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### **ORIGINAL ARTICLE**

## Using Novel Methods to Develop Data for Evidence-Based Practice: Understanding LGBTI Stigma and Discrimination at the Sub National Level in Europe Using the Eurobarometer

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#### ABSTRACT

Drawing on data from the Eurobarometer Survey, this study explores the distribution of stigma and discrimination towards LGBTI communities at the sub-national level. There has been increased attention at global and pan-European levels around LGBTI rights mostly drawing on national-level measurements. However, there is limited research or understanding of the complex and pervasive problem of stigma and discrimination towards LGBTI groups at regional levels. Yet, it is widely noted that regional disparities exist across demographic characteristics; thus, national-level data may not be suitable for planning and policy making. We utilized two questions from the Eurobarometer as a proxy for levels of stigma and discrimination against LGBTI communities. We drew on novel Small Area Estimation (SAE) methods to produce the first reliable estimates and analysis for sub-national areas across Europe. The findings widen our understanding of differences around stigma and discrimination towards LGBTI communities both *between* and *within* nation states, emphasizing how regional-level analysis is necessary to develop targeted policies and interventions. Our findings demonstrate that programming and policy based on only national data should be utilized with caution. We argue that novel methods, such as SAE, can be utilized to support more effective data-driven decision making.

#### 1 | Introduction

Inequalities based on sexual and gender identity have gained increased attention across Europe and globally in recent years. There have been several pan-European statements, resolutions, and directives that address issues related to LGBTI communities (European Social Survey 2016). Additionally, there has been a shift in public attitudes towards greater acceptance of LGBTI communities, particularly across Europe during the 1990s; however, the scale of these changes is country specific (Kuyper et al. 2013). Nonetheless, large-scale sample surveys are not designed to produce precise and accurate sub-national estimates of LGBTI discrimination and equality. As a result, surveys aiming to examine discrimination in the EU have been launched. The Eurobarometer is a survey commissioned by the Directorate-General for Justice and Consumers and is coordinated by the Directorate-General for Communication. Among the other topics studied in the survey, variables on attitudes towards LGBTI people, LGBTI rights, and level of comfort with LGBTI displays of affection in public are collected (European Commission, Brussels 2019).

Despite significant advances, LGBTI communities continue to face large-scale stigma and discrimination globally, and

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Fitzgerald et al. (2014) highlight that public attitudes across Europe remain divergent. The importance of social attitudes lies in the fact that they can heavily influence the acceptance or rejection of LGBTI people, with negative beliefs leading to rejection, exclusion, discrimination, and violence (Flores 2019). Whilst EU policy has secured the rights and protections of many LGBTI citizens, in some countries located in Central and Eastern Europe, political and socio-cultural barriers against LGBTI inclusion and acceptance remain. In contrast, in Northern European countries, support for LGBTI communities is higher compared to those in Central and Eastern Europe (Moretti 2023). Chapter 3 of the European Union (EU) Charter of Fundamental Rights (REFS) enshrines the principles of equality, with the European commission instigating a range of initiatives to advance LGBTI equality. However, these are applied and translated differently across member states, resulting in significant spatial heterogeneity (see ILGA Europe 2018). This leads to exclusion, negatively impacting both the lives of LGBTI people as well as the communities they live in.

Increasing evidence indicates that LGBTI people suffer poorer outcomes related to health, economic success, education and wellbeing (Jadva et al. 2023; Perales 2019; Redman 2010). Politically, there have been recent punitive polices in Uganda, and the United States targeting LGBTI people, including bans on transgender youth seeking gender-affirming care. There has been growing interest in understanding regional differences in LGBTI communities. For example, examining the spatial patterning of LGBTI communities can facilitate understanding around health inequalities and thus inform the development of population health interventions (Lee et al. 2018). Thus, it is important to understand the specificities and complexities of the issue as "What we measure affects what we do" (Stiglitz et al. 2009). Identifying geographic areas where inequalities persist is a first step, therefore there is a strong argument for applying a geographic spatial lens to levels of stigma and discrimination. Such an approach could, facilitate the development of appropriate targeted policy, planning and programme actions that can work towards reducing stigma and discrimination and ultimately achieving LGBTI equality.

The article is structured as follows. Section 2 gives an overview of the theoretical framework around stigma and discrimination and outlines the impact of LGBTI inequalities. Section 3 discusses the importance of sub-national data, with Section 4 providing an overview of the data sources and the small area estimation methods adopted. Section 5 presents the results and analysis. Finally, the article concludes with Section 6 exploring the implications of the findings and limitations, and future research. Some ideas are presented on how a space-sensitive approach may be helpful in regional development policies.

#### 2 | Understanding Stigma, Discrimination, and LGBTI Inequalities

#### 2.1 | Theoretical Perspectives on Stigma

Members of LGBTI communities may be constructed as different, challenging social norms; inhabiting an identity which lies outside the boundaries of prescribed conventional sexual

behavior, resulting in an associated "stigma" of fear, disapproval, rejection, and shame. The strength of this stigma can present significant social, economic health and wellbeing penalties and Goffman's (1968) classic work, and newer work by Link and Phelan (2001), help to make sense of this. Goffman (1968) describes stigma "as an attribute that is deeply discrediting ... [involving] a relationship between attribute and stereotype" (1968: 13–14). A person with, or lacking, a certain attribute is categorized as less desirable and reduced to a tainted or devalued individual with a spoiled identity. This attribute is a stigma, made up of the difference between one's actual identity (attributes one does possess) and one's virtual (assumptions about who s/he ought to be) (1968: 2). Link and Phelan (2001) critique more current work on stigma for its lack of conceptual clarity and application, and for an absence of accounts of experience. They argue that most work on stigma is individualistic, ignoring structural issues and focusing on those who do the stigmatizing. Consequently, they propose a new model of stigma. Drawing on Goffman's position which explains stigma as the relationship between an attribute and a stereotype, they develop the notion of the relationship, seeing it in terms of the way the distinguishing and labeling of human differences take place in line with dominant cultural beliefs, linking labeled persons to undesirable characteristics. Moreover, those labeled are separated by situating them in distinct categories, so creating an "us" and "them" dichotomy. Finally, status loss and discrimination ensue, leading to unequal outcomes and disadvantage. It is through social, economic and political power then, that differences are identified, stereotypes constructed, separation takes place and discrimination occurs. The social nature of the selection of difference is important, the attributes influencing this selection being historically and culturally contingent.

