The role of media in sexual and reproductive health education in low- and middle-income countries: a mixed methods investigation

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PREFACE

NOTES ON MANUSCRIPT-BASED THESIS

The thesis is presented as a manuscript-based thesis that includes two articles: one that has been submitted for publication in the Journal of Global Health and another that will be submitted to the journal Lancet Global Health. This thesis follows McGill requirements for thesis preparation of manuscript-based theses.

CONTRIBUTIONS

As the M.Sc. candidate and first author of the two manuscripts, I was responsible for designing and planning the majority of the work and data acquisition, interpreting the results and writing the articles. The overall concept for the research was determined by myself, and my supervisors, Drs. Yves Bergevin and Tibor Schuster. Drs. Yves Bergevin, Tibor Schuster and Britt McKinnon provided their guidance and feedback on the articles and assisted with analysis and interpretation of the findings. Dr. Pierre Pluye provided useful methodological advice for the first article, the mixed methods systematic review. Amy Booth assisted with data collection for the first article, the mixed methods systematic review.

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ABSTRACT

Background: An estimated 200 million women and girls in low and middle-income countries (LMICs) wish to delay, space or avoid becoming pregnant, yet are not using contraceptives. This thesis seeks to investigate the effectiveness of mass media interventions for increasing knowledge and use of contraceptives, and to identify barriers to program implementation. However, while media represents a promising tool for health education, even the most efficacious interventions rely on reach of the media program. Therefore, this thesis also seeks to identify the important variables associated with radio and television use, in order to better characterize audiences and to guide media health education programs.

Methods: First, using a mixed-methods systematic approach, five electronic databases were searched using pre-determined search strategies and hand-searching of articles of mass media interventions for family planning education. Two reviewers independently applied clearly defined eligibility criteria to the search results, quality appraisal, data extraction from published reports, and data analysis (using meta-analysis and thematic analysis) following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Next, using Demographic and Health Survey (DHS) datasets of 41 countries, we used two statistical prediction methods, conventional logistic regression model (main effects only) and random forests, to estimate respondents' expected use of radio and/or television in relationship to various individual- and country-level predictor variables. The most important variables for determining media use were further analyzed for direction of relationships and the cross-validated misclassification errors of each method were compared.

Findings: The mixed methods systematic review found an overall low quality of studies evaluating media interventions for improving contraceptive and family planning knowledge and use. Moreover, although the majority of studies suggest a positive association between media interventions and family planning outcomes, the pooled results are still consistent with possibly null or small effects. The qualitative analysis indicates that barriers to contraceptive uptake include individual-level socio-demographic factors and knowledge, access (including issues relating to mobility and financing), and programming (including lack of participatory approaches). The multi-country analysis found that women who are slightly younger, urban-residing, more educated, and of a higher wealth status have a higher reported percentage of frequent radio and television use. For each media method (radio and television), having either a radio and/or television in the

household was the most important predictor of media use. The second most important variable for determining use of both media methods was the respondent's reported frequency of engaging with other media sources (i.e. television, radio or newspapers).
Conclusion: There is a need for rigorous impact evaluation, including randomised controlled trials, of mass media interventions on knowledge and uptake of family planning in LMIC settings. Interventions should be better tailored to cultural and socio-demographic characteristics of the target populations, while access to resources, including contraceptives, should continue to remain a priority and be improved, where possible. It is also important to keep in mind potential gaps in access to media sources when designing health education programs through media.

RÉSUMÉ

Contexte: On estime que 200 millions de femmes et de filles dans les pays à revenu faible et intermédiaire (PRFI) souhaitent retarder, espacer ou éviter de devenir enceintes, mais n'utilisent pas de contraceptifs. Cette thèse cherche à étudier l'efficacité des interventions médiatiques pour accroître les connaissances et l'utilisation des contraceptifs, et identifier les obstacles à la mise en œuvre des programmes. Cependant, si les médias représentent un outil prometteur pour l'éducation à la santé, même les interventions les plus efficaces reposent sur la portée du programme médiatique. Par conséquent, cette thèse cherche également à identifier les variables importantes associées à l'utilisation de la radio et de la télévision, afin de mieux caractériser les publics et de guider les programmes d'éducation à la santé des médias.
Méthodes: Tout d'abord, en utilisant une approche systématique à méthodes mixtes, nous avons cherché cinq bases de données électroniques en utilisant des stratégies de recherche prédéterminées et la recherche manuelle d'articles d'interventions de mass media pour l'éducation à la planification familiale. Deux évaluateurs ont indépendamment appliqué des critères d'éligibilité clairement définis aux résultats de recherche, à l'évaluation de la qualité, à l'extraction des données des rapports publiés et à l'analyse des données (en utilisant la méta-analyse et l'analyse thématique). Ensuite, en utilisant des ensembles de données démographiques et sanitaires (EDS) de 41 pays, nous avons utilisé deux méthodes de prédiction statistique, un modèle de régression logistique conventionnel (effets principaux uniquement) et forêts aléatoires, pour estimer

l'utilisation prévue de la radio et / ou de la télévision en avec des variables prédictives pour les individus et les pays. Les variables les plus importantes pour la détermination de l'utilisation des médias ont été analysées plus avant pour la direction des relations et les erreurs de classification erronée croisées validées de chaque méthode ont été comparées.

Résultats: La revue systématique des méthodes mixtes a montré que bien que la majorité des études suggère une association positive entre les interventions médiatiques et les résultats de la planification familiale, les résultats groupés sont toujours compatibles avec des effets d'intervention probablement nuls. L'analyse qualitative indique qu'il existe des obstacles à l'adoption de la contraception au niveau des connaissances individuelles (facteurs démographiques et notions préconçues), l'accès (y compris les questions de mobilité et de financement) et la programmation (manque d'approches participatives). L'analyse multi-pays a montré que pour chaque méthode médiatique (radio et télévision) disposant d'une radio et / ou d'une télévision dans le ménage était le prédicteur le plus important de l'utilisation des médias. La deuxième variable la plus importante pour déterminer l'utilisation des deux méthodes médiatiques était la fréquence déclarée par le répondant de s'engager avec l'autre source médiatique (à savoir la télévision, la radio ou les journaux). Une autre variable qui a montré une capacité prédictive à la fois pour la radio et la télévision était le nombre de membres du ménage.

Conclusion: Il demeure nécessaire d'effectuer une évaluation rigoureuse de l'impact, y compris par des essais contrôlés randomisés, des interventions des médias sur les connaissances et l'adoption de la planification familiale dans les pays à revenu faible et intermédiaire. Les interventions devraient être mieux adaptées aux caractéristiques culturelles et socio-démographiques des populations cibles, tandis que l'accès aux ressources devrait rester une priorité et être amélioré, si possible. Il est également important de garder à l'esprit les lacunes potentielles dans l'accès aux sources médiatiques dans la portée du programme lors de la conception des programmes d'éducation sanitaire à travers les médias.

ABBREVIATIONS

DHS: Demographic and Health Survey

FP: Family planning

ICPD: International Conference on Population and Development

IQR: Inter-quartile range

LMIC: Low and middle-income countries

RCT: Randomised controlled trial

SDGs: Sustainable Development Goals

SRHR: Sexual and reproductive health and rights

STIs: Sexually transmitted infections

UNFPA: United Nations Population Fund

USAID: United States Agency for International Development

WHO: World Health Organization

TABLES & FIGURES

CHAPTER 1: INTRODUCTION

"If women do not have the rights
to choose what happens to our bodies,
we risk relinquishing rights
in all other areas of our lives."
- bell hooks, *Feminism is for Everybody*

Today, there is an urgent situation facing over "200 million women and girls in developing countries who want to delay, space or avoid becoming pregnant," yet who "are not using effective methods of contraception" (1, 2). Global partners gathered at the 2012 London Summit on Family Planning to launch a "ground-breaking effort to make affordable, lifesaving contraceptives, information, services, and supplies available to an additional 120 million women and girls in the world's poorest countries by 2020" (2). The London Summit emphasized the importance of a human rights-based approach and the importance of ensuring women are able to make informed decisions and choices regarding child-bearing, as stipulated at the International Conference on Population and Development in the 1994 Programme of Action (1, 3). In the six years since the London Summit, there has been a notable acceleration of progress in terms of expansion of family planning and contraceptive services and supplies in developing countries; however, progress has been slow in terms of increasing *use* of family planning and contraceptives, particularly in Western Africa (contraceptive prevalence rate for modern methods: 7% in 1994, 13% in 2015), despite high unmet need (24% in 2015) (4, 5). While improving access to contraception and family planning services and supplies is necessary and should continue to be a top priority, it is not sufficient: there is a need to better understand which interventions are effective at improving knowledge, decision-making and use of contraception in developing countries particularly among young people who are sexually active yet do not wish to become pregnant and who wish to protect themselves against sexually transmitted infections (STIs). Moreover, research is only beginning to provide evidence about how and why education, poverty, gender inequality, social norms, religion and self-efficacy interact as major determinants of low effective demand and use in the face of available services (5-10). Addressing low utilization for contraceptives despite a desire to space or limit pregnancies is a key goal for the future, including the UN Sustainable Development Goals (SDG), which seek

to reduce global maternal mortality (Goal 3.1) and "ensure universal access to sexual and reproductive health-care services, including for family planning, information and education" (Goals 3.7), as part of the SDG goal to achieve universal health care coverage (Goal 3.8) (4).

RESEARCH IN CONTEXT

Various factors affect reproductive aged men and women's access to and use of family planning and contraceptives, including education, gender equality, poverty, and social mobilization. Some studies demonstrate that women and men with higher education are more likely to use family planning and contraceptive methods, and an inverse relationship between education and fertility is consistent in literature (9, 11-13). Female education tends to delay marriage (reducing the number of married years), and therefore also reducing fertility. Additionally, use of family planning allows women to "pursue additional education and participate in public life, including paid employment in non-family organizations" (14), suggesting a positive feedback loop between education and family planning.

Not only can family planning and contraceptives lead to greater opportunities for women, as they are able to plan pregnancies, but it is also importantly related to the struggle for gender equality. Throughout global feminist and gender equality movements, access to contraceptives has been an important issue upon which a majority of the public discussion and debate regarding reproductive health and women's rights was centered. Many prominent feminist scholars argue that sexuality, and particularly a woman's right "to choose when and with whom they would like to be sexual," was one of the foundations and catalysts for the feminist movement (7). As such, topics relating to sexuality and pregnancy were relevant to many women who were involved in the movements. The development of birth control allowed women to better plan when to have children, allowing them to pursue an education as well as enter the workforce (15). A meta-regression, conducted in 2007 of Demographic and Health Survey (DHS) data from Latin America, Southeast Asia and Sub-Saharan Africa found that: "the gap in modern contraceptive prevalence between the absolute poor and the rest of the population in developing countries is increasing over time and tends to widen in countries with higher incomes" (6, 16). Contraceptive rates and smaller families are also closely linked with achieving higher education levels and higher socioeconomic status (6, 16-18). However, while reducing gender inequities, improving female education, and reducing poverty influence knowledge and use of contraceptives, these strategies will likely take a generation or more to achieve. Combining these long-term goals of universal primary and secondary education

and gender equality with short-term strategies that address unmet need for family planning will be needed to achieve the goals of FP2020 and the SDGs. Therefore, this master's thesis focuses on the role of mass communication methods, in order to better understand the potential contributions of mass media to improvements in knowledge and use of contraceptives in countries with high unmet need. This thesis will consider 'media', 'mass media', and 'mass communication' as any method of communication to a broad audience (i.e. broadcasting, publishing, radio, television, text message programs, Internet, phone applications, etc.), that aim at collectively reaching communities. This is in contrast to individual communication methods which are directed to one person. Various innovative approaches to increase the understanding and use of family planning methods have been implemented, including but not limited to: community mobilization; education through health workers; billboards; text messaging; radio and television advertising; and radio and television serial dramas (soap operas). While vast resources have been allocated towards numerous behaviour/social change communication campaigns, there have been few rigorous studies that have analyzed the effectiveness of these interventions to determine which methods are effective and how best to use scarce program resources (19-24).

THESIS CONTRIBUTIONS

Following the United Nations Universal Declaration of Human Rights and the UN SDG Universal Health Coverage Goal 3.8 (4, 25), this thesis will be approached from the perspective that access to healthcare is a basic and fundamental right of all humans. Globally, there is a big shortage of access to skilled, salaried, supervised and supplied healthcare workers, resulting in a gap of services. For example, according to the World Health Organization, only about 78% of childbirths are attended by a skilled birth attendant, which translates into well over 75,000 births per day without a skilled birth attendant, posing significant threats to both the baby and the mother (26). There is an urgent need to improve the state of healthcare globally.

Throughout this thesis, it will be argued that one method to improve health is through health education and promotion. When people are educated about their bodies and their health, they are better positioned to make informed decisions and therefore have greater autonomy over their health, life and future. Yet, it is important to acknowledge that there are a variety of factors beyond education that influence peoples' self-determination with respect to their health. As a global community, it is important to be critically reflective of the research and information that is currently available pertaining to sexual and reproductive health. Because reproductive health is at

the intersection of gender, race, and health, it is undeniable that patriarchy, racism, transphobia and homophobia influence the research available about reproductive health (27-29). While this point is too large and all-encompassing to completely unpack in the context of a master's thesis, understanding and critically reflecting on this fact throughout all stages of this thesis certainly informs this research.

