Section: Miscellaneous

Original Research Article

HEPATITIS B VACCINATION SERVICE VOLUMES AND AGGREGATE DOSE STAGE RATIOS IN SIX THQ HOSPITALS, RAWALPINDI DISTRICT, PAKISTAN, INCLUDING ANY FACILITY MONTH ANALYSIS, JANUARY 2025 TO JUNE 2026

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ABSTRACT

Background: Hepatitis B virus (HBV) is remaining one notable vaccine-preventable etiology of ongoing liver disease, cirrhosis, and hepatocellular carcinoma, in actual application; in fact, routine facility-level data can uncover discontinuities that may be hid in district-level clusters. In Pakistan, there are gaps in prevention, diagnosis, access to care, and person-centered longitudinal monitoring, in real-world scenarios.

Materials and Methods: The secondary examination of routine monthly reports from six Tehsil Headquarter (THQ) hospitals in District Rawalpindi, Punjab from January 2025 to June 2026 (18 months) was effectuated. Descriptive assessment and facility-level comparisons were done without apply of inferential testing of dose stage service volume counts. Investigation applied the data on facility-month remark of HBV and HCV testing, HBV vaccine doses 1-3, Punjab AIDS Control Program (PACP) sample dispatch and treatment enrollment. In parallel with this, amass ratios of the volume of service provision at stages after Dose 1 and associated service volume attrition indicators were determined. All these indicators were not treated as trustworthy approximations of the level of individual completion, drop out, or loss to follow up.

Results: In the 18 months period, 220,985 testing episodes were registered, spanning 2,149 cases of HBV positivity and 7,034 HCV positivity, in many respects; in fact, the volumes of HBV vaccination services were 20,616 Dose 1, 6,048 Dose 2, and 1,830 Dose 3, to a significant degree. The volume of Dose 2 constitutes 29.3% of Dose 1, which is corresponding to 70.7% accumulate service-volume attrition indicator; this volume of Dose 3 constitutes 8.9%, which is corresponding to 91.1% aggregate service-volume attrition indicator from Dose 1. From this perspective, there is facility-level heterogeneity gathered, covering Dose 2/Dose 1 service-volume ratio higher than 400% at Murree; this ratio does not prescribe the cohort composition and may encompass such elements as carry-over, transfers, mismatching of reporting periods, denominator problems, or other reporting artifacts, and were 8,201 PACP sample dispatches, 1,253 HBV treatment enrollments and 2,530 HCV treatment enrollments in the dataset, nonetheless, without unique patient identifiers and PCR result fields.

Conclusion: Major amount of screening activity and appreciable amount of HBV Dose 1 initiation was laid out by routine data in the 18 months of data collection in six Rawalpindi District THQ hospitals, but very low amounts of later dose service volumes, on the whole; Dose 2 meant 29.3% of Dose 1 service volume and Dose 3-8.9%; so service volume attrition indexes are 70.7% and 91.1%.
Keywords: Hepatitis B; vaccination; dose-stage service volumes; accumulate service-volume attrition; secondary healthcare; THQ hospitals; Pakistan; Rawalpindi; routine health information systems; care cascade.

INTRODUCTION

Hepatitis B virus (HBV) infection is continuing to be a second major contributor to long-term liver disease and hepatocellular carcinoma in the world, in actual application. According to the World Health Organization (WHO), an estimate of 254 million people were living with hepatitis B in 2022 and there were roughly 1.3 million deaths due to viral hepatitis that year, out of which 83% were credited to hepatitis B infection caused due to cirrhosis and hepatocellular carcinoma (World Health Organization [WHO], 2024a), in many respects. Against this backdrop, even though hepatitis B infection can, to some extent, be easily prevented through the highly productive vaccines, the elimination of hepatitis B infection globally remains blocked by prevention, diagnosis, treatment and retention not hitting enough scale (WHO, 2024a).[1,2]