#### 2.2 | LGBTI Inequalities

Recent decades have seen advances in LGBTI rights, albeit mostly in more Western countries. LGBTI individuals have gained more recognition and seen increased decriminalization, as well as varying degrees of rights and forms of legal protection, which aim to eliminate discrimination and inequality; however stigma, exclusion, discrimination, and danger prevail for many LGBTI people (Bayrakdar and King 2023). Parker and Aggleton (2003) argue that stigma produces and reproduces relations of power and control, leading to some groups being devalued and others feeling that they are of a higher status. Consequently, stigma is linked to social inequality and so the spaces and structures that create and maintain exclusion must be understood. Globally, levels of acceptance have become more polarized and LGBTI stigma and discrimination remain a complex and pervasive problem with severe consequences. Drawing on data from the LGBTI Global Acceptance Index, analysis reveals that the most accepting countries have experienced increased levels of acceptance whereas the least accepting countries have seen decreased levels of acceptance (Flores 2019). Flores (2019) notes that whilst polarization remains, this has decreased with levels of increased acceptance more common than decreasing levels of acceptance. However, in contrast the European Union Agency for Fundamental Rights survey found that in 2019 more LGBTI (43%) and trans (60%) respondents felt discriminated against in the 12 months before the survey in all areas of life that the survey asked about, than did so in 2012 when the survey was previously administered

(LGBTI (37%) and trans (43%)) (FRA 2022), suggesting decreased levels of acceptance in Europe. Social shifts have seen the passing or discussion of 'homosexual propaganda' laws in some European countries, which, it has been argued, creates a climate of intimidation, and encourages homophobia and hate crime (De Groot 2022). Additionally, a "geography of exclusion" has seen the creation of LGBT-free zones in Poland (Żuk et al. 2021).

It is well documented that LGBTI people face discrimination across multiple domains of their everyday lives from education, housing, employment, and health and wellbeing. In the sphere of work, LGBTI people may face ostracism, harassment, being fired or denied a promotion, fear of discrimination, or being forced to hide their LGBTI status (Bowling and Beehr 2006; DeSouza et al. 2017; Özaltuğ and Yalçın 2023). Studies show that LGBTI people fear discrimination, even if they have not experienced it themselves, resulting in a concealment of their LGBTI status and avoidance of certain spaces such as healthcare (Casey et al. 2019). Experience of offensive or threatening situations is not uncommon, including incidents of a sexual nature-at work, on the street, on public transport, in shops, on the internet, or anywhere else, with only a minority of cases reported to the police or other organizations (FRA 2022). Housing discrimination results in a disproportionate number of LGBTI people experiencing homelessness (Savage and Barringer 2021; Shelton 2023). Evidence suggests that stigma and discrimination are important drivers of LGBTI health disparities (Hatzenbuehler et al. 2013) with LGBTI people facing increased risks of suicide, worse mental health, poorer sexual health, and lower health outcomes overall (Ceatha et al. 2021). Discriminatory country-level policies, prosecutions, and legal barriers potentially impact health by contributing to higher HIV prevalence among men who have sex with men (Lyons et al. (2023). Depression and anxiety disorders, substance use disorders, attempted suicide, and homelessness may begin in youth and continue into adulthood, creating health disparities across the life course (Parker et al. 2018). Experiences of the education system include high levels of victimization, bullying, and high levels of feeling unsafe (Göçmen and Yılmaz 2017). Evidence also suggests LGBTI students report statistically higher levels of truancy, lower grades, greater expectations not to finish high school, and lower expectations to engage in further educational opportunities (Aragon et al. 2014; Sansone 2019).

# 2.3 | The Sustainable Development Goals and LGBTI Stigma and Discrimination

Although there is no Sustainable Development Goal (SDG) explicitly linked to issues, the principle of "leave no one behind" (LNOB) is pertinent for LGBTI communities. LNOB is the "unequivocal commitment of all UN Member States to eradicate poverty in all its forms, end discrimination and exclusion, and reduce the inequalities and vulnerabilities that leave people behind and undermine the potential of individuals and of humanity" (UNSDG 2022:6). LNOB recognizes that marginalized communities may be excluded by local, national and international initiatives; they are subject to discriminatory laws and projects that do not acknowledge their specific needs and they experience negative social attitudes that result in violence and exclusion. To address this requires combating discrimination and rising inequalities within and among countries (UNSDG 2022).

Consequently, addressing inequality and discrimination towards people from gender and sexual minority groups is a key aspect of achieving global equality under the SDGs. The collection of high-quality data around LGBTI experiences of stigma, discrimination and exclusion remains limited and the need for better data is stated in SDG 17.8 (Establish Global Partnerships), which calls for data disaggregation by income, gender, age, and other characteristics. Additionally, SDG 10 also stresses the importance of reducing inequalities both within and among countries and to achieve this, there is the need for data disaggregation at the sub-national level.

Evidence-based policymaking (EBP) is based on the premise that policy decisions are successful when informed by evidence (Eden and Wagstaff 2021). The lack of quality, relevant, accessible, integrated, and timely local or regional data is a key obstacle to progress in monitoring and reporting on the SDGs, preventing the development of evidence-based policies and programs that respond to local-level needs and challenges. Timely, quality data is essential for evaluating progress and helping make decisions that impact outcomes towards achieving the SDGs. To enable such data to be of maximum use, it needs to be presented in such a way that end users, be they policymakers, researchers, programme implementers, and commissioners, can grasp trends, understand patterns, and gather insights. Collecting, analyzing, and using good evidence are key elements in successful EBP; however, gathering good evidence around sensitive topics such as LGBTI experiences and attitudes presents challenges that require novel data sources and methods (See Hammond and Moretti 2023).

