The Statistical Challenges of Designing Accelerated Longitudinal Cohort Studies: Insights from the GUIDE Project

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Abstract:

The *Growing Up in Digital Europe (GUIDE)* project is currently in its preparatory phase. It will generate high-quality comparative data on children's well-being across Europe through a multicountry accelerated longitudinal cohort (ALC) design. A piloting phase is underway in Italy to test survey instruments, sampling procedures, and field operations that will inform the design of future waves. This paper describes the structure of the accelerated design, outlines the main statistical challenges that must be addressed—such as mode effects, stratification, and attrition—and presents ongoing work using model-based simulations to evaluate the robustness of developmental curve estimation under different attrition scenarios.

1. *Background and rationale*

The Growing Up In Digital Europe (GUIDE) project aims to establish the first Europe-wide comparative birth cohort study. Its primary objective is to generate longitudinal statistical evidence on the well-being of children and young people growing up in Europe – from birth to adulthood – with the goal of informing and supporting evidence-based social policy across the continent. This will be achieved by developing harmonized survey tools and the coordinated administration of questionnaires to children and their caregivers across two birth cohorts. These cohorts will be followed from childhood or infancy through to early adulthood, with operations set to take place between 2028 and the mid-2050s.

Added to the *European Strategy Forum on Research Infrastructures* (ESFRI) Roadmap in 2021, GUIDE is currently in its preparatory phase (GUIDEPREP 2022–2026) and applies an accelerated longitudinal cohort (ALC) design on an unprecedented continental scale. ALC designs are increasingly central in population research, aiming to capture developmental trajectories within realistic time frames. By observing multiple overlapping cohorts, ALC designs disentangle age, period, and cohort effects more efficiently than single-cohort panels. The cross-country two-cohort design of GUIDE brings advantages but also introduces significant methodological and logistical

complexities, including harmonising sampling frames across jurisdictions, ensuring measurement invariance across developmental stages, and maintaining representativeness under heterogeneous field conditions.

GUIDE's survey design features two overlapping cohorts: an *infant cohort* beginning at roughly one year of age and a *child cohort* beginning around age eight. Both will be followed and interviewed using an age-specific questionnaire every three years until participants reach their mid-twenties. This accelerated configuration enables the reconstruction of developmental trajectories covering roughly the first 25 years of life within about two decades of data collection, thus substantially reducing the total time required for data collection compared to traditional single-cohort longitudinal studies.

Conceptually, GUIDE adopts an integrated model of child well-being that combines subjective (hedonic and eudaimonic) and objective dimensions. Indicators span emotional health, autonomy, social relationships, cognitive and physical development, education, family life, neighbourhood, and digital environment. This multidimensional framework reflects current theoretical and policy priorities in child well-being research (Rees et al., 2012; Pollock, Goswami, & Szymczyk, 2021) and underpins GUIDE's contribution to international policy agendas such as the *European Child Guarantee* and the *UN Sustainable Development Goals*.

From a methodological standpoint, GUIDE must achieve comparability and representativeness while remaining scalable across diverse statistical systems. Each participating country will draw probability-based samples for both cohorts – approximately 10,000 infant-caregiver and 8,000 child-caregiver pairs (in large countries) – using data-collection modes adapted to local feasibility (CAPI, CAVI, or CAWI). Cross-country harmonisation of the questionnaires is achieved through the TRAPD translation protocol (*Translation, Review, Adjudication, Pre-testing, Documentation*), coordinated via Centerdata's Translation Management Tool. Because the design is both longitudinal and cross-national, several analytical challenges arise, including aligning overlapping age ranges, testing psychometric equivalence across languages and age groups, managing attrition and refreshment samples, and dealing with multistage and mixed-mode sampling.

2. *The Italian pilot study*

To evaluate these challenges empirically, GUIDE launched a coordinated pilot phase as a methodological foundation for the first main wave. The conceptual and operational aspects of the Italian pilot study design are discussed in detail by Colella et al. (2026, *forthcoming*).

The Italian pilot, coordinated by the University of Bologna and the National Research Council (CNR-IRPPS), is currently taking place. It will collect data from about 600 families in each cohort by the end of 2025 and across four regions – Lombardy, Emilia-Romagna, Campania, and Apulia – chosen to capture the country's regional heterogeneity in socioeconomic conditions and service provision. The pilot aims to test recruitment strategies, evaluate the comparability of interview modes, and generate empirical evidence for refining the sampling plan of the first full wave. A pragmatic two-stage design is adopted.

- *Stage 1:* The Primary Sampling Units are municipalities divided into two strata: the regional capitals (Milan, Bologna, Naples, Bari) and provincial municipalities with more than 30,000 inhabitants. Ten municipalities per region were purposively selected to reflect demographic and geographic diversity.
- *Stage 2:* For the child cohort, recruitment relies on comprehensive school institutes (*istituti comprensivi*). From 862 institutes identified in the selected municipalities, 161 were chosen based on enrolment size, encompassing 358 schools that serve as gateways for contacting families of 8-year-olds. Schools will distribute information and consent forms electronically to families, who can schedule interviews online. For the infant cohort, recruitment will combine community contact points – nurseries, vaccination centres, early-childhood services and online outreach through local networks.

Data will be collected via computer-assisted interviews: CAPI for face-to-face sessions and CAWI for remote participation.

Although non-probabilistic, this design permits efficient sampling from the target population in the four regions and helps test procedures for future probability-based sampling.

3. *Statistical challenges and future work*

The empirical data generated from the Italian pilot study will inform the methodological design of the main survey in at least two key domains:

- Mode comparison (CAPI vs. CAWI): The Italian pilot's parallel administration of both modes allows quantitative assessment of measurement equivalence, response behaviour, and cost efficiency. Understanding how mode affects reporting – especially on subjective well-being indicators – will guide the definition of a robust mixed-mode protocol for Wave 1.

- Identification of effective stratification factors: Pilot data will be used to analyse which regional, demographic and socio-economic variables best explain differences in recruitment success and response patterns. This analysis will inform the stratification scheme for probability-based sampling in future waves.

Finally, we plan to investigate potential scenarios that may challenge the accelerated longitudinal cohort design adopted in GUIDE. A central question is whether the accelerated structure will allow for unbiased estimation of developmental trajectories for key indicators in the GUIDE questionnaire – such as emotional well-being, digital engagement, and educational outcomes. To address this, we will conduct a model-based simulation study examining different patterns and magnitudes of panel attrition and their effects on the estimation of developmental curves. This study involves the use of statistical models to estimate the developmental curve which are based on P-splines (Eilers & Marx, 1996). We expect the simulation will provide critical evidence for the design of retention strategies and for assessing the precision and robustness of growth-curve estimates under various attrition scenarios.

In our conference presentation, we plan to present either the results of this model-based simulation study or, depending on data availability, preliminary analyses from the Italian pilot study currently under implementation.

References

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