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Geographic variation in preventive and atraumatic restorative treatment classifications among Brazilian oral health teams, 2025–2026: a repeated cross-sectional study

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Abstract

Background

Routine indicators can support evaluation of dental services, but administrative performance classifications reflect registered procedures rather than clinical outcomes. We described the geographic distribution of preventive dental procedure (B5) and atraumatic restorative treatment (B6) classifications among primary care oral health teams in Brazilian state capitals.

Methods

This ecological repeated cross-sectional study analyzed publicly available SIAPS classifications for all 26 state capitals and the Federal District in three four-month periods of 2025 and the first four-month period of 2026. All data were obtained from public CSV exports on 17 October 2026. We summarized official categories, pooled good/optimal percentages, territorial distributions and between-period differences. Grouped-binomial generalized estimating equations (GEE) with territory-level jackknife variance and alternative models were secondary exploratory analyses.

Results

The dataset contained 216 territory–period–indicator records. Among classified teams, B5 good/optimal ratings were 9.1% (412/4,519) in the first period of 2025 and 13.0% (593/4,548) in the first period of 2026; corresponding B6 ratings were 33.8% (1,529/4,519) and 53.7% (2,444/4,548). The B6 percentage was higher in 25 of 27 jurisdictions in the later period, whereas B5 was higher in 15, lower in nine and unchanged in three. Exploratory GEE odds ratios comparing these two periods were 1.49 (95% confidence interval 0.75–2.97) for B5 and 2.27 (1.72–3.01) for B6. B5 results were sensitive to model choice.

Conclusions

Published B5 and B6 classifications varied widely among Brazilian capitals, with particularly marked territorial heterogeneity in B6. The larger proportion classified good/optimal in the later period does not establish improvement in clinical practices, within-team transitions or a sustained temporal trend. These public data can inform service monitoring when the classified-team denominator and uncertainties about historical calculation rules are explicitly acknowledged.

Background

Oral conditions constitute a major global public health burden, with substantial social and geographic inequalities in access to services and disease outcomes [1, 2]. International policy has consequently

emphasized the integration of oral health into primary care, prevention and accessible interventions [3, 4]. Brazil's National Oral Health Policy and the expansion of oral health teams within primary care have made service monitoring increasingly relevant, although geographical variation in provision remains substantial [5, 6].

Health service assessment requires a distinction between structures, processes and outcomes. Service-activity indicators can describe reported clinical production, but they cannot independently demonstrate effectiveness, continuity of care or population benefit [7]. Previous analyses of Brazilian dental services have documented uneven preventive and restorative activity, access and integration with other care services [8, 9, 10, 11, 12].

Preventive procedures and atraumatic restorative treatment (ART) form part of minimally invasive caries care; ART is a restorative approach but is not a complete proxy for minimally invasive practice or quality of treatment [13, 14, 15]. Brazil's national health information system classifies oral health teams using indicator B5 (the share of specified individual preventive procedures among individual dental procedures) and indicator B6 (the share of ART among specified restorations). The official classification thresholds refer to the procedure mix recorded for each team, not to clinical outcomes [16, 17].

Despite nationwide monitoring of oral health teams, the geographical distribution of their classifications for preventive activities and atraumatic restorative treatment remains incompletely characterized during the first reporting periods of the current system. We therefore described the four official categories and geographic heterogeneity of B5 and B6 across all Brazilian state capitals and the Federal District, using the publicly accessible SIAPS extract of 17 October 2026. Exploratory between-period and contextual comparisons were secondary objectives; we did not seek to estimate a sustained trend, causes of territorial variation or within-team change.

Methods

Design, setting and units of observation

This ecological repeated cross-sectional study included all 26 Brazilian state capitals and the Federal District. Four administrative reporting periods were analyzed: P1/2025 (January–April), P2/2025 (May–August), P3/2025 (September–December) and P1/2026 (January–April). These periods correspond to four-month evaluation windows (quadrimesters), not conventional calendar quarters. Each territory × period × indicator formed one observation (27 × 4 × 2 = 216). The observed units were aggregate classification counts for National Team Identifiers (Identificador Nacional de Equipe, INE); individual teams were not longitudinally linked.

