Conceptual Framework for the Development of a Summary Measure of Lifespan Inequity

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Abstract

Measures of lifespan inequality are increasingly used to assess population health from an egalitarian perspective, yet the normative assumptions embedded in their construction are rarely made explicit. This paper develops a normatively grounded summary measure of lifespan inequity, the Lifespan Inequity Index (LII), rooted in Ruger's Health Capability Paradigm. Within this framework, lifespan inequity is defined as the deprivation of health functioning under constrained health agency. This definition is operationalized as the depth of premature mortality occurring under structurally constrained conditions for autonomous health choice through a two-level measurement architecture. Foster–Greer–Thorbecke index captures functioning deprivation relative to a threshold within groups. The threshold is the Minimally Adequate Length of Life quantified as the adult modal age at death in the globally best-performing population. Capability weights across groups, derived from the circumstance-attributed component of mortality variation, capture the additional ethical importance of health shortfalls occurring under structurally constrained health agency. The two-level architecture mirrors the equality, priority, and sufficiency components of Ruger's shortfall-equality framework. We demonstrate the framework empirically across 1203 NUTS3 regions in 27 European countries in selected years between 2005 and 2019, with the external component of health agency constraints proxied by the Joint Research Center Local Vulnerability Index. The application shows that the LII separates configurations of lifespan inequity that pure mortality measures collapse. For example, Spain and Portugal show mortality shortfalls comparable to the Nordic countries but under sharply different structural conditions, while Bulgaria and Romania combine deep mortality shortfalls with severe structural vulnerability. The paper contributes a measurement framework that is transparent about its normative commitments and designed to support justice-sensitive monitoring of population health.

1 Introduction

Demographic measures commonly summarize population health in a single number. Life expectancy is the most common, but measures of lifespan inequality have also gained importance in recent decades. "Any judgment as to whether one health distribution is better (or worse) than another requires a normative theory" (Asada and Hedemann, 2002, p. 2). The normative assumptions underlying a measure

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should therefore be made explicit. They rarely are. In particular, lifespan inequality measures embed, whether their authors acknowledge it or not, normative commitments about which differences in lifespan matter morally and which do not, about the evaluative space in which health justice should be assessed, and about whose perspective and which reference standard should anchor cross-population comparisons. These are questions of distributive justice, not questions that data or statistical convention can settle, and different theories of justice answer them differently. Treating the choice of measure as a purely methodological decision does not remove these assumptions but simply leaves them unexamined (Asada, 2007; Murray et al., 2000).

Lifespan inequalities are generally examined using either a group or an individual approach. The group approach (also referred to as bivariate approach) quantifies systematic health differences across socio-economic strata defined by income, education, occupation, or race/ethnicity, but also depending on place of birth or across countries' populations. The individual approach (or univariate approach) characterizes the dispersion of health across individuals regardless of their other characteristics, describing social or physical location (Asada, 2013; Wolfson and Rowe, 2001). The group approach has dominated empirical and policy work on the grounds that health gaps between socially defined groups reflect structural injustice and are therefore the appropriate target of equity-oriented measurement (Almeida et al., 2001; Braveman, 2006; Braveman and Gruskin, 2003). The individual approach, forcefully advanced by Murray et al. (1999) and Gakidou et al. (2000) in the run-up to the *World Health Report 2000*, treats health as an intrinsic component of well-being whose unequal distribution matters in itself. This approach was criticized for decoupling inequality from social structure, and therefore, removing from the concept of health inequalities its ethical and political content (Almeida et al., 2001; Anand, 2002; Braveman, 2006; Braveman et al., 2000, 2001). On the other hand, the group approach to the measurement of lifespan inequalities has been criticized for its predominantly intrinsic normative assumption. As any population can be partitioned in many ways, the choice of grouping variable embeds a prior judgment about which social divisions are morally relevant, one that requires justification. Additionally, if inter-group inequalities are considered unjust, then the within-group inequalities obscured by group averages should likewise be regarded as unjust (Asada, 2013; Lippert-Rasmussen, 2013). Moreover, it is an individual, and not a group, who is ultimately the primary moral unit of analysis of health inequality (Asada, 2013; Lippert-Rasmussen, 2013; Temkin, 2013).

The ensuing debate has produced no clear winner. Asada (2013) argues that since neither approach alone fully captures what is morally and empirically at stake, the field should consolidate both. Building on this, Asada (2014) proposes a three-stage framework that decomposes total health inequality into (i) *univariate* inequality across individuals, capturing the overall dispersion of health; (ii) *univariate inequity*, the dispersion of the unfair component of health, identified through fairness-standardization on circumstance variables; and (iii) *bivariate inequities* tied to socially salient attributes such as income, education, gender, or race/ethnicity. The framework deliberately leaves open the contested value questions of the relative importance of overall versus socially-patterned inequity, and the relative weighting of different bivariate dimensions. It treats those value questions as matters for explicit ethical deliberation rather than a fixed methodological solution. The three-stage framework is, however, itself silent on a question its own architecture forces it to confront. The fairness-standardization at the heart of stage (ii) operates by partitioning observed health into a fair component (predicted from legitimate variables) and an unfair component (residual plus illegitimate variation). Because regression models of individual health typically explain only a modest share of the variance (20% in Asada's application), the unexplained residual dominates the unfair component by construction. The framework therefore presumes unexplained variation to be unfair, an assumption Asada (2014) themselves flag as "debatable" and as requiring "deeper consideration than mere technical" (p. 11). Empirically, this presumption has the effect of collapsing conceptually distinct definitions of health inequity into statistically indistinguishable estimates, so that the philosophical pluralism the framework promises is not recoverable from the data it produces. Resolving this residual problem requires more than a better index or richer data. It requires an architecture in which structural agency constraints are identified directly through observed circumstance-related mortality patterns rather than inferred from unexplained residual variation. The framework developed in this paper takes that step. By placing the individual as the primary locus of justice while systematically accounting for the social and environmental conditions that shape what health outcomes people can realistically achieve, it provides normative grounding for both dimensions of lifespan inequity that neither the bivariate nor the univariate tradition alone does.

Muszyńska-Spielauer et al. (2025) recently proposed a measure of lifespan inequity grounded in Nussbaum's version of the capability approach, applying Sen–Shorrocks–Thon indices, with Foster–Greer–Thorbecke indices as a complementary measure, to the distribution of ages at death relative to the Minimally Adequate Length of Life threshold. The measure is an important advance in grounding a lifespan inequality index in an explicit theory of justice. Nussbaum's framework, however, does not address the aggregation problem of whether and how priority should be given to larger lifespan shortfalls, and the authors therefore defer to the poverty-measurement axioms of Sen (1976) and related work for the quantification step. The definitional work is thus carried out under Nussbaum's authority and the aggregative work under the poverty-measurement tradition, with no philosophical bridge between them. This is the gap the present paper closes.

The paper contributes a justice-sensitive measure of lifespan inequity that integrates individual mortality shortfalls with structurally constrained health agency within a unified capability framework. The paper is structured as follows. Section 3.3 presents Ruger's Health Capability Paradigm, focusing on the functioning/agency distinction within health capability, the shortfall equality principle, and its sufficientarian/prioritarian hybrid structure. The next three sections develop the empirical framework following the three steps defined by Asada (2007, 2014): Section 3.1 defines lifespan inequity within Ruger's framework, Section 3.2 operationalizes the definition and specifies the two components of health agency constraint, and Section 3.3 specifies the functional form and weighting scheme. Section 4 presents empirical applications to European NUTS3 regions. Section 5 concludes.

2 Ruger's Health Capability Paradigm

Ruger's health capability paradigm (HCP) is grounded in an Aristotelian conception of human flourishing as its ethical foundation. Health is part of human flourishing rather than merely instrumental to it: being healthy is part of what it means to live a good life, not simply a precondition for achieving other independently valued ends (Ruger, 2006c, 2010a). Because health is intrinsic to well-being, its deprivation carries independent ethical importance that cannot be offset by gains in other dimensions of life. At the same time, continued life and adequate health are prerequisites for the exercise of other human capacities (Ruger, 2009). Grounded in equal moral respect for all persons, the HCP holds that individuals — not institutions or groups — remain the proper unit for conceptualizing, measuring, and evaluating health policy, even as health capabilities are shaped by structural and relational conditions (Ruger, 2010b).

