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ORIGINAL RESEARCH

Mapping the Risk of Female Genital Mutilation/Cutting Among Girls: Insights from Migrant Communities Living in Italy

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Abstract

This study investigates individual and contextual factors associated with support for the continuation of female genital mutilation/cutting (FGM/C) among migrant communities living in Italy to provide a map for risk prevention among children. Using survey data on 999 women originating from eight practicing African countries, we applied model-based recursive partitioning (MOB) to estimate a logistic regression tree. Independent variables include age at arrival, years spent in Italy, education, personal experience of FGM/C, and birthplace. Results reveal substantial heterogeneity across communities. While age at arrival played a minimal role, education and length of stay in Italy were associated with lower predicted probabilities of supporting continuation, with birthplace and personal experience of FGM/C being associated with higher predicted probabilities in specific subgroups. The estimated model was used to construct a predictive risk map. The highest predicted risk was found for girls whose mothers originate from Burkina Faso, Egypt, and Nigeria, with a low educational level, and who have themselves experienced the practice. Interestingly, an association with being cut (vs. not having undergone the practice) has been found across all originating countries, but not in Burkina Faso. Somalian, Eritrean, and Ethiopian girls, regardless of individual-level variables, had only a mild risk of undergoing the practice. Our findings demonstrate that predictive risk mapping can serve both as a social indicator for monitoring harmful practices and as a practical instrument to inform culturally sensitive prevention and policy interventions, provided that its results are interpreted as exploratory and not suitable for deterministic classification of individuals or communities.

Keywords Female genital mutilation/cutting · Risk map · Education · Prevention

Extended author information available on the last page of the article

1 Introduction

The World Health Organization (WHO, 2025) defines female genital mutilation/cutting (FGM/C) as any practice involving the partial or total removal of the external female genitalia, or other injury to the female genital organs, carried out without medical justification. This practice is deeply embedded in specific cultural, religious, and social contexts, and is documented in contexts, communities, and social groups across different world regions. Many of these contexts are located in some African countries, although the practice is absent in others. Forms of FGM/C have also been documented in parts of the Middle East and Asia, as well as among some indigenous communities in Latin America (Ross et al., 2015). According to the most recent estimates, more than 230 million women and girls have undergone some form of FGM/C, an increase of 30 million since 2016. Of these, 144 million live in Africa, nearly 80 million in Asia, and over 6 million in the Middle East (UNICEF & UNFPA, 2024). Between 1 and 2 million additional cases are documented among women and girls living in migrant communities outside these regions.

FGM/C serves multiple, often overlapping functions within complex cultural systems. It reinforces community identity and cohesion, in many cases perpetuating power structures rooted in generational hierarchies, gender roles, and social control (Abreu et al., 2015; Shakirat et al., 2020; Siddhanta et al., 2018). It may also serve as a rite of passage from childhood to puberty, although some scholars refer to it as a rite of institution, thereby defining gender belonging (Fusaschi, 2014), or as a mechanism to regulate female sexuality (Van Bavel, 2024). In many societies, FGM/C is perceived as enhancing women's social standing and improving marriage prospects (Shell-Duncan et al., 2016). However, the meanings attributed to the practice vary considerably across contexts, ethnic groups, generations, social classes, and local traditions. For this reason, FGM/C should not be interpreted as the expression of a homogeneous cultural or religious system, but as a practice whose meanings are locally negotiated and may vary historically (Shell-Duncan, 2008; Shweder, 2000).

The practice offers no health benefits and may cause serious harm. Girls may experience pain, hemorrhage, shock, and dangerous infections. Adult women may suffer from chronic urinary and reproductive problems, menstrual issues, and negative obstetric outcomes (Berg & Underland, 2013). Sexual health can also be impacted (Berg & Denison, 2012), as removing sensitive tissue often leads to ongoing pain and loss of sexual pleasure. Psychological effects include trauma, anxiety, depression, and post-traumatic stress disorder, which are worsened by stigma and limited mental health support. In practicing communities, refusing FGM/C can result in marginalization, while in societies where it is rejected, women who have undergone the procedure may face shame and isolation. Additionally, FGM/C may damage girls' education: long recovery times delay school attendance, and ongoing complications may cause permanent dropout, perpetuating cycles of poverty and gender inequality (Pallitto et al., 2025).

International recognition of FGM/C as a serious violation of human rights, along with the efforts of activists, local communities, feminist organizations, and religious leaders, has helped in reducing its occurrence in several areas (UNWOMEN, 2020). Data from Demographic and Health Surveys show that the prevalence among younger groups (15–19 years) is consistently lower than among older groups (45–49 years). Reductions of more than 20% have been observed in Burkina Faso, Sierra Leone, Ethiopia, Mauritania, and Chad. In contrast, declines in high-prevalence countries such as Guinea, Egypt, Mali, and Sudan remain

below 10%. Girls born today are about one third less likely to undergo FGM/C compared to their peers three decades ago (UNICEF, 2024). At the same time, national-level prevalence figures may conceal substantial heterogeneity across regions, ethnicities, religions, urban-rural settings, and transnational contexts. In several countries, FGM/C is concentrated in specific communities or regions, while it is rare or absent in others. Therefore, country-level prevalence should be interpreted as an aggregate indicator rather than as a homogeneous national cultural trait (Grose et al., 2019; Hayford et al., 2020).

In Europe, the issue's relevance has increased as migration from countries with a high prevalence of this practice has risen (IOM, 2024). The European Institute for Gender Equality (EIGE, 2022) estimates that between 53,900 and 93,000 migrant girls are at risk of FGM/C across 13 EU Member States. However, these figures are projections based on data collected in the country of origin and are not derived from data collected on migrants.

