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ABSTRACT

This study aims to identify patterns in women's contraceptive and pregnancy experience using retrospective calendar data from the 2016-17 Burundi Demographic and Health Survey (DHS). We apply sequence and cluster analysis of longitudinal data to identify discrete clusters that characterize women's contraceptive and pregnancy behaviors over the previous five years. We further pair clusters with data on knowledge, attitudes, and women's interactions with media and health services to create composite profiles of women in these clusters.

Of six clusters, three are characterized by contraceptive use and three are characterized by the absence of contraceptive use. Media exposure and attitudes regarding sex preference, wife beating, and self-efficacy largely do not explain cluster membership. Contraceptive knowledge is positively associated with two clusters and negatively associated with a third. Clusters also differ in their members' fertility desires, contraceptive intentions, and interactions with health services. Two "Family Builder" clusters are both characterized by the presence (but not timing) of multiple pregnancies in their calendar histories but differ in that women with high contraceptive knowledge, intentions to use contraception, and well-articulated family size ideals are characteristic of one cluster (Family Builder 1) and low contraceptive knowledge, no use of contraception, and vague family size preferences are characteristic of the other (Family Builder 2). These results can guide reproductive health programs as they target social and behavioral change and other interventions to the unique subpopulations they seek to serve.

Key words: Burundi, contraceptive histories, cluster and sequence analysis, social and behavior change, health services

ACRONYMS AND ABBREVIATIONS

DHS   Demographic and Health Survey(s)

EC   emergency contraception

IUD   intra-uterine (contraceptive) device

LAM   lactational amenorrhea method
LAPM long-acting and permanent method
LARC long-acting, reversible contraception

OR   odds ratio

PAM   partitioning around medoids
PSU   primary sampling units

SBC   social and behavior change
SDM   standard days method

UNFPA United Nations Population Fund
USAID United States Agency for International Development

1   INTRODUCTION

Researchers have tried to make data on contraception useful to reproductive health programs by applying market segmentation, with the aim that the reproductive health programs can better tailor their messages and services to target potential and existing family planning clients. The purpose of market segmentation is to identify distinct subpopulations who have different needs, attitudes, and behaviors around contraception. Segmentation methods group women into different homogenous profiles (i.e., segments) that characterize their needs and inclinations to use particular services.

A study in the Philippines contrasts "young intenders" with older "ready to limit" women (Wang et al. 2009). In Niger, one study differentiated groups of women who "trust family planning and the health system" from those who "accept limiting" (Dalglish et al. 2018), while another segmented women into "healthy proactives," "traditional autonomists," and "modern elites" (Camber Collective 2014, 2015). The (Re)solve project combines segmentation and behavioral design to, among other goals, develop interventions for adolescent girls based on their trust among peers and (mis)perceptions of pregnancy risk (Dabney et al. 2019). These various approaches, which often integrate qualitative data, generally focus on *attitudes* to form their segments and do not analyze women's behaviors.

A broad literature demonstrates that attitudes are associated with the use of modern contraception (Alemayehu et al. 2016; Ankomah, Anyanti, and Oladosu 2011; Grindlay et al. 2018; Nanda, Schuler, and Lenzi 2013; Samandari, Speizer, and O'Connell 2010; Walcott et al. 2015; Yue, O'Donnell, and Sparks 2010). These attitudes include those toward contraception generally as well as those toward the efficacy and safety of specific methods, self-efficacy, gender, and the role of men. One meta-analysis found that supportive attitudes increase the odds of contraceptive use by an average of 10% to 90%, depending on the specific attitude (Rosen et al. 2019). As a result, social and behavior change (SBC) interventions seek both to take advantage of supportive attitudes and target services to a clientele inclined to use them and to shift attitudes and social norms (Ayanore, Pavlova, and Groot 2017; Kaggwa, Diop, and Storey 2008; Sharan and Valente 2002; Storey et al. 1999; Wegs et al. 2016). This same meta-analysis indicated that SBC interventions work to increase modern contraceptive use both directly through their mass media and interpersonal communication activities and indirectly through their effect on attitudes and partner communication (Rosen et al. 2019).

In contrast to the strong focus on attitudes in most segmentation analysis, a recent study has developed methods to identify discrete groups of women based on behavioral data from contraceptive calendars in Demographic and Health Surveys (DHS) in Burundi and Nepal (MacQuarrie, Allen, and Gemmill 2020; MacQuarrie et al. 2019). DHS contraceptive calendars are a rich source of data on contraceptive behavior and pregnancy experience covering the five years preceding the survey (Croft, Bradley, and Allen 2018). Although these behavioral data complement attitudinal data well, the groups of women identified through these methods have not to date been described in terms of their attitudinal attributes.

This study aims to identify patterns in women's contraceptive and pregnancy experience using the dynamic experiences captured in retrospective, longitudinal calendar data. To do this, we apply sequence and cluster analysis of longitudinal data to identify discrete clusters that characterize women's contraceptive and pregnancy behaviors over the previous five years. We further pair the clusters with data on knowledge, attitudes, and women's interactions with media and health services to create rich, composite profiles of women in these clusters.