Public data, eligibility and provenance

Data on oral health team performance classifications were obtained from the publicly available CSV export entitled “Qualidade – Conceito obtido por indicador” (“Quality – Performance Classification by Indicator”), provided by the Brazilian Primary Health Care Information System (Sistema de Informação para a Atenção Primária à Saúde; SIAPS), Brazilian Ministry of Health, downloaded on 17 October 2026 [18]. The original CSV exports for the three four-month periods of 2025 and the first period of 2026 were preserved with their extraction date and file checksums. Only the 26 state capitals and the Federal District were retained in the analytic file; the source exports covered a broader set of municipalities. The reports were marked “preliminary data”. Aggregated published classification counts were used as provided; individual teams and procedures could not be reconstructed from these exports.

The denominator in each analysis was the number of INEs with a published classification in the respective territory, period and indicator. These counts must not be interpreted as the number of all registered, funded or otherwise eligible oral health teams. The public exports lacked both an independent eligible-team denominator and stable INE-level identifiers; classification coverage, turnover and within-team transitions could therefore not be assessed.

The SIAPS release history documents indicator updates in May 2026, partial reprocessing of B4/B5 results for the first reporting period of 2026, and later changes in the presentation of valid and evaluated teams [19–21]. The available documentation does not establish that every historical period was computed with identical rules. Accordingly, the four periods were treated as separate published administrative cross-sections; no assumption of full temporal measurement equivalence was imposed.

Indicators, classification and contextual variables

B5 reflects the proportion of defined individual preventive dental procedures among eligible individual dental procedures. Under the cited methodology, regular corresponds to values below 40% or above 85%, sufficient to 40–<55%, good to 55–<65% and optimal to 65–85%; thus, the categories are not globally monotonic in the raw procedure proportion. B6 reflects the proportion of ART among the defined restorative procedures; categories are regular (≤ 3%), sufficient (> 3–6%), good (> 6–8%) and optimal (> 8%) [16, 17]. Our descriptive outcomes were the counts and percentages in all four published categories. The binary summary “good/optimal” was the sum of two category counts divided by the number classified; it does not represent the underlying proportion of ART or preventive procedures.

For exploratory contextual comparisons, we used the 2025 municipal population estimates, 2023 municipal gross domestic product per capita and the 2010 Municipal Human Development Index. For the Federal District, jurisdiction-level values were used. These variables originate from official sources but are not temporally synchronous with each outcome period [22–24].

Data management and quality control

The analysis file was restricted to the 27 jurisdictions, four reporting periods and two indicators. We verified unique territory–period–indicator keys, nonnegative category counts, completeness, agreement of the four official categories with the classified-team denominator and bounds of derived proportions. There were no missing territory–period–indicator combinations. The classified-team totals for B5 and B6 were also checked for consistency within territory and period. The public data did not permit confirmation of team-level eligibility or longitudinal linkage. Source CSVs and the exact analytic file are preserved in Additional files 2–3.

Statistical analysis

The primary analysis was descriptive. For each indicator and reporting period, we calculated pooled category percentages among classified INEs and the median and interquartile range of the good/optimal percentage across the 27 jurisdictions. Pooled estimates weight territories in proportion to their numbers of classified INEs; territorial medians give each jurisdiction equal weight. We described within-territory percentage-point differences between P1/2025 and P1/2026 using unrounded numerators and denominators, reporting direction, median, interquartile range and the largest observed differences. Exclusions of individual jurisdictions with extreme contrasts were conducted post hoc only to assess numerical influence; they were not taken as evidence of invalid records.

As a secondary exploratory analysis, we estimated between-period contrasts separately for B5 and B6 using grouped-binomial generalized estimating equations (GEE), a logit link and a four-level period indicator. Counts of good/optimal ratings served as the grouped numerator and all classified ratings as the grouped denominator. We used an exchangeable working correlation within the 27 territories and a delete-one-territory jackknife covariance matrix [25]. Confidence intervals and coefficient tests used a t distribution with 26 degrees of freedom, and global tests used an F approximation with 3 and 23 degrees of freedom. Three comparisons with P1/2025 were adjusted by Holm's method. Because identical historical calculation rules could not be established, the GEE results are exploratory contrasts of reported classifications, not estimates of a validated temporal trend or within-team improvement.