#### 3 | Regional Analysis

## 3.1 | Importance of Sub-National Understanding

Spatial inequalities are well recognized, yet national level data masks variation at smaller regional levels (Vidyattama et al. 2013). Thus, the interplay of spatial alongside individual factors contributing to LGBTI outcomes is important (Davies et al. 2018). Area inequalities are related to other inequalities highlighting the need for indicators which are sensitive to regional differences to separate out the diversity of experience, as such complex phenomena cannot be reduced to a universal indicator for measurement across time and space (Schmid et al. 2023). The importance of sub-national geographic levels of analysis has increased with the start of new public management decentralization. It is recognized that many issues manifest at a local level and thus policies require adaptation to local conditions to be effective (Giguère 2003). Importantly, regions and of course smaller geographies are the areas where citizens live and engage with the local communities and services. Localisation processes have sought to garner local governments' support in achieving the SDGs through action on the ground and to make the SDGs a useful framework for local sustainable development policy (Jain and Espey 2022). To make the global goals and targets relevant at the local level, a process of SDG 'localization' has emerged recognizing that 'local-level indicators are necessary, as local governments influence the day to day lives of local citizens (Jain and Espey 2022). Data-driven advocacy, programming,

policy, and decision-making can guide intervention development and hold governments accountable. Data availability and quality have steadily improved over the years, however without solid data, the evidence base on which to draw is limited. Evidence based policy making places "the best available evidence from research at the heart of policy development and implementation" (Davies et al. 2018, 3). With many states and local actors facing resource constraints, collecting local-level and area specific data creates challenges. Drawing on small area estimate methods offers an affordable alternative producing valid and reliable estimates of the topic of interest for local and regional level actors, enabling them to target scare resources to create policy and interventions and to monitor and evaluate existing policy (Schmid et al. 2023; Vidyattama et al. 2013). Areas that deviate the most from national averages may be of the most interest to enable more efficient targeting (Vidyattama et al. 2013).

The spatial mediation of exclusion, regulation and coping have been addressed in LGBTI populations, for example politically conservative Eastern European countries have higher levels of internalized stigma compared to Western European nations (see Davies et al. 2018). Thus, country level data are not the most useful to precisely identify those with the most needs (Klein et al. 2023). Regional variations across the US between states that have laws protecting the rights of LGBTI communities and those that do not, demonstrate disparities in outcomes related to health, education and economic status (Hasenbush et al. 2014). In some parts of Europe, for example, Austria, Germany and Italy, there is limited state level legislation on specific LGBTI issues, this has resulted in some regional and/or local authorities addressing this absence via ad-hoc policies and actions to support LGBTI people. For example, in the Netherlands, national governmental funding is provided via a national center, which assists civil servants to design policies with the aim of improving attitudes towards LGBTI people in 18 municipalities (Rainbow Cities 2010; Council of Europe 2011). Therefore, to provide support for policy makers in this sense, it is crucial to produce accurate and precise empirical evidence of such phenomena at a sub-national level.

# 3.2 | Novel Data Sources and Methods for Regional Analysis

There are two key issues with data collection on discrimination. First, understanding levels of discrimination often relies on measures related to LGBTI experience of discrimination; asking people to reveal if they discriminate against LGBTI communities presents challenges, thus measures to assess this necessitate a more nuanced articulation of the issues. For example, the Eurobarometer survey asks questions about the acceptability of same-sex marriage. To address discriminatory attitudes, data is needed to identify the demographics of such groups and other related factors including spatial elements. Second, much work exploring discrimination towards LGBTI groups has focused on gathering data at the national level and there is limited subnational focus. However, local and regional policies play an important role in addressing discrimination and promoting the safety and inclusion of LGBTI communities. Understanding attitudes towards discrimination and their spatial manifestation can enable preventative approaches to be developed and targeted in appropriate areas. Perceptions of discrimination are

characterized by spatial heterogeneity at a subnational level; for example, research exploring gender inequality reveals significant disparities at regional levels (Cascella et al. 2022). The importance of regional science has increased the need for small area statistics (Vidyattama et al. 2013). Therefore, it is necessary to disaggregate estimates of relevant indicators, at least, at a regional level to identify the regions requiring more attention by policymakers.

Unfortunately, large-scale national sample surveys are not usually designed to produce reliable analysis for sub-national areas. Hence, in this article we make use of small area estimation methods (Rao and Molina 2015) to provide regional<sup>1</sup> estimates of indicators measuring public views on discrimination towards LGBTI people across Europe. Small area estimation methods offer powerful tools in this context. Here, we produce regional estimates of three indicators measuring public perceptions of discrimination in Europe. The analyses are based on the Eurobarometer 91.4, special topic "Discrimination in the European Union" 2019. Our empirical evidence shows that the estimates produced by small area estimation are reliable, giving important information to policy makers. We recognize that in the context of LGBTI communities, it is extremely relevant to provide studies also at a sub-regional level, that is, local level (provinces and municipalities) where LGBTI discriminations take place. However, a cross-country survey that records and releases such data in Europe at a sub-regional level is not available yet.

#### 4 | Methods

#### 4.1 | Small Area Estimation

It is well-documented that large-scale national sample surveys are not usually designed to produce reliable estimates and analysis for many sub-national areas (see Pratesi 2016, and Moretti and Whitworth 2020). An unmet need for small area statistics has driven the development of methods to derive such estimates (Vidyattama et al. 2013). Thus, small area estimation methods have been developed to fill this gap, to produce accurate and precise estimates for small geographical areas (see Rao and Molina 2015; Pratesi 2016, and Moretti and Whitworth 2020). Small area estimation (SAE) is a collection of methods gaining increasing interest across research and policy domains given the need for detailed geographical population information of social phenomena at the sub-national level (Pratesi 2016). SAE is the process of using statistical models to link national or state survey outcome variables, such as disease or crime indicators, to local area predictors, such as demographic and socioeconomic variables, so that target parameters for small areas can be predicted (Rao and Molina 2015). There are many techniques available to compute small area estimates and for a review on these we refer to Rao and Molina (2015). The small area estimation method followed here is based on the Empirical Best Linear Unbiased Predictor (EBLUP). This is a composite estimator which combines the direct estimator, based on the survey sample information only, with the synthetic estimator based on the area level Fay-Herriot model (Fay and Herriot 1979; Benavent and Morales 2016). In this approach, the two sets of estimators are combined via the shrinkage estimator, which is a function of the variance of the direct estimator and synthetic estimator.