2 METHODS

2.1 Data

This study uses data from the 2016-17 Burundi DHS survey, which is a nationally representative survey that applied a multi-stage, clustered sampling process with a response rate of 98.8% among eligible women (Ministère à la Présidence chargé de la Bonne Gouvernance et du Plan - MPBGP et al. 2017). Specifically, this study uses contraceptive calendar data from the DHS survey. A contraceptive calendar is a retrospective history that records monthly event data on reproductive and contraceptive experiences (Croft, Bradley, and Allen 2018), which we organized into five possible states: (1) no use of contraception; (2) use of a short-term, modern method of contraception; (3) use of a long-acting or permanent method (LAPM) of contraception; (4) use of a traditional method of contraception; and (5) pregnancy, birth, or termination. The short-term, modern methods are pills, injectables, male or female condoms, lactational amenorrhea method (LAM), emergency contraception (EC), and the Standard Days Method (SDM). The LAPMs are intrauterine devices (IUDs), implants, and female and male sterilization. Traditional methods include periodic abstinence/rhythm, withdrawal, and other traditional or folkloric methods.

2.2 Sequence and Cluster Analysis

We arrange the five states into calendar sequences that are exactly 59 months long for each woman, with month 1 being the earliest point in the woman's calendar (approximately five years before the interview) and month 59 being the most recent month. Our analytic sample consists of 13,293 women age 15-44 at the start of their calendar sequence. Prior to the analysis presented here, we used sequence and cluster analysis to group the women into six distinct contraceptive clusters based solely on patterns of behavior observed in their 59-month calendar sequences. Methodological details of the sequencing and clustering procedures used to identify the six clusters are documented elsewhere (MacQuarrie, Allen, and Gemmill 2020; MacQuarrie et al. 2019).

Briefly, we conducted sequence and cluster analysis in R using the TraMineR and WeightedCluster packages (Gabadinho, Ritschard, Mueller, et al. 2011; Gabadinho, Ritschard, Studer, et al. 2011; Studer 2013). We used Optimal Matching to calculate distances in our dissimilarity matrix. This matching parameter allows for insertions and deletions as well as substitutions in computing distances, which better accounts for the sporadic timing of pregnancies by potentially aligning them within women's sequences. We assumed uniform costs for all substitutions, insertions, and deletions so used a constant cost matrix to measure pairwise distances between sequences. Finally, we used a k-medoid (i.e., partitioning around medoids, or PAM) clustering algorithm to group women's sequences into six clusters. These parameters and the number of clusters in the final solution were guided by scores on a series of quality metrics (Gemmill 2019; Studer 2013).

2.3 Regression Analyses

We estimate separate multivariable logistic regression models to identify women's attributes associated with membership in each of the identified clusters. Our outcome variable is a dichotomous measure of membership in each cluster. For our regression models, we select seven covariates that describe knowledge and attitudes and six covariates that describe media exposure and interactions with the health system. These

variables align with conceptual frameworks describing how SBC interventions may influence contraceptive behavior (Rosen et al. 2019). In particular, the frameworks predict that SBC interventions that engage people through mass media initiatives and interpersonal communication (typically with providers) influence contraceptive behavior, both directly and indirectly, through increasing knowledge and shifting attitudes and norms (Rosen et al. 2019). In the regression models, contraceptive knowledge is categorized as low (0-9 methods), medium (10-11 methods), or high (12-14 methods) based roughly on the tercile distribution of the number of contraceptive methods known. Other knowledge variables, including correct knowledge of the fertility cycle and postpartum return to fecundity, were explored but excluded from the final, more parsimonious model because of their weaker bivariate associations.

We measure the ideal number of children and sex preference for children based on questions regarding how many girls, boys, and children of either sex a respondent would ideally like to have. We categorize women as having son preference if they preferred more boys than girls, daughter preference if they preferred more girls than boys, and gender balanced/no preference if they expressed no preference or preferred an equal number of girls and boys.

Attitudes accepting wife beating is a dichotomous variable set to one if women reported that wife beating was justified in at least one of five scenarios and zero if they reported that wife beating was not justified in any of the scenarios. Intolerance of wife beating (zero) is interpreted as the gender equitable perspective.

Attitudes toward protective self-efficacy is an index of the number of scenarios, ranging from 0 to 2, in which a respondent believed that a woman is justified in taking action to protect her sexual health. The two scenarios are (1) if a wife is justified in refusing sex with her husband if he has sex with other women and 2) if a wife is justified in insisting on using a condom if her husband has signs of a sexually transmitted infection. A higher index score is interpreted as the gender equitable perspective, demonstrating higher levels of support for protective self-efficacy.

We measure fertility desires based on whether a woman wanted a child within two years (i.e., soon), wanted a child after two or more years, wanted a child but was unsure of the timing, or wanted no more children (or was sterilized or infecund). We also include a measure of intention to use contraception (currently using contraception, intends to use in the future, does not intend to use).

Another measure we include is whether a woman owned a mobile phone or had accessed the internet in the past month. We measure if women reported hearing family planning messages on the radio, on tv, in newspapers/magazines, or via mobile phone in the past few months. A separate measure capturing general exposure to ratio, tv, or newspapers was tested but excluded from the final analysis.

We include a variable describing whether a woman visited a health facility or was visited at home by a health worker in the past 12 months and whether family planning was discussed during that visit. The health insurance variable captures whether women were covered by any type of health insurance.

Problems seeking medical advice is based on women's responses to whether any of the following presented a "big problem" when she is sick and wants to seek medical advice or treatment: getting permission to go, getting money needed for treatment, distance to the health facility, and not wanting to go alone. The variable is categorized as a dichotomous variable comparing women who experienced one or more of these problems with women who experienced none of them.