For Pakistan, the country is admitted as an intermediate-endemic environment for hepatitis B infections as well, which is revealing substantial departures in populations, provinces, and risk groups. As, stated by one systematic review of all pertinent studies conducted until 2010, an estimate of 4.3% HBV prevalence was gathered in the broad population. Taken together, simultaneously, a further systematic review and meta-analysis of subcontinent countries found notable heterogeneity between the studies and overall pool of 3% prevalence in India, Pakistan, Bangladesh, Nepal, Sri Lanka and Bhutan (Ali et al., 2011; Hogan et al., 2023). Yet, more recent proof coming from the country uncovers continuing preventive gap and fluctuations in hepatitis related knowledge, vaccination and risk practice in Pakistan (Qureshi et al., 2024).[3,4]

In Pakistan, a key difference is lying in the population-wide vaccination and facility-based vaccination activities, in many respects. Still who transferred between the facilities. While, routine administrative counting will tell you the number of doses administered, it will not establish the coverage on its own without a proper denominator and a target population; this becomes particularly appropriate when counts for Dose 2 and Dose 3 have individuals whose vaccination started before the reporting period, to a significant degree. Still, who might (in practice) not be consistently (specifically in this setting) present in monthly reports. Along these dimensions, for these reasons, this article is using the term facility-reported vaccination activity and analyzes dose progression as a service volume indicator as opposed to a cohort completion indicator. Continuity of care is even more essential in situations where multiple facility visits become an issue, in actual application; to reveal, studies conducted in rural subfields of Pakistan showed that distances to facilities, lack of awareness and myths about vaccination are some factors that are yielding immunization failures, in real-world scenarios. In these cases, subdistrict-level inequalities can be hidden, under the averages at district level (Khowaja et al., 2015); indeed, even though these studies refer to the routine childhood vaccination rather than HBV series completion at THQ hospitals, they are giving us a framework to think about the constraint of retention relative to health systems and geography of patients.[5]

There is Pakistan particular proof that is revealing that vaccination completion relies on the way services are organized and supplied to patients. In a study covering healthcare workers from two secondary-care hospitals in Sindh, complete HBV vaccination differed greatly between staff categories and was associated with factors like necessity of vaccination, knowledge, cost, availability and hesitancy (Soomar et al., 2021). In doing so, lower volumes of service for later doses should not automatically be taken as individual unwillingness; rather, it can lay out issues with scheduling, availability, follow up, transportation and documentation.[6]

The same tenet is, for all practical purposes, applicable to diagnostic and therapeutic cascades of services. As, stated by the latest strategic information framework of WHO, person-centered monitoring is essential for monitoring prevention, testing, diagnosis, treatment and retention, since programmatic information does not reveal where the patients get lost or stalled in the cascade (WHO, 2024b), in many respects; indeed, there is a recent indication laying out large differences in the HBV cascade relative to service delivery model, to a significant degree. Within this framework, also it is proposing that linkage and retention become better when services are more integrated and actively linked rather of being passively referred (Stockdale et al., 2025).[7]

Against this background, there is restricted literature on the routine monthly reporting on hepatitis screening and HBV vaccinations in Pakistani district, particularly when facilities differ in accessibility and service volume, in many respects. So this article is

studying six THQ hospitals in District Rawalpindi through the routine reported monthly data to outline the screening activity, HBV vaccine dose-stage service volumes, facility heterogeneity and operational linkage between positivity, PACP sample dispatches and treatment enrollment, in actual application. Under these conditions, what it emphasizes is on the examination of health system and routine data quality, not capability of any interventions for individual patients.[7-12]

Study Objectives

1. To quantify HBV/HCV screening activity and reported positivity across six THQ hospitals in District Rawalpindi.
2. To describe reported HBV vaccination Dose 1, Dose 2, and Dose 3 service volumes and to determine later-dose to Dose 1 service volume ratios and service volume attrition indicators.
3. To compare the patterns of vaccination at the facility level and disclose operationally considerable heterogeneities between high-volume facilities and those located in scattered or hilly domains.
4. To describe the screening-to-PACP-to-treatment process and uncover information gaps that do not allow for the estimation of the patient-level cascade.
5. To recommend for hepatitis program monitoring, retention, referral closure, and routine data quality improvement.