Migration can act as a disruptive force, undermining social legitimization processes and the symbolic importance of certain practices. Comparing cultural models, acknowledging diversity within communities, reducing social pressure, and encouraging intergenerational dialogue may help in promoting the abandonment of these practices (Farina, 2020). However, results vary: some communities gradually stop the practice, while others may reaffirm it, sometimes in modified forms that suit migrant contexts (Farina, 2020). In this study, we use data from an ad hoc survey on migrants: we were therefore able to include in our analysis key aspects such as time since migration, viewing it as a process through which social norms, belongings, networks, and family practices may be negotiated and reorganized in receiving-country contexts (Schwartz et al., 2010).

Over the past three decades, women have played an increasingly central role in migration flows, now accounting for nearly half of all cross-border migrants. Italy illustrates this transformation: for many years a country of emigration, it has only recently emerged as a destination for immigrants. Today, women account for approximately 50% of the foreign resident population, though proportions vary significantly by region of origin (ISTAT, 2024). Women's participation has helped to stabilize settlement processes and strengthen family units, which grow through both births and family reunification. This has led to new social and healthcare needs, especially among women from regions where FGM/C is common, as well as among girls born in Italy or who migrated at a young age.

A clear distinction must be made between two groups: adult women, who may have experienced FGM/C in their countries of origin; and girls living in Italy who are at risk of undergoing the practice. The needs of these groups differ significantly. On the one hand, adult women often need specialized healthcare services tailored to their specific conditions. Girls, on the other hand, mainly require preventive measures to protect them from the practice. Therefore, policies should focus on protective frameworks and community-based strategies.

Research conducted in African/Asian countries has shown that a family history of FGM/C, a lower level of mothers' education, or belonging to the Muslim religion increased the risk of FGM/C (El-Dirani et al., 2022). Education has consistently emerged as a decisive factor in shaping the attitude of women toward FGM/C (Farina et al., 2022; Hayford et al., 2020): higher levels of schooling are associated with reduced support for the practice, as education enhances knowledge of health risks, fosters critical awareness of gender inequalities, and increases the likelihood of engaging with alternative cultural models. The literature on social norms and social convention theory further suggests that FGM/C should not be

understood as the outcome of isolated individual preferences, but as a socially embedded practice shaped by community expectations, perceived sanctions, marriageability, intergenerational relations, and the anticipated costs of deviating from established norms (Hayford, 2005; Shell-Duncan et al., 2011; Wander & Shell-Duncan, 2020).

Preventing violations of the fundamental rights of girls in migratory communities, which is the focus of the present study, requires analytical frameworks that capture the determinants of vulnerability, influenced by family/individual characteristics and migration patterns. Scholars have likely relied on indirect methodologies to estimate the risk to girls of undergoing the practice of FGM/C in Western countries. Indirect methodologies estimate the number of girls at risk by combining data on migrant populations in destination countries with prevalence data from the countries of origin, often stratified by age, migration generation, country of birth, and sometimes region of origin or other adjustment factors. Such methods are useful when direct data are unavailable, but they rely on strong assumptions, particularly concerning the transferability of origin-country prevalence or risk levels to migration contexts (Ortensi et al., 2015). In the US, in 2012 the number of estimated girls at risk of FGM/C was more than three times higher than that calculated based on 1990 data (Goldberg et al., 2016). Women and girls originating from Egypt (20%), Ethiopia (18%), and Somalia (12%) represented the largest groups at risk of FGM/C or its consequences in this country, together accounting for about half of all cases. Older age and being first-generation women emerged as possible correlates of higher estimated risk.

As for Europe, a systematic review found that children born to second-generation women have reduced risk of undergoing the practice (Exterkate, 2013). Research conducted in the Netherlands found that second-generation girls more at risk of FGM/C come mainly from five originating countries: Somalia, Egypt, Ethiopia, Sierra Leone, and Guinea (Kawous et al., 2020). In Italy, the country setting of the present study, recent estimates indicate that around 7,000 foreign-born girls aged 0–14 are at risk of FGM/C. Under a medium-risk scenario, an additional 9,000 Italian-born girls are also considered to be potentially in danger (Ortensi et al., 2025). Research carried out in this country (Farina, 2020; Ortensi et al., 2018) shows relatively low levels of support for the continuation of FGM/C among women from practicing countries, particularly when compared with the prevalence rates in their countries of origin. These attitudes are shaped by multiple determinants, including the preservation of cultural traditions and the pursuit of social integration within diasporic communities (Dhakal & Alhassan, 2025; Farina, 2020). In line with this, a study conducted in Switzerland found that Sudanese migrants living in Switzerland expressed markedly more favorable attitudes toward uncut girls compared with their counterparts in Sudan, suggesting that selective migration from Sudan may largely explain this attitudinal gap (Vogt et al., 2017). Longer duration of residence in the host country is generally associated with greater exposure to different social environments and a higher likelihood of abandoning the practice, although this effect varies across communities of origin (Johnsdotter, 2018).

Building on these premises, this study aims to investigate potential factors that may serve as protective resources or increase the risk of undergoing FGM/C among girls living in Italy. Understanding what influences the likelihood of new generations being exposed to FGM/C is crucial for designing interventions that are both culturally sensitive and effective in protecting girls from this harmful practice. In addition, the analysis examines cross-country heterogeneity by assessing whether the relative importance of individual and migration-related correlates varies by women's country of origin. This has already been investigated in

African countries (e.g., Hayford et al., 2020) but has been less studied in migration countries (e.g., Kawous et al., 2020) like Italy. Our approach acknowledges that migration trajectories and cultural contexts may shape the persistence or transformation of FGM/C-related norms (Ferrari, 1996; Sood et al., 2020) within diaspora communities. More specifically, this study has three aims: first, to identify individual and migration-related characteristics associated with support for the continuation of FGM/C among migrant women living in Italy. Second, to examine whether and how these associations may vary by country of origin. Third, to construct predictive profiles useful for prevention, while explicitly acknowledging the interpretative limits of risk classification in migration contexts. To attain these objectives, we developed a risk map capable of identifying personal and contextual factors associated with support for continuing FGM/C into the next generation. By identifying women most likely to favor the practice, interventions such as education campaigns or community outreach can be better targeted. The map should be understood as an exploratory tool for aggregate prevention planning, not as an instrument for deterministic classification of individual girls, families, or national communities.