Multivariable models also control for age at the start of the calendar sequence, residence, education, and household wealth quintile. Regression analyses are conducted in Stata ME 16 and results are presented in odds ratios (ORs) to ease interpretation. All analyses are weighted to account for sampling probability and non-response, and *svyset* commands are used to account for the complex sampling design.

2.4 Limitations

This study has some limitations. First, the regression models are not intended to describe causal relationships. Many of the covariates in these models assess factors at the time of the survey, whereas the clusters are defined by behaviors over the past five years. The models are employed to describe the attributes of women constituting each of the identified clusters while controlling for a range of current factors.

Second, this study does not contain any measures of spousal communication or power dynamics. Such factors are often the target of SBC interventions and are seen as one possible pathway that influences modern contraceptive use (Assaf and Davis 2019; Nanda, Schuler, and Lenzi 2013; Raj et al. 2016; Yue, O'Donnell, and Sparks 2010). However, measures of spousal communication around family planning are not available in the 2016-17 Burundi DHS survey. We also exclude measures of household or contraceptive decision making. This topic is outside the scope of the current study and is explored elsewhere (Juan, Allen, and MacQuarrie 2020).

3   RESULTS

3.1   Contraceptive Clusters

We identify six distinct clusters from women's contraceptive calendar sequences in Burundi. These clusters are illustrated by their medoid—the most illustrative sequence for each cluster—in Figure 1. They comprise (1) Quiet Calendar (42% of women), characterized by women who did not experience pregnancy or use any methods of contraception; (2) Family Builder 1 (25%) and (3) Family Builder 2 (18%), which are similar in that they are both characterized by women who did not use any method and experienced two pregnancies, but varied in terms of timing during the calendar sequence; (4) Modern Mother (8%), characterized by women who adopted short-term modern methods toward the end of year 2 after a period of non-use and a pregnancy; (5) Consistently Covered Mother (6%), characterized by women who adopted LAPMs after a period of non-use and a pregnancy; and (6) Traditional Mother (2%), characterized by those who adopted traditional methods at the end of year 2 after non-use and a pregnancy. Additional details about these clusters are reported elsewhere (MacQuarrie, Allen, and Gemmill 2020; MacQuarrie et al. 2019).

Figure 1   Representative sequence (medoid) and proportion of each Burundi contraceptive cluster
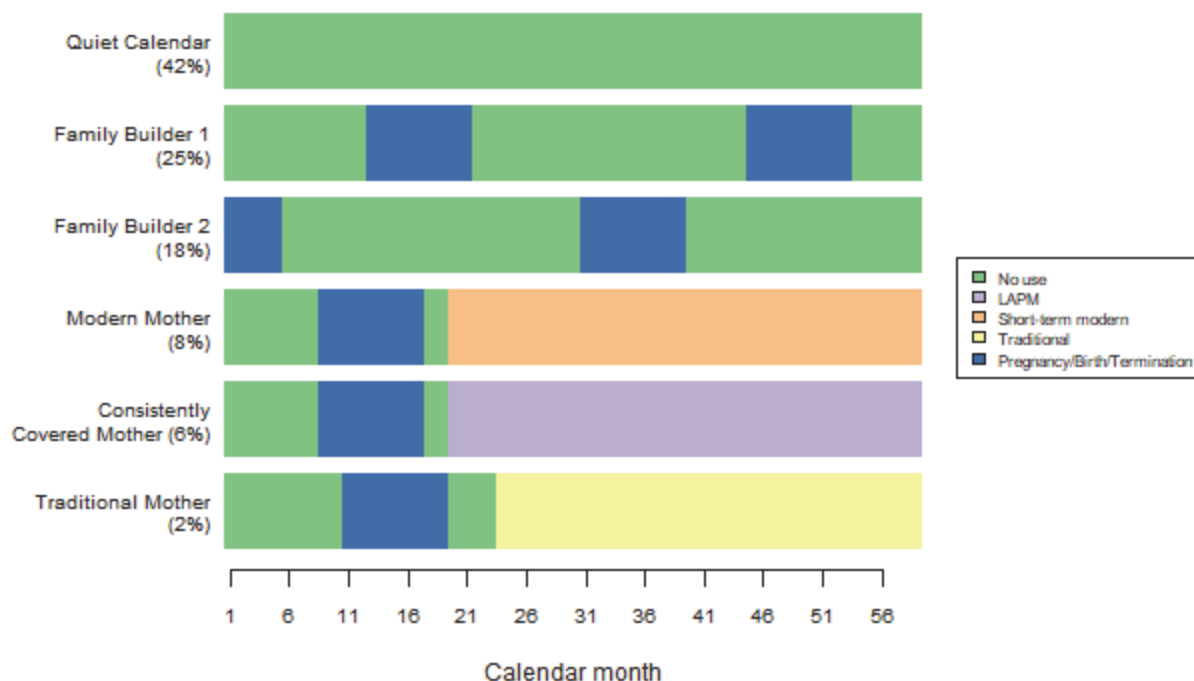
3.2   Sample Description

Table 1 presents the characteristics of women in the analytic sample, using the factors in the regression models. As described previously, Quiet Calendar is the most common cluster (42%) and Traditional Mother is the least common cluster (2%). The sample is relatively young, with the proportion declining from 24% in the youngest of the five age groups (age 15-19) to 9% in the oldest age group (age 40-44) at the start of the calendar sequence. The sample is largely rural (88%), with most women having either no education (45%) or primary education only (37%). The sample is evenly distributed across household wealth quintiles.