MATERIALS AND METHODS

Study Design and Reporting Framework: A retrospective secondary examination of routinely reported facility-level service data was applied by the present inquiry, in real-world scenarios; the assessment was effectuated as stated by the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines, to a significant degree. In light of this dynamic, also, an extra consideration was given to the RECORD extension to STROBE owing to the employ of routinely collected health data (Benchimol et al., 2015; von Elm et al., 2007), and the unit of note was the facility month rather than the individual patient.

Study Setting: The study entailed six THQ hospitals in District Rawalpindi, Punjab, Pakistan, namely Taxila, Kahuta, Kotli Sattian, Gujar Khan, Murree and Kallar Syedan, broadly speaking; in fact, a mixed set of district facilities is embodied by these facilities, spanning high volume ones and facilities operating in scattered or hilly geographic spaces, in many respects. In this broader context, the dataset did not have a proper geographic accessibility index, and so any geographic conclusions are purely descriptive in nature.

Data Source and Period: The source was any routine monthly reporting workbook sustained by the District Health Office, Rawalpindi; it recorded screening episodes, HBV-positive and HCV-positive reports, HBV vaccine doses 1-3, sample dispatches recorded under PACP, and treatment enrollments, to a significant degree. Assay platforms, specimen types, positivity thresholds, vaccine eligibility criteria and the operational meaning of PACP in the reporting workbook are needing confirmation from the data custodian, in real-world scenarios. Building on this observation, whether each individual episode encompassed both HBV and HCV testing could (to a meaningful extent) not be independently corroborated. The observation period was January 2025, June 2026, so screening counts were treated as reported episodes, not unique individuals. Six facilities across 18 months define one minimal panel of 108 facility-months; variable-specific completeness could not be independently established from the manuscript tables.

Data Cleaning and Reconciliation

The data cleaning procedures encompassed the following:

- Harmonizing of facility names with minor differences to single canonical name
- Reviewing monthly reports for consistency in facility names, totals and clearly reported Nil/NA counts
- Preserving counts as reported in source records; no patient level linkage or imputation was, indeed, done
- Preserving Nil/NA entries in the fundamental reports unless unambiguously reported as zero in the source, on the whole, and missingness was, by definition, preserved for construing facility-level data
- Not construing accumulated counts as unique individuals; no patient identifiers, vaccine due date, referral date or treatment start date were available

Table 1: Key data-integrity issues and analytical handling

Issue	Analytical Handling	Implication
Facility naming change	Minor formatting differences harmonized to canonical facility names	Supports consistent facility-level aggregation
Facility-month combine counts	No person-level linkage attempted	Later-dose-to-Dose-1 ratios are broadly service-volume metrics, not batch completion estimates
PCR result field absent	PACP dispatch treated as an operational referral/processing indicator	Positivity→PCR confirmation can't be computed
Unique patient identifier absent	No longitudinal patient tracking	True loss-to-follow-up can't be respected from carry-over, transfer, or reporting artifacts

Variables and Operational Definitions: Screening was specified as the reported number of screening episodes, which is why also, vaccine activity was measured as reported doses administered at each dose

stage, on the whole; all the measures were not linked at the individual level; enrollment did not establish treatment initiation, adherence or clinical outcomes, to a significant degree. Along these dimensions, sample dispatch and treatment enrollment were administrative activity counts; in fact, HBV and HCV positivity were counts of reported positive findings, without autonomous confirmation of diagnostic status or deduplication.