Overall, this thesis seeks to describe the relationship between mass media and reproductive health knowledge and behavior. This thesis is interdisciplinary, involving not only different qualitative and quantitative research methods, but also involving several academic disciplines including but not limited to: family medicine; epidemiology and biostatistics; psychology; sociology, and specifically the study of self-efficacy; international development studies; communications studies; and importantly gender studies.

Following the introduction, this thesis will carry out a literature review of the sociological role of contraception in reproductive health, and the role of mass media in reproductive health education, in 'Chapter 2: Literature Review – Contraception and Family Planning in Context'. It will be argued that it is necessary to critically reflect on the systemic structures of power that influence contraception promotion agendas.

Chapter 3 will present a mixed-methods systematic review of the literature regarding the effectiveness of current media interventions to increase dissemination of family planning and contraception knowledge, and potentially also use. In contrast to the previous chapter's literature review, Contraception and Family Planning in Context, which focuses on the sociological and historical background of context surrounding contraception and family planning, the systematic review in Chapter 3 examines the role of media in increasing knowledge of family planning and contraception. A manuscript version of 'Chapter 3: Are mass media interventions effective in increasing knowledge and use of family planning in low- and middle-income countries? A systematic mixed methods review' has been submitted to the Journal of Global Health.

Chapter 4 will provide an in-depth cross-national analysis of DHS data in 41 low- and middle-income countries to examine the factors associated with mass media usage, in order to be used to better understand target populations when designing health education programs. A version of 'Chapter 4: Factors associated with media use to improve delivery of health education programs

in developing countries: a multi-country analysis' will be submitted for publication in a peer-reviewed journal.

Chapter 5 will summarize the major conclusions and limitations of this thesis and will identify potential next steps. This work contributes to the generation of new knowledge on the role of mass media in influencing family planning and contraceptive knowledge and behaviours, which can be used to inform more effective programs to address critical health inequities.

CHAPTER 2: LITERATURE REVIEW – CONTRACEPTION AND FAMILY PLANNING IN CONTEXT

During the 2010 Millennium Development Goals Summit, United Nations Secretary-General Ban Ki-moon launched the unprecedented Every Woman, Every Child global movement, with the intention of addressing the major health challenges facing women, children and adolescents around the world (30). The Global Strategy for Women's, Children's and Adolescent's Health (2016-2030) became a global movement with many partners, including governments, civil society organizations, and UN organizations (31). In the years since this global movement was launched, sexual and reproductive health and rights (SRHR) have become a major component of public debate, worldwide. During the 2016 United States elections, then president-elect Trump promised to defund Planned Parenthood, an organization that provides reproductive health services and education, particularly surrounding family planning, as well as any other organization (nationally or internationally) that mentions abortion-related services, including counselling and referrals (32). When President Trump fulfilled this campaign promise in May 2018, it not only had large ramifications for millions of U.S. citizens who rely on these essential services, but also millions more worldwide who are serviced by international organizations whose funding was cut (32). Around the same time, the Government of Canada launched their official *Feminist International Assistance Policy* and announced renewed funding for reproductive health and rights initiatives (33, 34). It will therefore be crucial to ensure that valuable reproductive health resources are used effectively, based on the best evidence of what works.

This thesis is situated in the context of SRHR and focuses on family planning and contraception knowledge and education. Through education, individuals and communities are able to become better informed about their bodies and health, leading to greater autonomy and informed decision-making. While there are currently efforts to increase reproductive health education within schools (35, 36), this thesis will focus on media-based methods of education as a tool to reach individuals more widely. Moreover, achieving universal primary and secondary education for girls and boys is likely to take at least until 2030 (SDG Goal 4.1, 4.5). This further emphasizes the need for a multi-pronged approach, including more short-term approaches to increasing reproductive health knowledge and education.

This chapter will first provide a brief overview of the history of family planning approaches globally and outline the three main approaches to reproductive health. Second, it will demonstrate how media has been utilized to promote family planning and contraception. Finally, it will discuss some of the limitations of current research, including systemic biases which limit the type of information available and highlight the important considerations that should be addressed in future research in this area.

OVERVIEW OF THE ONGOING GLOBAL FAMILY PLANNING MOVEMENT

Throughout the global reproductive rights movement, birth control and abortion have been significant issues, upon which a majority of the public discussion and debate regarding reproductive health and women's rights has been centered. The development of birth control allowed women to better plan when to have children, permitting them to pursue an education and enter into the workforce. However, while knowledge of and access to family planning and contraception was used as a tool for women's empowerment and mobilization, it also became used by some governments and corporations as a tool for regulation and repression through population control measures. Population control includes any policies or attempts to limit the growth of a population, particularly in low-income or densely populated parts of the world (37, 38). Proponents of population control consider contraception to be a tool to support their agendas of limiting population growth, often at the expense of the individual's right to make their own decisions regarding their bodies and their health. Some historical examples of population control include systematic forced sterilization (which has occurred in India (27, 39, 40), and in U.S./Canada against Indigenous, black and Puerto Rican communities (27, 29)), the one-child policy in China (41, 42), and more recently forced birth control injections in Israel against Ethiopian refugees (43, 44).

A major turning point in global discussions regarding population and family planning / contraception occurred at the International Conference on Population and Development (ICPD) in Cairo, Egypt in 1994. Unlike previous conferences (Bucharest in 1974 and Mexico City in 1984), which maintained a population-control approach to family planning, the 1994 ICPD Programme of Action adopted a rights-based approach, including over 200 recommendations and five twenty-year goals relating to health, development, and social welfare. The ICPD in Cairo also included a much wider audience, involving not only government representatives, but also representatives of many non-governmental organizations, international agencies and citizen activists. The near

consensus that emerged as a result of this conference acknowledged that social factors influence fertility decisions, and that family planning services should be offered within broader reproductive health service packages. The following year, the impact of ICPD in Cairo was further strengthened at the Fourth World Conference on Women in Beijing, which also contributed to laying the groundwork for UN Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs).

Today there are three theoretical frameworks or approaches to the reproductive health movement, which are used to understand and advocate for improved reproductive health for all members of society. These three frameworks include: a healthcare framework (reproductive health), a rights framework (reproductive rights) and a social justice framework (reproductive justice) (26, 29, 45). The World Health Organization (WHO) defines reproductive health as concerned with the physical, mental, and social well-being of individuals and societies and relates to "reproductive processes, functions and system at all stages of life," such that "people are able to have a responsible, satisfying and safe sex life and [also] have the capability to reproduce and the freedom to decide if, when and how often to do so" (26). The current reproductive health framework encompasses health concerns related to cancers of reproductive organs (i.e. cervical, endometrial, ovarian, testicular cancers), contraception & family planning, preventing unsafe abortion, nutrition during pregnancy, child birth, sexually transmitted infections (including HIV), maternal mortality, female genital mutilation (FGM), violence against women, menstrual health, and more (26).

Next, reproductive rights encompass the recognition that individuals have the right to autonomy and control over their own sexual and reproductive lives (3). The United Nations Population Fund (UNFPA) recognizes that within reproductive rights, each person has the right to: a) "overall health, throughout the life cycle," b) access and information necessary to exercise "reproductive decision-making," c) "equality and equity for men and women… [when making] choices in all spheres of life," and, d) "sexual and reproductive security, including freedom from sexual violence and coercion, and the right to privacy" (46).

Finally, reproductive justice is an intersectional framework that argues that an individual's reproductive condition is "not just a matter of individual choices and access" (47), but is inextricably connected with "other social justice issues such as poverty, economic injustice, welfare reform, housing, prisoners' rights, environmental justice, immigration policy, drug policies, and violence" (48). As such, the reproductive justice framework contends that

advancements in reproductive health should not occur in isolation, and rather should occur at the same time that society work towards improving all other areas, as each are inter-connected. Overall, these three frameworks – reproductive health, reproductive rights, and reproductive justice – work together through a diverse set of strategies, dealing with service delivery, legal concerns, and movement building respectively, in order to improve the physical, mental, emotional and spiritual well-being of society (29, 49).

ROLE OF MEDIA IN SEXUAL AND REPRODUCTIVE HEALTH EDUCATION

Early on in the reproductive rights movement in North America, women recognized the significant role that media could play in educating people about birth control and normalizing contraceptive use. Throughout the 1950s and onwards, magazines, newspapers, and popular health manuals were used in North America to feature the most up-to-date health information, including reproductive health (50). As new technologies were popularized, the reproductive rights movement followed suit, transcending written methods and moving towards audio and visual methods through broadcasts over the radio and television. The media played a significant role in transforming family planning and contraception from being a concern of the private realm into a public issue.

Today, the utility of media is employed globally within the reproductive rights/family planning movements, in order to garner support and knowledge about reproductive health. Mass media education initiatives, by their very nature, are meant to be informative and educational to the general public. The generalized nature of mass media inherently means that the information can be approached indirectly (not personally), opening topics up to discussion in the first place and potentially offering the capacity for challenging the social/cultural/religious barriers and taboos surrounding the topic (51, 52).The technical and logistical advantages of mass media (e.g., radio, television, newspapers) include their "reach and frequency, control over message content and delivery, consistency, ease of translation into multiple languages, and relatively low cost per person exposed" (52, 53).

LIMITATIONS OF CURRENT SEXUAL AND REPRODUCTIVE HEALTH RESEARCH

Informed consent, including an individual's right to free choice, has emerged as a major tenant of medical ethics, particularly in a conventionally hierarchical and paternalistic profession (54). In the context of contraception, free, prior (and on-going) and informed choices require adequate knowledge about the variety of available options, benefits and the potential risks of each method,

access to the various supplies and services, as well as an individual's informed consent to have or not to have various methods applied to their body. As previously mentioned, the ICPD in Cairo signaled an international shift in thinking about reproductive health, family planning, public health and population. There was a renewed emphasis on the requirement that family planning programs must follow a human-rights based approach that cultivates informed 'choices' regarding child-bearing (3).

Despite this, there are still biases within contraceptive research and knowledge dissemination, which influences individuals' ability to make informed decision. First, from a knowledge production or research perspective, many scholars have highlighted the overwhelming focus on developing contraceptives targeting the female reproductive system, a bias that is rooted in the belief that women primarily are responsible for reproduction (7, 27, 29, 45). Currently, there are only two 'male contraceptive' options available: condoms and vasectomy (55, 56). Recently, new hormonal male contraceptive pills were found to be quite effective, yet research was discontinued due to the presence of side effects (55-62). The side effects that male users reported were similar to the side effects that many female hormonal contraceptive users continue to experience (63-65); so why do these harmful side effects seem to be receiving less attention when they are experienced by women, yet seen as a reason to discontinue research when experienced by men (55-62, 66, 67)? Second, from a knowledge dissemination perspective there are two major biases: first, in terms of which methods are advocated and taught, and second in terms of the type of information about the contraceptive methods that are disseminated. Besty Hartmann draws attention to the "persistent bias is towards systemic and surgical forms of birth control, as opposed to safer barrier methods" (27). Additionally, quite often the benefits of contraceptives are discussed, with little attention paid to the potential risks. For example, in many LMICs with less stringent pharmaceutical rules and regulations, contraceptives are sold without all or even any risks outlined (27). If contraceptive users are not made aware of both the risks and benefits of various contraceptive methods, it is not possible to make informed decisions and consent to using contraception.

Without adequate attention to knowledge production and knowledge translation regarding contraceptives and reproductive health, we can expect that it will continue to be difficult, if not impossible, for individuals to make informed, consensual based informed choices regarding family planning and contraceptives. For example, there continues to be very little research into the health of transgender and non-gender binary individuals, especially the long-term effects of using

hormonal supplements, or the interactions between hormonal supplements and contraception. By focusing on individual 'choices' or reproductive decisions, this approach obscures the many factors that influence an individual's ability to make vital decisions regarding their reproductive health, particularly surrounding contraception. Some factors beyond an individual's choice that many influence their decisions surrounding contraception may include: lack of adequate information, issues of consent for men and women, and access to services, among other factors. Overall, in order to affect social change, one should consider the broader socio-political, economic, cultural and religious factors and histories that situate people differently relative to each other and their access to knowledge and resources.

CHAPTER 3: REPORTED EVIDENCE ON THE EFFECTIVENESS OF MASS MEDIA INTERVENTIONS IN INCREASING KNOWLEDGE AND USE OF FAMILY PLANNING IN LOW AND MIDDLE-INCOME COUNTRIES: A SYSTEMATIC MIXED METHODS REVIEW (MANUSCRIPT 1)

PREFACE

This study, a systematic review mixed methods review, employs quantitative and qualitative methods of analysis, in order to accurately synthesize the wide scope of literature relating to media as a method of reproductive and sexual health education in low and middle-income countries. Specifically, this review seeks to determine the effectiveness of mass media interventions for increasing knowledge and use of contraceptives, and to identify barriers to program implementation. While the previous chapter provides a review of literature related to sexual and reproductive health, this chapter is focused on systematically synthesizing literature related to media and reproductive health, specifically family planning.

This manuscript includes a wide range of media-based interventions, and does not limit included studies based on the medium or technology used. This study seeks to describe the different approaches that have been used to increase knowledge and use of family planning in low and middle-income countries, therefore any social or media-oriented methods of education surrounding contraception and family planning was eligible for inclusion.