Table 1   Analytic sample profile

	Percent	Weighted n
Contraceptive Profile Cluster		
Quiet calendar	41.5	5,521
Family builder 1	24.9	3,308
Family builder 2	18.1	2,400
Modern mother	7.6	1,007
Consistently covered mother	5.6	750
Traditional mother	2.3	308
Socio-economic factors		
Age at the start of calendar sequence		
15-19	24.2	3,219
20-24	22.6	3,006
25-29	18.3	2,431
30-34	14.6	1,941
35-39	11.5	1,533
40-44	8.8	1,165
Residence		
Urban	12.5	1,666
Rural	87.5	11,627
Highest education level		
No education	44.8	5,955
Primary	36.8	4,896
Secondary or higher	18.4	2,441
Household wealth quintile		
Poorest	20.3	2,696
Poorer	20.2	2,688
Middle	20.1	2,671
Richer	18.9	2,513
Richest	20.5	2,725
Knowledge and Attitudinal Factors		
Contraceptive knowledge (# of methods known)		
Low (0-9)	29.2	3,881
Medium (10-11)	26.6	3,538
High (12-14	44.2	5,874
Ideal number of children		
0	1.5	195
1-2	8.3	1,110
3-4	62.4	8,292
5+	25.7	3,420
Non-numeric response	2.1	276
Sex preference for children		
Balanced or no preference	55.3	7,352
Son preference	30	3,993
Daughter preference	14.7	1,948
Attitudes accepting wife-beating		
In no scenario	38.6	5,132
In at least one scenario	61.4	8,161
Attitudes accepting self-efficacy (# of scenarios)		
0	14.1	1,880
1	32.5	4,314
2	53.4	7,100
Intention to use contraception in the future		
Using	22.3	2,960
Intends to use	41.4	5,503
Does not intend to use	36.3	4,829

Continued…

Table 1   **Analytic sample profile** *(continued)*

	Percent	Weighted n
Interactions with media and health systems		
Access to internet or mobile phone		
No	73.3	9,748
Yes	26.7	3,545
Heard FP media messages in last few months		
No	68.3	9,082
Yes	31.7	4,211
Visited with health facility or fieldworker in last 12 months		
No visit	18.5	2,455
Visited	48.5	6,445
Discussed FP at visit	33	4,393
Covered by health insurance		
No	76.8	10,211
Yes	23.2	3,082
Problems seeking medical advice when sick		
None	28.8	3,830
One or more	71.2	9,463
Total	100.0	13,293

3.3   Compiling Composite Profiles of Each Cluster

The regression analyses identify which of the women's attributes related to knowledge, attitudes, and health system and media exposure) are associated with cluster membership (Table 2). Combined, the results of these analyses provide composite profiles that richly described and further differentiated the clusters (as the clusters were originally based only on data from the calendar histories).

3.3.1   Quiet Calendar

Overall, Quiet Calendar women tend to be on the very young or older tails of the age spectrum, be educated, and own mobile phones. However, they do not have high contraceptive knowledge nor much interaction with health services. Although they prefer a small family size and prefer sons, they do not have defined plans for having a child (or another child) and do not intend to use contraception.

Table 2 shows a unique pattern of association between age and membership in the Quiet Calendar cluster not found in any of the other five clusters. Compared with women in the middle age group (age 30-34), both older women (OR=2.5–10.5, p<0.001) and adolescent women (OR=1.5, p<0.001) have higher odds of belonging to the Quiet Calendar cluster, while women in their 20s have lower odds (OR=0.6, p<0.001).

Among the other socio-economic factors, neither residence nor wealth is associated with Quiet Calendar cluster membership. However, education is associated with membership in this cluster: Women with secondary or higher education have higher odds (OR=3.7, p<0.001) of being in this cluster than do women without education. Nonetheless, women with medium or high knowledge of contraceptive methods have 30% lower odds (OR=0.7, p<0.001) of belonging to the Quiet Calendar cluster than do women who have low contraceptive knowledge; this was the only cluster to demonstrate a negative association with contraceptive knowledge.

Multiple attitudinal factors are associated with Quiet Calendar membership. Gender attitudes, however, are not. Women whose ideal family included many children have lower odds of being in the Quiet Calendar cluster than do women who reported 1-2 children as their ideal number of children. Women with a preference for sons have 15% higher odds (p<0.05) of being in the Quiet Calendar cluster than women who preferred gender balance or who had no preference in the sex composition of their children. Sex preference is not a factor in membership in any other cluster model.

When compared with women who wanted a child within two years, women who wanted a child but were unsure of the timing have more than four times the odds of being in the Quiet Calendar cluster, while those who wanted to delay children or wanted no more children have 65% lower odds (p<0.001). Women who are using contraception (OR=0.04, p<0.001) or intended to use contraception (OR=0.47, p<0.001) have lower odds of being in the Quiet Calendar cluster than women who do not intend to use contraception. Quiet Calendar women are no more likely than women non-members to have heard family planning messages in the media. This is in spite of their mobile phone and internet access: Women who had a mobile phone or access to the internet have 29% higher odds (p<0.001) of being in the Quiet Calendar cluster.