2 Methods

2.1 Data and Sample

Data for this study were obtained as part of the Daphne project *Prevalence of female genital mutilation in Europe* (FGMPrev, Leye et al., 2017) funded by the EU DG JUSTICE and carried out between 2014 and 2017 by a consortium including the University of Ghent, the University of Milan-Bicocca, and the French Institute for Demographic Studies (INED). These data were made available in the framework of the CERV-2022-DAPHNE DORA. The survey, targeting the main communities settled in Italy from FGM/C practicing countries, was conducted from June to December 2016, covering 1378 women aged 18 and over, living in Italy. The survey methodology developed in the FGM-Prev project combines facility-based and respondent-driven sampling. The investigation was conducted in many Italian cities while also covering suburban and mountain areas. With a few exceptions, traditional face-to-face interviews were realized. The process began with the recruitment of interviewers, selected with the active support of institutional, associative, and cooperative networks engaged in combating FGM/C and addressing broader issues concerning migrants. The interviews primarily involved migrant women originating from Burkina Faso, Côte d'Ivoire, Egypt, Eritrea, Ethiopia, Ghana, Nigeria, Senegal, and Somalia. Additional details are provided in the survey's technical materials (see Leye et al., 2017). It should be noted that the non-probability sampling method employed, while effective for reaching hidden populations, may limit generalizability. For this reason, the findings should be contextualized as an exploration of the sampled group's characteristics. Moreover, migration is a selective process: migrants may differ from non-migrant populations in origin countries with respect to education, socioeconomic background, religious affiliation, family trajectories, and attitudes toward FGM/C. Therefore, comparisons with origin-country prevalence or attitudinal data should be interpreted cautiously.

For the present analysis, only foreign-born women who reported being familiar with the practice of FGM/C and had complete data for the five covariates were included, resulting

in a final sample of 999 migrant women (76.2% of the initial sample, see the Supplementary Information for details). The final sample consisted mainly of first-generation women (97.4% of the sample) from Burkina Faso ($N=175$), Côte d'Ivoire ($N=92$), Egypt ($N=208$), Eritrea and Ethiopia ($N=109$), Ghana ($N=44$), Nigeria ($N=145$), Senegal ($N=115$), and Somalia ($N=111$). Data about the originating countries are reported in the Supplementary Information.

2.2 Measures

The variables used in this study include the attitude of migrant women toward the continuation of FGM/C practices in future generations (*Continuation.FGM*), which serves as the outcome variable. The outcome was measured through the survey question: "In your opinion, do you think that the practice should be continued?". The original response categories were "No", "Yes, but in hospital", and "Yes". For the purposes of the present analysis, the variable was dichotomized by aggregating the categories "Yes, but in hospital" and "Yes". Therefore, the outcome measures declared support for continuation, not actual future behavior or the direct occurrence of FGM/C among girls. The following five covariates were selected based on the results of analysis conducted by Ortensi et al. (2018) and Farina (2020).

- *Age.Arrival*. Refers to age at arrival in Italy expressed in years. This variable captures the extent of exposure to social norms surrounding FGM/C during formative years. Attitudes and practices internalized in childhood and adolescence are more enduring and resistant to change than those acquired later in life. Migrant women who arrive in Italy at a younger age are less exposed to the direct socialization processes within practicing communities in their countries of origin and may therefore be less likely to endorse the continuation of FGM/C. By contrast, women who migrate as adults may carry with them more deeply entrenched cultural norms.
- *Time.Spent*. Relates to time spent in Italy since migration, expressed in years. This variable reflects exposure to different social environments including legal frameworks, institutional environment, health-care systems, preventive campaigns, and social networks that may differ from those of a country of origin. The longer the residence, the greater the potential exposure to alternative cultural models, institutional frameworks, and preventive measures regarding FGM/C. Time in the host country thus operates as a proxy for integration, access to information, and participation in networks that may weaken social pressure to perpetuate the practice. Post-migration attitudes may reflect a combination of migration selectivity, transformation of social networks, institutional exposure, and changing family or community arrangements (Johnsdotter, 2018; Vogt et al., 2017).
- *Education*. The highest level of education attained is a factor variable with 2 levels: primary or no education (No/Primary); lower or upper secondary education and university (Secondary/University). Education has consistently been identified as a factor associated with lower support for the continuation of FGM/C, operating through multiple mechanisms. Higher educational attainment broadens women's access to knowledge about health risks and rights, fosters critical awareness of gender inequalities, and enhances their agency in decision-making processes. It also facilitates integration into

broader social networks beyond the ethnic community, thereby reducing the normative weight of traditions such as FGM/C. Previous research has shown that women's education and empowerment are associated with lower support for the continuation of FGM/C, although this association may vary by geographical context (El-Dirani et al., 2022; Farina et al., 2022).