ABSTRACT

Background: An estimated 200 million women and girls in low and middle-income countries (LMICs) wish to delay, space or avoid becoming pregnant, yet are not using contraceptives. This study seeks to investigate the effectiveness of mass media interventions for increasing knowledge and use of contraceptives, and to identify barriers to program implementation.

Methods: Using a mixed-methods systematic approach, we searched five electronic databases using pre-determined search strategies and hand-searching of articles of any study design published from 1994 to 2017 of mass media interventions for family planning education. Two reviewers independently applied clearly defined eligibility criteria to the search results, quality appraisal, data extraction from published reports, and data analysis (using meta-analysis and thematic analysis) following PRISMA guidelines.

Findings: We identified 59 eligible studies. Although the majority of studies suggest a positive association between media interventions and family planning outcomes, the pooled results are still consistent with possibly null intervention effects. The qualitative analysis indicates that there are barriers to contraceptive uptake at the level of individual knowledge (including demographic factors and preconceived notions), access (including issues relating to mobility and financing), and programming (including lack of participatory approaches).

Conclusion: There is a need for rigorous impact evaluation, including randomised controlled trials, of mass media interventions on knowledge and uptake of family planning in LMIC settings. Interventions should be better tailored to cultural and socio-demographic characteristics of the target populations, while access to resources should continue to remain a priority and be improved, where possible.

INTRODUCTION

Today, there is an urgent situation facing over "200 million women and girls in developing countries who want to delay, space or avoid becoming pregnant," yet who "are not using effective methods of contraception" (1, 2). As stipulated at the International Conference on Population and Development in 1994 (1, 3), it is imperative that reproductive health programs follow a human rights-based approach, the necessity of cultivating informed decisions, and choices regarding child-bearing. As such, global partners gathered at the 2012 London Summit on Family Planning to launch a "ground-breaking effort to make affordable, lifesaving contraceptives, information, services, and supplies available to an additional 120 million women and girls in the world's poorest countries by 2020" (2). Although there has been a notable acceleration of progress in terms of expansion of family planning services in developing countries, there is a critical need to improve knowledge, perceptions and use of contraceptives.

Literature to date has indicated that various factors are linked to individuals' access to family planning and contraceptives, most significant of which includes: education, poverty and gender inequality (9, 12, 15, 17, 18). Seminal works such as Belaid et al.'s systematic review on demand generation for family planning (68) and Shen and Han's on entertainment education for health communication (69) each provide critical guidance for health workers seeking to increase health education and autonomy through mass media-scale approaches. A recent study using data obtained from the Demographic and Health Surveys (DHS) Program to analyse the association between mass media exposure and contraceptive use in sub-Saharan Africa found that individuals exposed to mass media communication regarding family planning had 1·93 times the odds of using contraception than those who were not exposed to mass media messages (95% CI: 0·75, 2·14) (70). Randomised controlled trials (RCTs) have been conducted to measure the impact between mass-media interventions and health education and outcomes (e.g., HIV testing, child survival) (19-24), yet none have specifically focused on outcomes specific to family planning and contraception.

Therefore, the purpose of systematic review is to synthesise existing evidence on the use of large scale media interventions to increase knowledge and use of family planning and contraception in low & middle-income countries (LMICs). This review uses a mixed methods approach to investigate: a) the quality and limitations of the research being conducted; b) the factors associated with the success of various mass media interventions; and c) the reported evidence on the

effectiveness of mass media interventions at increasing knowledge and use of family planning and contraception.

METHODS

A parallel-results convergent synthesis mixed methods design (71, 72) was employed to collect, analyse, and integrate both quantitative and qualitative data reported in the literature.

SEARCH STRATEGY AND SELECTION CRITERIA

Throughout January 2017, searches of five electronic databases were conducted (by JS and AB) using pre-determined search strategies. The search strategy was composed of an arrangement of terms linking concepts of mass media and family planning/contraception (Web Appendices Table 1). The databases that were searched include: MEDLINE, AMED (Allied and Complementary Medicine), Embase, Global Health, and Social Work Abstracts. The references of articles that matched the eligibility criteria and grey literature, including the websites of relevant organizations (Web Appendices Table 1), were further searched and were subject to the same screening and selection process.

The systematic review included any social or media-oriented methods of education surrounding contraception and family planning, such as: media messaging (i.e. commercial and social marketing), radio and television serial dramas, folk theatre, internet campaigns, text messaging, etc. Studies of all design types were eligible for inclusion if they were published in either English or French from 1994 onwards, presented primary data, the primary focus was on family planning and/or contraception, did not involve new drug testing, differentiated types of media sources, and did not primarily focus on education of sexually transmitted infections (STIs). Studies were excluded if they were testing contraceptive drug development, studied diseases and illnesses (including STIs and/or HIV/AIDS), did not primarily focus on family planning and contraception outcomes, did not differentiate between media sources or types, or focused on non-scalable and therefore irreproducible methods (i.e. communication between family members and friends).

DATA ANALYSIS AND EXTRACTION

Following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (73) guidelines, after the inclusion and exclusion criteria were developed, two authors (JS and AB) applied the criteria to all search results to determine which articles were eligible for inclusion in this review. First, the titles and abstracts were screened, followed by full paper screening. Any

disagreements were resolved through discussion and consensus. All data was analysed for risk of bias and methodological quality assurance using appropriate quality assessment tools, including: TREND Statement for Quasi-Experimental studies, STROBE Checklist for Cross-Sectional studies and Joanne Briggs Institute for Qualitative studies (74-76). One author (JS) assessed all articles using this tool, and a second author (AB) verified the accuracy of the critical appraisals. Data was extracted from the articles using pre-determined extraction forms. The quantitative data extracted included: population exposure to mass media campaign, knowledge of contraceptives and use of contraceptives. The qualitative data included thematic codes of the results and discussion sections of all included studies (77).

SYNTHESIS

Quantitative synthesis

Quantitative studies were synthesised, where applicable, according to two outcome variables (contraceptive knowledge and contraceptive use) utilizing meta-analysis. Meta-analyses were conducted by study design, separating cross-sectional studies, pre-post studies (where outcomes were measured in the same population before and after an intervention), and controlled pre-post studies (which contained a control and intervention group that were analysed over time). Meta-analyses were also conducted by key study variables (year, country, intervention, etc.), and visually inspected to determine if any variable appeared to be strongly associated with any of the two outcome variables. To describe the heterogeneity of the intervention effects reported in the literature, we present the range of point estimates (i.e. prevalence ratios) across all included studies for each outcome variable. However, instead of computing pooled effect estimates and associated confidence intervals, we reported 95% prediction intervals for the prevalence ratios. This was due to the substantial heterogeneity between the studies, including differences in target populations, methods for dissemination and confounding control. A prediction interval estimates a pre-specified range (e.g. the central 95%) of expected effects in a large set of future studies conducted in the same underlying population (78). To explore the potential role of unmeasured confounding, we present contour plots that depict the minimum required level of confounder imbalance across intervention groups versus the minimum required confounder strength (causal effect on the outcome) that may explain the same estimated range of effects that was observed across the included studies. This graphical approach is based on established bias formulas (79) and previously proposed confounding function methods (80, 81).

Qualitative synthesis

All studies (qualitative and quantitative) were interpreted ("coded") by two reviewers (JS and AB). Codes were grouped into themes using inductive and deductive approaches to better understand the barriers to effective programming on reproductive health education through mass media. The theory development utilised a combination of two theories to describe how: a) media messages are translated into knowledge, through the concept of 'media literacy' (82), and b) knowledge is subsequently translated into action (83). Preliminary synthesis consisted of extracting the descriptive characteristics of the studies in a table and producing a textual summary of the results (Web Appendices Tables 2 and 3). Thematic analysis was then used to extract codes that were then grouped into three main themes (77).

Role of the funding source

Funding for this study was received from the Max E. Binz Award, through McGill University Faculty of Medicine.

RESULTS

The searches of the databases yielded 5129 citations after duplicates were removed electronically and by hand. Exclusions were made to the data set in three stages (Figure 1). After the inclusion criteria were applied to the citations, a total of 59 articles from the electronic search of databases were included in the final analysis. An additional six non-peer-reviewed sources were identified through searches of websites and references of included studies. All studies were based on retrospective self-reported or qualitative data, with pre-post (n=17), cross-sectional (n=36) and qualitative (n=5) study designs. There was one mixed methods study, which combined a cross-sectional survey with a qualitative study design. While randomised controlled trials have recently been initiated within the field of media and reproductive health education (19-24), results either have yet to be published or did not discuss contraception and therefore were not included in the study. After applying appropriate quality appraisal tools (74-76), the methodological quality of studies varied, with the majority categorised as 'moderate' overall evidence quality (n=39) and approximately one third of studies as 'high' quality (n=20) (Web Appendices Table 2).

The majority of studies were conducted in Africa (n=28; 16 of which were in Eastern Africa and 7 in Western Africa), followed by Asia (n=25; 20 of which were in Southern Asia), South America

(n=2), and 4 multi-continental studies. About half the included studies analysed the impact specific programming (n=7 radio or TV interventions, n=6 marketing (commercial and social) interventions, n=2 mobile phones interventions, and n=16 other forms of mass media programming interventions), while 28 studied the impact of regular (pre-existing, non-content specific) mass media (Web Appendices Table 3).

QUANTITATIVE RESULTS

The meta-analysis included 15 studies in total and analysed the association between media programming on family planning and two outcome variables: a) knowledge of contraception (n=5) and b) use of contraception (n=13) (see Figure 2 and 3). All generated prediction intervals indicate that relevant positive or negative associations may exist between media programs and outcome variables. However, the range of point estimates (i.e. prevalence ratios) for included studies for both contraceptive knowledge and contraceptive use suggest either positive or null associations.

The reported prevalence ratios for contraceptive knowledge range from 0·97 to 1·41, while the 95% prediction interval (PI) ranges from 0·51 to 2·36 (Figure 4). There were not enough studies analyzing the relationship between media interventions and contraceptive knowledge to make any conclusions regarding differences between studies or between types of media interventions.

The estimated PRs for contraceptive use yield a similarly wide prediction interval, ranging from 0·54 to 3·23 (Figure 4). However, there was substantial heterogeneity in the range of prevalence ratios, with individual studies finding no association to strong positive associations between media interventions and contraceptive use (0·96, 3·06). Control pre-post studies, which represent the highest quality of evidence currently available, tend to demonstrate the weakest association, with a reported point estimate range between 0·97 and 1·01, and a 95% prediction interval between 0·37 and 2·74. When analysed according to type of media intervention, multi-media programs (i.e. combining a number of intervention types, such as marketing, radio show, and youth group), and regular ongoing programming (i.e. not specifically tailored to family planning) appear to have a stronger association with contraceptive use. The PR point estimate range for each respectively is 1·03 to 2·86 (95% PI: 0·33, 7·30), and 1·08 to 3·09 (95% PI: not estimable). Radio programming showed no association with contraceptive use, with reported point estimates ranging from 0·96 to 1·08 (95% PI: 0·90, 1·21).

The contour plot displaying possible confounder characteristics explaining the range of effects that are consistent with the prevalence ratios reported by the individual studies indicates moderate to

extreme confounding scenarios that may be underlying the observed data. For instance, Hutchinson and Meekers 2012 reported a crude prevalence ratio (risk ratio) for contraceptive use of 1·22 based on a pre-post intervention design. According to the contour plot, an unmeasured confounder that was 4 times more prevalent in the intervention group than in the control group, and, at the same time, was linked with a 1·33 – fold increase of prevalence of contraceptive use, may alternatively explain this observed relative effect of 1·22 (Web Appendices Figure 2).

QUALITATIVE RESULTS

The codes that emerged from deductive/inductive thematic analysis were grouped into three themes, outlined below and summarised in Table 2 (and Web Appendices Figure 14).

Theme 1: Barriers to knowledge

Most studies discussed the influence of various demographic factors, such as education, socioeconomic status, geographic location, marital status, access to media, and religion, on contraceptive knowledge and use (68, 69, 84-142). In particular, individuals with a higher level of education, higher socioeconomic status, and who live in urban areas are at an increased likelihood of exposure to family planning messages (106, 107, 121, 123). Other factors, such as marital status, exposure to media, and religion can influence knowledge in a diverse set of ways, depending on the messages received from spouses, media and religious leaders (100, 108, 112, 118, 123, 124, 127, 135). Moreover, exposure to family planning and contraceptive messages does not necessarily lead to understandings of the various methods available, alluding to the continued importance of education by trained workers (68, 97, 125, 128, 132).

Geographic context appears to have a large influence on reproductive health knowledge, vis-à-vis program coverage and social networking. Studies found that there are fewer mainstream media methods (particularly TV) and organised groups in rural regions, resulting in the creation of informal networks to facilitate greater understanding of reproductive health (126, 136). Moreover, while some studies have shown that TV can contribute to increasing family planning education, it is not a preferred method of communication in many rural areas due to lack of availability (91, 98, 106, 129, 139-141). Mobile phones are emerging as a potentially efficient means to reach rural communities (91).

Preconceived impressions about contraceptives, including through previous Western influence and colonialism, hyper-sexualisation in media, the belief that family planning is a method of population

control, use of/belief in traditional methods of contraception, and fear of side effects, present other barriers to knowledge and use (87, 89, 100, 101, 111, 113, 120, 121, 123, 133, 142).