The central concept of the HCP is *health capability*, defined as a person's ability to be healthy. This notion encompasses actual health achievements, named in the capability approach as *functionings*, as well as *health agency*, wich refers to the capacity to make and act upon health-related choices (Ruger, 2009, 2010b). Both health functioning and health agency are normatively significant and policy-relevant, and an account of health capability requires attending to both.

Within the HCP, justice requires securing certain *central health capabilities* for all individuals as a matter of primary moral obligation. The two central health capabilities are: (a) the capability to avoid premature death, and (b) the capability to avoid escapable morbidity. Among them, avoiding premature death is the prerequisite for all others: "without life itself, no other human functionings, including 'agency,' are possible" (Ruger, 2006a, p. 407).

The following description of the HCP focuses on the central capability to avoid premature death, as this is the focus of this paper. The HCP assesses the achievement of this central health capability through the concept and method of *shortfall equality*: justice is evaluated in terms of the gap between length of life and the threshold age, which divides premature deaths from non-premature deaths. The normative structure of Ruger's shortfall equality principle combines the concepts of equality, priority and the (sufficientarian) threshold (Ruger, 2010a). The sufficientarian structure (Frankfurt, 1987) defines the morally relevant space: shortfalls below the threshold are unjust; deaths occurring above it carry no moral weight. Within this space, prioritarian principles (Crisp, 2003; Parfit, 1995) operate through disproportionate concern: those most severely compromised in terms of length of life have the strongest claims (Ruger, 2006a). This concern runs along two dimensions: depth of shortfall (those further below the threshold have stronger claims) and conditions of shortfall (deprivations arising under severely constrained health agency carry greater moral weight than equivalent deprivations arising under unconstrained agency, as they more fully reflect capability failure rather than autonomous choice). Both dimensions operate only below the threshold — above it, the sufficientarian structure renders priority weighting irrelevant.

The HCP operationalizes the central health capability of avoiding premature death with respect to a threshold in the highest performing population (Ruger, 2006b). This definition has two important features. First, the reference standard is empirical rather than idealized: it refers to what has actually been achieved by human populations under favorable conditions, not to a theoretical biological maximum or utopian aspiration. Second, it is universalist: the same reference standard applies to all populations, reflecting Ruger's commitment to equal moral respect for all persons regardless of national or social context. Societies are judged not against their own historical performance but against what the best-performing populations have demonstrably achieved.

Ruger (2010b) distinguishes between factors internal and external to the individual that together form an individual's health capability profile. Internal factors encompass both health functioning and the personal cognitive, motivational, and informational resources that determine health agency: health knowledge, health-seeking skills and beliefs, self-efficacy, decision-making capacity, and intrinsic motivation for health. Notably, by placing health functioning alongside these agency-related components within internal factors, Ruger treats functioning not merely as an outcome of health policy but as a dimension of the individual's health capability — consistent with her broader claim that functioning and agency are co-equal ends of justice. External factors refer to the broader social and physical environment: social norms and networks, material and economic circumstances, access to health services, and enabling public health and healthcare systems. The two sets of factors are complementary rather than substitutable. High internal capacity is insufficient when the external environment lacks adequate infrastructure, is characterised by economic precarity, or exposes individuals to environmental hazards. Conversely, a rich external enabling environment can partly compensate for limited internal capacity. A further commitment of the HCP is shared health governance: the general duty to promote central health capabilities is distributed across global, national, and local actors, as well as individuals themselves, with states holding primary responsibility (Ruger, 2009, 2012). Justice in health therefore requires institutional accountability for the conditions under which health agency can be exercised, and measurement of capability shortfall must register those conditions at the level at which they are produced.

3 Framework for defining and measuring lifespan inequity

We apply Ruger's Health Capability Paradigm to develop a framework for measuring lifespan inequity, following the three-step procedure for health inequity measurement (Asada, 2007, 2014): definition, operationalization, and quantification. Each step is developed in a separate subsection below.

The framework is a direct response to the intra-group inequality challenge raised in the introduction: the observation that group-level measures conceal within-group inequalities, while individual-level measures cannot register the structural patterning that distinguishes morally arbitrary deprivation from unconstrained shortfall (Asada, 2013; Lippert-Rasmussen, 2013). We address both dimensions simultaneously through a two-level architecture: a within-group component preserving the individual as the primary moral unit, and a between-group component quantifying the structural conditions under which individual shortfalls occur. The individual remains the locus of justice and the group enters as the institutional level at which the conditions for health agency are determined.

3.1 Defining Lifespan Inequity

Within Ruger's HCP, we define lifespan inequity as a capability deprivation constituted by the joint failure of health functioning and health agency. It manifests as the depth of premature mortality that occurs under conditions of constrained health agency, where those constraints arise from morally arbitrary circumstances. These structural conditions are themselves objects of justice evaluation, because they are morally arbitrary in Ruger's sense: circumstances over which the individual has no meaningful control yet which shape her health capability. These circumstances generate claims of justice against the structural arrangements that sustain them (Young, 1990). Under this definition we can measure health capability shortfall, i.e., the joint failure of functioning and agency.

3.2 Operationalization

The functioning dimension of capability shortfall is observable at the individual level as the distribution of ages at death in a period life table, where the period life table represents survival according to period-specific population health and mortality conditions (Preston et al., 2000). The agency dimension is approximated indirectly, at the structural level, through circumstance variables.

The threshold: Minimally Adequate Length of Life

Shortfall equality analysis requires a reference norm against which we quantify the shortfalls in health functioning. Such a norm takes the form of a defensible benchmark, reflecting what individuals ought to be able to achieve under just social conditions. Following Muszyńska-Spielauer et al. (2025), we name this threshold as the *Minimally Adequate Length of Life* (MALL), and quantify it as the adult modal age at death. Different from Muszyńska-Spielauer et al. (2025), we define the MALL as the best-practice global rather than country-specific modal age at death. This definition of the MALL has three properties that align it with Ruger's normative framework. First, it increases only when mortality declines at ages above the mode, so the threshold rises only when societies extend longevity at older ages; reductions in mortality below the mode reduce the number of premature deaths without shifting the threshold itself (see Muszyńska-Spielauer et al., 2025). Second, it is empirical rather than idealized: it refers to what human populations have actually achieved under favorable institutional and environmental conditions, not to a theoretical maximum. Third, it is universalist: the same standard applies to all persons regardless of national or regional context, reflecting Ruger's principle that the circumstances of birth cannot justify a lower sufficiency norm (Ruger, 2009, 2010b).

The agency dimension: internal and external components

Following Section 3.3, the two components of health agency are operationalized through empirical proxies that capture the conditions under which agency can be exercised. Ruger's framework locates responsibility for the conditions of health agency at the institutional level, but agency itself is exercised by individuals and agency constraints are experienced individually. The institutional level is the level of moral responsibility and policy intervention, not the level at which agency itself resides.

The standard empirical proxy for the internal component is educational attainment. Ruger explicitly links education to internal agency capacity: better-educated individuals can "negotiate the external environment more effectively to achieve health" (Ruger, 2010b, p. 43). Education is therefore not merely a socio-economic correlate of health but a central determinant of internal agency: it shapes health literacy, the ability to navigate healthcare systems, and the capacity to make informed autonomous health choices. This view finds independent support in the sociological literature: Link and Phelan (1995) propose that socio-economic status functions as a fundamental cause of health inequalities precisely because it embodies flexible resources that individuals use to avoid disease risks and minimise the consequences of illness, with education being both the primary source of this resource and the standard proxy through which the enduring socio-economic gradient in mortality has been documented (Link and Phelan, 1995; Phelan et al., 2004).

The external component of agency is approached through proxies that capture place-based structural conditions. Place of birth and place of residence are the primary axes along which the external opportunity structure varies, since they determine the institutional, environmental, and social environment within which an individual's health agency is exercised. Place of birth is among the most morally arbitrary of all circumstances in Ruger's sense, and residential mobility is itself constrained by the very socio-economic conditions that create deprivation, reinforcing the moral arbitrariness of place-based health capability constraints throughout the life course. A valid proxy must satisfy two conditions: it must capture the structural opportunity environment within which individuals live, and it must do so independently of the health outcome it is being used to weight (Robeyns and Byskov, 2025; Ruger, 2010b).