- *Experience.FGM*. A woman's experience of FGM/C is a factor variable with 2 levels: no or not sure (No); yes (Yes). In the original survey, some respondents reported not being sure whether they had undergone the practice. In the present sample, 87 women, corresponding to 8.7%, reported being unsure. The "no" and "not sure" responses were merged post-survey to dichotomize the variable and contrast women with complete awareness who had undergone the practice with all other women. Thus, the category "No" should be interpreted as "non confirmed experience of FGM/C" rather than certain absence in all cases. Direct personal experience of the practice is expected to shape attitudes toward its continuation, though the direction of those attitudes may vary (Bellemare et al., 2015; Newton & Glover, 2021). Research shows that experiencing FGM/C can reinforce its legitimacy as part of cultural identity and belonging. Including this variable thus allows the analysis to capture potential intergenerational transmission of norms through embodied experience.
- *Birthplace*. This is a factor variable with 8 levels (Burkina Faso, Côte d'Ivoire, Egypt, Eritrea and Ethiopia, Ghana, Nigeria, Senegal, and Somalia). Country of origin is a key contextual determinant, as prevalence and meanings of FGM/C differ widely across cultural settings. Norms surrounding the practice are embedded in collective traditions, religious interpretations, and legal frameworks. The inclusion of birthplace enables the model to account for such a structural variation, aligning with the literature on cultural relativism and social norms theory, which highlights the collective rather than purely individual dimension of FGM/C (Grose et al., 2019; Hayford, 2005; Hayford et al., 2020; Shell-Duncan et al., 2011; Wander & Shell-Duncan, 2020).

2.3 Statistical Methods

Model-based recursive partitioning (MOB; Zeileis et al., 2008) was employed to construct the risk map. This is an algorithm that allows for the identification of subgroups of subjects that differ in the parameters of a statistical model. The core idea is to enhance model fit by employing a tree-based algorithm that partitions the data and fits separate models within each terminal node. The rationale behind MOB stems from the observation that, in many scenarios, the assumption that a unique global model provides an adequate fit for the complete dataset may be unreasonable. Instead, it may be more appropriate to partition the data based on specific covariates so that, within each partitioned subset, a well-fitting model can be identified locally. MOB offers a unified framework integrating recursive partitioning with statistical model estimation and variable selection. Moreover, MOB enables the modeling of nonlinear relationships and the automatic detection of interactions among explanatory variables (Zeileis et al., 2008).

Given a dependent variable Y, in this study the attitude of migrant women toward the continuation of FGM/C practices, two distinct sets of covariates are considered. The first set, denoted as $(X_1, \ldots, X_p)$, is used in the parametric model; in the present study, it includes the variables *Age.Arrival*, *Time.Spent*, *Education* and *Experience.FGM.* The second set,

denoted as (Z_1, …., Z_l), is used for recursive partitioning in tree construction and, in this study, it consists of a single variable, namely *Birthplace*. The MOB algorithm comprises the following steps (Zeileis et al., 2008):

1. Fit the parametric model once to the entire dataset;
2. Assess whether the parameter estimates are stable with respect to each ordering of Z_1, …., Z_l. If instability is found, choose the variable Z_j associated with the highest parameter instability, otherwise stop;
3. Find the split point that locally optimizes the chosen objective function;
4. Split the node into child nodes and recursively repeat the process on the resulting sub-nodes.

The assessment of the stability of all model parameter estimates with respect to a given partitioning variable (Step 2) is performed by applying the generalized M-fluctuation test proposed by Zeileis and Hornik (2007) with the corresponding Bonferroni-adjusted *p*-values. The idea underlying Step 2 is to verify whether the parameters of the fitted model remain stable across the different orderings implied by the partitioning variables, or whether splitting the sample with respect to one of these variables could capture parameter instability and thereby improve the model fit. It is worth noting, however, that standard regression-based confidence intervals and *p*-values for the final node-specific models are not inferentially valid in the context of MOB. This is because the terminal nodes are selected through a data-driven procedure involving splitting-variable selection, cut-point selection, and recursive stopping, whereas standard regression inference assumes that the model structure and the analyzed subgroups were fixed in advance. Consequently, applying conventional inferential formulas after tree construction does not account for the additional uncertainty introduced by the partitioning process and may lead to overly optimistic assessments of precision and statistical significance. The node-specific estimates may be interpreted as descriptive summaries of local model heterogeneity and are used to characterize systematic differences in regression relationships across subgroups identified by the algorithm. The implementation of MOB is provided by the R package *partykit* (Hothorn and Zeileis 2015a, b).

In model-based trees, visualizations that integrate information on both the partitioning structure and the fitted models are particularly useful for interpretation. One effective approach is to display a spine plot for each explanatory variable for every terminal node. Spine plots are a generalization of stacked bar plots in which the width of the bars represents the relative frequencies of the explanatory variable, while the height of each bar indicates the conditional relative frequencies of the outcome variable within each category of the explanatory variable. When the explanatory variable is numerical, the spine plot is referred to as a *spinogram*, and the categories are created using the five-number summary of the numerical variable from the full dataset (min., 1st Qu., Median, 3rd Qu., max). The fitted lines represent the mean predicted probabilities within each group (Zeileis et al., 2008).

In our analysis, given that the outcome variable *Continuation.FGM* was dichotomous, the statistical model used in the MOB implementation was logistic regression, resulting in a logistic regression-based tree estimated using the R package *glmtree* (Ehrhardt, 2024). In addition, the cultural context of the country of origin may play a crucial role, as previously noted. Therefore, it is reasonable to assume that a global model including the birthplace as

a covariate may not adequately capture these cultural differences. Fitting local models to appropriate subgroups of the data – identified using MOB based on women's birthplace – may yield more accurate and meaningful results. Thus, the birthplace was chosen as the partitioning variable, enabling the MOB algorithm to detect subgroups in which the association between the predictor variables and the outcome varies significantly. Once the parameters of the model were estimated, predicted probabilities were calculated and were assessed through a sensitivity analysis.

3 Results

3.1 General Findings

Overall, a low percentage of women (24.3%, i.e., 243 out of 999) supported the continuation of FGM/C practices in future generations. However, substantial differences emerge when the data are disaggregated by birthplace, as shown in Table 1.

