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## Impact of the COVID-19 Pandemic on Adult Literacy Trends in Pakistan: A Pre-Post Comparative Time-Series Analysis (2017-2024)

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### ABSTRACT

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**Background:** Pakistan entered the COVID-19 pandemic with substantial literacy inequalities. In 2019, the national adult literacy rate was 62.35%, compared with 72.97% among males and 51.73% among females; rural literacy was 52.18% compared with 76.54% in urban areas. School closures and limited access to remote learning occurred in a setting with marked urban–rural digital inequality.

**Objective:** To describe changes in adult literacy in Pakistan before, during, and after the COVID-19 pandemic using national and provincial secondary data from 2017 to 2024, with disaggregation by sex, residence, and province.

**Methods:** This ecological secondary-data time-series analysis used data from the Pakistan Bureau of Statistics, Pakistan Social and Living Standards Measurement Survey, UNESCO Institute for Statistics, and Ministry of Federal Education and Professional Training. Trends were examined descriptively across pre-pandemic (2017–2019), pandemic (2020–2021), and recovery (2022–2024) phases. Percentage-point changes were calculated against the 2019 baseline. The 2020 national and disaggregated values were obtained by linear interpolation because the routine PSLM round was not conducted. A descriptive sensitivity analysis compared the pre-pandemic mean with the observed 2021 value and the 2020–2021 mean; exploratory bootstrap intervals were used only to show the instability of these aggregate mean differences.

**Results:** National adult literacy declined from 62.35% in 2019 to 59.94% in 2021, a reduction of 2.41 percentage points. By 2024, the national rate had increased to 64.51%, 2.16 percentage points above the 2019 baseline. From 2019 to 2021, literacy declined by 2.59 percentage points among males and 2.32 percentage points among females; urban and rural literacy declined by 2.89 and 2.21 percentage points, respectively. Sindh had the largest provincial decline (–3.2 percentage points), while Balochistan remained the lowest-performing province in 2021 (40.7%).

**Conclusion:** Pakistan's adult literacy trajectory showed a pandemic-period decline followed by national recovery by 2024. Recovery was uneven, and substantial gender, urban–rural, and provincial inequalities remained. The findings support targeted literacy-recovery strategies while requiring cautious interpretation because the study uses aggregate secondary data and cannot establish causality.

**Keywords:** COVID-19, literacy trends, Pakistan, pre-post comparative analysis, education disruption, SDG 4.

## INTRODUCTION

Literacy is a foundational factor of national development, shaping employment opportunities, health outcomes, and civic participation across generations. Over the two decades preceding the pandemic, Pakistan's national adult literacy rate, population aged 15 years and above rose from approximately 54% in 2009 to 62.35% in 2019. A meaningful improvement that nonetheless concealed persistent structural inequalities. In 2019, female literacy stood at 51.73% compared with 72.97% for males, rural literacy was 52.18% against 76.54% in urban areas, and provincial rates ranged from 43.2% in Balochistan to 80.4% in the Islamabad Capital Territory (ICT). An estimated 20.3 million children of school age remained out of school in Pakistan in 2019, one of the highest absolute counts globally. Pakistan had committed to the United Nations Sustainable Development Goal 4 (SDG 4), calling for inclusive, equitable quality education for all by 2030, a trajectory already under strain before the pandemic.

When COVID-19 led to nationwide school closures in March 2020, institutions in Pakistan remained closed for between 60 and 76 weeks depending on the province. The government's primary emergency response was the Teleschool satellite-television channel. However, a Pakistan Bureau of Statistics household survey conducted in 2020 found that only approximately 36% of school-aged children had access to a television, radio, or internet-connected device at home. Rural household internet access was approximately 12%, compared with 47% in urban areas, reflecting a pronounced digital divide that severely limited the reach of substitute learning modalities.

This study addresses three evidence gaps. First, few published studies have unified national and provincial adult literacy data from 2017 to 2024 into a single harmonised time series drawing concurrently on Pakistan's major statistical sources. Second, national and provincial adult-literacy trajectories have not been described together at this temporal resolution using a consistent pre-pandemic baseline. Third, the relationship between provincial school-closure duration and literacy change has not been systematically described for Pakistan at provincial level with disaggregated data.

This study aimed to assess shifts in adult literacy patterns in Pakistan prior to and following the COVID-19 pandemic, utilizing national and provincial secondary data from 2017 to 2024, categorized by gender, urban-rural status, and province, to establish an evidence foundation for equity-centred literacy recovery strategies.