3.3 Quantification

The quantification proceeds in three stages, each corresponding to one element of Ruger's hybrid normative structure. Individual shortfalls below the MALL implement the sufficientarian threshold. Within-group aggregation by the FGT index with $\alpha = 1$ implements linear prioritarianism within the sufficientarian space defined by the MALL. Between-group aggregation by capability weights implements Ruger's principle of disproportionate concern, distributing moral weight in proportion to the structural agency constraints faced by each group.

Health functioning shortfalls

Groups j are defined by the joint configuration of internal and external circumstance proxies, so that each group represents a distinct combination of internal and external conditions for health agency.

Individual shortfall is defined as:

$$z_i = \max(0, \mathrm{MALL} - x_i), \tag{1}$$

where x_i denotes the age at death of individual i. Deaths occurring at or above the MALL generate zero shortfall, implementing the sufficientarian structure: above the threshold, there is no contribution to the measure of lifespan inequity. Deaths below the MALL generate positive shortfall proportional to the gap from the threshold.

The within-group component of the LII is constructed from the Foster–Greer–Thorbecke (FGT) class of indices (Foster et al., 1984, 2010), originally proposed in the poverty measurement literature. The FGT class indexes a family of summary measures of distance from a threshold parameterized by a sensitivity parameter α. For a distribution of outcomes $\{x_i\}$ and a threshold z:

$$\mathrm{FGT}_\alpha = \frac{1}{n}\sum_i \left(\max\left(0, \frac{z - x_i}{z}\right)\right)^\alpha . \tag{2}$$

Different values of α correspond to different normative commitments: FGT with $\alpha = 0$ counts the proportion of the population below the threshold without regard to depth; FGT with $\alpha = 1$ measures the average normalised shortfall; FGT with $\alpha = 2$ weights deeper shortfalls more heavily than shallower ones.

The FGT family is one of two widely used poverty-measurement adaptations to lifespan inequity, alongside the Sen–Shorrocks–Thon (SST) index used in Muszyńska-Spielauer et al. (2025). We chose the FGT over the SST because the *alpha* parameter makes the within-group prioritarian commitment explicit and adjustable. The SST index has only the form analogous to FGT with $\alpha = 2$, embedding a stronger inequality aversion than the framework calls for, as discussed next.

We adopt $\alpha = 1$ for two reasons. First, Ruger's principle of disproportionate concern requires that those with greater shortfalls have stronger claims but does not specify the rate at which priority increases with depth. $\alpha = 1$ is the minimal commitment that respects this requirement, with each year below MALL contributing proportionally to the index, without imposing additional convexity that Ruger's framework does not independently warrant, which would be the case for $\alpha = 2$. Second, the two-level architecture defined in the previous step is operationalized so that the prioritarian work is done both within groups (through depth sensitivity) and between groups (through structural capability weights). For $\alpha = 1$, the two prioritarian components remain analytically separable in the final index: the capability weight γ_j carries the structural-prioritarian moral weight independently of the within-group depth term.

For each group j, the individual proportional shortfalls over the life-table death distribution as (derived for the life-table radix equal one in all groups, $\ell(0) = 1$) is aggregated with the FGT index with $\alpha = 1$ as:

$$\mathrm{FGT}_{1,j} = \int_{x=0}^{\omega} z_j(x)\rho_j(x)\,\mathrm{d}x, \tag{3}$$

where $\rho_j(x)$ denotes the density of deaths at age x in group j and $z_j(x) = \max\left(0, \frac{\mathrm{MALL}-x}{\mathrm{MALL}}\right)$ is the normalized individual shortfall at age x in group j. Shortfalls are normalized by the MALL to express them as proportions of a normal lifespan rather than absolute years, ensuring comparability across populations and over time as the threshold evolves (Muszyńska-Spielauer et al., 2025).

Capability Weights for Constrained Health Agency

The capability weights are not direct measures of health agency itself. Rather, they operationalize structural conditions constraining the exercise of health agency, identified through their empirical association with mortality. The framework therefore measures capability shortfall indirectly: it captures mortality deprivation occurring under constrained opportunity conditions for autonomous health choice, not agency capacity per se.

The capability weights operationalize Ruger's principle of disproportionate concern through a parametric ex-ante approach to inequality measurement: the empirical association between structural conditions and mortality serves as evidence for which features of the structural environment constrain health agency.

This procedure for deriving the capability weights corresponds to the parametric ex-ante approach in the health inequality of opportunity (IOp) literature (Fleurbaey and Schokkaert, 2009; García-Gómez et al., 2015; Jusot et al., 2013; Trannoy et al., 2010). While that literature is grounded in a different normative tradition from the one developed in Section 3.1, the operationalization parallels established practice: It is standard practice to estimate how much variation in mortality is attributable to circumstances, and to treat that share as the justice-relevant component. We borrow the procedure but not the normative architecture. In particular, we do not adopt the circumstance/effort partition with individual responsibility as the dividing line. In our framework, and following Ruger, the moral weight attached to structural conditions derives from their role in constraining health agency rather than from a distinction between responsibility and circumstances.

The regression informs but does not define the construct of health capability: it identifies which features of the structural environment are empirically associated with the central health capability of avoiding premature death, and the fitted circumstance-attributed component of mortality serves as the basis for the capability weights. Estimates constructed this way should be interpreted as lower bounds on true capability shortfall, since structural agency constraints not captured by the observed circumstance vector are absorbed into the residual rather than the explained variance component, in line with the standard interpretation in the parametric IOp literature (Carrieri and Jones, 2018; Rosa Dias, 2010).

The weights are derived in three steps.

In step one, we estimate the circumstance–mortality relationship through a Poisson regression of age- and sex-specific death counts on circumstance variables, with log-exposure as offset:

$$\log \mathbb{E}[D_{jax}] = \log P_{jax} + \alpha_a + \alpha_x + \alpha_t + \sum_k \beta_k^{\text{int}} I_{kj} + \sum_l \beta_l^{\text{ext}} X_{lj}, \tag{4}$$

where D_{jax} and P_{jax} are deaths and population in group j at age a and sex x; α_a, α_x, α_t are age, sex, and period fixed effects; I_{kj} are the internal-component circumstance proxies for group j (indexed by k); and X_{lj} are the external-component circumstance proxies for group j (indexed by l). Including age, sex, and period as fixed effects ensures that the coefficients identify the *structural* component of mortality variation associated with circumstances, net of demographic composition and period-specific shocks.

The Poisson specification with log-exposure offset is equivalent to a piecewise-constant proportional hazards model on the underlying individual data (Holford, 1980; Laird and Olivier, 1981), placing the approach within the standard survival-analytic framework while remaining appropriate for aggregated mortality data.

In step two, the weights for the circumstance-attributed component of health agency constraints are derived. For each group j, we compute the linear predictor restricted to the circumstance component:

$$\eta_j = \sum_k \hat{\beta}_k^{\text{int}} I_{kj} + \sum_l \hat{\beta}_l^{\text{ext}} X_{lj}. \tag{5}$$

This isolates the part of log-mortality systematically related to a group's circumstances — both internal and external — after adjusting for age, sex, and period. The estimate is model-relative: other specifications within the same framework would give different numbers. We return to the implications of this in the discussion section.

The corresponding mortality multiplier, which expresses the multiplicative mortality penalty associated with group j's circumstance profile relative to a baseline, is derived as

$$\tilde{\gamma}_j = \exp(\eta_j) \tag{6}$$

The exponential form follows from the multiplicative structure of mortality and the proportional-hazards interpretation of the underlying model. It is preferred over an additive form $\tilde{\gamma}_j = 1 + \Delta_j$ because it is scale-invariant and reflects the empirical regularity that mortality penalties multiply rather than add across circumstances (Mackenbach et al., 2015; Phelan et al., 2004)

Finally, in step three, the raw multipliers are normalized so that the population-weighted average equals one:

$$\gamma_j = \frac{\tilde{\gamma}_j}{\sum_m \pi_m \tilde{\gamma}_m}, \tag{7}$$

where π_m is the population share of group m derived from actual composition of the study population (Equation 8). The normalization ensures that $\sum_j \pi_j \gamma_j = 1$. The weights therefore function as relative moral weights, redistributing concern across groups around a population average of 1. The LII coincides with the unweighted FGT index when constraints are uniformly distributed and departs from it as constraints diverge. The unweighted FGT index thus provides a natural benchmark against which the LII can be read.