Innovative methods of distribution of reproductive health information were mentioned as a facilitator to increased knowledge, highlighting the importance of a diverse strategy to address this issue. Some of the key innovative strategies that were employed by the studies include: text messaging to allow questions (68, 90, 97, 117, 143), working with community health workers and religious leaders (100, 112, 124, 135), soap operas/serial dramas (68, 69, 85, 92, 94, 98, 99, 102, 103, 105, 109, 112, 114, 118, 122, 124, 127, 132, 134, 138), marketing (social and commercial) (84, 85, 94, 95, 98, 105, 137), traditional folk events (68, 86, 108, 112, 126), and participatory community-building approaches (68, 86, 97, 102, 108, 114, 126, 137). Moreover, some studies argued that combining different innovative methods through 'complementary messages' (messages through different sources and medium) "may help to create an environment where the practice of contraception is perceived as a social norm" (69, 108, 132).

Theme 2: Barriers to use

Family planning and contraceptive behaviours appear to be closely related to issues of self-determination and agency, or the ability of a person ability to think, act, and conduct themselves according to their ethical-political values and traditions, particularly for women (68, 88, 100, 111, 119, 121, 125, 127, 133). Reduced sexual and reproductive health agency can include fear of discussing potentially sensitive topics with a spouse, inability to obtain contraceptives, spousal/familial refusal to adopt family planning, or issues of financial autonomy and mobility (68, 88, 100, 111, 119, 121, 125, 127, 133).

Studies highlighted the importance of involving communities in programming, including community outreach and social networking approaches (68, 87, 88, 94, 96-98, 103, 105, 106, 111, 113-115, 119, 121, 125-128, 133, 135, 136, 142). Examples of community involvement include involving male partners and families in family planning decision-making (118, 123), social networking (88, 94) and organised or non-organised youth groups (88, 92, 122, 131). The power of social networking to spread information through indirect exposure may also have positive impact on contraceptive awareness (96, 136).

Theme 3: Barriers to effective programming

Because the issue of family planning is closely related to other sexual and reproductive health issues, many studies have found that tackling contraceptive education in conjunction with other sexual and reproductive health issues tends to be effective (85, 94, 101, 104, 107, 109, 113, 115, 120, 123, 127-130, 135, 137-141). Some issues that tend to be targeted in conjunction with contraceptive education include STIs (in particular HIV/AIDS), gender equity, and primary and secondary education for girls and boys.

Finally, some studies addressed the difference between top-down approaches, including use of mass media, social marketing, entertainment education to model desired behaviours, and bottom-up approaches, including participatory approaches, strengthening the capacity of stakeholders, and allowing communities to lead in decision-making processes (87, 89, 100, 101, 111, 113, 120, 121, 123, 133, 141).

DISCUSSION

The objective of this study is to describe current literature relating to media methods of sexual and reproductive health education in low and middle income countries, including strengths and weaknesses of current programming, in order to guide prospective research and programming on family planning and contraception education. Based on the reported data in the included literature of this review, there appears to be associational evidence that media interventions may be effective at improving population-level outcomes relating to family planning and contraception (105, 127, 132). In fact, the vast majority of observed associations suggest positive effects, however, with varying degrees of estimate precision and conclusiveness. Nevertheless, after aggregating the numerical information using inferential statistics i.e. 95% prediction intervals, the overall evidence remains plausible yet inconclusive in answering whether or not mass media interventions have a relevant impact on increased knowledge or use of contraceptives. The range of reported effects (prevalence ratios) for the association between media exposure and contraceptive knowledge varies from 0·97 to 1·41 (95% PI: 0·51, 2·36), while the range of reported effects for the association between media exposure and contraceptive use is from 0·96 to 3·09 (95% PI: 0·55, 3·19) (Figure 4). This lack of precision of expected associations in future studies is primarily due to the limited quality of evidence available, i.e. absence of rigorous study designs (e.g. RCTs) and inadequate methods for confounding control.

The results of the qualitative analysis may help shed some light on some of these potential factors. The findings indicate that there are barriers to contraceptive uptake at the level of individual knowledge (due to demographic factors such as whether the individual lives in urban or rural settings and preconceived notions), access (including issues relating to agency), and programming (including lack of participatory approaches). These socio-cultural factors be should accounted for when designing media interventions, in order to increase their success.

While great effort was extended to extract as much information as possible from the currently available evidence, we find that this topic is severely lacking rigorous quality research. Because there have not been any rigorous RCTs published on this topic, the review was limited to qualitative, cross-sectional and pre-post studies, meaning that it is not possible to infer causal relationships between exposure to mass media and contraceptive use. Moreover, within the meta-analysis, there was a great deal of heterogeneity between studies and high potential for confounding, as the studies varied across time, geography and program design, all of which are factors that could influence the outcome variables. Another limitation based on the available study designs was the issue of contamination. Through a brief analysis of exposure to programs among those in the intervention and control group, this study found that many participants in the control group were also exposed to the programs, which may have the effect of minimizing the observed magnitude of association between intervention and outcome. Finally, within the meta-analysis outcome variables, there is no indication regarding the depth of contraceptive knowledge (i.e. are participants aware of side effects and the diversity of options available), nor specifics about what methods of contraception individuals have chosen to use and why. Overall, the results provide insights for program managers regarding what steps in the behavior change pathway might require more attention and outline factors to consider when designing and implementing programs.

Although a majority of studies included in this review suggest a positive association between media interventions and family planning outcomes, the pooled results (i.e. prediction intervals) are still consistent with null intervention effects. Despite these inclusive findings, we cannot rule out the possibility that media interventions are truly having a positive effect on family planning outcomes. In other words, absence of evidence of an effect does not imply evidence of absence of an effect. One inevitable challenge that any review in this field of inquiry faces, is the heterogeneity of study populations and the fact that interventions are typically tailored to the context where they are implemented. It is essential that more research be conducted in order to understand why

individuals do not use certain modern methods of contraception, despite increased knowledge and a desire to space, limit or avoid pregnancy.

Future research studies should therefore employ rigorous mixed methods designs, incorporating pragmatic (cluster) randomized controlled trials, to evaluate the impact of various mass media education approaches to improve contraceptive knowledge and use, across heterogeneous populations.

DECLARATION OF INTERESTS

There are no conflicts of interest to disclose.

Figure 1. Flowchart of selection of eligible articles

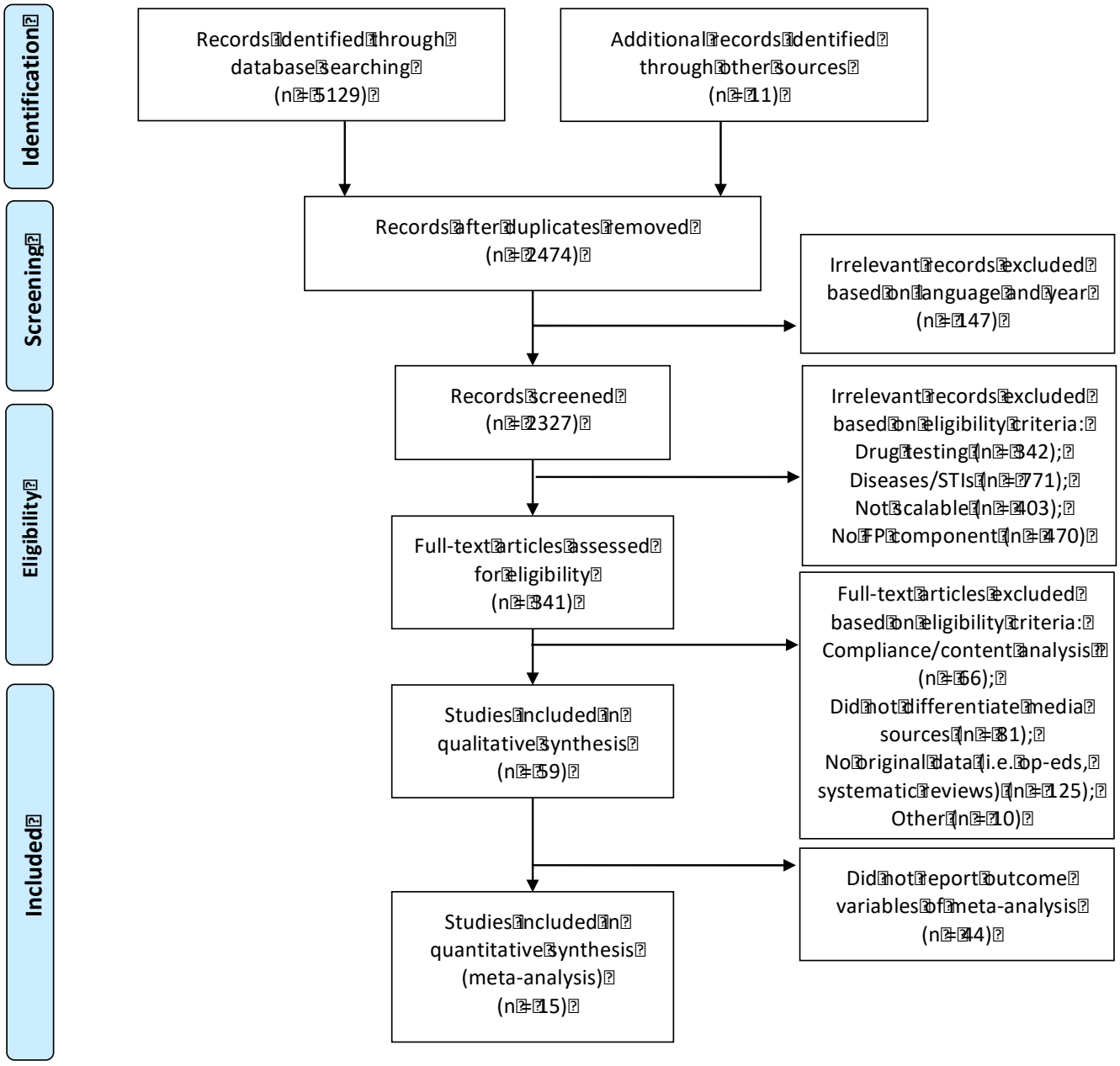
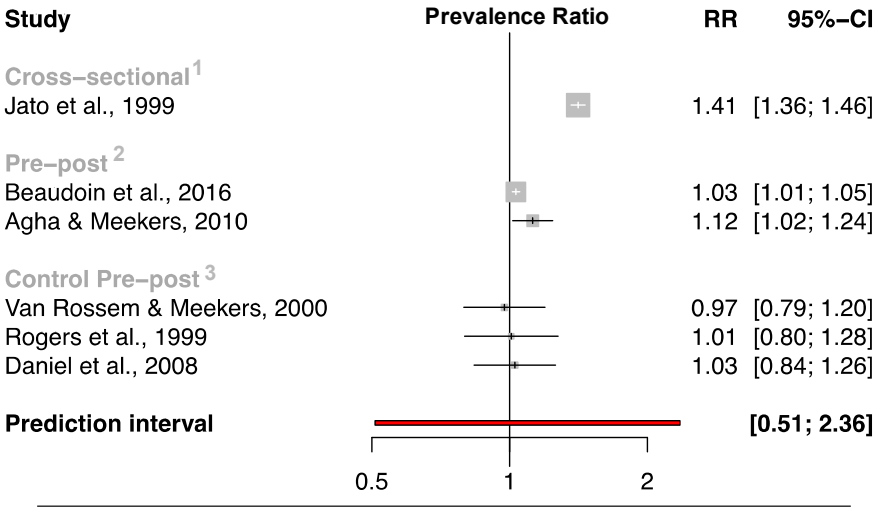


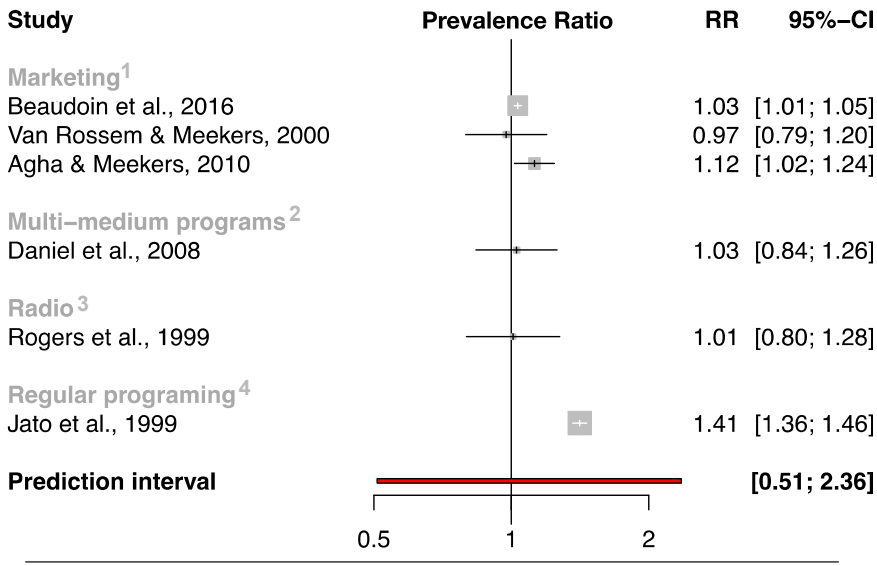
Figure 2a. Association between media programs on reproductive health and contraceptive knowledge by study design



[1] Cross sectional studies are those that analyze outcomes at a specific point in time, with comparisons between reported media users and non-users.
[2] Pre-post studies are those that compare the same population, before and after an intervention was applied.
[3] Control Pre-post studies are those that compare two groups (control and intervention groups) over a period of time; estimates for these studies were calculated using difference-in-difference computations.