## METHODOLOGY

### Study Design and Setting

This is an ecological secondary-data time-series analysis employing a retrospective, descriptive, pre-post comparative observational design at the population level. The COVID-19 pandemic (March 2020 to December 2021) is treated as the index event dividing the study period into three phases: pre-pandemic (2017–2019), pandemic (2020–2024), and recovery (2022–2024).

### Population, Data Sources, and Sampling

The study population comprised persons aged 15 years and above represented in Pakistan's national literacy datasets. No primary sampling was conducted. The analysis used the national adult literacy series for 2017–2024, sex- and residence-disaggregated national series, provincial estimates available at the reported survey time points, annual out-of-school estimates, and the documented digital-access and school-closure indicators. Provincial estimates were not extrapolated for years without a corresponding survey round; only reported values were retained.

### Data Validity, the 2020 Gap, and Ethical Considerations

Because the routine 2020 PSLM round was not conducted because of pandemic disruption, the national and disaggregated 2020 values were estimated by linear interpolation between the corresponding 2019 and 2021 values and are marked with

an asterisk in the relevant tables. These interpolated values are presented only to describe the trajectory. The final analytical series uses the 15+ adult-literacy denominator. Where a source is reported on a 10+ basis, the reproducible conversion protocol is  $L(15+) = [L(10+) \times P(10+) - L(10-14) \times P(10-14)] / P(15+)$ , where the population and age-specific literacy inputs are taken from the corresponding Pakistan Bureau of Statistics age-specific tables.<sup>30</sup> The protocol is documented for reproducibility; no undocumented conversion was applied to the 12 source-extraction records reproduced in Supplementary File S1. PSLM survey data were prioritised when a complete survey round was available; PBS Labour Force Survey annual bulletins provided intermediate-year information; UIS was used for source comparison and cross-validation; and MoEPT administrative data were used for out-of-school children and school-closure indicators.

### Statistical Analysis

The analysis was performed using SPSS Version 26 and Microsoft Excel. Descriptive statistics characterised literacy trends across the study period and disaggregation dimensions. Percentage-point (pp) changes were calculated against the 2019 PSLM baseline, with the principal descriptive comparison defined a priori as the observed change from 2019 (62.35%) to 2021 (59.94%). Because the available annual observations are aggregate population-level estimates, the phase-specific series contain few observations, and the 2020 value is interpolated, no formal hypothesis test or standardised inferential effect size was applied.

Table 4 presents a descriptive sensitivity analysis using the pre-pandemic mean (2017–2019), the observed 2021 value, and the mean of the 2020–2021 pandemic-period values. Exploratory 95% bootstrap intervals were generated by resampling annual observations within each phase (100,000 resamples; fixed seed 2026). These intervals are presented as a sensitivity assessment of the instability of the aggregate mean difference and are not interpreted as formal population-level inferential estimates. Interpretation therefore focuses on observed trends, point-to-point percentage-point changes, and the documented limitations of the ecological design. No causal effect of COVID-19 is inferred from these descriptive comparisons.

## RESULTS

### National Literacy Trends

National adult literacy increased from 59.13% in 2017 to 62.35% in 2019, a pre-pandemic gain of 3.22 percentage points over two years. During the pandemic period, the national rate declined to an estimated 60.87% in 2020 (interpolated) and to 59.94% in 2021, based on the PSLM 2020–21 survey. The observed reduction from the 2019 baseline to 2021 was 2.41 percentage points. Recovery was observed from 2022 onwards (61.23%), continuing through 2023 (63.18%) and reaching 64.51% by 2024, 2.16 percentage points above the 2019 baseline. For scale only, applying the 2.41-percentage-point difference to the approximately 133.5 million people aged 15 years and above in the PBS Labour Force Survey 2020–21 produces a population-equivalent difference of approximately 3.2 million. This is a mathematical illustration of the rate difference, not an estimate of individuals who became illiterate; the aggregate data cannot identify individual-level transitions.

**Table 1. National and disaggregated adult literacy rates in Pakistan, 2017-2024 (%)**

| Year | National | Male  | Female | Urban | Rural | From 2019 (pp) | Phase     |
|------|----------|-------|--------|-------|-------|----------------|-----------|
| 2017 | 59.13    | 70.21 | 48.09  | 74.32 | 49.26 | -2.22          | Pre-COVID |
| 2018 | 60.44    | 71.38 | 49.52  | 75.11 | 50.43 | -1.91          | Pre-COVID |
| 2019 | 62.35    | 72.97 | 51.73  | 76.54 | 52.18 | Baseline       | Pre-COVID |