The prevalence of support for the continuation of FGM/C practices is extremely low or low among women born in 5 out of the 8 countries included in the sample (Côte d'Ivoire, Eritrea and Ethiopia, Ghana, Senegal, and Somalia). In contrast, support is very high among Nigerian women and consistently high among women originating from Burkina Faso and Egypt. These data only partially align with country-of-origin support rates (UNICEF, 2024, see the Supplementary Information). Indeed, based on UNICEF data, elimination of FGM/C was invoked by 18.9% of women living in Somalia (vs. 96.4% in our sample), by 87.1% of women living in Burkina Faso (vs. 41.7% in our sample), and by 77.4% of women living in Nigeria (vs. 35.9% in our sample).

Overall, the sample is almost equally divided between women who reported having undergone FGM/C (54.9%) and those who stated they had not been cut or were unaware of having been cut (45.1%), whereas the majority of the women reported being educated (No/Primary: 30.3%, Secondary/University: 69.7%). However, the distributions differ when the data are stratified by birthplace, as shown in Table 2.

Overall, the average number of years spent in Italy is 10.7 (min: 0, 1st Qu.: 2, Median: 9, 3rd Qu.: 17, max: 52), whereas the average age at arrival in Italy is 25.4 (min: 0, 1st Qu.: 21, Median: 25, 3rd Qu.: 29, max: 69). Figures 1 and 2 display, respectively, the distribution of the years spent in Italy and the age at arrival in Italy by birthplace (see also the Supplementary Information).

Table 1 Frequency distribution (percentages in parenthesis) of the variable continuation. FGM stratified by birthplace

Birthplace	Support of FGM/C continuation		
	No	Yes	Tot.
Burkina Faso	102 (58.3%)	73 (41.7%)	175
Côte d'Ivoire	89 (96.7%)	3 (3.3%)	92
Egypt	157 (75.5%)	51 (24.5%)	208
Eritrea & Ethiopia	107 (98.2%)	2 (1.8%)	109
Ghana	43 (97.7%)	1 (2.3%)	44
Nigeria	52 (35.9%)	93 (64.1%)	145
Senegal	102 (88.7%)	13 (11.3%)	115
Somalia	107 (96.4%)	4 (3.6%)	111

Table 2 Frequency distribution (percentages in parenthesis) of the variables experience. FGM and Education stratified by Birthplace

Birthplace	The woman underwent FGM/C		Level of achieved education	
	No	Yes	No/Primary	Secondary/University
Burkina Faso	75 (42.9%)	100 (57.1%)	108 (61.7%)	67 (38.3%)
Côte d'Ivoire	81 (88.0%)	11 (12.0%)	17 (18.5%)	75 (81.5%)
Egypt	73 (35.1%)	135 (64.9%)	7 (3.4%)	201 (96.6%)
Eritrea&Ethiopia	53 (48.6%)	56 (51.4%)	14 (12.8%)	95 (87.2%)
Ghana	41 (93.2%)	3 (6.8%)	8 (18.2%)	36 (81.8%)
Nigeria	31 (21.4%)	114 (78.6%)	72 (49.7%)	73 (50.3%)
Senegal	85 (73.9%)	30 (26.1%)	50 (43.5%)	65 (56.5%)
Somalia	12 (10.8%)	99 (89.2%)	27 (24.3%)	84 (75.7%)

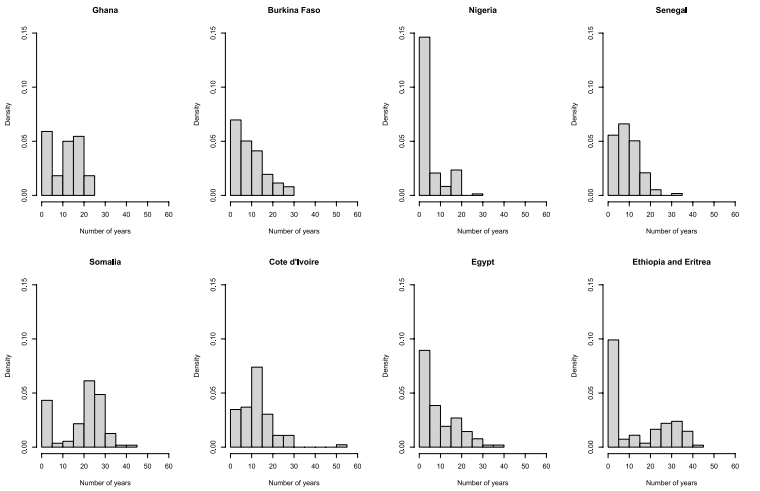

Fig. 1 Frequency distribution of the number of years spent in Italy, stratified by birthplace

3.2 Factors Associated with FGM/C Risk and Protection

Figure 3 shows the results of fitting the MOB model to the data. Each leaf node displays the estimated parameters of the logistic regression model fitted to the observations within that node. The first split separated women born in Burkina Faso, Nigeria, and Egypt from those

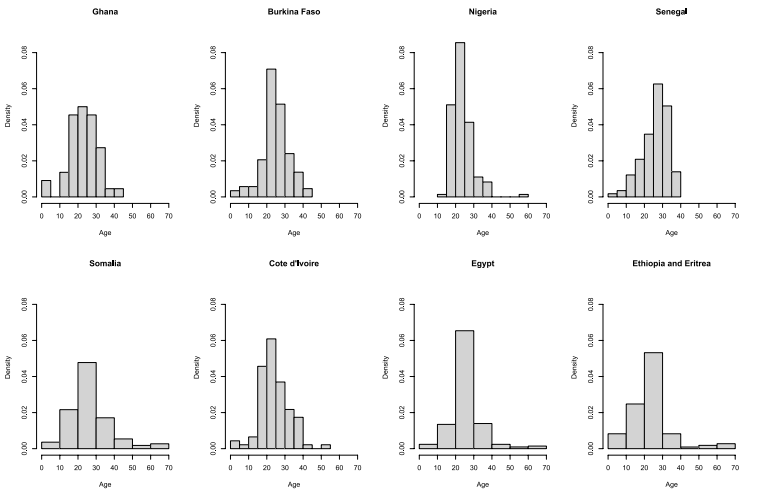

Fig. 2 Frequency distribution of the age at arrival in Italy, stratified by birthplace