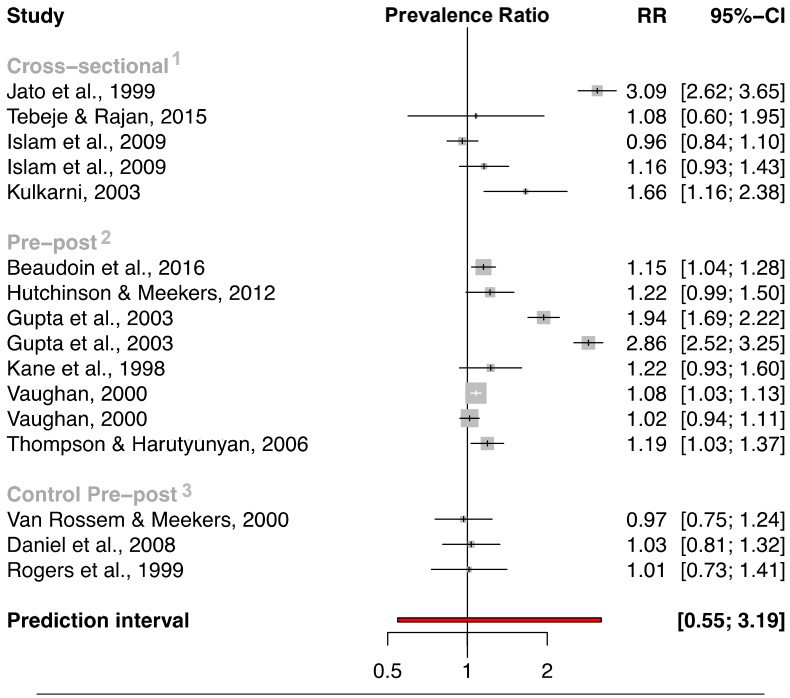
** note: on x-axis, >1 favors intervention, <1 favors no intervention.

Figure 2b. Association between media programs on reproductive health and contraceptive knowledge by intervention



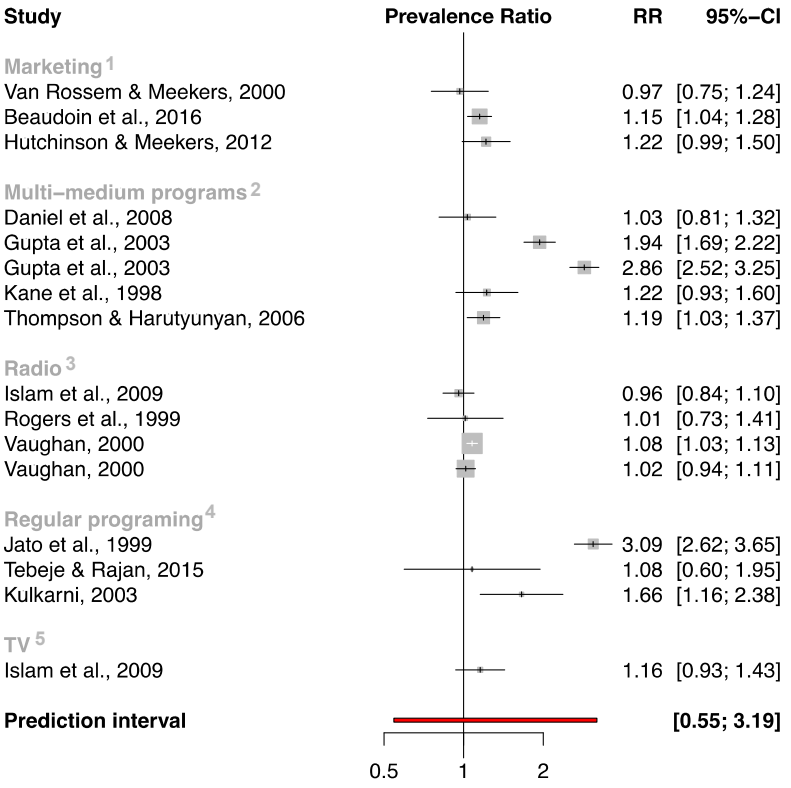
[1] Marketing interventions utilize advertising techniques to promote family planning.
[2] Multi-medium programs employ a number of intervention types, such as marketing, radio show, and youth group.
[3] Radio interventions include soap operas, educational shows, advertisements, etc. conducted through the radio.
[4] Regular programming refers to media exposure that is not specifically tailored to family planning.

Figure 3a. Association between media programs on reproductive health and contraceptive use by study design



[1] Cross sectional studies are those that analyze outcomes at a specific point in time, with comparisons between reported media users and non-users.
[2] Pre-post studies are those that compare the same population, before and after an intervention was applied.
[3] Control Pre-post studies are those that compare two groups (control and intervention groups) over a period of time; estimates for these studies were calculated using difference-in-difference computations.

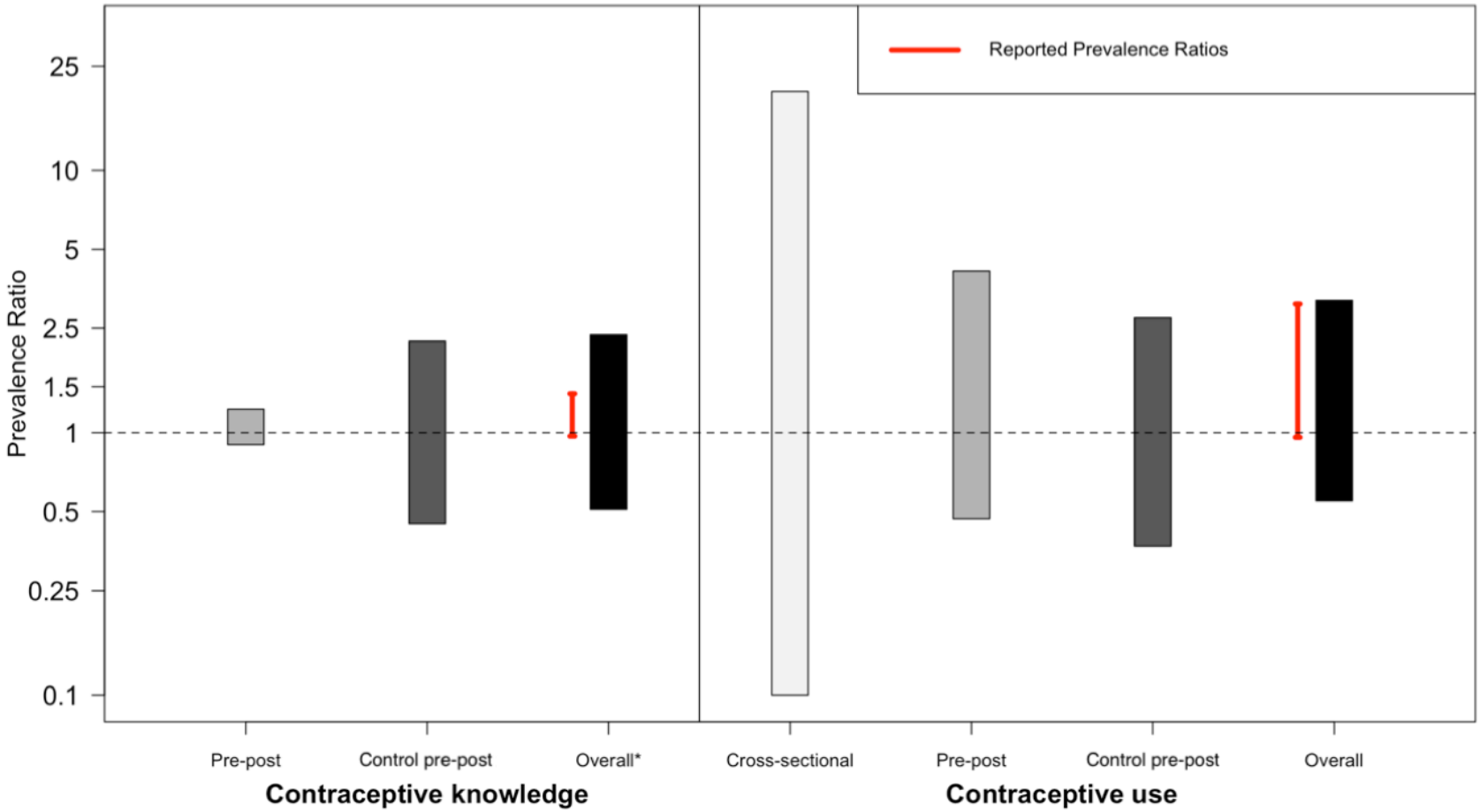
Figure 3b. Association between media programs on reproductive health and contraceptive use by intervention



[1] Marketing interventions utilize advertising techniques to promote family planning.
[2] Multi-medium programs employ a number of intervention types, such as marketing, radio show, and youth group.
[3] Radio interventions include soap operas, educational shows, advertisements, etc. conducted through the radio.
[4] Regular programming refers to media exposure that is not specifically tailored to family planning.
[5] TV interventions include soap operas, educational shows, advertisements, etc. conducted through the television.

** note: on x-axis, >1 favors intervention, <1 favors no intervention.

Figure 4. Pooled prediction intervals for prevalence ratios of exposure, knowledge and use due to media interventions by study design



* The overall prevalence ratio prediction interval for contraceptive knowledge included one additional cross-sectional study, for which a prediction interval could not be generated.

** note: on y-axis, >1 favors intervention, <1 favors no intervention.

Table 1. Themes emerging from qualitative coding and thematic analysis

Main Categories of Analysis	# of Studies
Barriers to FP/contraceptive knowledge	
Demographic factors • Factors such as education, socioeconomic status, geographic location, marital status, access to media, religion, etc., have been analysed as effecting contraceptive knowledge and use	49
Innovative methods of distribution of SRH information • Articles discussed the use of text messaging to allow participants to ask questions, working closely with religious leaders, soap operas/serial dramas to address a wide range of social issues, traditional folk events, participatory community-level approaches and the use of social marketing.	16
Preconceived notions of Sexual & Reproductive Health (SRH)/Family Planning (FP) • Western influence/hyper-sexualisation in media; belief that FP is a method of population control; journalists problematizing paradigms of 'behaviour change' methods; prior use of traditional/natural methods; fear of side effects	7
Urban vs. Rural • Geographic context has a large influence on social networking (organised networks tend to be less present in rural regions) and media methods (while TV is effective, it is not readily available in some rural areas)	3
Barriers to FP/contraceptive use	
Community outreach/networking tends to lead to greater use • Individual outreach (i.e. via healthcare workers) is important (but not scalable); involvement male partners and families in FP decision making is significant, social networking (organised youth groups or non-organised)	18
Lack of agency/self-determination affects health • Lack of agency relating to sexual and reproductive health (SRH), financial autonomy and mobility	9
Barriers to FP/contraceptive programming	
Relationship to other SRH factors (i.e. STIs/STDs, gender equality, etc.) • Tackling family planning and contraception in conjunction with other SRH issues tends to be effective and important pre-requisites for social change	10
Top-down vs. Bottom-up community-level approaches • Articles highlighted the difference between top-down approaches (emphasise use of mass media, social marketing, entertainment education to encourage/model desired behaviours) and bottom-up approaches (emphasise participatory approaches & strengthening capacity of stakeholders)	9

CHAPTER 4: FACTORS ASSOCIATED WITH MEDIA USE TO IMPROVE DELIVERY OF HEALTH PROGRAMS IN LOW- AND MIDDLE-INCOME COUNTRIES: A MULTI-COUNTRY ANALYSIS (MANUSCRIPT 2)

PREFACE

This study, a multi-country analysis, employs two quantitative methods of analysis, in order to accurately compare and synthesize the factors that are associated with media use in low and middle income countries. First, a conventional logistic regression model (main effects only) was utilized. Second, a modern machine learning approach, random forest modelling including 200 regression trees, was utilized and compared to the conventional logistic regression model. The most important variables for determining media use were further analyzed for direction of relationships and the cross-validated misclassification errors of each method were compared.

While the previous chapters considered a wide range of media-based approaches, this manuscript considers radio and television as the primary sources of media education. Radio and television are two of the most widely available sources of media communication, as print methods are inaccessible to individuals who are ilterate, and other methods tend to be more expensive and therefore inaccessible to individuals of a lower socioeconomic status. Furthermore, the study was limited to the questions that were recorded in the dataset used in this study, the Demographic and Health Surveys.

As this thesis as outlined, media represents a promising tool for health education. However, the overall effectiveness of even the most efficacious interventions relies on reach of the media program. Therefore, this study seeks to identify the important individual- and country-level variables associated with radio and television use.

ABSTRACT

Background: Radio and television educational programming have demonstrated promise in increasing public health awareness and improving various health outcomes, including related to reproductive health, communicable disease prevention, and smoking cessation. However, while media represents a promising tool for health education, the overall effectiveness of even the most efficacious interventions relies on reach of the media program. Therefore, this study seeks to identify the important individual- and country-level variables associated with radio and television use, in order to better characterize audiences and guide media health education programs.

Methods: Demographic and Health Survey (DHS) datasets of 41 developing countries were used to predict access and use of radio and/or television based on relevant demographic variables, employing two statistical prediction methods. First, a conventional logistic regression model (main effects only) was fitted. Second, a random forest model including 200 regression trees for each outcome variable (potentially including high level interactions) was used. The most important variables for determining media use were further analyzed for direction of relationships and the cross-validated misclassification errors of each method were compared.