The direct estimates are unreliable due to small sample size but design-unbiased, whereas the synthetic estimates may be biased but show a small variance compared to the direct estimates. Hence, there is a trade-off between the two to provide efficient small area estimates. On the one hand, a larger weight will be attached to the direct estimates when the variance of these is small (in the case of large area sample sizes). On the other hand, a larger weight will be attached to the direct estimate is large (Fay and Herriot 1979). In this article, we adopt a small area estimation approach based on the Fay-Herriot model given that its accuracy is fully explored in the literature, and it is considered a traditional approach in small area estimation (see e.g., Pratesi et al. 2021).

#### 4.2 | Data and Variables

We use data from the Eurobarometer 91.4, and the special topic "Discrimination in the European Union" (European Commission, 2019, 2020). Data collection took place in May 2019. The target population consists of the population of the nationalities of the EU member states and other EU nationals who are resident in the 28 Member States and aged 15 years and over (European Commission, 2020). The sampling is based on a multistage design, (see European Commission, 2020). The following countries are included in our study: Austria, Belgium, Bulgaria, Republic of Cyprus, Czechia, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Lithuania, Luxemburg, Latvia, Malta, The Netherlands, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia, and the United Kingdom. The regions object of the analysis (small areas) are the ones available at the lowest level of the NUTS (Nomenclature of territorial units for statistics) European classification in the data. The sample size is equal to n = 27,438.

Table 1 presents the descriptive statistics of the sample sizes and sampling fractions across the regions. The regional sample sizes are small, with an average sampling fraction of 0.00018 (median equal 0.00009). This means that it is not possible to produce reliable direct estimates at the regional level for all the European regions; in fact, these would produce large standard errors in the direct estimates in many areas (Guha and Chandra 2021; Chandra et al. 2011; Moretti 2023). Therefore, we face the small area estimation problem. To address this issue, we adopt a model-based small area estimation method described in Section 4.1 above.

Table 2 shows the Eurobarometer 91.4 questions used in this article and their levels of measurement after recoding. Collectively, the answers to these sets of questions provide some insight into the levels of acceptance, that is, the extent to which LGBTI people are seen in ways that are positive, and inclusive, in relation to an individual's opinions about LGBTI people and attitudes towards LGBTI rights (Flores 2019).

TABLE 1 | Descriptive statistics of region sample sizes and sampling fractions.

	Minimum	First quartile	Median	Mean	Third quartile	Maximum
Sample size	8	40	86	111	149	514
Sampling fraction	0.00001	0.00003	0.00009	0.00018	0.00024	0.00136

#### TABLE 2 | Eurobarometer 91.4 questions used in this article.

Question	Measurement	Variable
[QC13] Regardless of whether you have children or	not, please tell me, using a scale from 1 to 10, how o	comfortable you would feel if

one of your children was in a love relationship with a person from one of the following groups. '1' means that you would feel "not at all comfortable" and '10' that you would feel "totally comfortable"

[QC13.10] A person of the same sex as your child <sup>a</sup>	1 = comfortable 0 = not comfortable	Same sex
[QC13.11] A transgender person <sup>a</sup>	1 = comfortable 0 = not comfortable	Transgender person
[QC13.12] An intersex person <sup>a</sup>	1 = comfortable 0 = not comfortable	Intersex person

[QC17] To what extent do you agree or disagree with each of the following statements? School lessons and material should include information about diversity in terms of ...

[QC17.3] Sexual orientation (being gay,	1 = agree
lesbian, or bisexual people) <sup>b</sup>	0 = disagree
[QC17.4] Being transgender <sup>b</sup>	1 = agree
	0 = disagree
[QC17.5] Being intersex <sup>b</sup>	1 = agree
	0 = disagree

<sup>a</sup>These variables were recoded into binary ones where values between 5 to 10 were assigned value 1, that is, "being comfortable," and 0 contains categories from 1 to 4. <sup>b</sup>There variables were recorded into binary ones where 1 (totally agree) and 2 (tend to agree) values were assigned value 1, that is, agree, whereas 0 contains 3 (tend to disagree) and 4 (totally disagree). The reliability and validity of the regional estimates computed via the Fay-Herriot model are evaluated and presented in Appendix A due to space constraints. Particularly, we consider some diagnostics measures used in the literature (Brown et al. 2001; Chandra et al. 2011; Moretti 2023), showing the good quality of our regional estimates.

#### 5 | Results and Discussion

Figure 1 shows the regional proportions of respondents that are comfortable if one of their children was in a gay or lesbian love relationship. Figure 2 and Figure 3 present the estimates in case of a relationship with a transgender person or an intersex person, respectively. Regarding the indicators related to the school and lessons material, Figure 4 shows the regional proportions of the respondents who agree that school and lessons material should include information about diversity in terms of sexual orientation, whereas Figures 5 and 6 in terms of being transgender and being intersex, respectively.

Overall, the regional estimates are all highly correlated across indicators. Namely, the Spearman's ranking correlation between the regional estimates of the three indicators related to relationships (Figures 1–3) takes values greater than  $0.95^2$ . The same was found for the other three indicators related to school and lessons material (Figures 4–6). These show that these variables are all very related in terms of regional ranking.

By looking at Figures 1-3, it can be seen that there is considerable spatial heterogeneity between and within European countries. Larger values of the indicators, meaning that respondents tend

to be more comfortable if one of their children was in a LGB love relationship and with a transgender or intersex person, can be seen in the Scandinavian countries, that is, Norway and Finland, as well as the United Kingdom. Interestingly, we can see that the between-region variability is small in such places; this means that the public is widely comfortable across regions. Small between-region variability can also be observed in Lithuania, Latvia, and Estonia. However, in these countries the indicators take smaller values, showing that there tends to be consistent levels of stigma across these countries. By looking at the three maps, we can see that higher proportions can be seen in the regions where their capitals are located, suggesting that higher levels of tolerance that are often found in "cosmopolitan cities" (Huijsmans et al. 2021), spread to the surrounding areas. Among the Eastern European countries, Romania shows large between-region variability; in particular, the Nord-East region presents the largest values of the three indicators, whereas in the neighboring Nort-Vest region, respondents tend to be less comfortable. Poland also shows important between-region variation. In particular, the region called Pomorskie stands out, presenting the highest value of the indicators in Figures 1-3. Thus, it is potentially a place hostile to LGBTI communities and a space where stigma and discrimination are prevalent. Estimates from Portugal are placed toward the medium-smallest values, indicating that respondents are less comfortable compared to other Western European countries. There is some within-country heterogeneity; in particular, citizens in the Centro region are the least comfortable, whereas the highest value of the indicator can be observed in the Algarve region, suggesting greater acceptance and decreased stigma and discrimination here.

