Study Protocol and Statistical Analysis Plan

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Public Search Interest in Limb-Lengthening Procedures and Cosmetic Stature Augmentation: A Google Trends Analysis

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1. Background and Rationale

Limb-lengthening surgery was originally developed to correct pathological limb-length discrepancy and restore function. In recent years, its indications have expanded to include cosmetic stature augmentation, reflecting evolving social and cultural influences on patient demand. This shift introduces clinical, ethical, and psychosocial considerations, including realistic expectation-setting and appropriate patient selection.

Google Trends has become an increasingly used tool in medical research for assessing public awareness, interest, and information-seeking behavior, particularly for procedures whose popularity may be shaped by social media influence, celebrity trends, and cultural norms. This study applies that method to limb-lengthening and cosmetic stature-augmentation search behavior.

2. Study Objectives

To characterize temporal and geographic patterns of public online search interest in limb-lengthening and cosmetic stature-augmentation procedures across four English-speaking countries (United States, United Kingdom, Canada, Australia) between January 1, 2015 and July 19, 2025, and to identify recurring themes within related search queries.

3. Study Design

Retrospective observational time-series analysis of aggregated, anonymized Google Trends data. No human participants were recruited, enrolled, or followed; no individual-level or identifiable data were accessed at any stage. Reporting follows the STROCSS guidelines.

4. Methods

4.1 Keyword Identification

An initial seed set of five terms ("limb lengthening," "limb lengthening surgery," "surgery for height," "lengthening surgery," "height increase surgery"), drawn from prior published literature, was expanded using the SEO platform Semrush (Keyword Magic Tool). Each seed term was searched separately per country (Australia, Canada, United Kingdom, United States) in May 2025, and the top 10 keywords by average monthly search volume (trailing 12-month Semrush data) were extracted per seed term per country, yielding 200 candidate keyword entries (50 per country).

Candidates were screened in country-specific Google Trends searches (January 1, 2015 – July 19, 2025; category "All"; search type "Web Search") and retained if relevant to limb-lengthening/cosmetic stature terminology, showed measurable trend data, and ranked among the most consistent high-interest terms across all four countries. Terms were excluded for low ranking, insufficient measurable data, or irrelevance (e.g., penile or dental crown lengthening).

Six final terms were retained: "limb lengthening," "leg lengthening," "leg lengthening surgery," "height surgery," "limb lengthening surgery," "lengthening surgery." A combined query using the Google Trends "+" operator was also generated to produce a combined search-interest pattern.

4.2 Related Queries

For each of the six terms, Google Trends "Top" and "Rising" related queries were recorded separately by country, each carrying a relative popularity score (0–100). Related queries were grouped into descriptive themes based on wording and meaning:

- Cost — prices, fees, affordability
- Safety/complications — risks, complications, side effects
- Online forum/Reddit — mentions of Reddit or discussion forums

- Medical tourism — countries or overseas destinations
- General procedure information

4.3 Data Source

Google Trends (Google LLC, Mountain View, CA) provides aggregated, anonymized relative search volume (RSV) data, normalized to a 0–100 scale, reflecting the relative frequency of search queries over time and geography. Raw exported Google Trends time-series CSV files for all search terms and countries are retained as source data for transparency and reproducibility. No demographic, individual-level, or identifiable information is available from or accessed via this data source.

5. Statistical Analysis Plan

5.1 Descriptive Statistics

Monthly RSV values were summarized by country and search term using mean, standard deviation, median, interquartile range (IQR), minimum, and maximum. IQR was calculated in addition to standard deviation because some RSV series included zero values and uneven distributions.

5.2 Temporal Trend Analysis

Calendar month was coded from 1 to 127 across the study period and correlated with monthly RSV values for each search term within each country using Spearman's rank correlation, to assess the direction and consistency of change in search interest over time.

5.3 Pairwise Correlation Analysis

Pairwise Spearman correlation coefficients were calculated between the six search terms within each country (15 comparisons per country; 60 comparisons overall), to assess the consistency and co-movement of related search terminology. Zero RSV values were retained as valid observations; tied ranks were handled using standard Spearman methodology.

5.4 Significance Threshold and Multiplicity

All tests were two-tailed, with $p < 0.05$ considered statistically significant. Given the number of pairwise comparisons performed (60 total), analyses were treated as exploratory, and p-values were interpreted cautiously rather than formally adjusted for multiplicity.

5.5 Handling of Missing or Insufficient Data

Because this study uses a full, publicly available aggregated time series rather than a recruited or sampled cohort, no participant-level missing-data scenario applies. Where Google Trends returned insufficient or non-measurable data for a candidate keyword during the screening stage, that term was excluded from the final keyword set rather than imputed; no imputation was performed on the six retained time series.

5.6 Software

Statistical analyses were performed using standard statistical software capable of Spearman rank-correlation analysis; frequencies and percentages were not applicable, as the data are continuous aggregated RSV values rather than individual-level categorical counts.

6. Applicability of Patient-Registry Quality Elements

This study does not constitute a patient registry. It involves no recruitment, enrollment, or follow-up of individual human participants, and no patient-level data of any kind are collected, stored, or analyzed. Accordingly, the following elements are not applicable to this protocol: quality assurance/site monitoring plan, data validation/range-check procedures against a registry database, source data verification against medical records or case report forms, a

participant-level data dictionary, standard operating procedures for patient recruitment or adverse event reporting, and formal sample-size/power calculation (the full available Google Trends time series for each term and country was used, rather than a recruited cohort).