Policy Brief Series #108

Research And Development Solutions

District-Level Estimates of Hypertension and Diabetes Prevalence in Pakistan

Mapping the Unmeasured NCD Burden Using Transfer Learning and Spatial Bayesian Modelling

WHY DISTRICT-LEVEL NCD ESTIMATES MATTER

Pakistan's health system plans budgets, staffing and screening at the district level, yet no national biomarker survey has ever produced district-level prevalence estimates for hypertension or diabetes. Investment therefore follows administrative formulae rather than evidence of need, so genuinely high-burden districts may be under-resourced simply because their burden has never been measured.

This brief presents the first district-level prevalence surface for adult hypertension and diabetes across Pakistan's 134 districts built from existing, cost-free Census and survey data letting planners move beyond national and provincial averages to target resources where they are most needed.

KEY RESULTS

National calibrated prevalence is 43.2% for hypertension and 5.9% for diabetes. But district estimates vary far more than these averages suggest 2.4-fold for hypertension (21.2-51.7%) and roughly three-fold for diabetes (2.8-9.2%).

The two conditions are clustered in different places:

- High hypertension: northern and central Sindh plus parts of Punjab: Jacobabad (51.7%), Sukkur (51.5%), Okara (50.8%), Khairpur (50.5%), Kashmore (49.5%).
- High diabetes: northern Punjab: Rawalpindi (9.2%), Khushab (9.1%), Chakwal (8.6%), Bahawalnagar (8.4%), Bhakkar (8.2%).
- Lowest burden: Balochistan for hypertension (Killa Saifullah 21.2%); Washuk, Balochistan for diabetes (2.8%).

Province-level prevalence (population-weighted)

Province	HTN %	Diabetes %
Punjab	43.8	7.0
Sindh	46.0	5.1
Khyber Pakhtunkhwa	42.2	4.3
Balochistan	26.3	3.5
National	43.2	5.9
Province	HTN %	Diabetes %

POLICY IMPLICATIONS

- Because hypertension and diabetes burden do not co-locate, a single province-level NCD narrative cannot serve both; target screening and treatment investments separately by condition.
- District-level estimates make visible priority districts: Jacobabad, Sukkur, Khairpur (hypertension); Rawalpindi, Chakwal, Khushab (diabetes) that provincial averages hide.

KEY MESSAGES

1. Pakistan's first district-level prevalence estimates for adult hypertension and diabetes, from existing census and survey data.
2. National prevalence is 43.2% for hypertension and 5.9% for diabetes.
3. Burden varies 2.4-fold for hypertension and about 3-fold for diabetes between districts. This variation is not visible in national averages.
4. Hypertension clusters are in northern and central Sindh and parts of Punjab. Diabetes clusters in northern Punjab. The two need separate targeting.
5. Estimates are stable and reproducible, offering a replicable template for other LMIC settings.

- The method is low-cost and replicable, letting provincial health departments and donors align NCD resources, staffing and screening with measured need rather than administrative formulae.

METHODS

- Models (BART primary; LightGBM sensitivity check) were trained on demographic and socioeconomic predictors from 166-173 countries, linked to WHO hypertension and GBD/IHME diabetes prevalence.
- They were applied to district covariates built from Pakistan's Census 2023 and PSLM 2019-20 survey.
- Predictions were spatially smoothed with a Leroux CAR model and calibrated to provincial and national totals, with full uncertainty intervals per district.

VALIDATION

District estimates were highly stable under jackknife validation (correlation = 1.000), corroborated by an independent model (LightGBM), with strong spatial clustering after smoothing (Moran's I 0.78 / 0.74).