### Same Sex Relationship (Comfortable)



A.S.

FIGURE 1 | Regional proportions of respondents that would be comfortable if one of their children were in a gay or lesbian intimate relationship.

## Relationship with Transgender (Comfortable)



Sect

FIGURE 2 | Regional proportions of respondents that are comfortable if one of their children is in an intimate relationship with a transgender person.



## Relationship with Intersex (Comfortable)

Sec. 8

FIGURE 3 | Regional proportions of respondents that are comfortable if one of their children was in an intimate relationship with an intersex person.

## School material on LGB (Agree)



Jugh





Sec.5

FIGURE 5 | Regional proportions of respondents agreeing with introducing material on transgender people in school and lesson material.

## School material on Intersex people (Agree)



#### Beck



The results from the maps related to introducing LGBTI materials and lessons into schools, Figures 4–6, share similarities with the previous analysis in Figures 1–3. Figures 4–6, present the regional proportions of respondents agreeing with introducing material in school and lessons material on LGB, transgender, and intersex people, respectively. Like the case discussed above, the regional estimates of the three indicators are strongly correlated, that is, the Spearman's ranking correlation coefficients take values greater than 0.97. Thus, the proportions of respondents who agree with that type of material being introduced in school and lessons are similar across the three indicators in Europe. However, there are interesting within-country variations.

By looking at maps in Figures 4-6, we can see some slight differences compared to the indicators presented above. In particular, the proportion of Italian areas taking smaller values here, with a small within-country variation. Portugal also has larger proportions in this case, but with an interesting within-country heterogeneity. The Algarve region is the area with the largest values of the three indicators, whereas the Centro region is characterized by the smallest proportion of people who agree with the statement. Sweden and Finland show very large values of the indicators, with a very small within-country variability. Greece shows more positive public opinions in this dimension compared to the previous maps, with a small within-country variability. The Thessaly region, which is in the North of the country, presents a smaller value of the indicator compared to the other Greek regions. The lowest levels of the indicators are observed in the regions of Eastern European countries. In particular, the lowest

TABLE 3	Spearman's 1	ranking	correlations	between	the	regional
estimates acro	ss the indicato	ors objec	t of study.			

	LGB	Trans	Intersex
	agree	agree	agree
Same sex comfortable	0.83	0.78	0.78
Trans comfortable	0.82	0.78	0.78
Intersex comfortable	0.81	0.77	0.77

value of the indicators can be observed in the South-Eastern Bulgarian region (Yugoiztochen). Small proportions, denoting that the public tend not to be in favor of introducing school material on LGBTI people, can also be seen in Romania, although a larger value is found in the region where the capital is located. Latvian regions also present small proportions compared to the neighboring countries. Germany is also an interesting case, showing that southern regions tend to be more conservative in these topics. Overall, the lowest values of the indicator can be seen for the one focusing on transgender people.

To compare the two sets of maps, maps related to relationships and maps related to the introduction of material at school, we estimated the Spearman's ranking correlation between the regional estimates across the indicators, and these are shown in Table 3 below. This shows us that although there is a high correlation between the rankings across the indicators at the regional level, these are not perfect, showing the need for disentangling the regional estimates in different maps.

#### 6 | Conclusion

This article has empirically studied the regional variability in stigma and discrimination directed towards sexual and gender diverse communities at the subnational level across Europe. To measure stigma and discrimination, concepts which are challenging to research as it is highly unlikely most survey respondents would outright state they have discriminatory attitudes, we considered different indicators, that is, the proportions of respondents who are comfortable if one of their children was in a gay or lesbian love relationship, in a love relationship with a transgender person, or in a love relationship with an intersex person. Furthermore, we analyzed indicators related to school material inclusion in education; in particular, proportions of respondents agreeing with introducing material in school and lessons material on LGB, transgender, and intersex people. Our use of small area estimation methods presents a novel and imaginative approach with high methodological rigor to understanding regional disparities across the European block. While discriminatory attitudes have been considered at the country level (Flores 2019), attention has not been paid to subnational analyses across European countries. To the best of our knowledge, this is the first study that investigates public opinions towards LGBTI communities focusing on relationship and school material at a subnational level in Europe.

The consequences of stigmatization are numerous, affecting both personal and work relationships, inducing shame and embarrassment, and attracting negative labels and resultant stigmatized identities (Ayhan et al. 2020; Rostosky et al. 2022). The analysis reported here makes a highly significant contribution by going beyond national comparisons and highlighting the regional variations within nations towards acceptability of LGBTI communities. The analysis has highlighted considerable spatial differences. In particular, the results highlight that there are differences both between and within nation states in terms of attitudes of acceptability towards LGBTI communities. Eastern European countries show more negative attitudes towards LGBTI communities, with important differences at the regional level. Italy is also located on the negative attitudes side. Countries located in North Europe, as well as Western European countries, show more positive attitudes, with a smaller within-country variability.

Our approach and these findings have significant potential to influence policy and practice, although only partially; our analysis using variables from the Eurobarometer survey as proxy measures of the stigma and discrimination sexual and gender diverse communities face complements recent calls for research that goes beyond national indicators which fail to be representative of the entire country (di Bella et al. 2021). By demonstrating that there are differences within nations at regional levels, the study creates important new knowledge which emphasizes the need for local level data to drive policy and intervention development. By drawing on novel (in the field) methods to understand regional variations, national policies aimed at reducing inequalities can be better targeted to those regions more in need of improvements, and local policy actions can be developed contextually to accommodate the specificities, strengths, and weaknesses of each region (di Bella et al. 2021). The approach we have taken provides a blueprint for others seeking to go

beyond national level data to address complex and universal social problems in Europe and beyond.

Place-based policies are policy interventions tailored to local specificities, considering local socio-economic, cultural, and institutional contexts (Bentley and Pugalis 2014) and consider the diversity of local contexts, agency, and resources, which leads to tailor-made solutions for each place (Vasta et al. 2019). This approach emphasizes the importance of the relationship between place-based communities, institutions, and geography, thus necessitating the acknowledgment of the specificities of the local or regional context (Barca et al. 2012). As such, we believe that our research, which highlights place-based differences, has important implications for a wide range of actors, including policy makers, local government officials, programme managers, and LGBTI organizations working to achieve LGBTI equality. A regional analysis can provide understanding of the geographical area to support the development of localized campaigns and to assist the creation of localized actions. Furthermore, similarities across the indicators in terms of regional estimates ranking suggest joint programmes to address inequalities in these areas may be beneficial.