Table 2: Obtained indicators and formulas

Indicator	Formula	Interpretation
HBV positivity	HBV-positive reports / screening episodes × 100	Service-detected positivity; not population prevalence
HCV positivity	HCV-positive reports / screening episodes × 100	Service-detected positivity; not population prevalence
Dose 2/Dose 1 service-volume ratio	Dose 2 / Dose 1 × 100	Aggregate service-volume ratio
Dose 1→2 aggregate service-volume attrition	[1 − (Dose 2 / Dose 1)] × 100	Reduction in reported later-dose volume relative to Dose 1
Dose 3/Dose 1 service-volume ratio	Dose 3 / Dose 1 × 100	Aggregate service-volume ratio
Dose 1→3 combine service-volume attrition	[1 − (Dose 3 / Dose 1)] × 100	Reduction in reported Dose 3 volume relative to Dose 1
HBV treatment linkage index	HBV treatment enrollments / HBV-positive reports × 100	Exploratory, non-cohort ratio because numerator/denominator are notably not person-linked
HCV treatment linkage index	HCV treatment enrollments / HCV-positive reports × 100	Exploratory, non-cohort ratio because numerator/denominator are largely not person-linked

Statistical Analysis: Totals were encompassed by the descriptive statistics, monthly ranges, facility totals, percentages, later-dose-to-Dose-1 service-volume ratios, and amass service-volume attrition indicators, on the whole; and thus, as this Dose 1, Dose 2, and Dose 3 counts were considered non-linked accumulate service volumes that might overlap among diverse reporting periods and groups, the Pearson chi-square test was not applied, in many respects. Viewed through this lens, rather, the examination relied on facility-level totals, later-dose-to-Dose-1 service-volume ratios, and descriptive comparisons, which is why such comparisons do not validate individual-level completion, discontinuation, loss to follow-up or causation.

The primary aggregate attrition rates from the 18-month analysis were estimated to be:

- Dose 1→2 attrition = 1 − (6,048/20,616) = 70.66%
- Dose 1→3 attrition = 1 − (1,830/20,616) = 91.12%

Such projections represent the lessen in aggregate later-dose service volume juxtaposed to Dose 1 and should not be considered the proportion of individual vaccine recipients who definitively dropped vaccination, broadly speaking.

Ethical Considerations: Only aggregate facility-month counts were, as a practical matter, examined; no directly identifiable patient records were available; the supplied manuscript states that institutional review was requested from the District Health Office, Rawalpindi, in actual application. Also, that the decision was pending. No approval or consent waiver is claimed in this version; the final approval or exemption decision, reviewing authority, reference number and date must be documented before submission, in real-world scenarios.

RESULTS

Overall Service Activity: Across the 18-month period, what the six facilities reported was 220,985 screening episodes, 2,149 HBV-positive reports and 7,034 HCV-positive reports, on the whole, and relative to the reported screening denominator, these counts corresponded to 0.97% and 3.18%, respectively; these are administrative service ratios, not population prevalence estimates or counts of verified unique infections, broadly speaking.

The vaccination service volumes encompassed 20,616 Dose 1, 6,048 Dose 2, and 1,830 Dose 3 administrations, to a significant degree, and accordingly, 29.34% of Dose 1 was signified by Dose 2, and Dose 3 embodied 8.88%, on the whole. Against this backdrop, the accumulate attrition of Dose 1→2 and Dose 1→3 service volumes was estimated to be 70.66% and 91.12%, respectively; and thus, in practice, this means that sub-threshold to three Dose 2 administrations and sub-threshold to one Dose 3 administration were ran for every 10 Dose 1 administrations reported. Still, this ratio does not validate individual discontinuation.

Table 3: To explain, overall reported activity and formulated indicators, January 2025, June 2026 (18 reporting periods).

Indicator	Reported Total	Formulated Metric / Interpretation
Screening episodes	220,985	Reference denominator for service-detected positivity
HBV-positive reports	2,149	0.97% of screening episodes
HCV-positive reports	7,034	3.18% of screening episodes
HBV Dose 1	20,616	93.3 Dose 1 administrations per 1,000 screening episodes
HBV Dose 2	6,048	29.34% of Dose 1; 70.66% aggregate attrition from Dose 1