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Figure 1: Hypertension prevalence at the district level, Pakistan (BART)

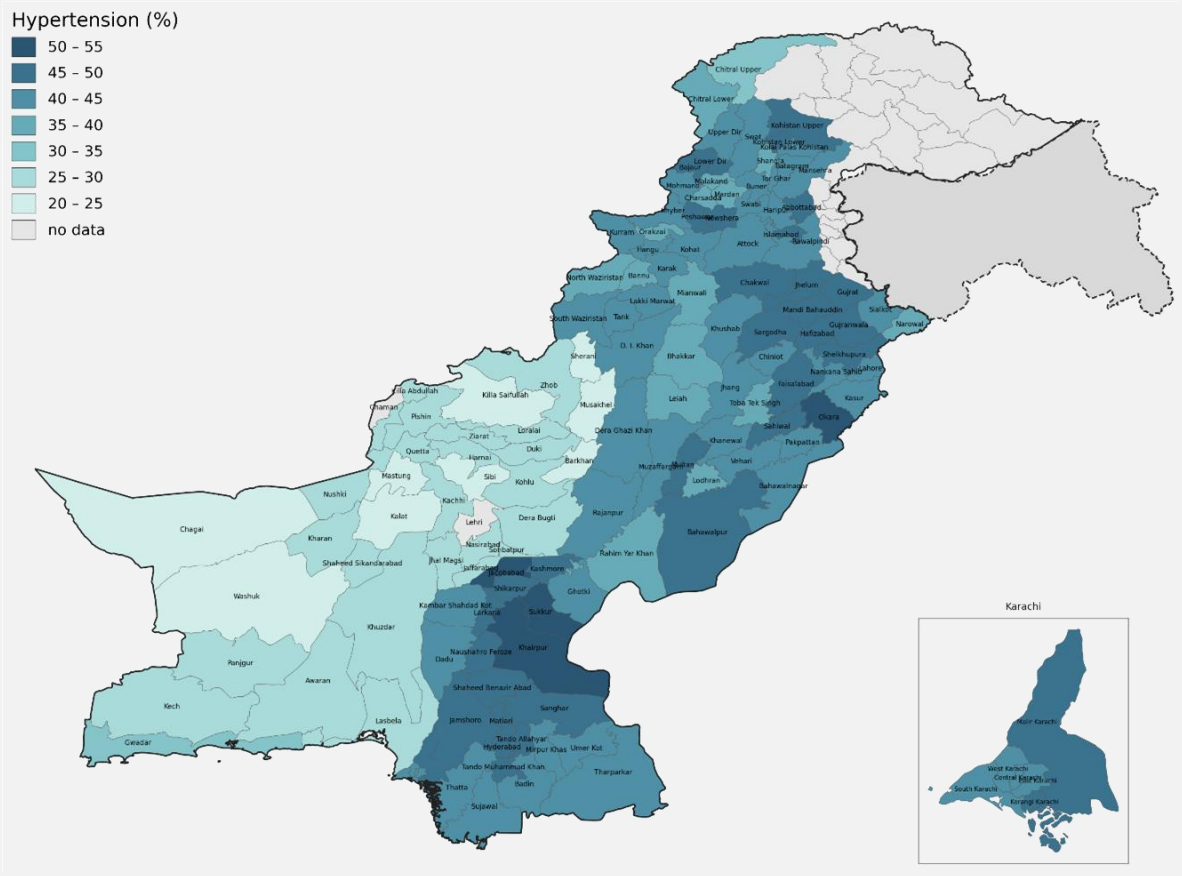
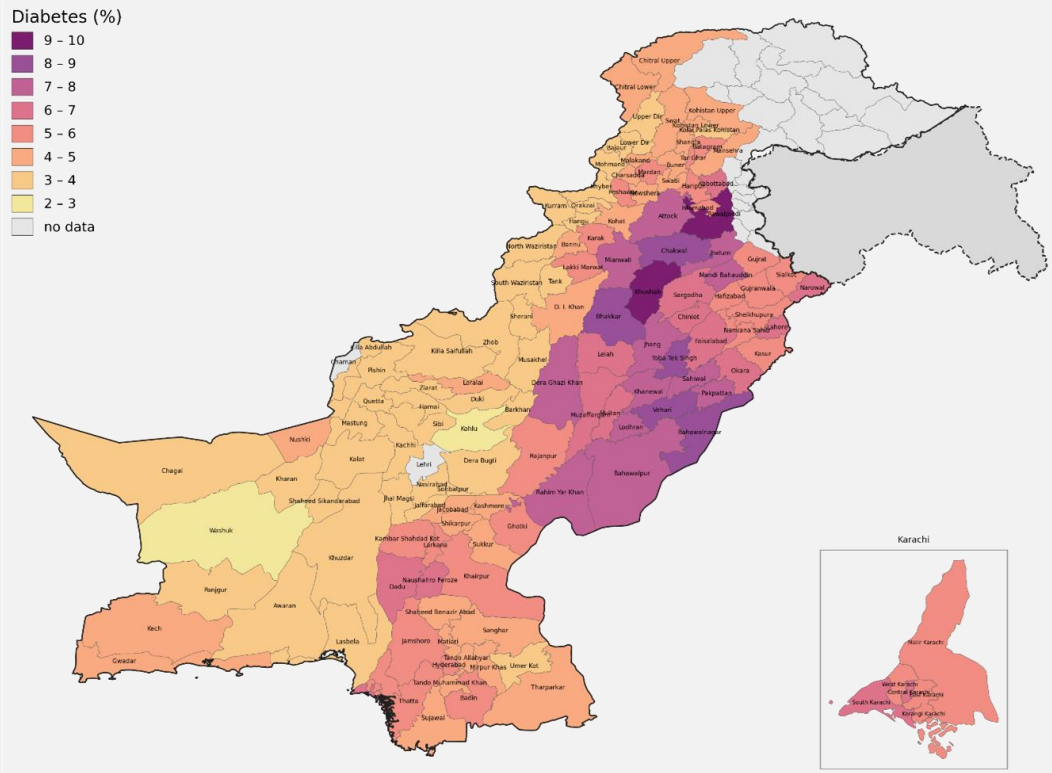