Table 2   Knowledge, attitudes, and media and health service interactions associated with cluster membership. Odds ratios from logistic regressions

	Quiet Calendar (42%)		Family Builder 1 (25%)		Family Builder 2 (18%)		Modern Mother (8%)		Consistently Covered Mother (6%)		Traditional Mother (2%)	
	Odds ratio	p-value	Odds ratio	p-value	Odds ratio	p-value	Odds ratio	p-value	Odds ratio	p-value	Odds ratio	p-value
Socio-economic factors												
Age at the start of calendar sequence (ref: 30-34)												
15-19	1.54	<0.001	1.15	0.171	1.00	0.979	0.56	<0.001	0.46	<0.001	0.14	<0.001
20-24	0.60	<0.001	1.42	<0.001	1.27	0.007	0.79	0.106	1.06	0.691	0.43	<0.001
25-29	0.59	<0.001	1.36	<0.001	1.23	0.008	0.85	0.193	1.03	0.852	0.61	0.012
35-39	2.47	<0.001	0.58	<0.001	0.67	<0.001	0.92	0.574	1.14	0.375	0.96	0.843
40-44	10.54	<0.001	0.09	<0.001	0.24	<0.001	0.82	0.314	0.95	0.815	1.77	0.046
Residence (ref: urban)												
Rural	1.05	0.616	1.19	0.064	0.93	0.476	0.61	0.001	1.28	0.131	0.80	0.290
Education (ref: none)												
Primary	1.10	0.130	0.99	0.900	1.04	0.512	0.85	0.119	0.78	0.025	1.24	0.274
Secondary or higher	3.68	<0.001	0.64	<0.001	0.51	<0.001	0.56	<0.001	0.50	0.002	1.16	0.550
Household wealth index (ref: poorest)												
Poorer	0.89	0.154	1.10	0.228	1.06	0.497	0.81	0.085	1.01	0.974	1.05	0.857
Middle	0.91	0.276	1.02	0.845	1.00	0.960	0.76	0.039	1.53	0.005	1.02	0.938
Richer	0.88	0.162	0.98	0.780	1.11	0.233	0.69	0.007	1.32	0.097	1.71	0.030
Richest	0.91	0.422	0.97	0.802	0.95	0.663	1.06	0.752	1.18	0.428	1.56	0.123
Knowledge and attitudes												
Contraceptive knowledge (ref: Low (<10 methods))												
Medium (10-11 methods)	0.70	<0.001	1.14	0.051	1.11	0.168	1.22	0.175	1.19	0.265	1.99	0.003
High (12-14 methods)	0.70	<0.001	1.20	0.002	0.95	0.419	1.43	0.006	1.23	0.082	1.83	0.005
Ideal number of children (ref: 1-2)												
0	0.95	0.855	1.15	0.531	1.01	0.961	0.69	0.400	1.09	0.832	1.10	0.886
3-4	0.68	<0.001	1.31	0.005	1.11	0.283	0.88	0.346	1.18	0.323	1.26	0.370
5+	0.46	<0.001	1.79	<0.001	1.22	0.059	0.75	0.069	0.99	0.933	1.05	0.868
Non-numeric response	0.44	<0.001	1.23	0.329	1.83	0.001	1.15	0.710	0.64	0.359	0.72	0.593
Sex preference for children (ref: gender balanced/no preference)												
Son preference	1.15	0.030	0.97	0.622	0.96	0.478	1.08	0.436	0.92	0.423	0.71	0.035
Daughter preference	1.12	0.147	0.96	0.529	1.01	0.930	0.97	0.788	0.77	0.055	1.13	0.503
Attitudes accepting wife beating in at least one scenario												
Yes	1.07	0.161	0.95	0.317	0.89	0.040	1.26	0.007	1.07	0.530	0.88	0.349
Attitudes accepting self-efficacy (# of scenarios, ref: none)												
1	1.04	0.687	1.01	0.913	0.82	0.031	1.46	0.015	1.10	0.548	1.21	0.501
2	1.04	0.684	1.03	0.666	0.82	0.030	1.26	0.113	1.05	0.730	1.44	0.188
Fertility desires (ref: wants within 2 years)												
Wants after 2+ years	0.35	<0.001	3.15	<0.001	1.28	0.009	0.64	0.002	0.54	<0.001	1.11	0.653
Wants, unsure timing	4.21	<0.001	0.29	<0.001	0.30	<0.001	0.35	<0.001	0.21	<0.001	0.45	0.061
Wants no more/sterilized/infecund	0.35	<0.001	2.70	<0.001	1.39	<0.001	0.71	0.015	0.86	0.318	0.70	0.096
Intention to use contraception in the future (ref: does not intend to use)												
Using	0.04	<0.001	1.30	<0.001	0.43	<0.001	29.96	<0.001	21.58	<0.001	32.98	<0.001
Intends to use	0.47	<0.001	1.24	0.101	1.01	0.888	5.53	<0.001	4.20	<0.001	5.17	<0.001
Interactions with health services and media												
Access to mobile phone or internet (ref: no)												
Yes	1.29	0.002	0.86	0.034	0.82	0.012	0.91	0.508	1.55	0.001	1.00	0.997
Heard family planning media messages in last few months (ref: no)												
Yes	1.10	0.160	0.97	0.483	0.90	0.084	1.16	0.094	0.77	0.012	1.28	0.092
Visited with health facility or fieldworker in last 12 months (ref: no visit)												
Visited	0.34	<0.001	2.04	<0.001	2.14	<0.001	1.35	0.038	1.26	0.150	1.08	0.725
Discussed family planning at visit	0.18	<0.001	2.92	<0.001	2.41	<0.001	1.37	0.042	1.32	0.115	0.94	0.800
Covered by health insurance (ref: no)												
Yes	0.77	<0.001	1.10	0.101	0.98	0.737	1.22	0.030	1.00	0.965	1.31	0.075
Problems seeking medical advice when sick (ref: none)												
One or more	1.27	<0.001	0.93	0.183	0.94	0.305	0.89	0.229	0.92	0.435	1.06	0.718
Observations	13,293		13,293		13,293		13,293		13,293		13,293	