Findings: Individuals who are slightly younger, urban-residing, more educated, and of a higher wealth status have a higher reported percentage of frequent radio and television use. For each media method (radio and television), having either a radio and/or television in the household was the most important predictor of media use. The second most important variable for determining use of both media methods was the respondent's reported frequency of engaging with other media sources (i.e. television, radio or newspapers). The overall accuracy for correctly classifying non-frequent and frequent media users was high (TV: 86.2% random forest, 85% logistic regression; radio: 78.2% random forest, 74.7% logistic regression).

Interpretation: When designing health education programs through radio and television, it will be important to consider coverage of media technology and who the target audiences are. For instance, in many regions, less than half of the population reports frequent radio use. Socioeconomic indicators, such as wealth index, media ownership (radio and television), and access to electricity, all showed predictive capability in estimating the probability of frequent media use. The results also suggest that those who engage with one media source are more likely to engage with other sources.

Funding: McGill University, Faculty of Medicine.

INTRODUCTION

Media interventions have been employed for decades to contribute towards public health advances among populations. Mass media education initiatives, by their very nature, are meant to be informative and educational to the general public. The generalized nature of mass media inherently means that the information can be engaged with indirectly (not personally), initiating discussion of topics and potentially offering the opportunity to challenge social/cultural/religious barriers and taboos surrounding sensitive topics (51, 52). The technical and logistical advantages of mass media (e.g., radio, television, newspapers) include their "reach and frequency, control over message content and delivery, consistency, ease of translation into multiple languages, and relatively low cost per person exposed" (52, 53).

Some literature to date has reported the success of media methods at increasing health education relating to a variety of health outcomes (144, 145). Most notably, media methods have been employed to promote health behaviors relating to a variety of conditions including: reproductive health, communicable disease prevention, smoking cessation, and other preventative measures (19-24, 144, 146-149). Media education has been found to have different effects based on the type of health outcome it is focusing on, with generally stronger results for encouraging adoption of new behaviors compared to cessation of long-standing behaviors (144, 145). Media interventions tend to show small positive associations with increased health outcomes in populations, and there are larger expected results when media is used in conjunction with other education outreach strategies (e.g., youth groups, community outreach events, etc.) (144, 145). A review of the potential benefits and harms of media as a tool for health education and promotion concluded that social media provides opportunities for: "(1) increased interactions with others, (2) more available, shared, and tailored information, (3) increased accessibility and widening access to health information, (4) peer/social/emotional support, (5) public health surveillance, and (6) potential to influence health policy" (150). Despite these benefits, there are also potential harms, related to quality and reliability of the information provided through media. As such, the study concludes that "the information exchanged needs to be monitored for quality and reliability, and the users' confidentiality and privacy need to be maintained" (150).

In general, media represents a promising tool for health education, as even the most effective intervention relies on reach of the media program, based on the populations access to and use of

radio and television. Regardless of the effectiveness of the content of the program, this crucial piece of the programs reach or coverage can limit a program's success. Therefore, when designing a program, in order to gain a better understanding of expected impact, it is important to know the current reach of different media platforms in the target population.

This study seeks to identify individual- and country-level factors associated with radio and television use, in order to better characterize potential audiences and guide more efficient delivery of media health education programs. We focus on two of the largest and most common techniques used to deliver health education programming: radio and television. Radio and television show considerable promise because they are currently some of the most widespread technologies available in low and middle-income countries (LMICs).

METHODS

DATA SOURCES

This study employed data collected through the Demographic and Health Surveys (DHS) of women aged 15-49 years, and additional country-level data collected through the UNdata and the World Bank (151, 152). A research proposal and data request was launched in January 2017 and was approved by DHS and McGill Department of Family Medicine the same month. The DHS are a series of large-scale, nationally representative household surveys conducted in low- and middle-income countries that are usually based on a stratified two-stage cluster design. The surveys, which are funded by the United States Agency for International Development (USAID), provide information about a variety of factors including sociodemographic characteristics and health indicators, such as "population, health, HIV, and nutrition through more than 300 surveys in over 90 countries" (153). Typically, the surveys are conducted every five years in each country that DHS surveys. This study included data from any country that had a Standard DHS survey, phases six and seven, conducted since 2010 to ensure time was given a less prominent influence in the results of radio and television use.

MEASURES

Based on the available data, the two main outcome variables were created to distinguish 'frequent users' and 'non-frequent users' of radio and television. 'Frequent users' of media (radio and television) were defined as individuals who reported a frequency of engaging with the media

source at least once per week, whereas 'non-frequent users' were defined as individuals who typically are exposed less than once per week to the respective media source. Key variables within the DHS dataset relating to standard socio-demographic characteristics, media usage, and health knowledge were explored throughout the study. Pertinent country-level variables, relating to economic status, mass media infrastructure, and indicators for the Sustainable Development Goals were identified and included in the analysis (152).

STATISTICAL ANALYSIS

R software version 3.4.1 was used to conduct all data analyses (154). To estimate expected engagement with radio and television in relationship to the various potential predictor variables, two statistical methods were employed: multiple binary logistic regression and random forests.

Prior to conducting statistical analyses, cases with any missing data were removed from the analysis set. To evaluate potential selections bias through the removal of these observations, marginal variable distributions were compared between cases that had at least one missing data point and complete cases. Next, cases were randomly sampled such that the number of frequent radio and/or television users and non-frequent radio and/or television users were equal. This was done to ensure greater balance between the sensitivity and specificity achieved by the random forest model. The same dataset was also used for the regression analysis. When the number of cases and controls are largely unbalanced, random forest modelling runs the risk of only accurately predicting the larger group at the expense of accurately predicting the smaller group.

Random forest modeling employing 200 regression trees was conducted for the primary outcome variables indicating the frequency of radio and television use (frequent user vs non-frequent user) respectively. Regression trees enable the incorporation of potentially high dimensional interaction terms in the prediction model. Random forests are a powerful method of machine learning which has gained prominence and attention due to an enhanced ability to model covariate-outcome relationships compared to classic approaches in statistical inference (such binary logistic regression, for example) (155, 156). Random forests, which circumvent manual specification of the prediction model, overcome the problem of over-fitting by averaging numerous decision trees and by evaluating the predictive performance using independent test samples (also called "cross validation"). Once the random forests were calculated, the out of bag error estimate, which applies the random forest to a cross-validated sample, was used to measure the accuracy of the model. Additionally, the sensitivity and specificity of the model was analyzed and receiver operating

characteristics (ROC) curves were created. A variable importance plot was then created to determine the most important variables for predicting whether an individual was a frequent radio or television user. For the five most important variables identified by for each random forest, the direction and magnitude of the relationship was further analyzed by comparing predicted outcomes based on the fitted random forests. The random forests were used to predict individuals' outcome group (frequent media user or non-frequent user), and the mean allocation of individuals' to either outcome group was compared between possible values for each variable.

Subsequently, nomograms based on multiple binary logistic regression analysis were created to allow for individual prediction of the probability of frequent radio and television use based on observed covariate values. The top 30 variables calculated from the random forest models were used to generate the nomograms. Some variables had to be removed due to singularity, as the logistic regression model could not overcome this issue, while the random forest model was able to. Additionally, variables that resulted in very small changes in the predicted probability of the outcome, contributing less than 10 points on the nomogram point scale, were further removed from the prediction scheme.

Finally, a cross-validated misclassification error was calculated for each prediction model approach, and compared.

ROLE OF THE FUNDING SOURCE

Funding for this project was received from the Max E. Binz Award, through McGill University Faculty of Medicine.

RESULTS

Following the eligibility criteria, 41 low- and middle-income countries with available DHS data were included in the study (Figure 1a, Table 1). The majority of eligible and included countries were within the continent of Africa (n=31), followed by the Asia-Pacific region (n=7), and finally Latin America and the Caribbean (n=3). There was considerable variability in covariates distributions between continents (Table 2). Marginal variable distributions of key variables were compared between cases with at least one missing data point and complete cases, to ensure the remaining cases were representative of the cases removed (Figure 1b, Web Appendices Figure 1). After verifying that the remaining cases were representative, 151,887 out of 1,443,561 cases (9.8%) with at least one missing data point were removed from the analysis.

Overall, 23.5% of the study population were classified as frequent radio users, and 55.5% as frequent television users. However, in Africa and Latin America and the Caribbean, the percent of individuals in the study population who reported frequent radio use (40% and 68%, respectively) was still slightly larger than the percent of individual who reported frequent television use (33% and 56%, respectively). In contrast, the percent of individuals who reported frequent television use in Asia-Pacific (67%) was more than four times the percent of individuals who reported frequent radio use (13%). Interestingly, frequent media use (both radio and television) was reported in less than half of the study population in Africa, while more than two-thirds of the study population in Asia-Pacific (particularly India, where the majority of cases for the Asia-Pacific region were located) and Latin America and the Caribbean reported frequent media use. Moreover, overall the mean age of those who report frequent media use tends to be slightly younger (29 ± 10 for both radio and television) than those who do not report frequent media use (30± 10 for both radio and television (Table 3). There was a higher percentage of individuals living in urban settings who reported frequent radio and television use (31% and 76%, respectively) compared to those living in rural settings (20% and 45%, respectively) (Table 3). Individuals in the study population who had not completed primary education (no educational attainment), have the lowest percentage of reported frequent media use (17% report radio use and 31% report television use) (Table 3). Individuals with higher than secondary education attainment have the highest percentage of reported frequent television use (89%), while individuals with primary education attainment have the highest percentage of reported frequent radio use (29%) (Table 3). Finally, for both radio and television use, there is a higher percentage of reported media use as wealth index increases, with more divergences in the frequency of reported television use (Table 3).

In every case, the fitted random forests were superior at predicting outcome variables than the classical logistic regression (main effects only) models.

RADIO LISTENING

A ranking of most important variables for predicting whether an individual was a frequent radio user or not was created from both fitted random forest and logistic regression.

The results of the random forest variable importance plot (Figure 2) indicate that the most important variable for determining radio listening status was whether the household owns a radio or not. Individuals residing in a household with a radio were classified as frequent radio listeners 69.9% (IQR = (64.0%, 84.0%)) of the time, compared with just 23.6% (4.5%, 43.0%) of those

who did not own a radio (Figure 3a). The second most important variable for determining frequent radio use according to the fitted random forest was the respondent's frequency of watching television. Individuals who report watching television almost every day were classified as frequent radio listeners 32.6% (6.0%, 63.0%) of the time, those who reported watching television at least once a week were classified as frequent radio listeners 61.9% (38.0%, 84.0%) of the time, those who reported watching television less than once a week were classified as frequent radio listeners 45.5% (15.0%, 98.0%) of the time, and those who did not report watching television at all were classified as frequent radio listeners 38.2% (7.0%, 68.5%) of the time (Figure 3b). The third most important variable for determining frequent radio use was the respondent's reported frequency of reading the newspaper. Similar to the trends observed with television use, individuals who reported reading the newspaper at least once a week were most often classified as frequent radio users compared to individuals who reported reading the newspaper almost every day or less than once a week (Figure 3c). The fourth most important variables were the number of individuals living in the household (with the average proportion of times an individual was classified as a frequent radio listener increasing slightly as the number of household members increased) (Figure 3d).

The results of the multiple logistic regression, displayed graphically through the nomogram, indicate that the most important variable for determining frequent radio use (variable with the largest number of possible 'point' earned in the model) is whether their household has a radio, followed by their reported frequency of watching television, their reported frequency of reading the newspaper, and their desire for more children (Figure 4). In general, the results of the nomogram variable importance rankings (determined by the number of possible points earned) corresponds with the variable importance rankings determined by the random forest model, indicating that the nomogram is a useful tool for predicting radio listening. The few differences between the nomogram and random forest model, for example the fact that desire for more children was determined to be the fourth most important variable for the nomogram but the eleventh most important variable for the random forest, may be due to interactions between the variables. Such interactions (i.e. effect modifiers) are accounted for in the random forest model, producing a more nuanced model, while the nomogram simply accounts for the effect of each variable without relationships between each variable.

Overall the fitted random forest was a superior predictor for radio listening, with a cross-validated out-of-bag misclassification error of 21.8%, and a sensitivity and specificity of 74.2% and 82.3%

respectively (Web Appendices Table 1, Web Appendices Figure 2a-b), compared to the misclassification error for the logistic regression of 25.3%.

TELEVISION VIEWING

A ranking of most important variables for predicting whether an individual is a frequent television viewer or not was created from both fitted random forest and logistic regression.

The results of the random forest variable importance plot (Figure 5) indicates that the most important variables for determining television viewing status was whether the household owns a television or not. Television owners were on average classified as television viewers 76.9% (75.5%, 89.5%) of the time, compared to those who did not own a television and were classified as television viewers only 11.1% (1.0%, 11.5%) of the time on average (Figure 6a). The second most important variable according to the fitted random forest was the respondent's reported frequency of listening to the radio. Individuals who reported listening to the radio almost every day were most likely to be classified as television viewers (56.2% (14.0%, 87.5%)), followed by those who reported listening to the radio at least once a week (48.8% (6.5%, 87.0%)), those who reported not listening to the radio at all (46.2% (4.0%, 85.5%)), and finally those who reported listening to the radio less than once a week (35.9% (2.0%, 76.5%)) (Figure 6b). The next most important variable for determining television use was the number of individuals living in the respondent's household (with the average proportion of times an individual was classified as a frequent television user decreasing as the number of household members increased), followed by whether the household had access to electricity (with those with electricity being much more likely to be classified as frequent television users) (Figure 6c-d).