Figure 2: Diabetes prevalence at the district level, Pakistan (BART)



Punjab: Hypertension 43.8%, Diabetes 7.0%

District	HTN %	HTN 95% CI	Diabetes %	Diab. 95% CI
Attock	44.9	42.7–47.3	7.7	6.5–8.8
Bahawalnagar	41.0	38.9–43.2	8.4	7.3–9.7
Bahawalpur	46.9	45.0–48.6	7.2	6.3–8.0
Bhakkar	39.5	37.0–41.9	8.2	7.0–9.6
Chakwal	45.2	43.2–47.4	8.6	7.1–10.3
Chiniot	42.2	40.0–44.5	6.8	5.8–8.1
Dera Ghazi Khan	41.6	39.6–43.8	7.5	6.7–8.3
Faisalabad	45.7	43.6–47.8	6.5	5.6–7.6
Gujranwala	47.6	44.9–50.5	5.4	4.6–6.3
Gujrat	49.1	46.8–51.4	5.7	4.4–7.2
Hafizabad	48.0	45.7–50.2	5.9	5.1–6.8
Islamabad	45.6	41.7–49.5	6.0	5.0–7.1
Jhang	40.1	38.4–41.7	7.4	6.5–8.3
Jhelum	46.0	43.7–48.6	7.5	6.2–8.9
Kasur	43.1	39.1–47.2	5.6	4.6–6.7
Khanewal	42.5	40.4–44.5	7.2	6.2–8.3
Khushab	42.6	40.5–44.6	9.1	7.8–10.6
Lahore	42.1	39.6–44.4	6.4	5.2–7.6
Leiah	38.4	36.5–40.2	6.5	5.5–7.7
Lodhran	38.9	36.5–41.2	7.4	6.1–8.8
Mandi Bahauddin	47.8	44.8–50.7	7.6	6.3–9.0
Mianwali	38.0	36.0–40.0	7.5	6.3–8.8
Multan	45.3	43.1–47.6	6.1	5.0–7.5
Muzaffargarh	43.5	40.5–46.6	6.5	5.6–7.4
Nankana Sahib	43.4	40.6–46.3	5.9	4.8–6.9
Narowal	39.8	37.6–42.0	6.6	5.3–8.1
Okara	50.8	48.9–52.7	6.8	6.0–7.7
Pakpattan	44.8	43.1–46.6	7.3	6.5–8.1
Rahim Yar Khan	39.7	37.9–41.4	7.1	6.1–8.2
Rajanpur	44.5	42.7–46.4	5.5	4.8–6.3
Rawalpindi	44.7	42.5–47.1	9.2	7.8–10.7
Sahiwal	47.5	46.1–49.1	7.5	6.7–8.4
Sargodha	46.7	44.6–48.9	6.6	5.6–7.8
Sheikhupura	48.5	46.1–50.9	5.7	4.5–6.8
Sialkot	43.4	40.6–46.1	5.9	4.3–7.4
Toba Tek Singh	37.4	35.5–39.1	8.3	7.0–9.6
Vehari	44.9	43.4–46.4	8.0	7.2–8.9