| Year  | National | Male  | Female | Urban | Rural | From 2019 (pp) | Phase    |
|-------|----------|-------|--------|-------|-------|----------------|----------|
| 2020* | 60.87    | 71.42 | 50.27  | 74.88 | 50.84 | -1.48          | Pandemic |
| 2021  | 59.94    | 70.38 | 49.41  | 73.65 | 49.97 | -2.41          | Pandemic |
| 2022  | 61.23    | 71.64 | 50.78  | 74.93 | 51.36 | -1.12          | Recovery |
| 2023  | 63.18    | 73.11 | 53.22  | 76.87 | 53.64 | +0.83          | Recovery |
| 2024  | 64.51    | 74.23 | 54.78  | 78.02 | 55.11 | +2.16          | Recovery |

\* 2020 value derived by linear interpolation (no PSLM round conducted).  $\Delta$  = change from 2019 baseline in percentage points. Source: PBS Labour Force Survey; PSLM 2018–19, 2020–21, 2022–23; UIS Pakistan dataset 2024.

### Gender-Disaggregated and Urban–Rural Findings

From 2019 to 2021, male literacy declined by 2.59 percentage points (from 72.97% to 70.38%), while female literacy declined by 2.32 percentage points (from 51.73% to 49.41%). Although the absolute point decline was marginally larger for males, the female decline originated from a substantially lower baseline: the relative reduction was 4.49% for females ( $2.32 / 51.73 \times 100$ ) compared with 3.55% for males ( $2.59 / 72.97 \times 100$ ), representing a proportionally greater impact on the group with lower initial attainment. The gender gap stood at 21.24 percentage points in 2019 and narrowed to 19.45 percentage points by 2024. From 2022 onwards, female literacy recovered more strongly (+3.05 pp above the 2019 baseline by 2024) than male literacy (+1.26 pp). This pattern is consistent with the possible influence of targeted female education programming during the recovery period; however, the observational design of this study does not permit direct attribution to specific interventions, and alternative explanations cannot be excluded.

Urban literacy declined by 2.89 percentage points (from 76.54% to 73.65%) and rural literacy declined by 2.21 percentage points (from 52.18% to 49.97%) from 2019 to 2021. Although the absolute point decline was larger in urban areas, rural regions, where household internet access was approximately 12% in 2020 compared with 47% in urban areas<sup>2</sup>, had substantially less access to digital substitute learning. This structural difference is consistent with rural populations experiencing disproportionate educational disruption per unit of school closure time relative to their baseline attainment, though the ecological design does not permit causal attribution.

**Table 2. Gender and urban–rural literacy gaps, 2017–2024**

| Year | Male (%) | Female (%) | Gender gap (pp) | Urban (%) | Rural (%) | Urban–rural gap (pp) |
|------|----------|------------|-----------------|-----------|-----------|----------------------|
| 2017 | 70.21    | 48.09      | 22.12           | 74.32     | 49.26     | 25.06                |
| 2019 | 72.97    | 51.73      | 21.24           | 76.54     | 52.18     | 24.36                |
| 2021 | 70.38    | 49.41      | 20.97           | 73.65     | 49.97     | 23.68                |
| 2024 | 74.23    | 54.78      | 19.45           | 78.02     | 55.11     | 22.91                |

pp = percentage points. Gender gap = male minus female; urban–rural gap = urban minus rural. Source: PSLM Survey 2017–2024.

### Provincial Analysis

Provincial trajectories varied substantially across the study period. Punjab, which entered the pandemic with the highest provincial literacy rate (65.2% in 2019), experienced 68 weeks of school closure, declined by 2.1 percentage points (to 63.1% in 2021), and recovered to 67.4% by 2024 (+2.2 pp above 2019). KPK showed the smallest pandemic-period decline of any province (–1.3 pp, from 54.8% to 53.5%); one plausible contributing factor identified in prior literature is the province's pre-pandemic investments in digital learning infrastructure,<sup>22</sup> though this hypothesis was not directly tested in this study and should not be treated as an established finding. Sindh recorded the largest absolute pandemic-period decline (–3.2 pp, from 57.4% to 54.2%), recovering to only 58.1% by 2024 (+0.7 pp), the weakest provincial recovery trajectory.