Future research could consider producing an analysis at the regional level of other types of discrimination and attitudes towards LGBTI communities that can be related to the indicators studied here. Interesting comparisons across time can be produced as well, for example, by drawing on the European Social Survey data. However, the current European Social Survey only considers gay men, lesbians, and bisexual people. Additionally, work to overlay regional characteristics such as political views, economic development, poverty levels, and employment data could support further understanding of regional differences. Estimates at a sub-regional level in Europe would be beneficial; however, currently, such data is not available in pan-Europe sample surveys; this is an important limitation of this work and should be considered in future European data collection projects. Work that explores how areas with similar characteristics could, or have, developed successful interventions to support LGBTI inclusion and acceptance would be beneficial in reducing LGBTI stigma and discrimination and working towards the overall goal of LGBTI equality. Finally, given the significance of resource constraints for programming and developing evidence-based policy, strategies to support data use and ascertain data needs warrant investigation through qualitative research.

#### **Ethics Statement**

The authors have nothing to report.

#### **Conflicts of Interest**

The authors declare no conflicts of interest.

#### Endnotes

<sup>1</sup> In this article, we use the term "region" as in the European Union regional statistics following the Nomenclature of Territorial Units for Statistics (NUTS) classification (Brandmüller and Önnerfors 2021). The NUTS classification subgroups each EU country into regions at three different levels. Importantly, statistics based on these regions are used in funding allocation, and in particular, this classification is adopted in

order to define regional boundaries and determine geographic eligibility for structural and investment social funds (Eurostat 2022).

<sup>2</sup>Notice that the maximum of the Spearman's ranking correlation is 1, indicating a perfect positive rank's correlation.

#### References

Aragon, S. R., V. P. Poteat, D. L. Espelage, and B. W. Koenig. 2014. "The Influence of Peer Victimization on Educational Outcomes for LGBTQ and Non-LGBTQ High School Students." *Journal of LGBT Youth* 11, no. 1: 1–19.

Ayhan, C. H. B., H. Bilgin, O. T. Uluman, O. Sukut, S. Yilmaz, and S. Buzlu. 2020. "A Systematic Review of the Discrimination Against Sexual and Gender Minority in Health Care Settings." *International Journal of Health Services* 50, no. 1: 44–61.

Barca, F., P. McCann, and A. Rodríguez-Pose. 2012. "The Case for Regional Development Intervention: Place-Based Versus Place-Neutral Approaches." *Journal of Regional Science* 52, no. 1: 134–152.

Bayrakdar, S., and A. King. 2023. "LGBT Discrimination, Harassment and Violence in Germany, Portugal and the UK: A Quantitative Comparative Approach." *Current Sociology* 71, no. 1: 152–172.

Benavent, R., and D. Morales. 2016. "Multivariate Fay-Herriot Models for Small Area Estimation." *Computational Statistics and Data Analysis* 94: 372–390.

Bentley, G., and L. Pugalis. 2014. "Shifting Paradigms: People-Centred Models, Active Regional Development, Space-Blind Policies and Place-Based Approaches." *Local Economy* 29, no. 4–5: 283–294.

Bowling, N. A., and T. A. Beehr. 2006. "Workplace Harassment From the Victims' Perspective: A Theoretical Model and Meta-Analysis." *Journal of Applied Psychology* 91: 998–1012.

Brandmüller, T., and Å. Önnerfors, eds. 2021. *Eurostat Regional Yearbook*. Publications Office of the European Union.

Brown, G., R. Chambers, P. Heady, and D. Heasman. 2001. "Evaluation of Small Area Estimation Methods: An Application to Unemployment Estimates From the UK LFS." In *Proceedings of Statistics Canada Symposium* 2001. Achieving data quality in a statistical agency: A methodological perspective.

Cascella, C., J. Williams, and M. Pampaka. 2022. "An Extended Regional Gender Gaps Index (eRGGI): Comparative Measurement of Gender Equality at Different Levels of Regionality." *Social Indicators Research* 159, no. 2: 757–800.

Casey, L. S., S. L. Reisner, M. G. Findling, et al. 2019. "Discrimination in the United States: Experiences of Lesbian, Gay, Bisexual, Transgender, and Queer Americans." *Health Services Research* 54: 1454–1466.

Ceatha, N., A. C. Koay, C. Buggy, et al. 2021. "Protective Factors for LGBTI+ Youth Wellbeing: A Scoping Review Underpinned by Recognition Theory." *International Journal of Environmental Research and Public Health* 18, no. 21: 11682.

Chandra, H., N. Salvati, and U. C. Sud. 2011. "Disaggregate-Level Estimates of Indebtedness in the State of Uttar Pradesh in Indian Application of Small Area Estimation Technique." *Journal of Applied Statistics* 38, no. 11: 2413–2432.

Council of Europe. 2011. "Discrimination on Grounds of Sexual Orientation and Gender Identity in EUROPE," https://www.coe.int/t/ Commissioner/Source/LGBT/LGBTStudy2011\_en.pdf.

Davies, M., N. M. Lewis, and G. Moon. 2018. "Sexuality, Space, Gender, and Health: Renewing Geographical Approaches to Well-Being in Lesbian, Gay, Bisexual, Transgender, and Queer Populations." *Geography Compass* 12, no. 5: e12369.

De Groot, D. 2022. "The Rights of LGBTI People in the European Union." https://www.europarl.europa.eu/RegData/etudes/BRIE/ 2022/729426/EPRS\_BRI(2022)729426\_EN.pdf.

DeSouza, E. R., E. D. Wesselmann, and D. Ispas. 2017. "Workplace Discrimination Against Sexual Minorities: Subtle and Not-So-Subtle." *Canadian Journal of Administrative Sciences/Revue Canadienne Des Sciences de L'administration* 34, no. 2: 121–132.

di Bella, E., L. Leporatti, L. Gandullia, and F. Maggino. 2021. "Proposing a Regional Gender Equality Index (R-GEI) With an Application to Italy." *Regional Studies* 55, no. 5: 962–973.