Aggregation to the population level

Group-level FGT index scores and capability weights are aggregated to a population-level summary index using shares of actual population at the study radix age. For each group j, the population weight is:

$$\pi_j = \frac{B_j}{\sum_m B_m}, \tag{8}$$

where B_j denotes the size of population in group j at the life table radix age. Therefore, we propose to derive the index from the age at death distribution in a life table of the total population "under current risk composition" (Muszyńska-Spielauer et al., 2025).

The Lifespan Inequity Index is then defined as the capability-weighted, population-weighted sum of group FGT index scores:

$$\text{LII} = \sum_j \text{FGT}_{1,j} \cdot \pi_j \cdot \gamma_j, \tag{9}$$

where γ_j is the normalized capability weight defined in Equation (7) and π_j is the population share defined in Equation (8).

The product $\pi_j \cdot \gamma_j$ defines an effective moral weight for group j that combines relative size of the sub-populations with structural agency constraint. Groups that are large and face high structural agency constraints receive the greatest effective weight; smaller or less-constrained groups receive less.

4 Empirical Application: European NUTS3 Regions

The empirical application serves three purposes. First, it demonstrates the operational feasibility of the LII by implementing the full three-stage quantification procedure. Second, it provides substantive evidence on the geography of lifespan inequity in Europe, examining both the cross-sectional distribution of the LII across 27 countries and its evolution over four reference years spanning 2005 to 2019. This period was characterised by sustained but uneven mortality improvement across the continent — initial convergence followed by renewed divergence in more recent years (Sauerberg et al., 2024). Third, it illustrates the added value of the capability weighting component by comparing the LII against the unweighted FGT index average and showing how the two diverge when structural agency constraints are unevenly distributed across regions.

We operationalize only the external, structural components of health agency, i.e., the institutional and environmental conditions that Ruger identifies as necessary for agency formation. We treat this as a measure of health agency enablement, acknowledging that a complete account would require integration of internal, cognitive, and motivational dimensions beyond the scope of this analysis. The external component of health agency is operationalized using NUTS3 regions as the unit of analysis, the institutional level at which the external component operates. We do not operationalize the internal component of health agency, i.e., cognitive and motivational resources, as it requires individual-level linked data, which is not available at European cross-regional scale to us at this point.

4.1 Data and Methods

The analytical sample covers 1203 NUTS3 regions across 27 European countries in four reference years: 2005, 2010, 2015, and 2019. For the number of NUTS3 regions per country and study year see Table 3 in the online supplementary material. The year 2005 is the first observation year in the data. The year 2020 is excluded to avoid distortion from COVID-19 excess mortality.

Mortality and population data at the NUTS3 level by age and sex are obtained from the ARDECO regional database (European Commission, Joint Research Centre, 2026a), maintained by the European Commission's Directorate General for Regional and Urban Policy. Deaths come in 5-year age groups with an open age interval of 90+. Exposures in the corresponding age groups were derived from the population by age in single-age groups, with an open age interval of 99+. NUTS3 life tables are constructed with age-specific mean years lived in the interval (a_x) borrowed from HMD country-level abridged life tables (Human Mortality Database, 2026).

The minimal adequate length of life (MALL) is estimated separately by sex at the national level by smoothing single-year mortality data (from Human Mortality Database (2026)) with a B-spline Poisson regression on ages 10 and above, locating the country-specific modal age as the maximum of the smoothed death density, and taking the maximum across countries within each year and sex. The procedure is consistent with the modal-age literature (Diaconu et al., 2020, 2016; Horiuchi et al., 2013; Ouellette and Bourbeau, 2011). Smoothing is required for the MALL because the modal age is a point feature whose location is sensitive to noise at the surrounding ages; the FGT index calculation, by contrast, integrates a smooth shortfall function over the sub-MALL portion of the life-table death distribution and is not sensitive to age-specific fluctuations in the same way.

FGT_1 is computed at the within-interval average age at death $x + a_x$ rather than the start age x, so that the contribution of each interval reflects the actual age at death of those who die in that interval rather than the lower bound of the interval.

Structural circumstance proxies are drawn from the Joint Research Center Local Vulnerability Index, accessed via the Risk Data Hub API maintained by the European Commission's Joint Research Centre (Eklund et al., 2023; European Commission, Joint Research Centre, 2026b). Three NUTS3-level sub-indices are retrieved for years 2005-2019: the social dimension (`lvi-soc`), the economic dimension (`lvi-eco`), and the environmental dimension (`lvi-env`). The capability weights γ_j are estimated, separately by year and sex, as a Poisson regression of regional deaths on 5-year age-group fixed effects and a composite vulnerability score V_j. The score is derived from the first principal component (PC1) of the standardised sub-indices: the three sub-indices are correlated, and PC1 captures their common variation as a single structural-vulnerability signal. This allows us to avoid the multicollinearity that would arise if the three dimensions were entered separately. The fitted contribution of V_j is then exponentiated and normalised so that $\sum_j \pi_j \gamma_j = 1$, where π_j is the share of population age zero (births) in region j within the country.

To make the country-level role of capability weighting transparent, we decompose the LII into a population-weighted mortality component and the contribution of structural conditions. For each country c, define:

$$\overline{\text{FGT}}_c = \sum_{j \in c} \pi_j \cdot \text{FGT}_{1,j}, \qquad \Delta_c^{\text{rel}} = \frac{\text{LII}_c - \overline{\text{FGT}}_c}{\overline{\text{FGT}}_c} \tag{10}$$

where $\overline{\text{FGT}}_c$ is the mortality shortfall weighted by the share of population at the radix age and Δ_c^{rel} is the relative contribution of capability weighting to the country's LII. Positive values indicate that mortality in country c is concentrated in regions with above-average structural agency constraints, raising LII above the unweighted shortfall; negative values indicate the opposite.

Full implementation details, including reconciliation of single-age populations with 5-year deaths, the specific a_x aggregation rules at boundary intervals, the partial 90+ contribution to FGT_1 when MALL > 90, and substitution rules for countries without HMD coverage, are documented in the replication code at `[repositoryURL]`.

4.2 Results

Table 1 reports the MALL in the four study years, by sex and by best-performing country. The MALL rises steadily for both sexes. Because the modal age responds only to mortality declines at ages above the existing mode, this upward drift indicates progressive old-age mortality compression in the best-performing populations. The sex-specific gap of roughly five years remains stable, indicating that the frontier has shifted upward in parallel for men and women rather than converging.

Panels (a) of Figures 1 and 2 present the regional FGT indices for females and males. The colour scale for all plots is centered on the pooled European mean in all study years by sex. A pronounced East-West gradient is the dominant feature of all the plots and is stable across the period: regions in Bulgaria, Romania, the Baltic states, Hungary, Slovakia, Croatia, and parts of Poland register the

Table 1: Minimally adequate length of life (MALL) and the country holding this value

	Female		Male	
Year	MALL	Country	MALL	Country
2005	90.6	Japan	85.6	Luxembourg
2010	91.4	Japan	86.8	Iceland
2015	92.0	Japan	87.7	Iceland
2019	92.8	Hong Kong	88.9	Hong Kong

Data Source: Human Mortality Database (2026)

deepest functioning shortfalls; regions in Switzerland, the Nordic countries, the Netherlands, and parts of Spain and France register the smallest shortfalls.