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Membership in the Quiet Calendar cluster is also associated with little interaction with health services. Having visited a health facility or visited with a health fieldworker in the past 12 months (OR=0.34, p<0.001), having discussed family planning with a health worker (OR=0.18, p<0.001), and having health insurance (OR=0.77, p<0.001) are each negatively associated with membership in the Quiet Calendar cluster. Meanwhile, women who encountered one or more problems seeking medical advice when sick have 1.3 times the odds of belonging to the Quiet Calendar cluster when compared with women who did not have such access problems. This factor is not associated with membership in any of the other cluster models.

3.3.2 Family Builder 1

The Family Builder 1 cluster generally consists of women who are younger than age 30, are not well-educated, and do not own a mobile phone or have internet access, but who have visited recently with a health worker. Cluster membership is also associated with high contraceptive knowledge, having a larger ideal family size, having a desire to avoid or delay pregnancy, and current use or intention to use contraception.

Compared with women in the middle age group, younger women have higher odds and older women have lower odds of being in this cluster than do women age 30-34. Women with secondary or higher education have 36% lower odds of cluster membership than women with no education. Women who had a mobile phone or internet access have 14% lower odds (p<0.001) of being in the Family Builder 1 cluster compared with women who lacked this access, the opposite direction as for the Quiet Calendar.

Women with high contraceptive knowledge have 20% higher odds (p<0.01) of belonging to the Family Builder 1 cluster than women with low contraceptive knowledge. Compared with women who believed that 1-2 was the ideal number of children, women whose ideal was 3-4 children have 31% higher odds and those whose ideal was 5 or more have 79% higher odds of being in the Family Builder 1 cluster.

Fertility desires have a strong, significant association with cluster membership. Women who wanted no more children have 3.15 times the odds (p<0.001) and those who wanted to delay birth by two or more years have 2.7 times the odds (p<0.001) of being in the Family Builder 1 cluster when compared with women who wanted a child soon. Women who were currently using or who intended to use contraception have 24% to 30% higher odds (p<0.001) of being in the Family Builder 1 cluster than do women who did not intend to use contraception.

Women who had visited a health facility or visited with a health fieldworker in the past 12 months have more than two times the odds of membership in the Family Builder 1 compared with women who had no visit. The same women have nearly three times the odds of membership if they had discussed family planning during that visit.

Factors related to residence, wealth, sex preference, gender attitudes, family planning media messages, health insurance, and problems seeking medical advice are not associated with membership in the Family Builder 1 cluster.

3.3.3 Family Builder 2

The Family Builder 1 and Family Builder 2 clusters resemble one another in terms of the elements in their calendar sequences, though they differ in the timing of these sequences. Although they share some similarities, Table 2 highlights differences between the two clusters.

Like Family Builder 1, the Family Builder 2 cluster consists of younger women who are not well-educated and who lacked mobile phones or internet access. Also like in Family Builder 1, having visited with a health worker in the past 12 months is positively associated with membership in the Family Builder 2 cluster (OR=2.14, p<0.001), with the magnitude of the association being larger for women who discussed family planning during that visit (OR=2.41, p<0.001). The Family Builder 1 and 2 clusters are similar in their members' fertility desires; however, the magnitude of the effect is smaller for Family Builder 2. For the Family Builder 2 cluster, the odds of membership are slightly higher among women who wanted to delay another birth by two or more years (OR=1.28, p<0.001) or have no more children (OR=1.39, p<0.001); for the Family Builder 1 cluster, the odds of membership are 2.7-3.2 times higher for these women.

The Family Builder 2 cluster differs from the Family Builder 1 cluster in terms of contraceptive knowledge and intentions, ideal family size, and gender attitudes. Women who provided a non-numeric response when asked about their ideal family size have 83% higher odds of being in the Family Builder 2 cluster than women who preferred 1-2 children. In contrast to the model for Family Builder 1, the ideal number of children is not otherwise associated with cluster membership. Unlike Family Builder 1, women who are using contraception have 57% lower odds (p<0.001)—not higher odds—of belonging to the Family Builder 2 cluster than women who did not intend to use contraception. Contraceptive knowledge is not a factor in cluster membership for the Family Builder 2 cluster.

Women belonging to the Family Builder 2 cluster tend to be mixed in their gender attitudes. Those who believed wife beating to be acceptable—the gender *inequitable* perspective—have 11% lower odds (p<0.05) of cluster membership than women who found wife beating unacceptable. However, the other gender equity variable operates in the opposing direction: Women who believed that a woman was justified in protecting her sexual health in at least one scenario—the gender *equitable* perspective—also have 18% lower odds (p<0.05) of belonging to this cluster than women who found protective self-efficacy unacceptable. This finding is robust in that several alternate specifications of these variables and the omission of either of these variables does not change the finding.