Sindh: Hypertension 46.0%, Diabetes 5.1%

District	HTN %	HTN 95% CI	Diabetes %	Diab. 95% CI
Badin	43.8	41.5–45.7	5.3	4.4–6.1
Central Karachi	43.5	41.4–46.0	6.1	4.7–7.6
Dadu	43.9	41.9–46.0	6.9	6.1–7.9
East Karachi	44.8	42.0–47.5	6.0	4.8–7.2
Ghotki	40.8	38.9–42.7	5.1	4.4–5.9
Hyderabad	47.4	43.8–51.0	5.7	4.6–7.0
Jacobabad	51.7	49.0–54.2	4.7	3.9–5.5
Jamshoro	47.2	44.6–49.7	5.1	4.3–6.0
Kambar Shahdad Kot	43.9	42.4–45.4	5.5	4.6–6.4
Kashmore	49.5	46.4–52.5	4.3	3.6–5.2
Khairpur	50.5	47.8–53.4	5.0	4.3–5.8
Korangi Karachi	45.7	43.1–48.7	5.3	4.2–6.7
Larkana	45.8	41.4–50.3	5.2	4.5–6.1
Malir Karachi	47.8	44.7–51.0	5.1	4.2–6.1
Matiari	47.0	44.8–49.2	4.6	4.0–5.3
Mirpur Khas	44.7	42.7–46.8	4.3	3.6–5.1
Naushahro Feroze	47.0	44.9–49.0	6.3	5.2–7.5
Sanghar	47.4	45.5–49.6	4.8	4.1–5.7
Shaheed Benazir Abad	48.7	45.9–51.8	4.3	3.5–5.2
Shikarpur	48.6	46.3–51.0	4.8	4.0–5.8
South Karachi	44.3	41.5–47.2	6.2	5.2–7.2
Sujawal	41.7	38.7–44.7	4.1	3.5–4.8
Sukkur	51.5	49.0–54.1	4.4	3.5–5.5
Tando Allahyar	45.8	44.0–47.5	4.6	4.0–5.3
Tando Muhammad Khan	45.4	43.7–46.9	4.7	4.1–5.4
Tharparkar	43.7	41.2–46.1	4.5	3.7–5.7
Thatta	43.9	41.1–46.6	5.5	4.7–6.3
Umer Kot	44.4	42.2–46.6	3.9	3.2–4.5
West Karachi	43.0	39.7–46.3	5.4	4.2–6.8