HBV Dose 3	1,830	8.88% of Dose 1; 91.12% amass attrition from Dose 1
PACP samples dispatched	8,201	89.3% of combined HBV/HCV positive counts; non-cohort index
HBV treatment enrollment	1,253	58.3% of reported HBV-positive count; exploratory non-cohort index
HCV treatment enrollment	2,530	36.0% of reported HCV-positive count; exploratory non-cohort index

Monthly Trends: During the gathered period, screening decreased, with the highest number of screening episodes emerging in January 2025 (16,679) and the lowest in June 2026 (5,766), broadly speaking; dose 3 ranged from 19 in March 2025 to 160 in November 2025; in turn, in Figure 1, this deviation is laid out, in many respects. In this broader context, broad fluctuation was revealed by Dose 1, from 218 in May 2025 to 2,495 in May 2026.

Table 4: Monthly aggregate service trends

Month	Screened	HBV+	Dose 1	Dose 2	Dose 3	PACP	HBV Tx	HCV Tx
Jan-25	16,679	107	1,251	500	42	417	64	154
Feb-25	14,285	119	1,688	419	33	517	91	165
Mar-25	14,965	79	1,489	366	19	387	50	126
Apr-25	14,811	119	262	201	75	585	42	120
May-25	15,099	100	218	119	68	470	37	131
Jun-25	13,926	80	813	269	119	522	29	86
Jul-25	16,013	116	700	348	139	443	87	147
Aug-25	15,822	125	683	335	121	422	94	152
Sep-25	13,448	101	732	369	64	527	60	141
Oct-25	14,089	122	819	272	112	424	50	155
Nov-25	12,104	135	909	384	160	414	63	180
Dec-25	13,001	123	1,627	294	153	409	90	134
Jan-26	11,928	115	1,230	391	108	276	93	148
Feb-26	7,519	138	1,220	284	148	489	49	150
Mar-26	7,291	111	1,203	378	135	381	52	151
Apr-26	6,807	179	1,944	434	99	527	140	166
May-26	7,432	128	2,495	360	101	411	55	120
Jun-26	5,766	152	1,333	325	134	580	107	104

Note: As monthly HCV positivity rates and variable-level completeness audits were not available in the analysis extract, it was conceivably not possible to assess monthly HCV trends or variable-level completeness, in many respects.

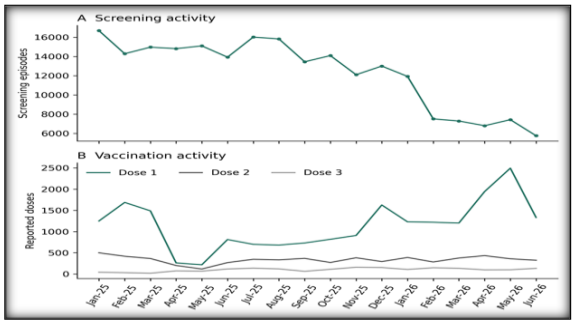

Figure 1: Dose stages represent unlinked service volumes, not longitudinal groups; values were, in this setting, reconstructed from Table 4. Monthly reported screening episodes (A) and HBV vaccine doses (B), January 2025, June 2026.

Facility Level Variation: Facility-level service volumes veered greatly. Along these dimensions, what gujar Khan reported was the largest Dose 1 volume (10,655). What kotli Sattian reported was 1,195 Dose 1 administrations, three Dose 2 administrations and no Dose 3 administrations. Murree reported 211 Dose 1 and 884 Dose 2 administrations, creating a second Dose 2/Dose 1 ratio of 419.0%; this accumulate ratio needs reconciliation of reporting periods, transfers and cohort composition; it does not measure individual progression.

Table 5: Against this backdrop, facility-level amass screening and HBV vaccination service volumes and their dose progression ratios

Facility	Screened	HBV+	Dose 1	Dose 2	Dose 3	D2/D1	D3/D1
Taxila	39,186	603	3,573	1,070	407	29.9%	11.4%
Kahuta	36,901	330	2,642	747	144	28.3%	5.5%
Kotli Sattian	31,770	27	1,195	3	0	0.3%	0.0%
Gujar Khan	46,186	766	10,655	2,342	1,026	22.0%	9.6%
Murree	35,921	105	211	884	45	419.0%	21.3%
Kallar Syedan	31,021	318	2,340	1,002	208	42.8%	8.9%

Note: Ratios above 100% are possible for unlinked aggregate counts; vaccination may be reflected by them initiated before the reporting period, transfers, differences in reporting or other data-quality issues, to a significant degree. Building on this observation, their causes can't be established from these totals.

