Supplementary Material

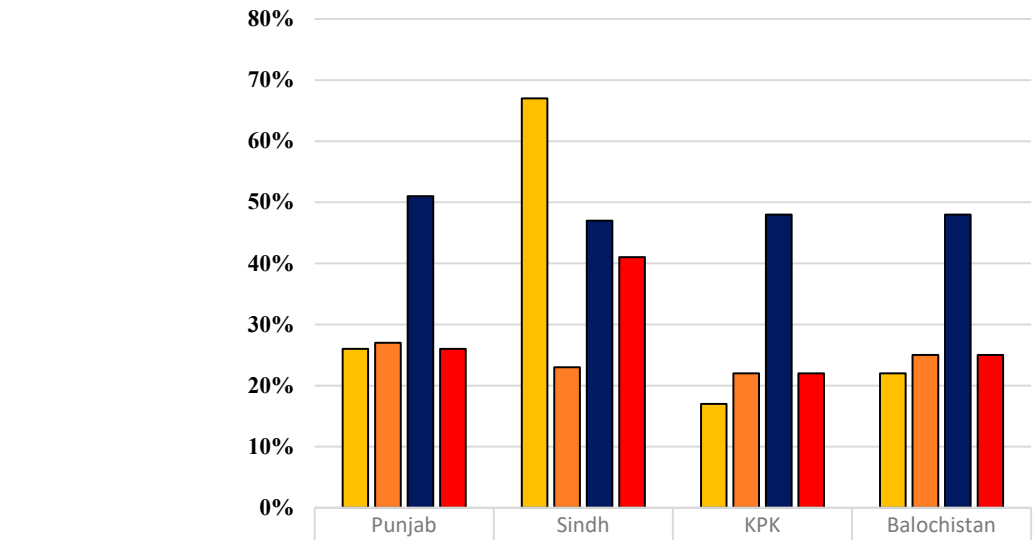
Supplementary Table S1: INFORM COVID-19 risk categories and context-specific risk factors

Risk categories	Risk factors	Definitions	Data sources
Hazard and Exposure	Population density	This factor represents the population density of the country.	[28]
	Average household size	The average household size comprises those who usually live together and share their meals.	[28]
	Average annual growth rate of Population	This factor indicates the average annual growth rate of the population.	[28]
	Population living in rural areas	This factor refers population living in rural areas.	[28]
	Population living in urban areas	This factor represents the population living in urban areas.	[28]
	Environmental factors (seasons)	This factor indicates environmental factors, including four seasons (summer, winter, spring, and autumn).	[29]
	Households' access to an improved source of drinking water	This factor shows the improved source of drinking water includes tap water, hand pump, motor pump, dug well protected, spring protected, bottle water tanker/truck/water-bearer, and filtration plant.	[27]
	People safely manage sanitation & hygiene (toilet facility)	This factor refers to adequate treatment /disposal of human excreta and sewage, preventing human contact with faces, and handwashing with soap.	[27]
Socio-economic vulnerability	Businesses closure due to COVID-19 lockdown	It shows the business closures due to the COVID-19 lockdown.	[8]
	Household economic situation	This factor refers to the worst economic situation for a household.	[27]
	Household characteristics	It includes household composition based on family size (one person, two persons, or more than two persons).	[30]
	Household consumption expenditures	It represents household food and non-food consumption and expenditures.	[8]
	Food insecurity	This factor represents the severe food insecurity	[8]
	Lack of transportation services	It shows a lack of transportation services due to the COVID-19 lockdown.	[8]
	No use of health facilities due to fear of COVID-19	It represents people's less use of health facilities due to fear of COVID-19 infection.	[8]
	Temporary halt in education	This factor shows the temporary halt in education due to the COVID-19 lockdown.	[8]
	Governance and institutional capacity	It illustrates governance and institutional capacity to manage the pandemic.	[3]
Lack of coping capacity	Assistance provided by the government	It is the division of assistance provided by the government in different dimensions such as financial, e-assistance, nonpharmaceutical, and medical assistance programs.	[3]
	Development of COVID-19 app. by government	This factor refers to the government's development of the COVID-19 app to facilitate the people and keep the record in digital form.	[31]
	Population having access to computers and internet	It shows the number of people having a computer.	[27]
	Population having access to mobile phones and internet	It shows the number of people owning mobile phones.	[27]
	Public awareness programs (washing hands, wearing masks, social distancing)	This factor refers to nonpharmaceutical prevention measures.	[8]
	COVID-19 immunization coverage	It shows the number of people 18 years of age or above and eligible to get the COVID-19 vaccine.	[32]

COVID-19 quarantine facilities (beds for isolation)	This factor refers to the total COVID-19 quarantine facilities (beds for isolation) available in the country.	[13]
COVID-19 data sharing and collection mechanism	This factor indicates the COVID-19 data sharing and collection mechanism developed by the government.	[33]
Public funded labs for COVID-19 testing	It shows how many public funding labs are for COVID-19 testing.	[12]
COVID-19 designated tertiary hospitals	It shows COVID-19 designated tertiary hospitals in Pakistan.	[11]
Medical assistance programs	This factor represents medical assistance programs of the government to manage the pandemic.	[3]
Financial support for poor people through 'Ehsaas' program	This risk factor refers to the government's special financial support package for poor people during the pandemic.	[8]

Note: All factors were standardized to percentages for uniform analysis in the development of the conditional probability table to assess propagation impact. For example, Population density, originally calculated in square kilometers, and Population living in urban and rural areas, measured in numbers, were converted into percentages. Similarly, Financial support for poor people through the 'Ehsaas' program, initially quantified in monetary terms, was also converted into percentages. This standardization allows for a consistent evaluation of the factors and their respective categories to better understand their propagation impact.

Supplementary Figure S1: Provincial-level comparison of COVID-19 risk and its associated dimensions



	Punjab	Sindh	KPK	Balochistan
Hazard and Exposure	26%	67%	17%	22%
Socio-economic vulnerability	27%	23%	22%	25%
Lack of coping capacity	51%	47%	48%	48%
Total COVID-19 risk	26%	41%	22%	25%