The results of the nomogram modelling, based on logistic regression, indicate that the most important variable for determining television use is whether there is a television in the respondent's household, followed by their reported frequency of listening to the radio, whether the respondent's household has electricity, the respondent's ideal number of children, and whether the respondent's household has a radio (Figure 7). Again, the results of the nomogram variable importance rankings correspond reasonably well with the variable importance rankings determined by the random forest model, indicating that the nomogram is a useful tool for predicting television viewing.

Overall the fitted random forest was a superior predictor for television viewing, with a cross-validated out-of-bag misclassification error of 13.8%, and a sensitivity and specificity of 85.2%

and 87.3% respectively (Web Appendices Table 2, Web Appendices Figure 3a-b), compared to the misclassification error for the logistic regression of 15.0%.

DISCUSSION

Media has the potential to play an important role in increasing health education, promotion and preventive care, particularly in communities that are poorly resourced, have a shortage of health workers, and where gaps in access to health care exist. Studies have indicated that radio and television health education programs have had a positive correlation with some health outcomes (19-24, 146-149). However, in order to best adapt health education programs through the media, it is imperative to understand which populations are and are not being reached by the programs. Answering this question requires understanding who engages with media in the first place.

Using large representative survey datasets gathered through the DHS program (153), factors related to media use were analyzed. Two statistical methods, logistic regression (classic statistical approaches) and random forests, were employed to determine which variables were the most significant for classifying radio and television use. When comparing the performance of both logistic regression and random forest modelling using misclassification error calculations, there appears to be a superiority of random forests over classic statistical modelling. Because random forest allows greater flexibility in designing the model and allows the data to speak for itself rather than imposing a model on the data, it is much more accurate at predicting outcomes (155, 156). Through the implementation and comparison of both statistical models, this paper has successfully demonstrated the strength of newer statistical approaches based on machine learning. Not only has this paper demonstrated the successful implementation of modern machine learning techniques, but it has also presented its practical use by generating large predictive accuracies. As a result, it paves a way forward for the continued use of modern machine learning approaches to better inform programming for public health.

An interesting finding of this paper, is that currently there are just over twice as many people in many low- and middle-income countries who report frequent television use, compared to those who report frequent radio use. However, the percentage of individuals who reported frequent radio and television use were quite different across continents, with more frequent radio users in Africa and Latin America and the Caribbean than frequent television users. This suggests that radio programming may have a slightly higher coverage than television programming in Africa and

Latin America and the Caribbean, while television programming would have a higher coverage in Asia-Pacific (particularly India, where the majority of cases for the Asia-Pacific region were located). Moreover, the results suggest that the individuals with the highest reported frequency of media use are slightly younger, urban-residing, more educated and of a higher wealth status. Programs may therefore wish to use different media sources (i.e. radio vs. television) depending on which continent the program is being implemented, and may also wish to consider which populations would be most likely to be exposed to the media programs.

Another key finding of this paper is that for each media method (radio and television) owning either a radio or television respectively was the most important predictor of media use. This implies that wealth and ownership are a rate-limiting step for increasing exposure to media, which correlates with the findings that individuals of higher wealth statuses have a higher frequency of reporting media use than those of lower wealth statuses.

The second most important variable for determining use of both media methods was the respondent's reported frequency of engaging with the other media source (i.e. television or radio). The reported frequency of reading the newspaper was also shown to be the third most important variable for determining frequent radio use. This indicates that those who engage with one media source are more likely to engage with other sources, implying the potential existence of 'cultures of media use'. As a result, the introduction or increased use of one media source may correlate with the increased use of other media sources.

There are a few key limitations of this study. First, while it is important to explore what factors are associated with or predict media use, there still exists a significant gap in terms of understanding the content of media sources that individuals are engaging with. This is difficult to capture on a large-scale multi-country study, as much of the media content would most likely be context- and country-specific. A mixed methods systematic review of literature of media uses for reproductive health education found that there are many barriers to health education through media, including potential lack of confidence in uni-directional media messages (157). Given this, future research should explore the effect of various types of media and media content, to determine if certain approaches have a larger impact. Moreover, community media (i.e. participatory media that is produced largely by non-profit, volunteer-run institutions (158)) may be explored as an important opportunity to engage communities in content-creation, and to design context-specific messages on health education, promotion and autonomy. Community media has a long history in collective

community education, and potentially facilitating empowerment and social change, because it engages media listeners in the knowledge dissemination process at all steps (159, 160). Further, this paper focused on radio and television as potential media education sources, however future research may wish to explore the reach of cell phones (for text messaging and applications) and internet as other media technologies. As technology becomes more widespread, it would also be interesting to look at time trends in media use, to see when use of newer media sources begin to surpass older methods. In addition to qualitative and quantitative content analysis, and investigation of other media technology methods, there is also need for randomized controlled trials, the gold standard in interventional studies, to determine how media impacts health service use and health outcomes.

Figure 1a. Flowchart of selection of eligible countries in analyses

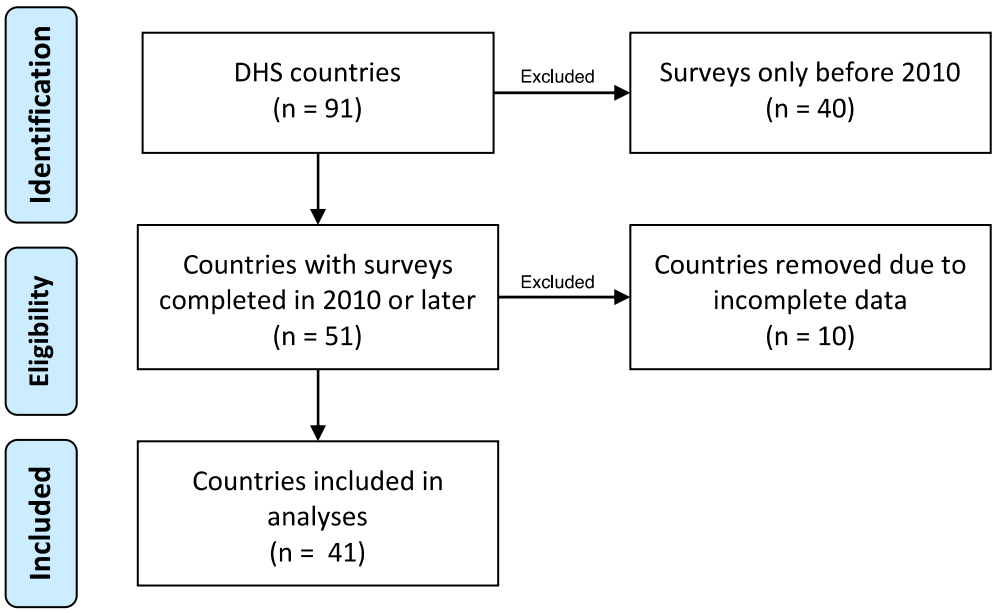


Figure 1b. Flowchart of included cases in analyses

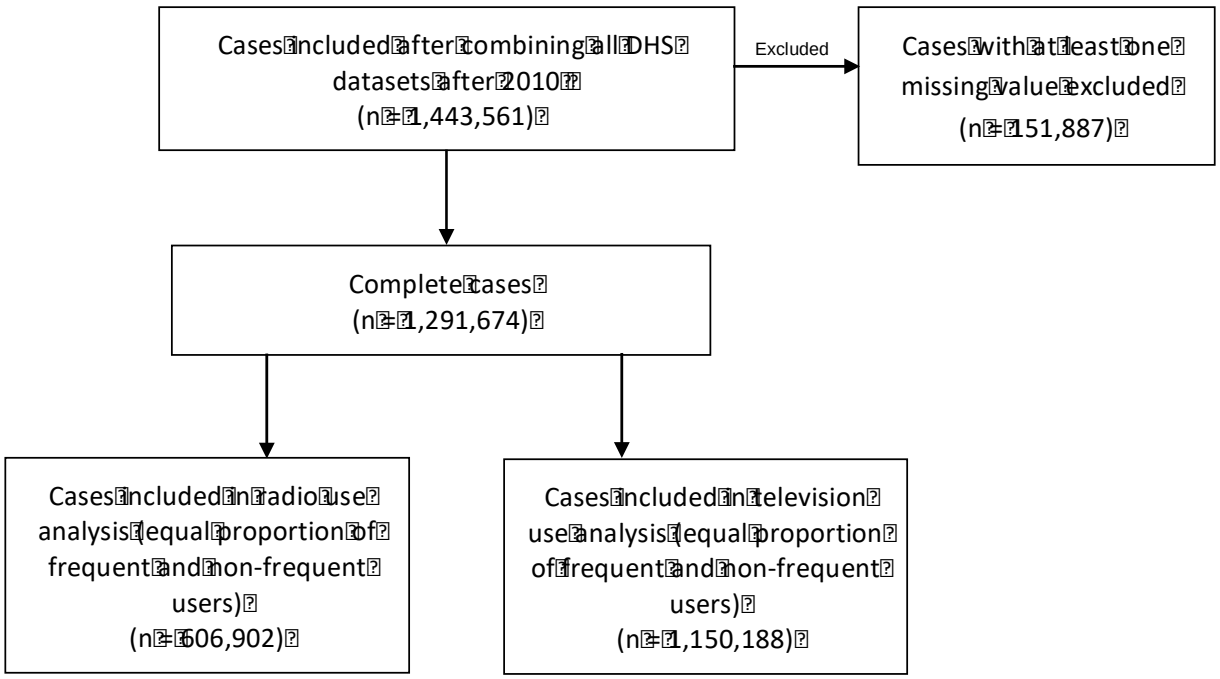


Table 1. Country survey characteristics

Country	Year	Sample Size
Asia-Pacific (n=8)		
Afghanistan	2015	29,461
Cambodia	2014	17,578
India	2015-16	699,686
Indonesia	2012	45,607
Myanmar	2015-16	12,885
Nepal	2016	12,862
Pakistan	2012-13	13,558
Africa (n=31)		
Angola	2015-16	14,379
Benin	2011-12	16,599
Burkina Faso	2011	17,087
Burundi	2010	9,389
Cameroon	2011	15,426
Chad	2014-15	17,719
Comoros	2012	5,329
Congo	2011-12	10,819
Democratic Republic of Congo	2013-14	18,827
Cote d'Ivoire	2011-12	10,060
Egypt	2014	21,762
Ethiopia	2016	16,515
Gabon	2012	8,422
Gambia	2013	10,233
Ghana	2014	9,396
Kenya	2014	31,079
Lesotho	2014	6,621
Malawi	2015-16	24,562
Mali	2012-13	10,424
Mozambique	2011	13,745
Namibia	2013	9,176
Niger	2012	11,160
Nigeria	2013	38,948
Rwanda	2014-15	13,497
Senegal	2010-11	8,488
Sierra Leone	2013	16,658
Tanzania	2015-16	13,266
Togo	2013-14	9,480
Uganda	2011	8,674
Zambia	2013-14	16,411
Zimbabwe	2015	9,955
Latin America & Caribbean (n=3)		
Guatemala	2014-15	25,914
Haiti	2012	14,287
Honduras	2011-12	22,757

Table 2. Descriptive statistics for women age 15-49 years by continent

	Total	Africa	Asia-Pacific	Latin America & Caribbean
Current age				
Mean (SD)	30 (± 10)	29 (± 9)	30 (± 10)	29 (± 10)
Type of residence				
Rural	857,580 (66%)	266,008 (62%)	569,050 (69%)	22,522 (56%)
Urban	434,094 (34%)	166,260 (38%)	250,336 (31%)	17,498 (44%)
Highest completed educational level				
No education	388,136 (30%)	145,559 (34%)	236,721 (29%)	5,856 (15%)
Primary	269,156 (21%)	132,407 (31%)	119,231 (15%)	17,518 (44%)
Secondary	521,978 (40%)	134,279 (31%)	373,388 (46%)	14,311 (36%)
Higher	112,404 (9%)	20,023 (5%)	90,046 (11%)	2,335 (6%)
Wealth index factor score				
Poorest	248,515 (19%)	83,930 (19%)	157,283 (19%)	7,302 (18%)
Poorer	261,827 (20%)	80,878 (19%)	173,276 (21%)	7,673 (19%)
Middle	260,205 (20%)	81,670 (19%)	170,113 (21%)	8,422 (21%)
Richer	257,076 (20%)	86,413 (20%)	162,277 (20%)	8,386 (21%)
Richest	264,051 (20%)	99,377 (23%)	156,437 (19%)	8,237 (21%)
Listens to radio at least once per week				
No	988,213 (77%)	257,958 (60%)	717,462 (88%)	12,793 (32%)
Yes	303,461 (23%)	174,310 (40%)	101,924 (12%)	27,227 (68%)
Watches television at least once per week				
No	575,094 (45%)	285,085 (66%)	272,272 (33%)	17,737 (44%)
Yes	716,580 (55%)	147,183 (34%)	547,114 (67%)	22,283 (56%)
Household has: electricity				
No	371,772 (29%)	263,802 (61%)	96,315 (12%)	11,655 (29%)
Not a dejure resident	34,991 (3%)	9,704 (2%)	24,727 (3%)	560 (1%)
Yes	884,911 (69%)	158,762 (37%)	698,344 (85%)	27,805 (69%)
Household has: radio				
No	866,918 (67%)	247,828 (57%)	115,963 (14%)	25,974 (65%)
Not a dejure resident	34,991 (3%)	9,704 (2%)	24,727 (3%)	560 (1%)
Yes	389,765 (30%)	174,736 (40%)	678,696 (83%)	13,486 (34%)
Household has: television				
No	550,713 (43%)	266,122 (62%)	268,284 (33%)	16,307 (41%)
Not a dejure resident	34,991 (3%)	9,704 (2%)	24,727 (3%)	560 (1%)
Yes	705,970 (55%)	156,442 (36%)	526,375 (64%)	23,153 (58%)