Eden, L., and M. F. Wagstaff. 2021. "Evidence-Based Policymaking and the Wicked Problem of SDG 5 Gender Equality." *Journal of International Business Policy* 4: 28–57.

European Commission. 2019. "Special Eurobarometer 493. Discrimination in the European Union. Conducted by Kantar Public at the Request of Directorate-General for Justice and Consumers. Survey Coordinated by the Directorate-General for Communication (DG COMM 'Media Monitoring and Eurobarometer' UNIT)."

European Commission. 2020. "Eurobarometer 91.4. 2019). GESIS Data Archive, Cologne. ZA7575 Data File VERSION 1.0.0."

European Social Survey. 2016. "ESS Round 8 Question Design Template—New Core Items. Concept: Attitudes Toward Homosexuality."

Eurostat. 2022. "Eurostat Your Key to European Statistics—Regional Statistics by NUTS Classification." https://ec.europa.eu/eurostat/web/regions/data/database.

Fay, R. E., and R. Herriot. 1979. "Estimates of Income for Small Places: An Application of James Stein Procedures to Census Data." *Journal of the American Statistical Association* 74: 269–277.

Fitzgerald, R., L. Winstone, and Y. Prestage. 2014. "Searching for Evidence of Acculturation: Attitudes Toward Homosexuality Among Migrants Moving From Eastern to Western Europe." *International Journal of Public Opinion Research* 26, no. 3: 323–341.

Flores, A. R. 2019. Social Acceptance of LGBT People in 174 Countries. University of California, Los Angeles School of Law Williams Institute, https://escholarship.org/content/qt5qs218xd/qt5qs218xd\_noSplash\_ 7cd0debad76b1e424872a41959a2350d.pdf.

FRA. 2022. "A Long Way to Go for LGBTI Equality." https://fra.europa. eu/sites/default/files/fra\_uploads/fra-2020-lgbti-equality\_en.pdf# page=12.

Giguère, S. 2003. "Managing Decentralisation and New Forms of Governance." In *Managing Decentralisation: A New Role for Labour Market Policy*, edited by S. Giguere, vol. 1, 11–27. OECD.

Göçmen, İ., and V. Yılmaz. 2017. "Exploring Perceived Discrimination Among LGBT Individuals in Turkey in Education, Employment, and Health Care: Results of an Online Survey." *Journal of Homosexuality* 64, no. 8: 1052–1068.

Goffman, E. 1968. Stigma: Notes on the Management of Spoiled Identity. Penguin.

Guha, S., and H. Chandra. 2021. "Measuring and Mapping Disaggregate Level Disparities in Food Consumption and Nutritional Status via Multivariate Small Area Modelling." *Social Indicators Research* 154: 623–646.

Hammond, N., and A. Moretti. 2023. "Data Like any Other? Sexual and Reproductive Health, Big Data and the Sustainable Development Goals." *Sexualities* 27, no. 7: 1277–1300. https://doi.org/10.1177/ 13634607231152599.

Hasenbush, A., A. Flores, A. Kastanis, B. Sears, and G. Gates. 2014. "The LGBT Divide: A Data Portrait of LGBT People in the Midwestern, Mountain & Southern States." https://escholarship.org/uc/item/17m036q5.

Hatzenbuehler, M. L., J. C. Phelan, and B. G. Link. 2013. "Stigma as a Fundamental Cause of Population Health Inequalities." *American Journal of Public Health* 103, no. 5: 813–821.

Huijsmans, T., E. Harteveld, W. Van der Brug, and B. Lancee. 2021. "Are Cities Ever More Cosmopolitan? Studying Trends in Urban-Rural Divergence of Cultural Attitudes." *Political Geography* 86: 102353.

ILGA Europe. 2018. "Rainbow Europe Index 2018." https://www. ilga-europe.org/rainboweurope/2018.

Jadva, V., A. Guasp, J. H. Bradlow, S. Bower-Brown, and S. Foley. 2023. "Predictors of Self-Harm and Suicide in LGBT Youth: The Role of Gender, Socio-Economic Status, Bullying and School Experience." *Journal of Public Health* 45, no. 1: 102–108.

Jain, G., and J. Espey. 2022. "Lessons From Nine Urban Areas Using Data to Drive Local Sustainable Development." *Npj Urban Sustain* 2: 7.

Klein, G. D., E. Bryer, and M. Harkins-Schwarz. 2023. "Generating Data to Facilitate More Equitable Distribution of Health Resources: An Illustration of How Local Health Surveys Can Identify Probable Need in Mixed Socio-Economic Regions." *Public Health* 217: 155–163.

Kuyper, L., J. Ledema, and S. Keuzenkamp. 2013. Towards Tolerance: Exploring Changes and Explaining Differences in Attitudes Towards Homosexuality Across Europe. SCP-Publication.

Lee, J. G., T. Wimark, K. S. Ortiz, and K. B. Sewell. 2018. "Health-Related Regional and Neighborhood Correlates of Sexual Minority Oncentration: A Systematic Review." *PLoS One* 13, no. 6: e0198751.

Link, B., and J. Phelan. 2001. "Conceptualizing Stigma." Annual Review of Sociology 27, no. 3: 363–385.

Lyons, C. E., J. O. T. Rwema, K. Makofane, et al. 2023. "Associations Between Punitive Policies and Legal Barriers to Consensual Same-Sex Sexual Acts and HIV Among Gay Men and Other Men Who Have Sex With Men in Sub-Saharan Africa: A Multicountry, Respondent-Driven Sampling Survey." *Lancet HIV* 10, no. 3: e186–e194.

Moretti, A. 2023. "Regional Public Opinions on LGBTI People Equal Opportunities in Employment: Evidence From the Eurobarometer Programme Using Small Area Estimation." *Social Indicators Research* 166, no. 2: 413–438.

Moretti, A., and A. Whitworth. 2020. "Development and Evaluation of an Optimal Composite Estimator in Spatial Microsimulation Small Area Estimation." *Geographical Analysis* 52, no. 3: 351–370.