Residence, household wealth, sex preference, health insurance, and problems seeking medical advice are not indicative of membership in this cluster, as is also the case with Family Builder 1.

3.3.4 Modern Mother

The Modern Mother cluster consists of women who had high contraceptive knowledge, wanted to delay/avoid pregnancy, were using or intended to use contraception, and had had a recent visit with a health worker. The women in this cluster tend to be older than age 20, live in urban areas, and lack secondary or higher education.

Several socio-economic factors are associated with membership in the Modern Mother cluster—one of the three clusters characterized by contraceptive use. Women in the Modern Mother cluster are unlikely to be

adolescents. Women age 15-19 at the start of the calendar sequence have 44% lower odds (p<0.001) of cluster membership than women age 30-34. Compared with urban women, women who resided in rural areas also have 39% reduced odds (p=0.001) of being in this cluster—the only cluster for which residence is a factor. Similar to the Family Builder clusters, women with secondary or higher education also have lower odds of cluster membership. There is some indication that women in the richer wealth quintile have lower odds of belonging to the Modern Mother cluster than do the poorest women, but wealth is otherwise not a factor.

Contraceptive knowledge, fertility desires, and contraceptive intentions are associated with membership in the Modern Mother cluster. Ideal number of children and sex preference are not associated with membership in this cluster, nor in any other cluster characterized by contraceptive use. Women with high contraceptive knowledge (12-14 methods) have higher odds of membership (OR=1.43, p<0.01), similar to Family Builder 1 and Traditional Mother clusters. Women who wanted to delay, wanted to avoid, or were unsure of the timing of having another child have lower odds of being in the Modern Mother cluster than do women who wanted a child soon, ranging from 29% lower for women who wanted no more children (OR=0.71, p<0.05) to 65% lower for women who were unsure (OR=0.35, p<0.001). The odds of being in the Modern Mother cluster are much higher among women who intended to use (OR=5.53, p<0.001) or were currently using (OR=30, p<0.001) contraception when compared with women not using contraception.

Gender attitudes are also mixed in this cluster, but in the opposite direction as in the Family Builder 2 cluster. The odds of Modern Mother membership are higher among those who found wife beating acceptable (OR=1.26, p<0.01)—the gender *inequitable* perspective—and among those who thought protective self-efficacy was acceptable in one scenario (OR=1.46, p<0.05)—the gender *equitable* perspective.

As for factors related to media and health service interactions, women who visited with a health worker or discussed family planning during a health worker visit in the past 12 months have 35% to 37% higher odds of cluster membership than do those with no health worker visit. When compared with women who lacked health insurance coverage, women with health insurance also have 22% higher odds of being in the Modern Mother cluster—one of two clusters for which health insurance is a factor. Mobile phone or internet access and family planning messages in the media are not associated with membership, nor are problems seeking medical advice when sick.

3.3.5   Consistently Covered Mother

Women in the Consistently Covered Mother cluster tend to not be adolescents, lack education, not have a mobile phone or internet access, and not have heard family planning media messages in the past few months. The cluster consists of women who were more apt to want a child soon, but who were using or intended to use contraception.

Age, education, and hearing family planning media messages are negatively associated with cluster membership, while mobile phone/internet access and contraceptive intentions are positively associated. Like in the Modern Mother cluster, women age 15-19 (and no other age group) have 54% lower odds of cluster membership (p<0.001) than do women age 30-34. Women with either a primary education or a secondary or higher education also have lower odds (22% and 50%, respectively) of being in the Consistently Covered Mother cluster compared with women with no education.

The odds of cluster membership are 23% lower (p<0.05) among women who had heard family planning media messages and 55% higher among those with a mobile phone or internet access (p=0.001). This is the only cluster for which hearing family planning media messages in the past few months is associated with cluster membership.

Regarding fertility desires, women who wanted to delay or avoid pregnancy have 46% to 79% lower odds of belonging to the Consistently Covered Mother cluster than do women in the reference category. In other words, women who wanted a child soon have greater odds of being in this cluster—a finding similar to that in the Modern Mother model. In spite of these desires, women who intended to use contraception have 4.2 times the odds and women who were currently using contraception have 21.6 times the odds of being in this cluster compared with women who do not intend to use contraception.

In contrast to the other clusters characterized by contraceptive use, women in this cluster do not necessarily have high contraceptive knowledge. Ideal number of children, sex preference, gender attitudes, health insurance, and problems seeking medical advice are not associated with membership.

3.3.6 Traditional Mother

Contraceptive knowledge and intentions are the only attitudinal factors associated with membership in the Traditional Mother cluster. Women with medium or high contraceptive knowledge have nearly twice the odds (ORs=1.83-1.99, p<0.01) of being in the Traditional Mother cluster than do women with low knowledge. In a pattern similar to the Modern Mother and Consistently Covered Mother clusters, women who intended to use contraception have more than five times the odds and those who were using contraception have nearly 33 times the odds of being in the Traditional Mother cluster (p<0.001).