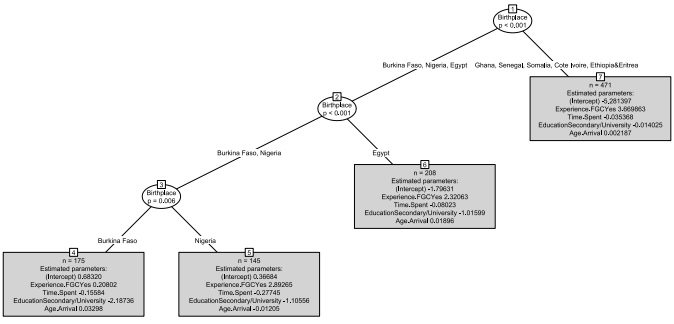

Fig. 3 MOB tree for the support for the continuation of FGM/C practices

born in Ghana, Senegal, Somalia, Côte d'Ivoire, Ethiopia, and Eritrea. The latter group of countries will be referred to as "Other Africans". Subsequent splits separated women born in Egypt, Burkina Faso, and Nigeria, resulting in three distinct leaf nodes.

Although the leaf node 7 (Other Africans) exhibits an unbalanced distribution of the variable *Continuation.FGM* (4.9% of women supporting the continuation of FGM/C practices out of 471 women), the absolute number of women supporting the continuation of FGM/C practices (23) is sufficient to support a local logistic regression model with four predictors. While the events-per-variable (EPV) ratio is approximately 6, which is below the traditional

rule-of-thumb of 10 (Peduzzi et al., 1996), more recent simulation studies suggest that logistic regression estimates can remain informative and valid with EPV ratios as low as 5 to 9 (Vittinghoff & McCulloch, 2007). Moreover, as a sensitivity analysis to ensure that the results were not driven by this imbalance, the model was re-estimated using Firth's penalized likelihood (Firth, 1993). The coefficients showed only a minor adjustment, with reductions not exceeding 10%. This suggests that the initial estimates are quite stable and were not substantially affected by the unbalanced distribution of the variable *Continuation.FGM.*

With respect to leaf node 6 (Egypt), the predictor *Education* exhibits a sparse distribution, with only 7 women with no or only primary education. Although no perfect separation occurs (4 out of 7 women support the continuation of the FGM/C practice), this imbalance can lead to parameter instability and biased MLE estimates. To assess the robustness of the results, the logistic regression model within this node was re-estimated using Firth's penalized likelihood. The resulting coefficient was 10% lower than the standard estimate, suggesting relative stability in the effect's direction. This stability was also observed for the other coefficients in the model. However, the predictive application remains sensitive: while women with no or only primary education are assigned higher predicted probabilities of continuation of the practice, these estimates rely on a relatively fragile statistical foundation due to the limited local sample size.

The coefficients of the variable *Age.Arrival* displayed in the four nodes were close to zero, with corresponding odds ratios of 1.03 (Node 4), 0.99 (Node 5), 1.02 (Node 6), and 1 (Node 7). This suggests that the age at arrival in Italy did not appear to play a major role in shaping participants' views regarding the continuation of FGM/C practices in future generations.

To provide a visualization that integrates information on both the partitioning structure and the fitted models, Fig. 4 displays a spine plot for every explanatory variable within each terminal node.

Given that the *Age.Arrival* variable was not significantly associated with the attitudes toward the continuation of FGM/C practices within the sampled group, its spinogram and the corresponding mean probabilities are not discussed, as these probabilities primarily reflected the influence of the other covariates.

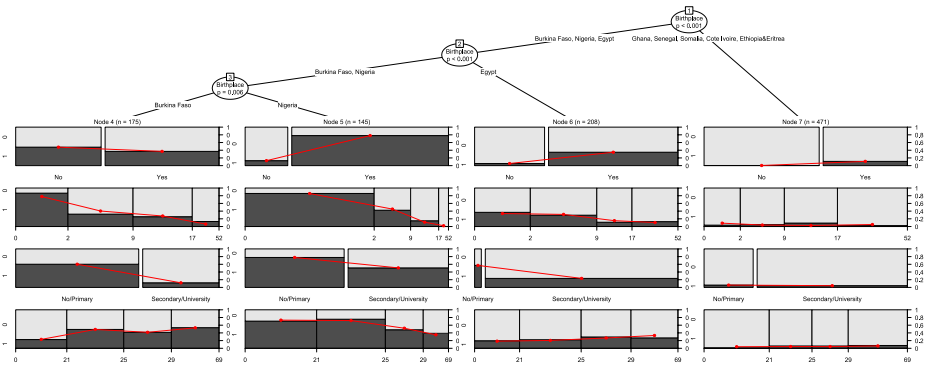

Fig. 4 MOB tree for the support for the continuation of FGM/C practices: for each leaf, the spine plot/spinogram for each predictor (from top to bottom: Experience.FGC, Time.Spent, Education, Age.Arrival), is depicted

In terms of countries, the following presentation distinguishes three broad empirical patterns. First, countries for which previous experience of FGM/C played a relatively marginal role. Second, countries where previous experience of FGM/C played a major role. Third, cases where the support for the continuation of the practice was, in general, low.