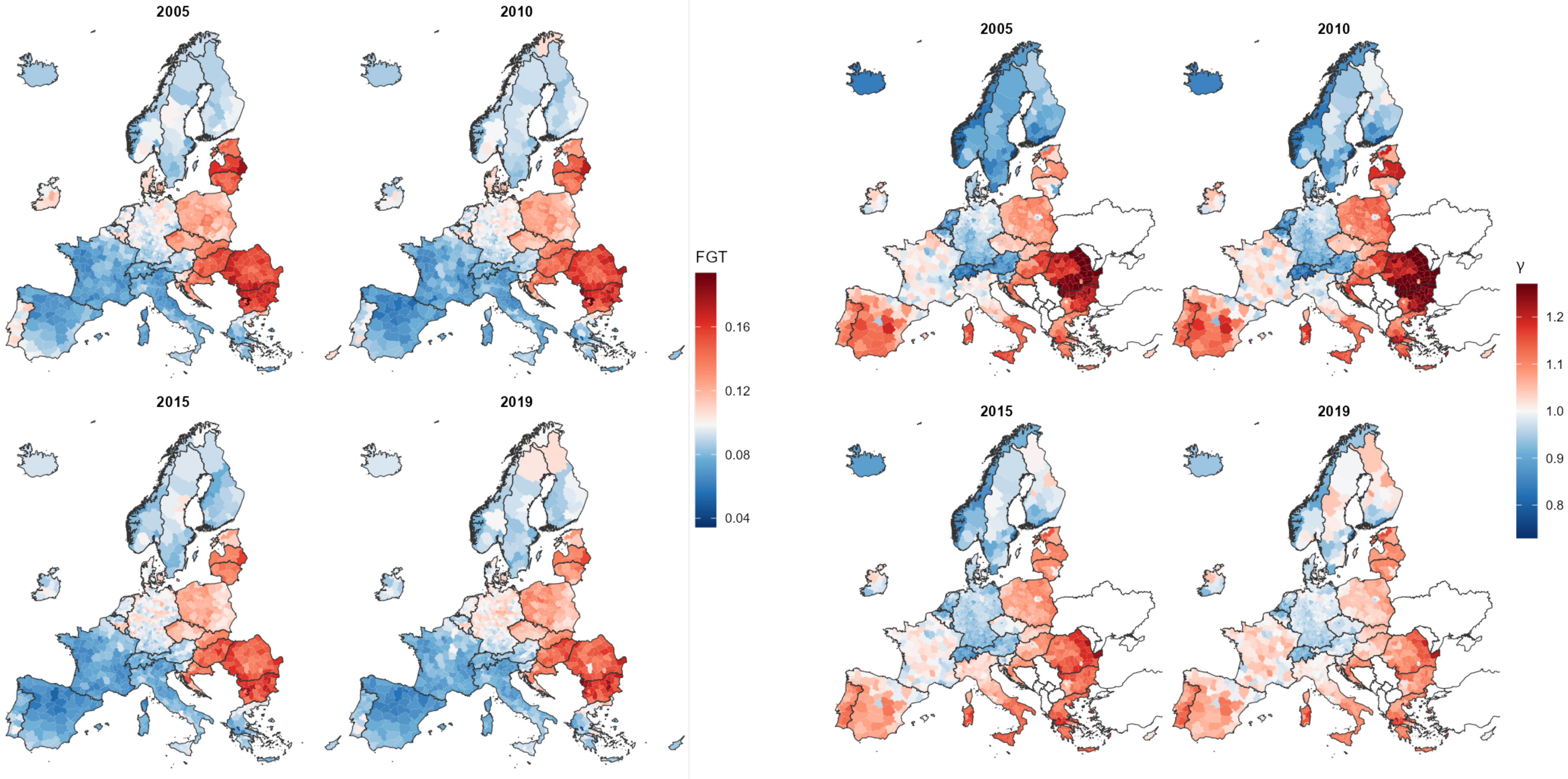
The temporal pattern is one of broad but uneven improvement. The largest reductions between 2005 and 2010 occur in the Baltic states and parts of Central Europe, and convergence toward the European mean continues through 2015. By 2019 several regions in the southeastern periphery show stagnation or partial reversal, in line with the renewed divergence in European regional mortality documented by Sauerberg et al. (2024). Within-country heterogeneity is visible at NUTS3 scale, most clearly in Germany, France, Italy, and Spain. The male maps are markedly more heterogeneous than the female maps, and the male-female differential is largest in the Baltic and Central European countries, in line with the well-documented excess male mortality of the post-socialist transition period (Mackenbach et al., 2008). In the framework's vocabulary, panels (a) report functioning shortfall, not capability shortfall: they are silent on the structural agency constraints under which these deaths occur, which are shown in panels (b).

Panels (b) of Figures 1 and 2 report the capability weights γ_j, which by construction have a population-weighted European mean of one in each year. Regions with $\gamma > 1$ (red) face above-average structural agency constraints; those with $\gamma < 1$ (blue) operate under more favourable structural conditions. Three patterns are visible. Regions in Southern Spain, Southern Italy, and parts of Greece appear blue on the FGT index maps, indicating relatively low health capability shortfalls, but red on the γ maps. The Nordic countries display low values on both. Within Eastern Europe the picture is heterogeneous: Bulgaria and Romania exhibit both the highest FGT and the highest γ throughout, while Czechia has elevated FGT and, since 2015, γ near or below the European average.

The geography of γ differs systematically from the geography of FGT, confirming that functioning and structural agency capture distinct dimensions of capability shortfall. In Southern Europe, residual premature mortality is concentrated in regions of pronounced structural constraints, so the framework registers it as carrying greater moral weight than FGT alone implies. In the Nordic countries, the low functioning shortfalls arise under comparatively unconstrained agency, so capability weighting leaves them largely unchanged. Bulgaria and Romania are the limiting case the theory anticipates: deep functioning shortfalls compound with severe structural constraints.

Table 2 reports Pearson correlations across NUTS3 regions. The correlation between FGT and γ is moderate, confirming that structural agency constraints and mortality shortfall are related but distinct. This is precisely the empirical condition under which capability weighting can do meaningful normative

Figure 1: Regional FGT and capability weights, females



(a) FGT index

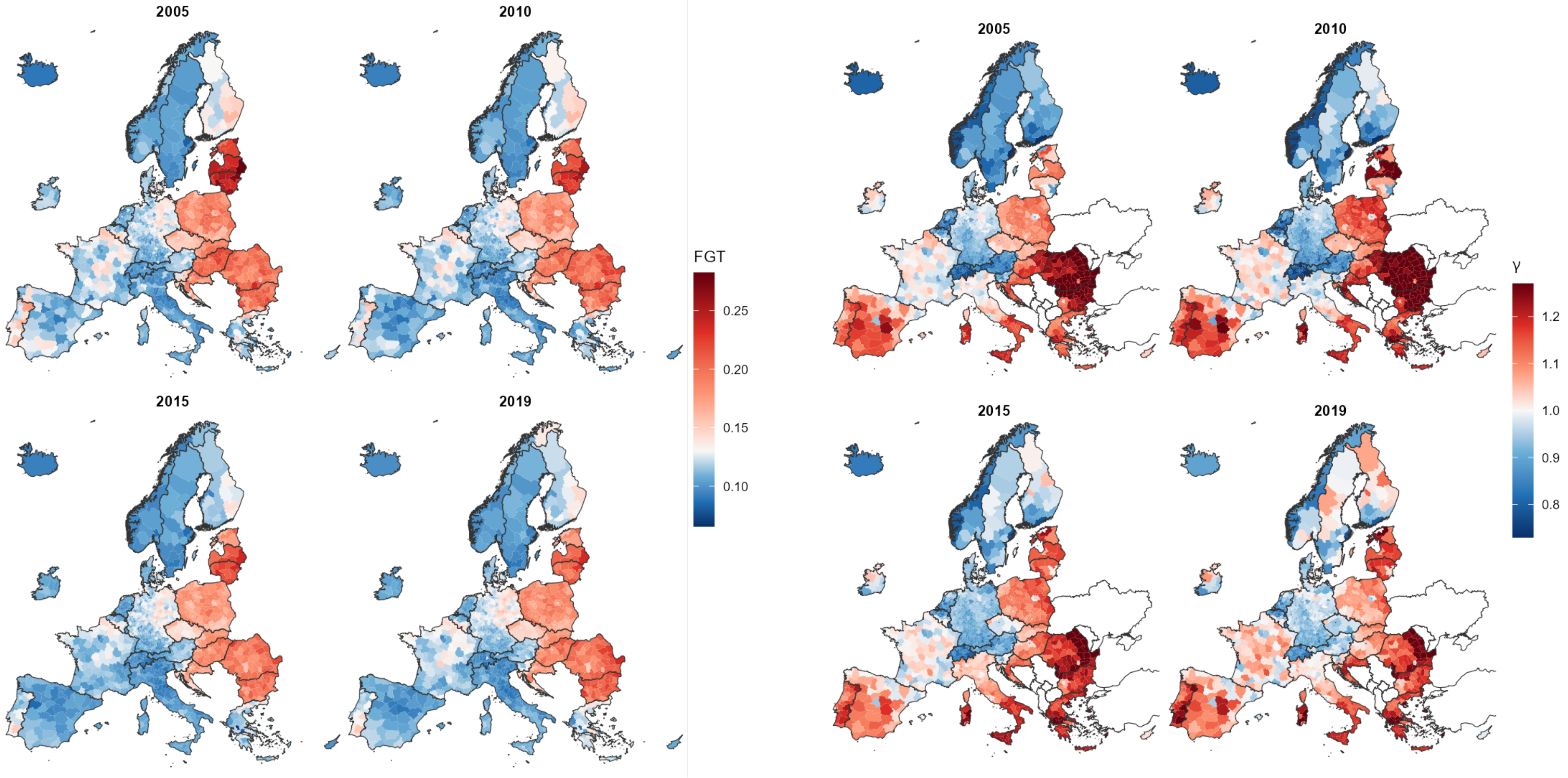
(b) Capability weights

Note: For FGT index: Diverging color scale centered at the European mean FGT for females (pooled across reference years), 0.099. Blue indicates regions below the European average; red indicates regions above it. Scale is fixed across all four panels to facilitate temporal comparison.