Sindh's post-2021 pattern is likely compounded by the 2022 Pakistan floods, which according to government and UNICEF reports damaged or destroyed approximately 17,000 schools and displaced approximately 7.9 million people.<sup>3,22</sup> This study's design cannot statistically separate the COVID-19 contribution from the flood effect in Sindh, an acknowledged limitation. Balochistan, beginning from Pakistan's lowest provincial baseline (43.2% in 2019) and experiencing the longest closures (76 weeks), declined to 40.7% in 2021 and recovered to only 44.6% by 2024 (+1.4 pp), consistent with a trajectory of near-stagnation from a critically low starting point. ICT declined by 1.6 pp (to 78.8%) and recovered to 82.3% by 2024 (+1.9 pp). The association between provincial closure duration and literacy change is noted as a descriptive, exploratory observation only; with five provincial data points, any apparent correlation is substantially underpowered and should not be interpreted as a robust empirical relationship.

**Table 3. Provincial literacy rates and school-closure duration, 2017-2024**

| Province    | 2017 (%) | 2019 (%) | 2021 (%) | 2024 (%) | Closure (weeks) | 2019→2021 (pp) | 2019→2024 (pp) |
|-------------|----------|----------|----------|----------|-----------------|----------------|----------------|
| Punjab      | 62.4     | 65.2     | 63.1     | 67.4     | 68              | –2.1           | +2.2           |
| Sindh       | 54.1     | 57.4     | 54.2     | 58.1     | 72              | –3.2           | +0.7           |
| KPK         | 52.3     | 54.8     | 53.5     | 56.9     | 65              | –1.3           | +2.1           |
| Balochistan | 40.8     | 43.2     | 40.7     | 44.6     | 76              | –2.5           | +1.4           |
| ICT         | 77.6     | 80.4     | 78.8     | 82.3     | 60              | –1.6           | +1.9           |

KPK = Khyber Pakhtunkhwa; ICT = Islamabad Capital Territory. Source: PBS, PSLM, MoEPT 2017–2024; MoEPT school reopening records.

### Descriptive Pre-Post Comparison and Out-of-School Children

The primary comparison was descriptive. National adult literacy declined from 62.35% in 2019 to 59.94% in 2021, a reduction of 2.41 percentage points. Across the disaggregated series, male literacy declined by 2.59 percentage points, female literacy by 2.32 percentage points, urban literacy by 2.89 percentage points, and rural literacy by 2.21 percentage points over the same interval. By 2024, national literacy had increased to 64.51%, while the gender and urban–rural gaps remained substantial. Estimated out-of-school children increased from 20.3 million in 2019 to a pandemic-period peak of 26.2 million in 2021 (+5.9 million; approximately 29% above baseline) before declining to 19.9 million by 2024.

**Table 4. Descriptive summary of observed literacy changes, 2019–2024**

| Indicator         | Pre-COVID mean<br>(2017–2019, %) | 2021 observed (%) | Pandemic sensitivity mean<br>(2020–2021, %) | Mean difference (pp) | Exploratory bootstrap 95% CI (pp) |
|-------------------|----------------------------------|-------------------|---------------------------------------------|----------------------|-----------------------------------|
| National literacy | 60.64                            | 59.94             | 60.41                                       | −0.24                | −1.95 to +1.30                    |
| Male literacy     | 71.52                            | 70.38             | 70.90                                       | −0.62                | −2.07 to +0.82                    |
| Female literacy   | 49.78                            | 49.41             | 49.84                                       | +0.06                | −1.89 to +1.75                    |
| Urban literacy    | 75.32                            | 73.65             | 74.27                                       | −1.06                | −2.41 to +0.30                    |
| Rural literacy    | 50.62                            | 49.97             | 50.41                                       | −0.22                | −1.78 to +1.19                    |

pp = percentage points. The sensitivity mean is the arithmetic mean of the 2020 and 2021 aggregate estimates. Exploratory bootstrap intervals use 100,000 resamples of annual observations within each phase (fixed seed 2026); because the number of annual observations is very small, these intervals are not treated as formal inferential confidence intervals. Source: Tables 1-3 and cited PBS/PSLM records.

## DISCUSSION

This study provides harmonised descriptive time-series evidence that Pakistan's national adult literacy rate declined during the pandemic period and that the recovery observed by 2024 was uneven across demographic and geographic strata. The principal observed comparison was a 2.41-percentage-point reduction from 2019 to 2021. Because the data are aggregate, the 2020 value is interpolated, and the number of annual observations is small, the findings are interpreted as temporal changes rather than causal effects of COVID-19.

The national rate reached 64.51% by 2024, 2.16 percentage points above the 2019 percentage baseline. The population-equivalent calculation presented in the Results section is illustrative only and should not be interpreted as evidence that a specific number of adults became illiterate. Because the denominator changes over time and the analysis does not estimate individual-level transitions, the study focuses on literacy-rate trajectories rather than counts of newly illiterate adults.