For women born in Burkina Faso (Node 4), the mean probability of supporting the continuation of the FGM/C practice, given that they have experienced it, was slightly lower than the probability of not supporting its continuation. This was the only group in which experiencing FGM/C was not positively associated with support for its continuation. We may hypothesize that the role of the variable *Experience.FGM* is masked by the compositional effect of low education (Burkina women in our sample were those with the lowest level of education, see Table 2 and see Karmaker et al., 2011, for a discussion on the role of this variable for the case of FGM/C in Burkina Faso). Both education and the amount of time spent in Italy were associated with lower support for the continuation of FGM/C, with education having a notable influence, given that the lower mean probability of supporting the continuation of the FGM/C practice is observed for highly educated women.

For Nigerian women (Node 5), a high mean probability of supporting the continuation of FGM/C practice was observed among those who had experienced it and had just arrived in Italy. The role of education as a mitigating resource appeared limited in this specific sample, as the mean probability of supporting the continuation of FGM/C remained high even among well-educated women. For Egyptian women (Node 6), prior experience of the practice showed the strongest positive association with support for its continuation.

Node 7 considered women born in Ghana, Senegal, Somalia, Côte d'Ivoire, Ethiopia, or Eritrea. For them, the mean probability of supporting the continuation of the FGM/C practice was low, regardless of their education level, experience of the practice, or the amount of time spent in Italy.

3.3 Estimated Probabilities

The risk map was completed by using the estimated model to calculate predicted probabilities for selected combinations of relevant variables. Since the influence of the *Age.Arrival* variable was negligible, it was set at its median value of 25 years, whereas the list of the considered combinations for the remaining three variables is shown in Table 3. Given that the variable *Time.Spent* is continuous, the three quantiles of its distribution, calculated from the entire dataset, were selected as values of interest.

Table 4 displays the estimated probabilities based on the profiles presented in Table 3. Whenever possible, prediction confidence intervals are provided to account for uncertainty. Nevertheless, these remain purely suggestive due to the non-probability sampling design, which limits formal statistical inference.

To define risk profiles based on the predicted probabilities reported in Table 4, suitable thresholds were established to determine the bandwidths of predicted risk: a probability of 0–0.15 indicates incidental (minimal) risk; 0.16–0.50 indicates influencing risk; and a probability greater than 0.50 indicates foundational risk. In Table 4, values highlighted in yellow indicate incidental risk, those in orange indicate influencing risk, and those in red indicate foundational risk.

Among women from Burkina Faso as their birthplace, a foundational risk was observed in those with no or primary education and a medium-to-low length of stay in Italy. In con-

Table 3 Coding scheme for selected variable combinations

Code	Experience of FGM/C	Education	Time Spent*
C1	Yes	No or primary education	2
C2	No	No or primary education	2
C3	Yes	Lower, upper secondary education or university	2
C4	No	Lower, upper secondary education or university	2
C5	Yes	No or primary education	9
C6	No	No or primary education	9
C7	Yes	Lower, upper secondary education or university	9
C8	No	Lower, upper secondary education or university	9
C9	Yes	No or primary education	17
C10	No	No or primary education	17
C11	Yes	Lower, upper secondary education or university	17
C12	No	Lower, upper secondary education or university	17

* The values correspond to the three quantiles calculated from the entire dataset

Table 4 Probability Risk profiles: incidental risk (lower, yellow), influencing risk (intermediate, orange), foundational risk (higher, red)

Code	Burkina Faso	Nigeria	Egypt	Other Africans*
C1	0.80 (0,64-0,90)	0.92 (0,81-0,97)	0.70†	0.16 (0,07-0,33)
C2	0.77 (0,63-0,87)	0.38 (0,14-0,70)	0.19†	0.01 (0,00-0,04)
C3	0.31 (0,14-0,55)	0.79 (0,64-0,88)	0.46 (0,34-0,58)	0.16 (0,09-0,29)
C4	0.27 (0,13-0,48)	0.17 (0,05-0,43)	0.08 (0,03-0,19)	0.01 (0,00-0,04)
C5	0.58 (0,44-0,71)	0.61 (0,38-0,81)	0.57†	0.13 (0,06-0,27)
C6	0.53 (0,36-0,69)	0.08 (0,02-0,28)	0.12†	0.00 (0,00-0,03)
C7	0.13 (0,06-0,26)	0.34 (0,17-0,57)	0.32 (0,24-0,41)	0.13 (0,08-0,21)
C8	0.11 (0,04-0,25)	0.03 (0,01-0,12)	0.05 (0,02-0,12)	0.00 (0,00-0,03)
C9	0.28 (0,16-0,45)	0.15 (0,03-0,45)	0.41†	0.10 (0,04-0,23)
C10	0.24 (0,10-0,48)	0.01 (0,00-0,07)	0.06†	0.00 (0,00-0,02)
C11	0.04 (0,02-0,11)	0.05 (0,01-0,23)	0.20 (0,12-0,32)	0.10 (0,06-0,16)
C12	0.03 (0,01-0,12)	0.00 (0,00-0,03)	0.02 (0,01-0,07)	0.00 (0,00-0,02)

* Ghana, Senegal, Somalia, Côte d'Ivoire, Ethiopia and Eritrea

†No confidence intervals reported due to small sample size in 'no/Primary' *Education*

trast, an incidental risk was observed among well-educated women who had lived in Italy for a long time. Therefore, education appeared to be the primary mitigating resource against support for continuing FGM/C in future generations, followed by the number of years spent in Italy.

Among women born in Nigeria, the duration of residence in Italy is correlated with a reduction of the risk: the longer the duration of stay, the lower the risk of supporting the continuation of FGM/C, to the point where the relation with the experience of practice is not significant. This pattern suggests that, among Nigerian women in the sample, migration-related exposure and duration of residence may be particularly relevant correlates of attitudes toward continuation.