For capability weights: Red indicates regions where capability weighting amplifies the apparent shortfall ($\gamma_j > 1$); blue indicates regions where it dampens it ($\gamma_j < 1$).

Data Sources: European Commission, Joint Research Centre (2026a,b); Human Mortality Database (2026).

Figure 2: Regional FGT and capability weights, males



(a) FGT index

(b) Capability weights

Note: For FGT index: Diverging color scale centered at the European mean FGT for males (pooled across reference years), 0.130. Blue indicates regions below the European average; red indicates regions above it. Scale is fixed across all four panels to facilitate temporal comparison.

For capability weights: Red indicates regions where capability weighting amplifies the apparent shortfall ($\gamma_j > 1$); blue indicates regions where it dampens it ($\gamma_j < 1$).

Data Sources: European Commission, Joint Research Centre (2026a,b); Human Mortality Database (2026).

work. If γ closely tracked FGT, weighting would largely re-scale FGT without redistributing moral concern. If γ were unrelated to FGT, it would amount to noise. The observed moderate correlation is what the theoretical framework anticipates — structural agency constraints explain a substantial part of the geography of premature mortality without exhausting it, leaving room for the weighting stage to redistribute moral concern in a non-trivial way.

On the other hand, the correlation between FGT and FGT$\times\gamma$ is consistently high, indicating that the capability weighting does not inflate the index or reshape the cross-regional FGT distribution. It scales each region's shortfall up or down by a moderate amount. This is the expected outcome, as the functioning shortfall remains the primary observable component of capability shortfall, with capability weighting doing meaningful but bounded modification. The substantive content of that refinement cannot be read from the linear correlation, however, and is examined in the country-level analysis below. Finally, the FGT-γ correlation declines markedly over time, implying that the geography of premature mortality and the geography of structural disadvantage have become less aligned across the study years across European NUTS3 regions.

Table 2: Pearson correlations across NUTS3 regions between FGT and capability weights ($r(\text{FGT}, \gamma)$), and FGT and the capability-weighted product (r(FGT,FGT$\times\gamma$)), by year and sex.

	Females		Males	
Year	$r(\text{FGT}, \gamma)$	$r(\text{FGT}, \text{FGT}\times\gamma)$	$r(\text{FGT}, \gamma)$	$r(\text{FGT}, \text{FGT}\times\gamma)$
2005	0.50	0.96	0.56	0.95
2010	0.51	0.95	0.61	0.94
2015	0.33	0.96	0.48	0.95
2019	0.28	0.97	0.46	0.96

All correlations significant at $p < 0.001$. *Sources:* European Commission, Joint Research Centre (2026a,b); Human Mortality Database (2026).

Figures 3 and 4 report country-level lifespan inequity index (LII) values (panels (a)) and the relative contribution of capability weighting to the index (panels (b)). The numbers are presented in Tables 4 and xxx in the online supplementary material.

The geographical pattern of LII is broadly consistent with the regional FGT geography but exhibits a sharper east-west gradient than the FGT index for NUTS3 regions. Switzerland, Sweden, Luxembourg, Norway, and Iceland register the lowest LII for both sexes throughout; Bulgaria, Romania, Latvia, Lithuania, and Hungary register the highest. Bulgaria and Romania occupy the high end of the European LII distribution because deep functioning shortfalls coincide with severe structural agency constraints — the configuration the framework was built to register. Each dimension alone would register their disadvantage, but neither would place them at the extreme of the distribution; that position emerges from the compounding of the two. For example, the 2019 male LII for Bulgaria, Romania, Latvia, and Lithuania (0.22-0.23) is almost three times the Swiss value (0.08), a magnitude that reflects the multiplicative interaction of the two levels rather than additive disadvantage on either.

The maps with the relative contribution of capability weighting to the index expose a normatively important pattern that the unweighted FGT index obscures. Spain and Portugal sustain consistently positive contributions despite comparatively favorable mortality outcomes: the premature deaths that do occur fall on populations whose structural conditions are well below the European average, and the framework assigns these greater moral weight than the mortality data alone would register. The Nordic countries show the inverse: low LII paired with capability-weight contributions near zero or negative, indicating that the premature deaths that remain arise under comparatively unconstrained agency. The framework is built so that these two configurations — favorable functioning under constrained agency, and favorable functioning under unconstrained agency — are not collapsed into the same summary, and the country panels show this distinction doing real interpretive work.

The temporal evolution shows broad improvement in both dimensions over the study period. The Eastern European countries experienced substantial reductions in LII, particularly for males: between 2005 and 2019 male LII fell by between 6% in Bulgaria and 16% in Hungary. The relative-contribution panels show that the capability-weight contribution also declined alongside the underlying weights themselves (see Figures 3 and 4), indicating improvement in both components of capability shortfall — both the functioning dimension and the structural agency conditions under which functioning shortfalls occur.

Summarizing, the country-level analysis is the empirical expression of the paper's central normative claim. Identical mortality shortfalls do not carry identical moral weight: the LII registers this where classical lifespan inequality measures cannot.

5 Discussion and Conclusion

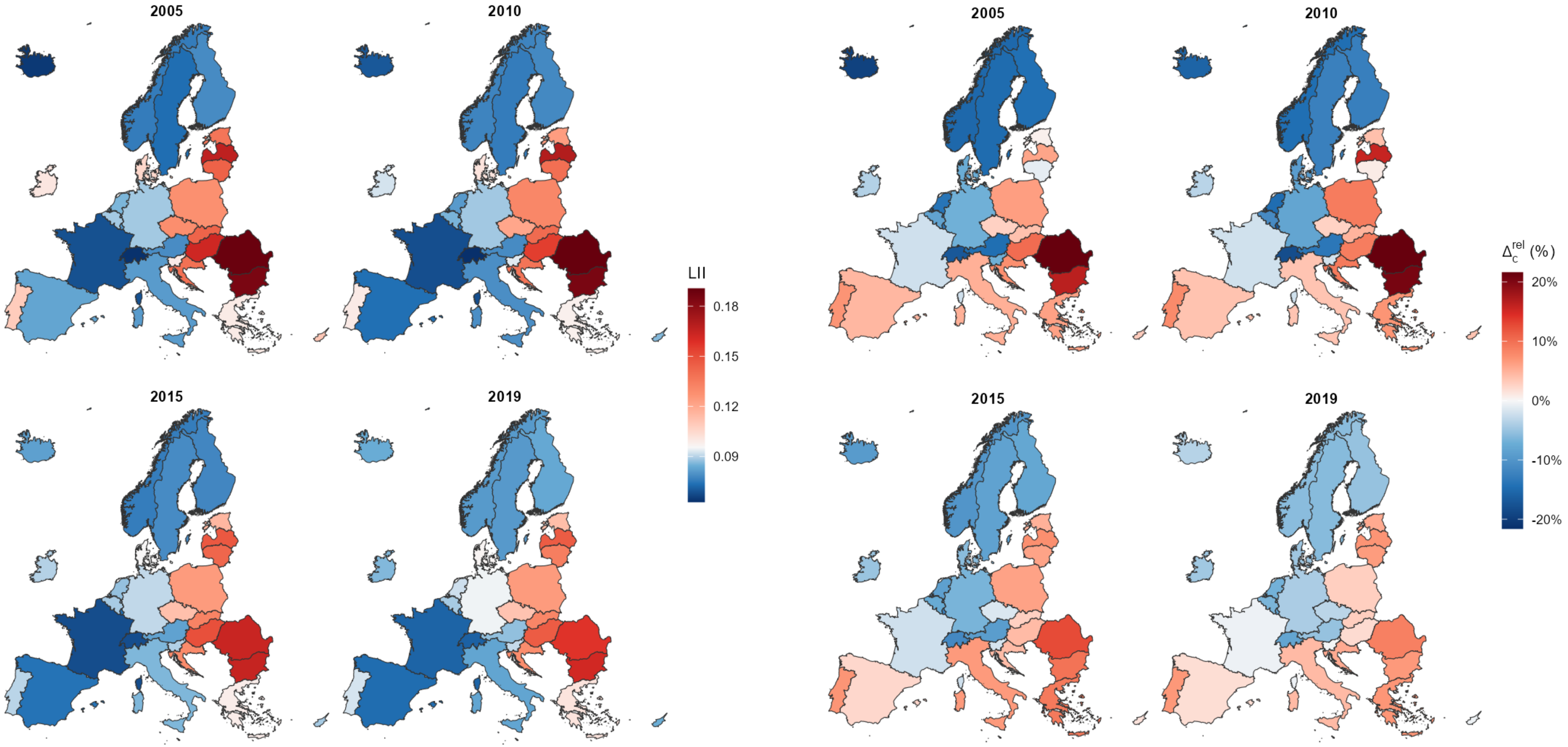
This paper has developed a theoretically grounded summary measure of lifespan inequity rooted in Ruger's health capability paradigm. The central theoretical contribution is the explicit connection between Ruger's functioning and agency dimensions of health capability and the two-level measurement architecture: FGT shortfall indices within groups capture functioning shortfall, while capability weights across groups capture the additional ethical importance of shortfalls occurring under health agency constraints. Together, these two components operationalize health capability shortfall as the joint failure of functioning and agency.