Sensitivity analyses examined working correlation, exclusion of the Federal District, leave-one-territory-out estimates, territory fixed-effects logistic regression and a mixed beta-binomial model fitted to the extracted dataset. The beta-binomial model estimates a conditional association, whereas GEE estimates a marginal association; these odds ratios do not target identical quantities. Contextual models, reported only in Additional file 1, were exploratory because they involved 27 independent territorial units and imprecise estimates. Models examined Municipal Human Development Index and population, gross domestic product per capita and population, or macroregion, with adjustment for reporting period. STROBE and RECORD informed reporting [26, 27]. Computational instructions, source files and software versions are available in Additional file 3. OpenAI's ChatGPT was used to support language editing and the development and refinement of statistical code. All authors reviewed and verified the resulting text and code and remained responsible for the analytical decisions, results, references and interpretations.

Results

Data completeness and classified-team denominators

The dataset downloaded on 17 October 2026 comprised 216 aggregate records, covering all 27 jurisdictions and all four reporting periods. The number of classified INEs was identical for B5 and B6 within each period: 4,519 (P1/2025), 4,489 (P2/2025), 4,573 (P3/2025) and 4,548 (P1/2026). These counts refer only to INEs assigned a published category, not to all teams potentially eligible for evaluation. No territory–period–indicator combination was missing.

Distribution of the official performance categories

For B5, pooled good/optimal percentages across P1/2025, P2/2025, P3/2025 and P1/2026 were 9.1%, 8.6%, 8.1% and 13.0%. Corresponding territorial medians were 6.7%, 6.3%, 5.2% and 8.2%, respectively. The unrounded P2/2025 median was exactly 6.25%, conventionally rounded to 6.3%. B6 pooled percentages were 33.8%, 39.1%, 47.4% and 53.7%; territorial medians were 30.0%, 30.6%, 41.8% and 51.1% (Table 1; Fig. 1). All percentages are conditional on having a published classification, not on eligibility for evaluation.

Table 1
Official performance classifications by indicator and four-month reporting period

Ind.	Period	INEs, n	Regular %	Sufficient %	Good %	Optimal %	Good/optimal %	Median (IQR) %
B5	P1/2025	4519	74.9	16.0	5.1	4.0	9.1	6.7 (2.3–11.4)
B5	P2/2025	4489	74.8	16.6	5.6	3.0	8.6	6.3 (2.5–9.8)
B5	P3/2025	4573	73.3	18.7	5.2	2.8	8.1	5.2 (2.5–10.1)
B5	P1/2026	4548	64.4	22.6	7.7	5.3	13.0	8.2 (4.1–16.5)
B6	P1/2025	4519	59.4	6.8	4.1	29.7	33.8	30.0 (12.2–37.2)
B6	P2/2025	4489	52.6	8.3	4.0	35.2	39.1	30.6 (20.1–41.5)
B6	P3/2025	4573	43.8	8.8	4.8	42.6	47.4	41.8 (30.8–58.0)
B6	P1/2026	4548	37.8	8.5	5.0	48.7	53.7	51.1 (35.8–62.7)

Ind., indicator; INE, National Team Identifier; IQR, interquartile range. Percentages use classified INEs as the denominator. Good/optimal percentages were calculated directly from counts and may differ by 0.1 percentage point from the sum of rounded component percentages. Territorial medians and IQRs give equal weight to each jurisdiction. The B5 P2/2025 median is 6.25% before half-up rounding to 6.3%. Counts do not represent the total eligible workforce.

Territorial heterogeneity and descriptive contrasts

Between P1/2025 and P1/2026, the B6 good/optimal percentage was higher in 25 jurisdictions and lower in two; B5 was higher in 15, lower in nine and unchanged in three (Table 2; Additional file 1, Tables S1–S2). For B6, the median territorial difference was + 23.7 percentage points (interquartile range 6.9 to 29.2). Especially large differences were observed in São Luís (4.4% to 94.6%; 3/68 to 70/74 classified INEs) and João Pessoa (6.3% to 63.9%; 12/190 to 124/194). For B5, the median difference was + 0.4 percentage points (interquartile range − 1.0 to 4.5), and Rio de Janeiro changed from 11.8% to 44.2%. These values compare separately published groups of classified INEs rather than trajectories of individual teams.

