bahauddin	83.14	Attock	7.80	Mandi Bahauddin	76.64
18	Toba Tek Singh	82.04	Mandi Bahauddin	7.82	Toba Tek Singh	74.39
19	Multan	81.20	Khushab	8.38	Khushab	74.19
20	Khushab	80.97	Bhakkar	8.51	Multan	73.73
21	Chiniot	80.25	Kasur	8.59	Okara	72.52
22	Vehari	79.48	Vehari	8.96	Vehari	72.36
23	Jhang	78.47	Multan	9.20	Chiniot	71.15
24	Okara	78.08	Toba Tek Singh	9.32	Jhang	71.03
25	Pakpattan	76.73	Jhang	9.48	Bhakkar	69.26
26	Lodharan	76.15	Pakpattan	9.76	Pakpattan	69.24
27	Kasur	75.73	Khanewal	11.12	Kasur	69.22
28	Bhakkar	75.70	Chiniot	11.33	Lodharan	67.40
29	Khanewal	74.73	Bahawalnagar	11.43	Khanewal	66.42
30	Rahim Yar Khan	73.15	Lodharan	11.49	Bahawalnagar	64.36
31	Bahawalpur	72.79	Bahawalpur	11.84	Bahawalpur	64.17
32	Bahawalnagar	72.67	Rahim Yar Khan	12.57	Rahim Yar Khan	63.96
33	Layyah	71.20	Layyah	14.28	Layyah	61.03
34	Muzaffargarh	54.14	Muzaffargarh	14.39	Muzaffargarh	46.35
35	D G Khan	48.05	D G Khan	19.60	D G Khan	38.63
36	Rajanpur	45.67	Rajanpur	21.30	Rajanpur	35.95