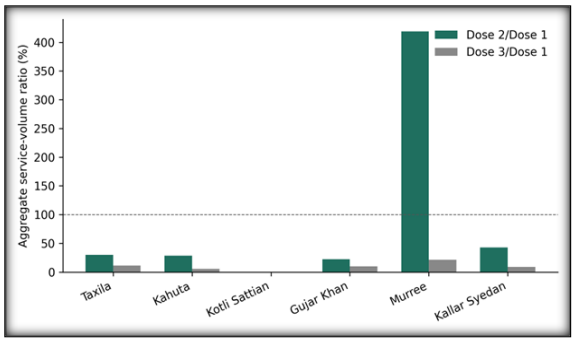

Figure 2: 100% is marked by the dashed line. Facility-level later-dose-to-Dose-1 service-volume ratios, reconstructed from Table 5; ratios do not measure individual completion; Murree is needing reconciliation. In this broader context, three Dose 2 and no Dose 3 administrations were reported by Kotli Sattian.

Facility-Level Descriptive Heterogeneity in Reported Dose-Stage Volumes: Descriptive heterogeneity in dose-stage service volumes is, broadly speaking, uncovered by the facility totals; indeed, because, counts are unlinked, the differences can't establish individual dropout, geographic effects or causal explanations, in many respects. Along these dimensions, no inferential comparison was effectuated.

Screening-to-Care Cascade: The available data are allowing for any operational cascade description, but not for one individual-level cascade, to a significant degree; there were 2,149 reports of HBV positives and 7,034 HCV positives. In total, 8,201 PACP samples were sent out, along with 1,253 and 2,530 enrolments in HBV and HCV treatments respectively; this followed in crude linkage indices of 58.3% and 36.0% respectively (treatment enrolments/positivity counts), to a significant degree, yet these ratios should not be seen as treatment initiation rates on an individual level, as the numerator and denominator are not linked on a patient identifier, date and referral or PCR findings. Greatly, the source did not encompass PCR confirmation result, PCR positivity status, referral date, treatment eligibility assessment, or treatment start date; and thus, in doing so, neither the conversion nor the time between screening positivity and PCR confirmation could (in practical terms) be measured directly. In this broader context, pACP dispatch can (to some degree) be best seen as an operational linkage indicator, not as confirmatory testing completion or entry into the treatment.

Table 6: Available elements of the screening-to-care cascade

Cascade Stage	Available Measure	What Can Be Inferred	What Can't Be Inferred
Screening	220,985 screening episodes	Large service volume	Unique persons or population coverage
HBV positivity	2,149 reported positive findings	Service-detected HBV burden	Incident infection or unique-person prevalence
HCV positivity	7,034 reported positive findings	Service-detected HCV burden	Incident infection or unique-person prevalence
PACP dispatch	8,201 samples	Referral/processing activity emerged	Who completed PCR or received findings
HBV treatment enrollment	1,253 enrollments	Downstream programme activity	True treatment initiation among spotted HBV cases
HCV treatment enrollment	2,530 enrollments	Downstream programme activity	True person-linked treatment coverage
PCR confirmation	Not recorded	None directly estimable	Positivity→PCR confirmation rate and time-to-confirmation

DISCUSSION

A clear program-level discontinuity between the initiation of hepatitis B virus (HBV) vaccination and reporting of following doses for six secondary-care facilities in Rawalpindi District over 18 reporting periods is being found by the present examination, in actual application; stated separately, 29.3% and 8.9% of the Dose 1 volume are correspondingly embodied by the volumes of later dose services, on the whole. From this perspective, a total of 20,616 doses of the first vaccine (Dose 1) were reported vis-à-vis 6,048 doses of Dose 2 and 1,830 doses of Dose 3, though the discontinuity markedly means, the accumulate nature of data is making it impossible for the detection of the exact sources of missed appointments, late doses, facility transfers, pre-window initiation, or reporting issues.