Table 2
Geographic distribution of differences between the first 2025 and 2026 reporting periods

Indicator	Higher, n	Lower, n	Unchanged, n	Median Δ p.p. (IQR)	Largest decline, p.p.	Largest rise, p.p.
B5	15	9	3	+ 0.4 (-1.0 to + 4.5)	-10.7 (Cuiabá)	+ 32.3 (Rio de Janeiro)
B6	25	2	0	+ 23.7 (+ 6.9 to + 29.2)	-5.8 (Goiânia)	+ 90.2 (São Luís)

p.p., percentage points; IQR, interquartile range. Differences are computed for each jurisdiction from unrounded good/optimal classification counts. “Higher”, “lower” and “unchanged” compare P1/2026 against P1/2025; they do not imply within-team change. The IQR gives each of the 27 territories equal weight.

The pooled B5 difference between P1/2025 and P1/2026 was + 3.92 percentage points; excluding Rio de Janeiro reduced it to + 0.77 points. For B6, the difference was + 19.90 points and remained + 17.04 points after excluding São Luís and João Pessoa. These exclusions were post hoc descriptive influence checks rather than adjusted analyses. Leave-one-territory-out GEE point estimates ranged from OR 1.10 to 1.62 for B5 and from 2.11 to 2.40 for B6 (Additional file 1, Table S3).

Secondary exploratory models

In exploratory GEE comparisons, B5 had an odds ratio of 1.49 (95% CI 0.75–2.97) for P1/2026 relative to P1/2025, with a global period p-value of 0.055. The corresponding B6 estimate was 2.27 (95% CI 1.72–3.01), with global p < 0.001. Absolute pooled model contrasts were 3.9 percentage points (95% CI − 3.9 to 11.7) for B5 and 19.9 points (95% CI 13.3–26.5) for B6 (Table 3). These secondary associations should not be interpreted as linked-team improvement or validated temporal trends.

Table 3
Exploratory GEE comparisons using data downloaded on 17 October 2026

Indicator	Contrast	OR (95% CI)	Difference in p.p. (95% CI)	Global p	Holm-adjusted p
B5	P1/2026 vs P1/2025	1.49 (0.75–2.97)	3.9 (-3.9–11.7)	0.055	0.716
B6	P1/2026 vs P1/2025	2.27 (1.72–3.01)	19.9 (13.3–26.5)	< 0.001	< 0.001

GEE, generalized estimating equations; OR, odds ratio; CI, confidence interval; p.p., percentage points. Grouped-binomial GEE used an exchangeable working correlation and territory-level jackknife covariance (27 independent territories). Global p-values test all three period indicators; Holm-adjusted p-values refer only to the P1/2026 versus P1/2025 log-odds coefficient. Comparable historical calculation rules cannot be assumed.

In the mixed beta-binomial sensitivity model, the territory-conditional odds ratio was 1.41 (95% CI 1.10–1.81) for B5 and 2.99 (95% CI 2.31–3.88) for B6. The B5 interval excludes unity, unlike the marginal GEE

interval, underscoring sensitivity to model assumptions and estimand. Contextual estimates were imprecise and did not provide a reliable basis for claims about the presence or absence of socioeconomic inequalities (Additional file 1, Tables S3–S4).

Discussion

The public SIAPS classifications revealed marked geographic heterogeneity across Brazilian state capitals. B6 good/optimal ratings were generally more frequent in the later reporting period, whereas B5 changes were less uniform and sensitive to model specification. This distinction offers an administrative view of the reported distribution of preventive and minimally invasive restorative activities, without demonstrating the clinical appropriateness of those procedures or improved outcomes. Its practical contribution is a territory-wide benchmark of classifications during the early years of monitoring, interpreted in light of the limitations of routine data.

The interpretation of these results depends on what each indicator measures. The increase in B6 from 33.8% to 53.7% reflects the proportion of classified INEs categorized as good or optimal, not the share of restorations actually performed using atraumatic restorative treatment. For B5, a regular category may reflect either a low preventive procedure proportion or one above 85%; category changes are therefore not a monotonic proxy for the intensity of prevention. Neither indicator measures clinical indication, treatment quality, continuity of care or oral health outcomes. Evaluation frameworks should therefore integrate classification data with access, needs, service processes and results [28].