The framework also improves on the prior capability-based measure of Muszyńska-Spielauer et al. (2025), which used Nussbaum's version of the capability approach to define morally relevant deaths but relied on Sen's poverty axioms for aggregation because Nussbaum does not address the aggregation problem. Ruger's principle of disproportionate concern grounds both within-group depth-priority and between-group structural-priority in a single normative source, so the two-level architecture operationalizes a unified normative structure rather than bridging two traditions.

5.1 Substantive findings

The most striking substantive result of the European application is that the East–West gradient in lifespan inequity is severe and persistent across the study period, and that the LII reveals a feature of this gradient that the unweighted FGT obscures: in the worst-performing regions, deep mortality shortfalls coincide with high structural vulnerability, so the two sources of disadvantage stack rather than offset. Bulgaria, Romania, the Baltic states, and Hungary occupy the high end of the LII

Figure 3: Country-level LII and the relative contribution of capability weighting to the country's LII, females



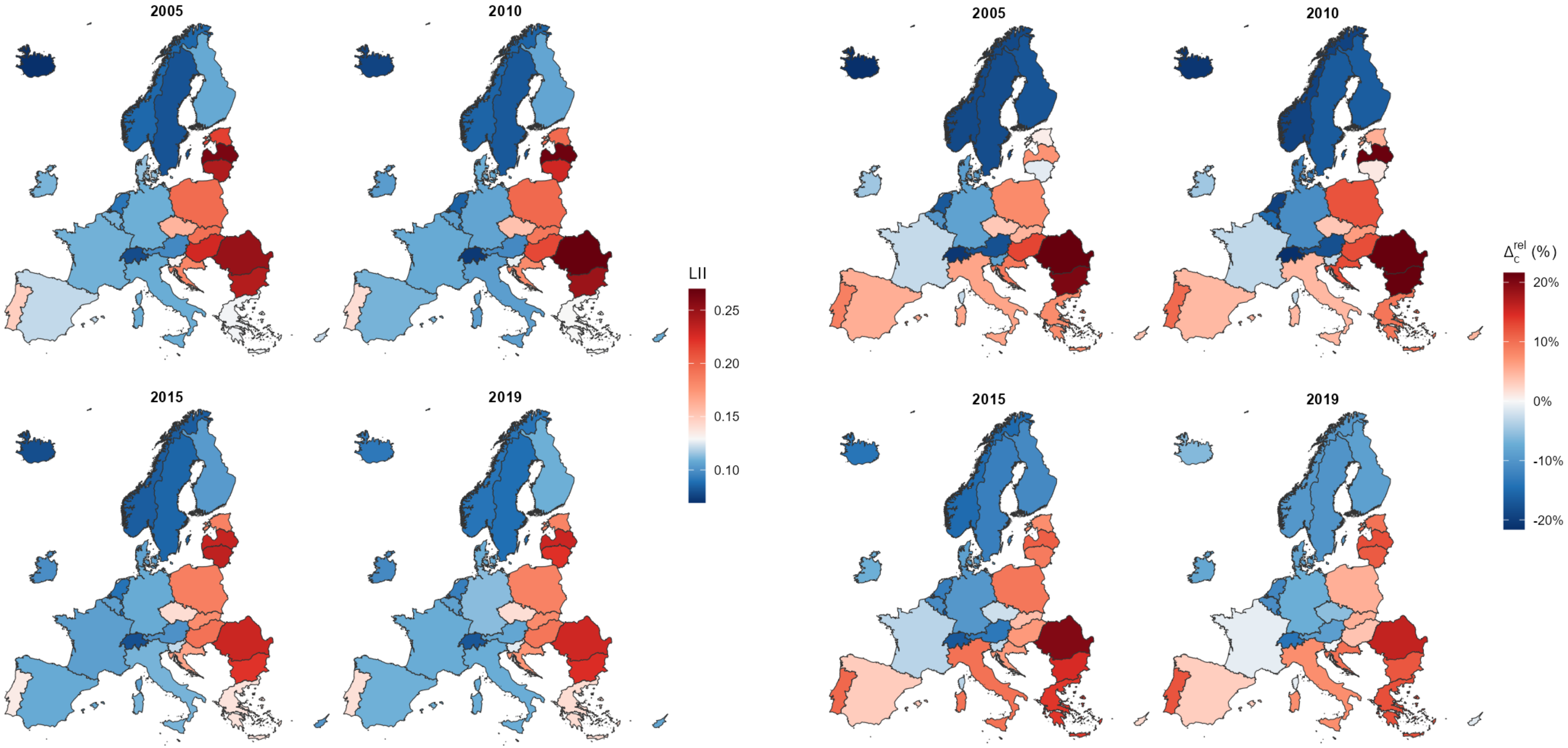
(a) LII

(b) Relative contribution of capability weights

Note: For LII: The colour scale is centred at the European aggregate LII, averaged across reference years ($\overline{LII} = 0.095$).
For capability contribution: Red indicates countries where capability weighting amplifies the shortfall above the unweighted FGT ($\gamma_j > 1$); blue indicates countries where it dampens it ($\gamma_j < 1$).

Data Sources: European Commission, Joint Research Centre (2026a,b); Human Mortality Database (2026).

Figure 4: Country-level LII and the relative contribution of capability weighting to the country's LII, males



(a) LII

(b) Relative contribution of capability weights

Note: For LII: The colour scale is centred at the European aggregate LII, averaged across reference years ($\overline{LII} = 0.129$).
For capability contribution: Red indicates countries where capability weighting amplifies the shortfall above the unweighted FGT ($\gamma_j > 1$); blue indicates countries where it dampens it ($\gamma_j < 1$).

Data Sources: European Commission, Joint Research Centre (2026a,b); Human Mortality Database (2026).

distribution throughout 2005–2019, with male values in 2019 reaching 0.22–0.23, almost three times the Swiss value of 0.08. These magnitudes are lower bounds: structural constraints not captured by the LVI are excluded from the weights, so the true gap between the most and least inequitable European regions is at least this large. In the most disadvantaged regions, deep functioning shortfalls are not occurring under structurally neutral conditions; they occur in regions whose vulnerability indices place them well above the European average, so the ethical importance of the shortfall is compounded by the agency constraints under which it occurs. The LII registers this compounding; the FGT alone does not.

The contrast between southern Spain and the Nordic countries sharpens the methodological point. Both sustain mortality shortfalls in the lower range of the European distribution, but the Nordic countries combine this with structural conditions near the European best, while southern Spain does so under structural vulnerability well above the European average. The LII registers the asymmetry: the Nordic countries sit at the low end of the LII distribution, while Spain and Portugal carry persistently positive contributions from capability weighting despite their favourable functioning outcomes. The unweighted FGT would treat these cases as broadly similar; the LII does not, because the ethical importance of comparable mortality shortfalls is not identical when the structural conditions producing them differ. This is not a technical refinement but a substantive normative claim that the measure operationalizes: justice-sensitive monitoring of population health requires registering not only the depth of health shortfall how much premature mortality occurs but also under which structural conditions it occurs.