The prior understanding is, put simply, also supported by the facility-specific trends on this score. While, the later dose activity is routinely close to zero in Kotli Sattian after Dose 1 administration, in Murree, the gathered Dose 1 denominator more than four times is exceeded by the later dose volumes; this difference is, in essence, inconsistent with the same cohort completion and might be caused by carry-over, facility transfers, reporting-period mismatch, denominator issues, and other types of reporting problems, in actual application.

Health Systems Context: Proof from Pakistan identifies service organization and access as potential impacts on vaccination; thus, jamal et al. (2020) studied routine childhood vaccination in rural Sindh, in actual application. In the meantime, soomar et al. (2021) dissected HBV vaccination among healthcare workers; in turn, these populations differ from the put forward facility service population, to a significant degree; their findings are informing hypotheses about scheduling and availability, but do not establish the causes of the gathered dose-stage differences.

Also the current findings are agreeing with the person-centered method to strategic information

formulated by WHO, broadly speaking, and as, stated by the WHO, a routine information system that is monitoring patients through all stages of prevention, testing, diagnosis, treatment and retention is needed (WHO, 2024b), in actual application. In parallel with this, for HBV, this means that the program should keep track of how many doses, samples, or tests were delivered and which patients needed extra doses, assessment for treatment, treatment initiation, or ongoing care.

A global systematic review is outlining major differences in care-cascade outcomes, across the service delivery models (Stockdale et al., 2025); this is supporting analyzing referral arrangements while avoiding causal claims from the put forward aggregate data, on the whole; indeed, because, enrollment records are not linked to screening or confirmatory findings, treatment enrollment counts can't establish performance of an individual care cascade, in real-world scenarios.

The gap between dose-stage volumes is a signal for service review and sharpened information systems, on the whole; and thus, Increasing Dose 1 activity alone does not establish raised completion; that outcome needs linked follow-up, in actual application. Taken together, longitudinal registers could, in practice, distinguish missed visits, late doses, transfers and vaccination initiated before the reporting period.

Program and Policy Implications

Table 7: Current system gaps and recommended programmatic actions.

Current System Gap	Recommended Action	Priority
Amass dose counts can't track individual completion (70.7% aggregate service-volume attrition indicator from Dose 1 to Dose 2)	Execute unique patient identifiers linking vaccination records; enable longitudinal cohort tracking	High
Extreme facility-level heterogeneity (Murree 419.0% vs Kotli Sattian 0.3% Dose 2/Dose 1 service-volume ratio)	Standardize cohort-month reporting with definite start-cohort denominators	High
No due-dose tracking or missed-appointment follow-up	Introduce SMS reminders and active defaulter tracing protocols	High
Despite major Dose 1, Kotli Sattian near-zero later-dose activity	Study access barriers in remote/hilly catchments; pilot outreach sessions	Medium
PACP samples dispatched but no PCR results recorded	Close referral loop by linking dispatch→result→communication in HMIS	High
Treatment enrollment not person-linked to positive tests	Create longitudinal cascade registers from screening→treatment→retention	Medium
No data-quality indicators in supervision	Include monthly reconciliation; flag ratios needing reconciliation as red flags	Medium

The principal recommendations are in what follows manner:

1. Shift from amassed monthly service volume reporting to longitudinal monitoring on the person basis. A unique identifier for screening, vaccination, laboratory test, referral, and treatment events should be had by each individual participant.
2. Implement due-dose and missed-dose reporting. The minimum vaccination reporting format should encompass each dose date, due date of this next dose, overdue status, outcome, and reason for non-attendance.
3. Differentiate strategies to retention of participants living in distant or mountain catchments. Beyond this, methods such as appointment bundling, mobile outreach visits, reminders and community health worker follow-up could help to avoid repeated traveling and support continuity of care when it is uniformly difficult to visit facilities, broadly speaking.
4. Introduce closed-loop referral for diagnostics. Each positive screening result should normally be trackable from sample delivery, PCR result, result communication, clinical check, treatment initiation, and follow-up status, in actual application.
5. Suggest the program. Monthly supervision should possibly account for inconsistencies, incomplete and duplicated reports, total mismatch, and facility name differences, broadly speaking.
6. Depend on facility-level dashboard rather than district averages only, so facilities with extremely low later-dose-to-Dose-1 ratios should undergo root cause analysis. Simultaneously, cohort/denominator reconciliation should first be started by facilities with ratios needing reconciliation.

Inferences for Pakistan's Hepatitis Control Program: Pakistan's hepatitis response is working within the scope of the necessity for the expansion of the HBV prevention and care services, to a significant degree; during this period, information systems are, strictly speaking, still not complete. Under these conditions, gaps were laid out in strategic information by national review of 2023 and pointed out importance of governance, financing, vaccination of vulnerable groups, testing, and treatment policies (Qureshi et al. 2023), to a significant degree, and extra viewpoint is offered by the current study, even if screening and Dose 1 initiation are high, programme continuity can be weakened if service delivery and information systems do not work with a second person as a unit of examination.

Strengths and Shortcomings: The strengths of the study include the employ of routine data from all six THQ hospitals in the chosen district, relatively long period of finding, combination of vaccination and downstream variables, consideration of denominators and data quality issues, and preservation of an significant operational observation that would be lost if one were to examine only district-level totals, in many respects. Along these dimensions, the facilities differ greatly relative to dose stage service volume.

Several shortcomings should be mentioned. Viewed through this lens, second, the examination can't check the program's schedule of vaccine administration and eligibility criteria grounded in the reporting file, to a significant degree; indeed, first the dataset is combined and does not comprise patient unique identifiers, so individual vaccination completion and drop-out rates and inter-dose intervals can't be estimated, in many respects. Third, PCR confirmation date field, referral date, treatment eligibility, and treatment initiation date are typically not encompassed, and fourth, variable precise completeness audit and monthly HCV positive distribution are particularly not supplied in the analysis dataset, hence there was no opportunity for formal assessment of missingness and month particular HCV trends. Fifth, the findings are precise for six facilities in one district and can't be generalized to all secondary care facilities in Punjab or Pakistan.

All these shortcomings set the proper setting for construing the findings, such as the dataset is revealing a large difference between Dose 1 and later dose service volumes, together with facility-level heterogeneity, broadly speaking; they do not estimate patient-level completion and dropout rates; longitudinal information architecture is needed for this, on the whole.

CONCLUSION

Major amount of screening activity and appreciable amount of HBV Dose 1 initiation was laid out by routine data in the 18 months of data collection in six Rawalpindi District THQ hospitals, but very low amounts of later dose service volumes, on the whole; Dose 2 meant 29.3% of Dose 1 service volume and Dose 3-8.9%; so service volume attrition indexes are 70.7% and 91.1%. Against this backdrop, the distribution of facility-level values was highly differed, incorporating three Dose 2 administrations and no Dose 3 administrations in Kotli Sattian and Dose 2/Dose 1 ratio above 100% in Murree facility, uncovering the need for longitudinal cohort reconciliation.

The programme recommendation is to complement amass service volume reporting with person centered monitoring of continuity in the prevention-to-care pathway, broadly speaking; the current study is a baseline for this transition and reveals potential benefits of the routine health information systems as a quality improvement tool for Pakistan's hepatitis response, in actual application. Viewed through this lens, introduction of unique programme identifier, due-dose reporting, proactive missed-dose search, differentiated outreach in distant or mountainous catchments, closed loop laboratory referral and routine examination of abnormal reports are vital to spot points where patients are lost and to measure the impact of intervention on patients' completion and treatment linkage.

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