According to the estimated probabilities, personal experience of FGM/C emerged as the primary driver of support among women born in Egypt, while the length of stay in Italy does not appear to exert a mitigating effect. Given that *Education* exhibits a sparse distribution, with only 7 women having no or only primary education, the estimated risk profile for this subgroup should be interpreted with considerable caution.

As to women born in Ghana, Senegal, Somalia, Côte d'Ivoire, Ethiopia, or Eritrea, there were only two situations with risk levels exceeding incidental risk: associated with having undergone the FGM/C practice; and a short duration of residence in Italy. However, these were two cases among those producing a change in classification of the risk when the original bandwidths were increased by 0.05. Overall, for these women, birthplace appeared to be the factor most strongly associated with lower support for the continuation of FGM/C.

It is particularly worth discussing the case of Somalia, an originating country where almost all women undergo the practice and, according to UNICEF data, only about 18.9% think that the practice should be stopped (see the Supplementary Information). Women originating from this country have been indicated as being at particular risk from FGM/C perpetuation in both the US (Goldberg et al., 2016) and the Netherlands (Kawous et al., 2020), even though these studies did not construct a detailed risk map like the one proposed in our investigation but are based on an indirect extrapolation methodology. Our results indicate only a mild probability of FGM/C for Somalian girls living in Italy. This result seems not to be influenced by individual-level variables like education and time spent in Italy, which did not emerge as crucial from the MOB. In our sample, Somalian women were those with the highest time spent in Italy (mean = 19.23 yrs., SD = 11.01). Thus, we may account for these findings in terms of an effect of migration and a shift of cultural context (Johnsdotter, 2018). Two possible arguments may explain this pattern. First, practical and logistical barriers may reduce the feasibility of performing FGM/C after migration. Access to traditional practitioners is limited, and returning to the country of origin may be hindered by economic constraints, insecurity (political instability or conflict), or irregular legal status: conditions that are particularly relevant for Somalian women. Second, there might be a legislative effect: in Italy, the legal consequences of performing FGM/C include possible loss of parental rights and expulsion, which may act as strong deterrents. Similar considerations could be put forward for the case of Ethiopia, which previous literature also highlighted as being a country of origin that placed women at particular risk from FGM/C.

3.4 Sensitivity Analysis

A sensitivity analysis was conducted to assess the robustness of the predictions with respect to the chosen thresholds by examining the classifications obtained after increasing or decreasing the original bandwidths by ±0.05. When the bandwidths were increased by 0.05, Burkina Faso and Nigeria exhibited an 8.3% variation in the risk profiles (1 case), whereas Egypt and Other African countries showed a 16.6% variation (2 cases). When the

bandwidths were decreased by 0.05, Nigeria showed an 8.3% variation in the risk profiles (1 case), while Burkina Faso, Egypt, and Other African countries exhibited a 16.6% variation (2 cases).

4 Conclusions

This study uses a model-based recursive partitioning approach to map predicted probabilities of support for the continuation of FGM/C among girls in migrant communities in Italy. Using survey data from 999 foreign-born women originating from eight practicing countries, we found that overall support for continuation was relatively low (24.3%), yet there is substantial heterogeneity by country of origin. The risk map obtained with the MOB shows that women from Ghana, Senegal, Somalia, Côte d'Ivoire, Ethiopia, and Eritrea have consistently low probabilities of supporting continuation, while women from Burkina Faso, Nigeria, and Egypt exhibited markedly higher and more variable predicted probability profiles.

Across the identified subgroups, education and length of residence in Italy were the most important correlates of lower predicted probabilities. Higher educational attainment was consistently associated with lower predicted probabilities of supporting continuation, particularly among women from Burkina Faso and Egypt. Time spent in Italy reduced predicted probabilities notably among Nigerian women, effectively attenuating the association of prior experience of FGM/C for long-term residents. Personal experience of FGM/C was a relevant correlate of higher predicted probability, most strongly so among Egyptian and Nigerian women; an exception was observed for women from Burkina Faso, where the fact of having undergone FGM/C did not significantly increase the probability of supporting continuation. Age at arrival showed negligible influence in our models.

Substantively, the findings of the present study demonstrate that support to the continuation of FGM/C in migration contexts is heterogeneous and cannot be fully inferred from data on FGM/C prevalence in the country of origin alone. Education, migration-related exposure, embodied experience, and contextual origin interact with support in different ways across groups. This highlights the need for prevention policies that are sensitive to community diversity without assuming that the national origin mechanically determines attitudes or practices.

Limitations of the present study include the cross-sectional nature of the survey, reliance on self-reported measures, absence of potentially relevant variables in the database —such as religion and urban–rural residence— and the sampling frame (facility-based and respondent-driven components) that may affect generalizability. Data were collected in 2016 and reflect the communities and migration dynamics of that period; ongoing monitoring is recommended to capture temporal changes. Future research should broaden the scope to include men's attitudes, family decision-making dynamics, and longitudinal designs to assess attitude change over time. It is also open to future studies to compare the migration effect in different EU countries (like the Netherlands, see Kawous et al., 2020), and non-EU countries (like the US, see Goldberg et al., 2016).

In conclusion, model-based risk mapping offers a practical, evidence-informed tool to guide culturally sensitive, targeted prevention and service planning for FGM/C in migration contexts, provided that its deployment is accompanied by careful communication strategies

to avoid stigmatization and to foster community partnership. The map should be used as an exploratory and contextual tool for prevention planning. Its value lies in helping policymakers and practitioners recognize heterogeneity, prioritize dialogue, and design interventions that are attentive to both human rights and the risk of stigmatizing migrant communities.

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Data Availability Data are available from DHS surveys.

Declarations

Conflict of interest None.

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