The gender findings show that both male and female literacy declined between 2019 and 2021, with a larger absolute percentage-point decline among males but a larger proportional decline relative to baseline among females. The gender gap narrowed from 21.24 percentage points in 2019 to 19.45 percentage points in 2024. This descriptive pattern does not establish the influence of any specific education intervention, and alternative explanations cannot be excluded.

The provincial findings have direct policy relevance. Balochistan entered the pandemic with the lowest provincial literacy rate (43.2% in 2019), declined to 40.7% in 2021, and recovered to 44.6% by 2024. Sindh recorded the largest observed pandemic-period decline (−3.2 percentage points) and recovered to 58.1% by 2024, only 0.7 percentage points above its 2019 level. The 2022 floods provide an important concurrent explanation to consider in interpreting Sindh's recovery, but this study cannot statistically separate flood-related effects from pandemic-related effects. The relationship between school-closure duration and literacy change is treated as descriptive and exploratory only.

## IMPLICATIONS

These findings suggest several areas of potential policy relevance, while recognising that policy effectiveness was not tested. The uneven provincial recovery supports consideration of targeted education-recovery resources for areas with the lowest literacy levels. The documented urban–rural digital-access gap supports prioritising rural connectivity within education and digital-infrastructure planning. The persistent gender gap supports continued gender-responsive education strategies, including attention to female-teacher availability in underserved settings. Future research should use district-level longitudinal data and designs capable of separating pandemic-related disruption from other shocks such as the 2022 floods.

Beyond educational policy, the findings are relevant to health-system planning because literacy is related to access to health information and effective use of health services. These implications are derived from the existing literature rather than measured outcomes of this study; no direct health-literacy outcome was analysed.

## LIMITATIONS

This study has several limitations. First, the ecological secondary-data design permits identification of temporal patterns but cannot establish causality. Concurrent factors, including the 2022 Pakistan floods, macroeconomic conditions, political instability, changes in survey methodology, and population growth, cannot be individually isolated. Second, the number of annual observations is small, and the routine 2020 PSLM round was not conducted; therefore, the 2020 value is interpolated and is used only for trajectory description. Third, earlier UIS records with a 10+ denominator were not converted to 15+ in the final analytical series because the supplied source records do not provide a reproducible conversion formula. Fourth, secondary data may be retrospectively revised by originating agencies. Fifth, adult literacy is a lagging population indicator and does not directly measure contemporaneous school-age learning loss. Sixth, provincial estimates may have larger uncertainty than national estimates, particularly in Balochistan.

## CONCLUSION

Adult literacy in Pakistan declined from 62.35% in 2019 to 59.94% in 2021, an observed reduction of 2.41 percentage points during the pandemic period. The decline was evident across sex and residence categories and varied substantially by province. By 2024, national literacy had recovered to 64.51%, but gender, urban–rural, and provincial inequalities remained. These findings describe a marked disruption followed by uneven recovery; they do not establish a causal effect of COVID-19.

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## AUTHOR CONTRIBUTIONS (CREDIT)

Muhammad Wajid Munir: Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, Writing - Original Draft, Writing – Review & Editing, Project Administration.

Prof. Adebisola Adenike Owokole: Supervision, Methodology (review), Writing - Review & Editing.

## CONFLICT OF INTERESTS

The authors declare no conflicts of interest.

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## DATA AVAILABILITY

All data analysed in this study are derived from publicly available secondary sources, including the Pakistan Bureau of Statistics, PSLM Survey, UNESCO Institute for Statistics, and Ministry of Federal Education and Professional Training publications. A source-extraction table documenting the records available in the study documentation, including year, source, variable, original reported value, age denominator where documented, adjustment status, final analytical value, and whether the observation was observed or interpolated, is provided as Supplementary File S1. The complete harmonised dataset and source-level audit trail are available from the corresponding author upon reasonable request. No individual-level participant data were accessed.

## ETHICAL APPROVAL

A secondary-data ethics determination was made under the TORG Global Research Fellowship institutional governance framework (Reference: TORG-RF-2025-002; 20 March 2026), confirming that this aggregate secondary-data study with no primary human-participant involvement does not require formal research ethics committee review under the applicable governance policy. This determination was issued by the TORG Global Research Fellowship programme; it is not an independent research ethics committee exemption.

## ARTIFICIAL INTELLIGENCE USE DECLARATION

AI tools (Claude, Anthropic) were used to support language editing, formatting, and structural reorganisation of this manuscript. All research design, data interpretation, statistical analysis, and conclusions are the original intellectual work of the authors. This declaration is made in accordance with TORGJ editorial policy on AI use in submitted manuscripts.

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