Özaltuğ, A., and B. Yalçın. 2023. "Workplace Discrimination Towards LGBTQ Employees and Employee Candidates in the Job Market: A European Approach to the Workplace Discrimination Towards LGBTQ." In *Legal Issues of International Law From a Gender Perspective*, 69–89. Springer International Publishing.

Parker, C. M., J. S. Hirsch, M. M. Philbin, and R. G. Parker. 2018. "The Urgent Need for Research and Interventions to Address Family-Based Stigma and Discrimination Against Lesbian, Gay, Bisexual, Transgender, and Queer Youth." *Journal of Adolescent Health* 63, no. 4: 383–393.

Parker, R., and P. Aggleton. 2003. "HIV and AIDS-Related Stigma and Discrimination: A Conceptual Framework and Implications for Action." *Social Science & Medicine* 57: 13–24.

Perales, F. 2019. "The Health and Wellbeing of Australian Lesbian, Gay and Bisexual People: A Systematic Assessment Using a Longitudinal National Sample." *Australian and New Zealand Journal of Public Health* 43, no. 3: 281–287.

Pratesi, M., ed. 2016. Analysis of Poverty Data by Small Area Estimation. Wiley.

Pratesi, M., L. Quattrociocchi, G. Bertarelli, A. Gemignani, and C. Giusti. 2021. "Spatial Distribution of Multidimensional Educational Poverty in Italy Using Small Area Estimation." *Social Indicators Research* 156: 563–586. Rainbow Cities. 2010. Building a Network—Roundtable of Local Focal Points LGBT Equality Policies—Rainbow Cities. Hague.

Rao, J. N., and I. Molina. 2015. Small Area Estimation. John Wiley & Sons.

Redman, L. F. 2010. "Outing the Invisible Poor: Why Economic Justice and Access to Health Care Is an LGBT Issue." *Georgetown Journal on Poverty Law & Policy* 17: 451.

Rostosky, S. S., M. T. Richardson, S. K. McCurry, and E. D. Riggle. 2022. "LGBTQ Individuals' Lived Experiences of Hypervigilance." *Psychology* of Sexual Orientation and Gender Diversity 9, no. 3: 358–369.

Sansone, D. 2019. "LGBT Students: New Evidence on Demographics and Educational Outcomes." *Economics of Education Review* 73: 101933.

Savage, B., and M. N. Barringer. 2021. "The (Minority) Stress of Hiding: The Effects of LGBT Identities and Social Support on Aging Adults' Concern About Housing." *Sociological Spectrum* 41, no. 6: 478–498.

Schmid, C. B., R. Cook, and L. Jones. 2023. "Measuring Gender Inequality in Great Britain: Proposal for a Subnational Gender Inequality Index." *Social Politics: International Studies in Gender, State and Society* 30, no. 2: 580–606.

Shelton, J. 2023. "LGBTQ+ People and Homelessness." In *The Routledge Handbook of Homelessness*. Routledge.

Stiglitz, J. E., A. Sen, and J. P. Fitoussi. 2009. "Report by the Commission on the Measurement of Economic Performance and Social Progress." https://ec.europa.eu/eurostat/documents/8131721/8131772/ Stiglitz-Sen-Fitoussi-Commission-report.pdf.

UNSDG. 2022. "Operationalizing Leave No One Behind." https://unsdg. un.org/sites/default/files/2022-04/Operationalizing%20LNOB%20-%20final%20with%20Annexes%20090422.pdf.

Vasta, A., E. Figueiredo, S. Valente, H. Vihinen, and M. Nieto-Romero. 2019. "Place-Based Policies for Sustainability and Rural Development: The Case of a Portuguese Village "Spun" in Traditional Linen." *Social Sciences* 8, no. 10: 289.

Vidyattama, Y., R. Cassells, A. Harding, and J. Mcnamara. 2013. "Rich or Poor in Retirement? A Small Area Analysis of Australian Private Superannuation Savings in 2006 Using Spatial Microsimulation." *Regional Studies* 47, no. 5: 722–739.

Żuk, P., P. Pluciński, and P. Żuk. 2021. "The Dialectic of Neoliberal Exploitation and Cultural-Sexual Exclusion: From Special Economic Zones to LGBT-Free Zones in Poland." *Antipode* 53, no. 5: 1571–1595.

#### Appendix: Small Area Models Diagnostics A

To evaluate both the reliability and validity of the small area estimates, we consider some diagnostics measures (see Brown et al. 2001; Chandra et al. 2011; Moretti 2023). These diagnostics are based on the following hypotheses:

- 1. The model-based small area estimates should provide an approximation to the direct survey-based estimates that is consistent with these values being "close" to the expected values of the direct estimates.
- 2. The model-based small area estimates should be more precise than the direct estimates. This can be checked by comparing the mean squared error estimates.

Figures A1 and A2 show the bias diagnostics plots to test the hypothesis in point 1 above. Given that the direct estimates are unbiased, we should expect a linear relationship between these and the model-based estimates. By looking at Figures A1 and A2 we can see that the model-based small area estimates are like the direct estimates, showing that the model-based approach did not introduce much bias in the small area estimates. Related to this, we also estimated Spearman's ranking correlations between the direct and model-based estimates, showing excellent results, that is, these correlations are all larger than 0.90, showing that the models do not introduce bias in the regional estimates.



FIGURE A1 | Bias diagnostics plots for love relationship indicators depicted in Figures 1-3 for European regions: Model-based Fay-Herriot model estimates versus direct estimates.



FIGURE A2 | Bias diagnostics plots for school material and lessons indicators depicted in Figures 4–6 for European regions: Model-based Fay–Herriot model estimates versus direct estimates.

We now show in Figures A3 and A4 the comparison between the Coefficient of Variation (CV) of the regional estimates computed via the direct estimator and Relative Root Mean Squared Error (RRMSE) of the regional

estimates computed via the Fay-Herriot model. By adopting a small area estimation approach, we can obtain more efficient regional estimates compared to the direct estimates across all the indicators and regions.



**FIGURE A3** | CV and RRMSE of the regional estimates of the love relationship indicators depicted in Figures 1-3 (direct estimates versus Fay-Herriot model estimates). There are arranged by growing regional sample size.



**FIGURE A4** | CV and RRMSE of the regional estimates of the school material and lessons indicators depicted in Figures 4–6 (direct estimates versus Fay-Herriot model estimates). There are arranged by growing regional sample size.