The extremes observed in São Luís and João Pessoa illustrate why aggregate classification changes should not be interpreted as individual-team improvements. High or low percentages may also be influenced by differences in eligibility, reporting, local service organization or procedural coding, which cannot be separated using these data. Excluding those jurisdictions did not eliminate the pooled descriptive difference in B6, but this numerical sensitivity exercise provides no evidence that the historical indicator definitions were equivalent.

Pooled percentages and territorial medians offer different views of the same administrative classifications. Larger jurisdictions contribute more classified INEs to pooled results, while territorial summaries weight each capital equally. Neither statistic measures how comprehensively eligible teams were classified. Similar aggregate denominators can also conceal turnover among participating teams. Earlier studies of electronic primary care information systems identified variation in implementation and reporting capacity, supporting caution about the completeness and comparability of routine records [29].

The exploratory contextual models gave wide confidence intervals. Although each indicator was observed four times per jurisdiction, only 27 independent territories contributed information on largely time-invariant contextual variables. Moreover, the socioeconomic measures were from different reference years and could not describe short-term changes in service organization. The absence of statistically precise associations does not establish homogeneity or rule out geographic inequalities, consistent with previous Brazilian research on access and service organization [30, 31].

This study covered all state capitals and the Federal District and retained all four official categories from preserved public CSV exports collected on one date. Nonetheless, the series comprised only four four-month reporting periods and is insufficient for establishing a stable temporal trend. Historically identical calculation rules could not be confirmed, and the reports downloaded on 17 October 2026 were explicitly preliminary. Eligible-team totals and stable INE identifiers were unavailable, precluding estimation of classification coverage, team turnover or within-team transitions. No procedure-level information, patient characteristics, clinical appropriateness or health outcomes were available. Jackknife-based uncertainty estimates do not remove these limitations of routine administrative measurement.

For health service monitoring, the results highlight the value of examining both pooled and equally weighted territorial summaries, retaining all official categories and reporting the denominator as the number of INEs actually classified. Reporting-period definitions and extraction dates should be retained whenever administrative indicators are used for geographic comparisons. Future monitoring would be more informative if public datasets also included stable nonidentifying team identifiers, historical eligibility denominators and documentation of indicator calculation changes. Until then, the classifications should be used as prompts for service-level inquiry, not rankings of clinical performance.

Conclusions

Across Brazilian capitals, published B5 and B6 classifications differed substantially by territory, particularly for B6. The proportion of classified INEs in the B6 good/optimal categories was higher in P1/2026 than P1/2025; B5 differences were less consistent. These findings describe administrative classifications and cannot establish changes in treatment practice, improvement within teams, coverage of eligible teams or a sustained trend. Territorial reporting with explicit denominators can support cautious monitoring and guide more detailed service evaluations.

Abbreviations

ART
atraumatic restorative treatment
CI
confidence interval
GEE
generalized estimating equations
GDP
gross domestic product
INE
Identificador Nacional de Equipe (National Team Identifier)
IQR
interquartile range
P1/P2/P3

first/second/third four-month reporting period
SIAPS
Sistema de Informação para a Atenção Primária à Saúde.

Declarations

Ethics approval and consent to participate

The study used exclusively publicly accessible, aggregate administrative records without person-level information or the possibility of identifying individuals. Under article 26, items II and V, of Brazilian National Health Council Resolution No. 674/2022, research restricted to public-access information or previously aggregated non-identifiable data is exempt from review by the CEP/Conep system [32]. No contact with human participants occurred; informed consent was therefore not applicable.

Consent for publication

Not applicable. The manuscript contains no identifiable individual data.

Availability of data and materials

The datasets supporting the conclusions of this article are included within the article and its additional files. Additional file 2 contains the analysis-ready dataset, and Additional file 3 contains the original SIAPS CSV exports, statistical code, software requirements, numerical results, data dictionary, checksums and reproducibility instructions. The source data are publicly available through the SIAPS public module [18]. All supplied data are aggregate and non-identifiable.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

CBVL contributed to conceptualization, methodology, investigation, data curation, and writing, review and editing; LLSF contributed to conceptualization, methodology, investigation, interpretation of results, and writing, review and editing; MACO contributed to conceptualization, methodology, formal analysis,

interpretation of results, and writing, review and editing; ROS contributed to conceptualization, methodology, formal analysis, interpretation of results, and writing, review and editing; and EHGL contributed to conceptualization, methodology, supervision, interpretation of results, and writing, review and editing. All authors critically reviewed the manuscript, read and approved the final version, and agreed to be accountable for all aspects of the work.