Although sex preference is not generally associated with membership in any other cluster model, women who had a preference for sons have 29% lower odds (p<0.05) of being members of the Traditional Mother cluster compared with women who had no preference regarding sex composition. Membership in this cluster is not otherwise associated with attitudes toward ideal family size, gender, or fertility desires. Furthermore, members and non-members do not differ in their interactions with health services and media, including mobile phone/internet access, hearing family planning media messages, health worker visits, health insurance, or problems seeking medical advice.

As shown in Table 2, age at the start of the calendar sequence shows a positive association with being in the Traditional Mother cluster. Compared with women age 30-34, younger women have lower odds of cluster membership, while those age 40 and older have higher odds of membership.

4   CONCLUSIONS

This study identified six clusters of reproductive behavior in Burundi and used data on women's contraceptive knowledge, attitudes, and interactions with the media and health services to determine associations between these factors and membership in the individual clusters. Three of the clusters are characterized by contraceptive use, and three are characterized by the absence of contraceptive use. A large majority of women in the study (85%) belong to one of the non-contraception clusters, with a minority (16%) belonging to one of the three contraception clusters.

Two of the non-contraception clusters are characterized by family building (i.e., the use of no contraception and the experience of two pregnancies). The Family Building 1 and 2 clusters appear at first glance to be nearly identical, differing only by the timing of pregnancies. This raises the question as to (1) whether their identification as separate clusters was an anomaly of the statistical procedures used and was based on variance in when women were interviewed relative to their pregnancies or (2) whether they are, indeed, programmatically meaningful, distinct groups of women. The results of our regression analyses support the latter conclusion.

Although women in Family Builder 1 and 2 clusters have some attributes in common (they are generally young and have interacted with a health provider recently), they differ in several important ways. In Family Builder 1, women tend to have medium to high contraceptive knowledge, are using or intended to use contraception, and desired moderate to large families (at least three children). In contrast, women in the Family Builder 2 cluster are more likely to provide a non-numeric answer about their ideal number of children, suggesting that women who fall into this profile are in a concentrated family building stage but may not believe they can exercise much control over their reproductive lives (Coale 1973; Frye and Bachan 2017; Hayford and Agadjanian 2011; Lloyd and Ivanov 1988; McCarthy and Oni 1987; Trinitapoli and Yeatman 2011; Van de Walle 1992). This contrast comports with other analyses that indicate that women in the Family Builder 1 cluster have more experience with contraception than do women in Family Builder 2, are less likely to experience unmet need, and are more likely to participate in decisions related to contraceptive use (Juan, Allen, and MacQuarrie 2020; MacQuarrie, Allen, and Gemmill 2020).

The three clusters characterized by contraceptive use are each characterized by the type of contraception used—short-term, modern methods; LAPMs; and traditional methods. Although women who are members of these clusters may be using contraception, some (such as members of the Consistently Covered Mother cluster) may want to have another child soon. This illustrates the dynamic nature of fertility desires over time (Bernardi, Mynarska, and Rossier 2015; Dasgupta, Zaba, and Crampin 2015; Roy et al. 2003; Speizer and Lance 2015) suggesting that, just as women who are not using contraception may need these services soon, women who are contracepting may soon need LARC-removal services, antenatal care, or other reproductive services in support of their reproductive intentions (Brandi and Fuentes 2020; Staveteig, Mallick, and Winter 2015).

Contraceptive knowledge was positively associated with membership in the Family Builder 1 and Traditional Mother clusters and negatively associated with membership in the Quiet Calendar cluster. Surprisingly, it was not associated with membership in either cluster defined by the use of modern methods,

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suggesting a need for improved counseling on a range of contraceptive methods, including how they work and their efficacy, side effects, and alternatives.

Gender equitable attitudes are believed to be related to contraceptive use (Nanda, Schuler, and Lenzi 2013; Raj et al. 2016; Walcott et al. 2015). However, in this study, we found that gender attitudes were seldom associated with membership in clusters based on contraceptive and pregnancy experiences. When they are associated with cluster membership (i.e., in the Family Builder 2 and Modern Mother clusters), attitudes toward violence and women's self-efficacy operated in opposite directions, suggesting that gender attitudes are more complex and nuanced than typically conceptualized.

Mass media initiatives are a common component of SBC interventions and have been shown to increase contraceptive use (Hutchinson and Meekers 2012; Jah, Connolly, and Ryerson 2018; Rosen et al. 2019; Speizer et al. 2014). However, in this study, we found that exposure to family planning messages in the media is largely not associated with cluster membership.

We also found that visiting with a health worker and discussing family planning with that health worker is positively associated with membership in the Modern Mother cluster and both Family Builder clusters. For Family Builders, these health worker visits may have been related to maternal health care, given that the women in these clusters have recent pregnancies in their calendar sequences. Their interactions with health services reinforces the importance of counseling about postpartum family planning (and beyond) during antenatal care visits. Recent interaction with health services was negatively associated with membership in the Quiet Calendar cluster—the largest cluster, encompassing more than 4 in 10 women in Burundi. Problems seeking medical care and low contraceptive knowledge are also associated with the Quiet Calendar cluster. This presents a formidable challenge to reproductive health programs, and innovative approaches may be required to reach hard-to-reach women with information and general health services before contraceptive or pregnancy care is needed.

This study made novel use of DHS calendar data in Burundi to identify six discrete clusters of women based on their contraceptive and pregnancy experiences over the past five years, and to determine the attributes associated with these clusters. The results can guide reproductive health programs as they target SBC and other interventions to the unique subpopulations they seek to serve.

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