5.2 Validity and specification-sensitivity

The framework specifies one defensible measurement of health capability shortfall in Ruger's sense, not the unique one. Its elements depend on substantive choices that belong to the framework itself rather than being neutral technical decisions. Different specifications consistent with Ruger's framework would yield different numerical values. For value-laden concepts such as health inequity in general and health capability shortfall in particular, the construct and its measurement procedure cannot be fully separated (Asada, 2007; Bradburn et al., 2017); the appropriate response is to make the constitutive choices explicit rather than disguise them as methodological convenience. This position is consistent with the established treatment of specification-sensitivity in the parametric inequality of opportunity literature, where modeling-choice dependence is treated as a feature requiring transparency and sensitivity analysis rather than a defect (García-Gómez et al., 2015; Jusot et al., 2013).

The construct validity of the LII rests on whether it discriminates between cases that the underlying theory says it should. For normatively loaded constructs, criterion validity against an external benchmark is not the appropriate standard: any benchmark that already operationalized the contested normative content would have had to settle the same questions the LII tries to settle, so agreement with it would show only that the two measures share a framework, not that either is correct. The empirical results in Section 4 demonstrate that the LII registers the moral distinctions the framework treats as fundamental. The contrast between southern Spain and the Nordic countries — comparable functioning shortfalls under sharply different structural conditions — is precisely the discrimination

Ruger's framework requires a measure to make. The contrast between Bulgaria and Romania (joint failure of functioning and agency) and Switzerland (small functioning shortfall under unconstrained agency) is the kind of distinction an unweighted shortfall measure would collapse.

A limitation of the present application is that it implements only the external component of health agency constraints. The internal component, proxied, for example, by educational attainment, requires individual-level linked data unavailable at European cross-regional scale. The framework's full claim — that health capability shortfall is the joint failure of functioning, internal agency, and external agency — is therefore only partially demonstrated here, and the joint operationalization is left as a natural extension.

5.3 Implications for policy and future work

The framework is grounded in Ruger's principle of shared health governance, which locates primary responsibility for the conditions of health capability at the institutional level. As a result, the LII registers where institutional arrangements have not secured the central health capability of avoiding premature death, and is built to support monitoring of population health whose normative commitments are explicit and contestable. Two features of the measure are particularly relevant for institutional accountability. First, the universalist threshold means that countries are evaluated against demonstrable human achievement rather than against their own historical performance, so that improvement at the national level registers as inequity reduction only when it keeps pace with the moving frontier. Second, the decomposition of the LII into a mortality-shortfall component and a capability-weighting component allows the source of high inequity values to be identified: a country whose LII is driven primarily by deep mortality shortfalls calls for different institutional responses than one whose LII is driven primarily by structural conditions concentrating premature deaths among the most vulnerable. Spain and Bulgaria require different policy diagnoses, and the LII makes the difference visible in a way that an undifferentiated summary measure of lifespan inequality does not.

Several extensions are natural directions for future work. The most immediate is implementing the internal component of agency constraint through educational attainment in empirical applications. Regional mortality and population data by education would allow the joint operationalization of internal and external components that the framework specifies but our European cross-regional application cannot demonstrate. The Nordic countries, where individual-level register data are available, would be a natural setting for this extension. A second direction is longitudinal application. The present cross-sectional analysis treats each reference year independently, but capability shortfall is plausibly a stock as well as a flow: cumulative exposure to structural disadvantage may generate stronger justice claims than contemporaneous exposure of equal magnitude, an asymmetry the framework as currently specified does not register. A measure sensitive to the duration of structural constraint would extend the framework toward the cradle-to-grave conception of health capability that Ruger's account implies (Ruger, 2010b). A third direction is global application using Global Burden of Disease data, which would test whether the framework's universalist threshold and symmetric treatment of social and natural circumstances hold up under the sharper between-region heterogeneity that European data do not exhibit.

The Lifespan Inequity Index is one defensible operationalization of Ruger's health capability paradigm, not the unique one. Its value lies less in the specific numerical results it produces than in the architecture it makes available: a measurement framework in which the threshold, the within-group function, the between-group weights, and the components of agency constraint each correspond to an identifiable element of an explicit theory of justice, and each can therefore be examined and contested on the terms of that theory. Measurement of population health inequity requires measures whose normative commitments are explicit and contestable. The LII is built to that requirement.

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6 Appendix

Table 3: Number of NUT3 regions by country and reference year

	2005	2010	2015	2019
AT	35	35	35	35
BE	44	44	44	44
BG	28	28	28	28
CH	26	26	26	26
CY	1	1	1	1
CZ	14	14	14	14
DE	400	400	400	400
DK	11	11	11	11
EE	5	5	5	5
EL	52	52	52	52
ES	59	59	59	59
FI	19	19	19	19
FR	96	96	96	96
HR	21	21	21	21
HU	20	20	20	20
IE	8	8	8	8
IS	2	2	2	2
IT	107	107	107	107
LT	10	10	10	10
LU	1	1	1	1
LV	5	5	5	5
MT	2	2	2	2
NL	40	40	40	40
NO	15	15	15	15
PL	73	73	73	73
PT	26	26	26	26
RO	42	42	42	42
SE	21	21	21	21
SI	12	12	12	12
SK	8	8	8	8
Total	1203	1203	1203	1203

Table 4: Lifespan Inequity Index by country and total, year and sex

	Females				Males			
Country	2005	2010	2015	2019	2005	2010	2015	2019
CH	0.063	0.063	0.068	0.071	0.078	0.072	0.079	0.082
SE	0.073	0.076	0.078	0.081	0.080	0.082	0.086	0.089
NO	0.076	0.077	0.076	0.081	0.087	0.085	0.083	0.090
LU	0.080	0.074	0.073	0.077	0.096	0.088	0.086	0.095
IS	0.064	0.070	0.082	0.084	0.069	0.076	0.079	0.092
FR	0.068	0.068	0.068	0.072	0.110	0.108	0.104	0.108
ES	0.083	0.074	0.074	0.073	0.121	0.111	0.108	0.110
IE	0.101	0.092	0.090	0.086	0.111	0.104	0.099	0.097
MT	0.097	0.094	0.089	0.090	0.106	0.109	0.104	0.096
NL	0.086	0.081	0.087	0.092	0.091	0.085	0.090	0.094
CY	0.111	0.086	0.089	0.084	0.121	0.109	0.101	0.106
FI	0.078	0.078	0.078	0.083	0.107	0.106	0.103	0.109
IT	0.081	0.079	0.086	0.083	0.109	0.104	0.111	0.109
AT	0.079	0.078	0.083	0.087	0.097	0.097	0.100	0.106
BE	0.089	0.085	0.089	0.089	0.111	0.104	0.104	0.105
DK	0.105	0.101	0.096	0.096	0.114	0.109	0.105	0.109
DE	0.089	0.088	0.091	0.095	0.109	0.106	0.108	0.113
SI	0.099	0.094	0.090	0.091	0.131	0.127	0.121	0.126
Europe	0.097	0.095	0.094	0.095	0.133	0.130	0.125	0.128
PT	0.109	0.099	0.090	0.093	0.148	0.141	0.135	0.140
GR	0.099	0.098	0.098	0.101	0.128	0.129	0.138	0.141
CZ	0.129	0.121	0.113	0.112	0.160	0.154	0.141	0.140
EE	0.137	0.124	0.116	0.113	0.216	0.197	0.184	0.183
HR	0.139	0.138	0.130	0.129	0.183	0.179	0.167	0.174
PL	0.128	0.131	0.124	0.124	0.196	0.198	0.186	0.185
SK	0.143	0.141	0.133	0.131	0.194	0.190	0.178	0.180
HU	0.163	0.155	0.150	0.146	0.228	0.213	0.193	0.191
LT	0.144	0.140	0.143	0.135	0.241	0.229	0.235	0.222
LV	0.167	0.170	0.147	0.146	0.262	0.267	0.232	0.230
BG	0.185	0.185	0.165	0.162	0.239	0.249	0.221	0.224
RO	0.190	0.190	0.164	0.158	0.250	0.270	0.230	0.229

Note: Countries are ordered by the 2019 mean LII across sexes, from lowest to highest.

Data Sources: European Commission, Joint Research Centre (2026a,b); Human Mortality Database (2026)