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Figures

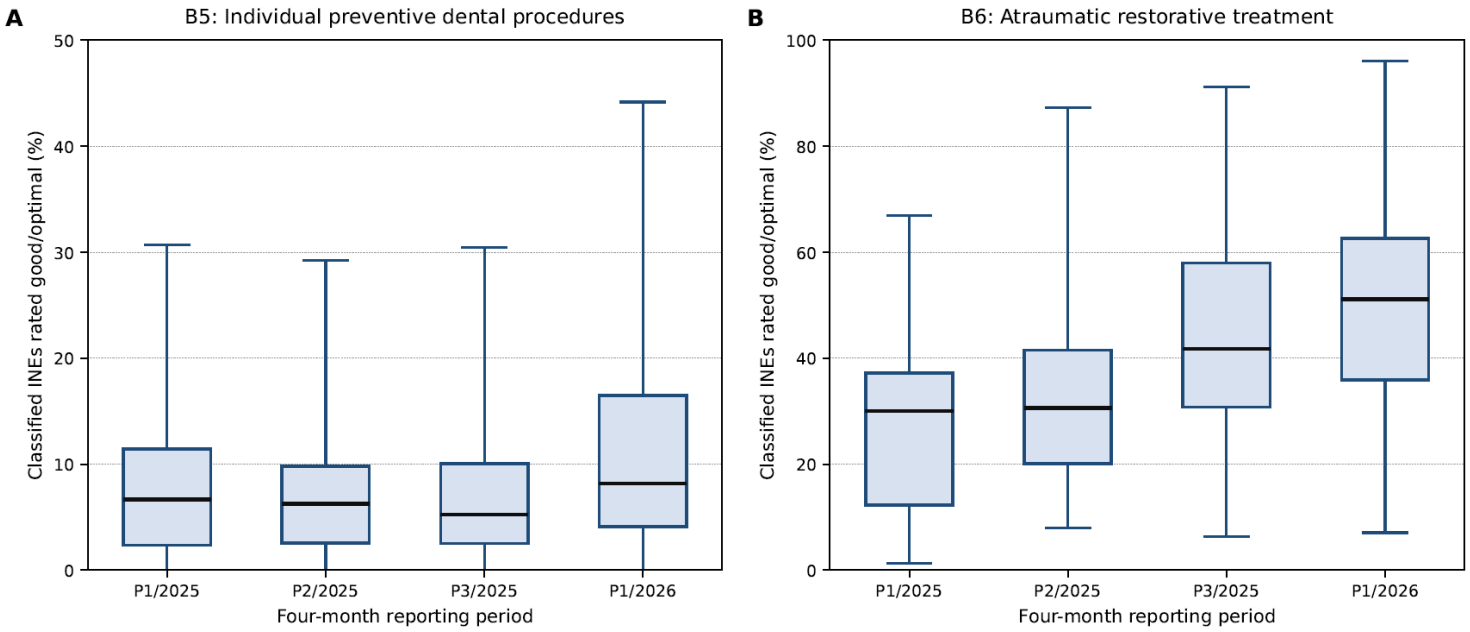

Figure 1

Distribution of B5 and B6 classifications across Brazilian capitals

Boxplots summarize percentages of classified National Team Identifiers (INEs) rated good/optimal in each four-month reporting period, giving equal weight to each of the 27 capital jurisdictions. Whiskers show the minimum and maximum values; boxes show the interquartile range and the centre line the median. Panel A is B5 (individual preventive dental procedures); panel B is B6 (atraumatic restorative treatment). Note the different vertical scales between panels. The figure represents published cross-sectional classifications, not linked-team trajectories or clinical treatment outcomes. Source: public SIAPS export downloaded on 17 October 2026.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Additionalfile2.csv
- Additionalfile1.docx
- Additionalfile3.zip