Khyber Pakhtunkhwa: Hypertension 42.2%, Diabetes 4.3%

District	HTN %	HTN 95% CI	Diabetes %	Diab. 95% CI
Abbottabad	47.4	45.2–49.6	6.9	5.7–8.1
Bajaur	46.4	43.6–49.3	3.5	2.8–4.3
Bannu	40.0	37.2–43.0	4.4	3.7–5.1
Batagram	43.4	40.3–46.7	5.1	4.0–6.1
Buner	42.4	39.2–45.6	4.0	3.4–4.7
Charsadda	38.5	35.9–41.0	4.9	4.1–5.9
Chitral Lower	36.5	34.1–39.0	4.9	3.6–6.6
Chitral Upper	34.1	31.7–36.6	4.7	3.3–6.0
D. I. Khan	41.7	39.1–44.3	4.1	3.6–4.8
Hangu	43.2	40.1–46.1	3.9	3.2–4.7
Haripur	45.0	42.7–47.3	5.4	4.6–6.2
Karak	40.0	37.1–42.7	5.0	3.9–6.2
Khyber	42.4	39.5–45.2	3.1	2.6–3.7
Kohat	44.4	41.8–46.9	4.5	3.8–5.5
Kohistan Lower	46.1	43.0–49.5	4.1	3.5–4.8
Kohistan Upper	46.2	42.7–49.6	4.0	3.4–4.8
Kolai Palas Kohistan	43.0	38.8–47.3	3.9	3.0–5.1
Kurram	40.4	37.6–43.0	3.3	2.7–4.0
Lakki Marwat	43.6	40.9–46.3	5.2	4.4–6.1
Lower Dir	45.0	41.5–48.5	3.4	2.8–4.2
Malakand	39.2	35.9–42.6	4.2	3.3–5.0
Mansehra	44.0	41.3–46.5	4.5	4.0–5.1
Mardan	35.4	33.1–37.7	5.4	4.5–6.3
Mohmand	43.3	39.8–46.6	3.1	2.5–4.0
North Waziristan	39.8	37.2–42.4	3.7	3.0–4.4
Nowshera	46.0	43.4–48.8	4.7	3.9–5.5
Orakzai	39.6	37.1–42.3	3.1	2.6–3.7
Peshawar	47.1	43.7–50.3	5.5	4.5–6.6
Shangla	39.8	37.1–42.5	4.0	3.4–4.8
South Waziristan	40.7	37.2–44.2	3.4	2.8–4.1
Swabi	40.4	38.0–42.8	4.8	4.0–5.7
Swat	43.8	41.5–46.2	4.5	3.8–5.3
Tank	43.6	40.4–46.6	3.5	3.0–4.2
Tor Ghar	42.9	40.2–45.7	5.2	4.5–6.1
Upper Dir	42.3	38.1–46.5	3.1	2.5–3.8

Balochistan: Hypertension 26.3%, Diabetes 3.5%

District	HTN %	HTN 95% CI	Diabetes %	Diab. 95% CI
Awaran	25.3	23.5–26.9	3.3	2.9–3.7
Barkhan	22.6	20.0–25.4	4.0	3.3–4.8
Chagai	25.0	21.8–28.6	3.1	2.2–4.2
Dera Bugti	29.0	26.3–32.0	3.1	2.4–3.9
Duki	25.0	22.5–27.4	3.5	2.9–4.2
Gwadar	31.2	28.9–33.7	4.2	3.5–5.0
Harnai	26.3	24.4–28.2	3.2	2.7–3.9
Jaffarabad	29.8	27.7–31.9	3.7	3.1–4.3
Jhal Magsi	26.8	23.9–30.0	3.3	2.5–4.3
Kachhi	25.1	23.0–27.6	3.1	2.5–3.8
Kalat	24.2	22.2–26.4	3.4	2.9–4.0
Kech	28.2	26.4–30.2	4.3	3.6–5.1
Kharan	27.0	24.7–29.4	3.2	2.6–3.8
Khuzdar	28.8	26.3–31.5	3.2	2.6–3.8
Killa Abdullah	28.3	24.5–32.4	3.6	2.9–4.7
Killa Saifullah	21.2	20.0–23.1	3.2	2.7–3.8
Kohlu	25.5	23.2–28.0	3.0	2.5–3.5
Lasbela	28.1	25.7–30.7	3.7	3.1–4.5
Loralai	26.0	23.8–28.2	4.3	3.4–5.2
Mastung	22.8	20.6–25.3	3.2	2.6–3.9
Musakhel	24.9	22.2–27.8	3.5	2.7–4.3
Nasirabad	28.4	26.1–30.9	3.1	2.7–3.7
Nushki	25.2	23.6–26.9	4.2	3.5–4.8
Panjgur	28.1	25.0–31.5	3.2	2.4–4.3
Pishin	26.1	23.9–28.3	3.9	3.2–4.7
Quetta	29.2	26.5–31.8	4.0	3.4–4.6
Shaheed Sikandarabad	25.4	23.5–27.4	3.0	2.5–3.6
Sherani	23.2	20.9–25.6	3.3	2.6–4.1
Sibi	24.8	22.9–26.8	3.6	3.0–4.1
Sohbatpur	28.3	25.3–31.5	3.4	2.8–4.0
Washuk	24.3	22.1–26.7	2.8	2.4–3.3
Zhob	25.0	21.9–28.5	3.2	2.4–4.0
Ziarat	28.4	26.1–30.6	3.8	3.4–4.4