	Total	Africa	Asia-Pacific	Latin America & Caribbean
Number of household members				
<2	63,017 (5%)	28,176 (7%)	32,825 (4%)	2,016 (5%)
2-5	359,877 (28%)	100,951 (24%)	247,591 (30%)	11,335 (28%)
5-9	716,319 (55%)	225,540 (53%)	468,012 (57%)	22,767 (57%)
10-14	119,638 (9%)	50,841 (12%)	65,321 (8%)	3,476 (9%)
15-19	22,746 (2%)	11,957 (3%)	10,423 (1%)	366 (1%)
20+	10,077 (1%)	6,516 (2%)	3,501 (0%)	60 (0%)
<2	63,017 (5%)	28,176 (7%)	32,825 (4%)	2,016 (5%)
Number of children 5 years and under in household				
0	618,380 (48%)	123,061 (29%)	476,689 (58%)	18,630 (47%)
1	352,890 (27%)	135,590 (32%)	203,623 (25%)	13,677 (34%)
2	214,033 (17%)	103,613 (24%)	104,620 (13%)	5,800 (14%)
3	69,472 (5%)	38,169 (9%)	29,905 (4%)	1,398 (3%)
4	21,220 (2%)	12,993 (3%)	7,873 (1%)	354 (1%)
5	8,363 (1%)	5,365 (1%)	2,875 (0%)	123 (0%)
6+	7,316 (1%)	5,190 (1%)	2,088 (0%)	38 (0%)
Total children ever born				
<2	553,406 (43%)	167,237 (39%)	365,423 (44%)	20,746 (52%)
2-5	10,350 (1%)	7,203 (2%)	2,759 (0%)	388 (1%)
5-9	2,479 (0%)	1,755 (0%)	611 (0%)	113 (0%)
10-14	422,420 (33%)	107,133 (25%)	305,060 (37%)	10,227 (26%)
15-19	290,894 (23%)	132,574 (31%)	150,265 (18%)	8,055 (20%)
20+	12,125 (1%)	8,079 (2%)	3,555 (0%)	491 (1%)
Current marital status				
Divorced	15,123 (1%)	9,730 (2%)	5,280 (1%)	113 (0%)
Living with partner	54,707 (4%)	46,992 (11%)	426 (0%)	7,289 (18%)
Married	852,526 (66%)	240,544 (56%)	596,543 (73%)	15,439 (39%)
Never in union	310,236 (24%)	107,840 (25%)	188,774 (23%)	13,622 (34%)
No longer living together/separated	23,104 (2%)	15,197 (4%)	5,123 (1%)	2,784 (7%)
Widowed	35,978 (3%)	11,965 (3%)	23,240 (3%)	773 (2%)

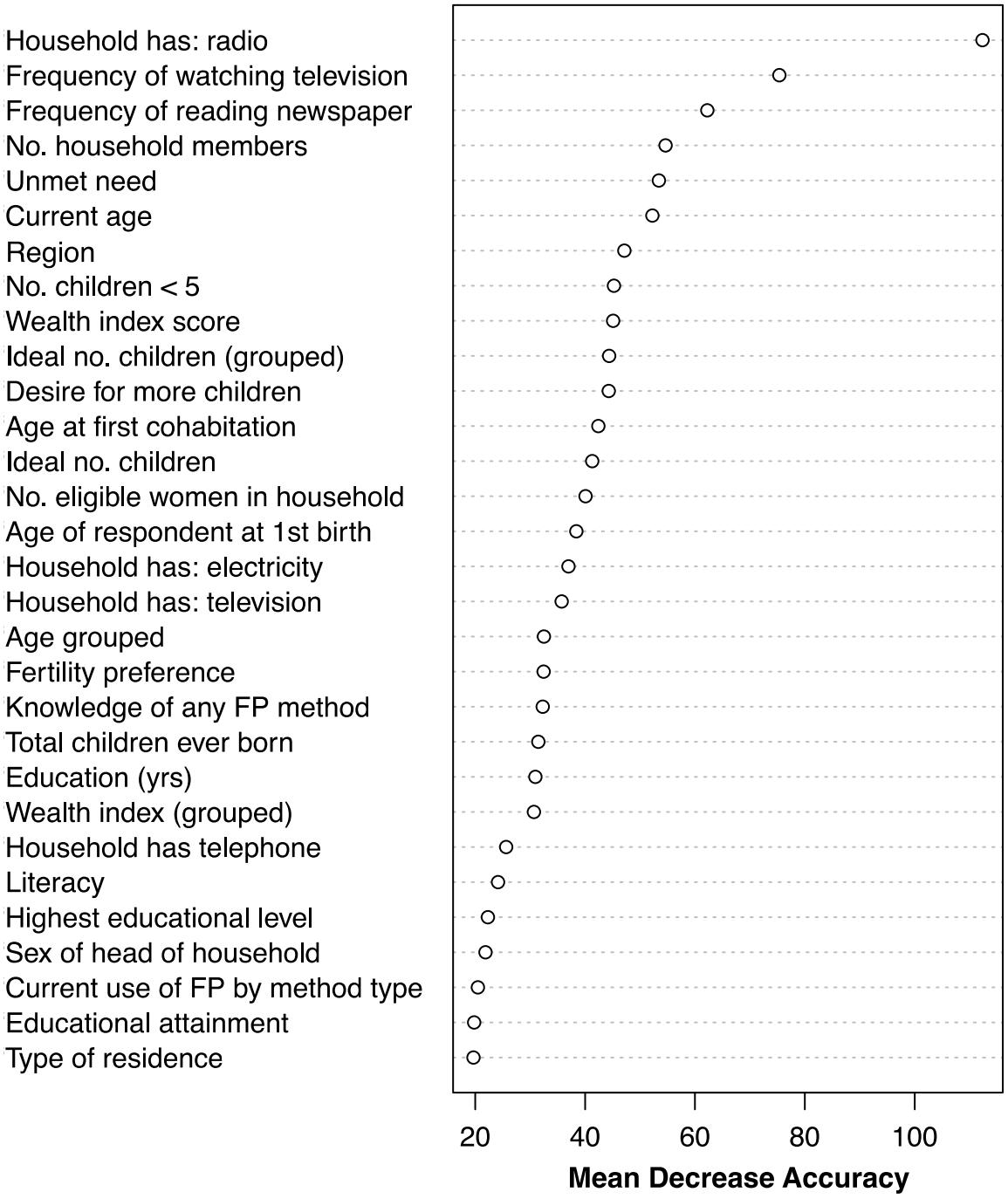
Table 3. Descriptive statistics for women age 15-49 years by media use (radio and television)

	Radio Use			Television Use		
	Total	**Non-frequent**	**Frequent**	**Total**	**Non-frequent**	**Frequent**
Continent						
Africa	432,268 (33%)	257,958 (60%)	174,310 (40%)	432,268 (33%)	285,085 (66%)	147,183 (34%)
Asia-Pacific	819,386 (63%)	717,462 (88%)	101,924 (12%)	819,386 (63%)	272,272 (33%)	547,114 (67%)
Latin America & Caribbean	40,020 (3%)	12,793 (32%)	27,227 (68%)	40,020 (3%)	17,737 (44%)	22,283 (56%)
Current age						
Mean (SD)	30 (± 10)	30 (± 10)	29 (± 10)	30 (± 10)	30 (± 10)	29 (± 10)
Type of residence						
Rural	857,580 (66%)	687,139 (80%)	170,441 (20%)	857,580 (66%)	470,669 (55%)	386,911 (45%)
Urban	434,094 (34%)	301,074 (69%)	133,020 (31%)	434,094 (34%)	104,425 (24%)	329,669 (76%)
Highest completed educational level						
No education	388,136 (30%)	321,149 (83%)	66,987 (17%)	388,136 (30%)	266,149 (69%)	121,987 (31%)
Primary	269,156 (21%)	190,970 (71%)	78,186 (29%)	269,156 (21%)	152,726 (57%)	116,430 (43%)
Secondary	521,978 (40%)	394,335 (76%)	127,643 (24%)	521,978 (40%)	143,387 (27%)	378,591 (73%)
Higher	112,404 (9%)	81,759 (73%)	30,645 (27%)	112,404 (9%)	12,832 (11%)	99,572 (89%)
Wealth index						
Poorest	248,515 (19%)	213,739 (86%)	34,776 (14%)	248,515 (19%)	199,945 (80%)	48,570 (20%)
Poorer	261,827 (20%)	212,073 (81%)	49,754 (19%)	261,827 (20%)	153,523 (59%)	108,304 (41%)
Middle	260,205 (20%)	199,146 (77%)	61,059 (23%)	260,205 (20%)	105,999 (41%)	154,206 (59%)
Richer	257,076 (20%)	187,258 (73%)	69,818 (27%)	257,076 (20%)	74,702 (29%)	182,374 (71%)
Richest	264,051 (20%)	175,997 (67%)	88,054 (33%)	264,051 (20%)	40,925 (15%)	223,126 (85%)
Listens to radio at least once per week						
No	988,213 (77%)			988,213 (77%)	454,559 (46%)	533,654 (54%)
Yes	303,461 (23%)			303,461 (23%)	120,535 (40%)	182,926 (60%)
Watches television at least once per week						
No	575,094 (45%)	454,559 (79%)	120,535 (21%)	575,094 (45%)		
Yes	716,580 (55%)	533,654 (74%)	182,926 (26%)	716,580 (55%)		
Household has: electricity						
No	371,772 (29%)	262,075 (70%)	109,697 (30%)	371,772 (29%)	328,631 (88%)	43,141 (12%)
Not a dejure resident	34,991 (3%)	27,411 (78%)	7,580 (22%)	34,991 (3%)	11,982 (34%)	23,009 (66%)
Yes	884,911 (69%)	698,727 (79%)	186,184 (21%)	884,911 (69%)	234,481 (26%)	650,430 (74%)
Household has: radio						
Yes	389,765 (30%)	185,643 (48%)	204,122 (52%)	389,765 (30%)	196,989 (51%)	192,776 (49%)
No	866,918 (67%)	775,159 (89%)	91,759 (11%)	866,918 (67%)	366,123 (42%)	500,795 (58%)
Not a dejure resident	34,991 (3%)	27,411 (78%)	7,580 (22%)	34,991 (3%)	11,982 (34%)	23,009 (66%)

	Radio Use			Television Use		
	Total	**Non-frequent**	**Frequent**	**Total**	**Non-frequent**	**Frequent**
Household has: television						
No	550,713 (43%)	422,485 (77%)	128,228 (23%)	550,713 (43%)	463,494 (84%)	87,219 (16%)
Not a dejure resident	34,991 (3%)	27,411 (78%)	7,580 (22%)	34,991 (3%)	11,982 (34%)	23,009 (66%)
Yes	705,970 (55%)	538,317 (76%)	167,653 (24%)	705,970 (55%)	99,618 (14%)	606,352 (86%)
Number of household members						
<2	63,017 (5%)	45,556 (72%)	17,461 (28%)	<2	63,017 (5%)	45,556 (72%)
2-5	359,877 (28%)	280,477 (78%)	79,400 (22%)	2-5	359,877 (28%)	280,477 (78%)
5-9	716,319 (55%)	552,933 (77%)	163,386 (23%)	5-9	716,319 (55%)	552,933 (77%)
10-14	119,638 (9%)	87,436 (73%)	32,202 (27%)	10-14	119,638 (9%)	87,436 (73%)
15-19	22,746 (2%)	15,610 (69%)	7,136 (31%)	15-19	22,746 (2%)	15,610 (69%)
20+	10,077 (1%)	6,201 (62%)	3,876 (38%)	20+	10,077 (1%)	6,201 (62%)
Number of children 5 years and under in household						
0	618,380 (48%)	489,669 (79%)	128,711 (21%)	0	618,380 (48%)	489,669 (79%)
1	352,890 (27%)	261,980 (74%)	90,910 (26%)	1	352,890 (27%)	261,980 (74%)
2	214,033 (17%)	159,886 (75%)	54,147 (25%)	2	214,033 (17%)	159,886 (75%)
3	69,472 (5%)	51,159 (74%)	18,313 (26%)	3	69,472 (5%)	51,159 (74%)
4	21,220 (2%)	15,197 (72%)	6,023 (28%)	4	21,220 (2%)	15,197 (72%)
5	8,363 (1%)	5,780 (69%)	2,583 (31%)	5	8,363 (1%)	5,780 (69%)
6+	7,316 (1%)	4,542 (62%)	2,774 (38%)	6+	7,316 (1%)	4,542 (62%)
Total children ever born						
<2	553,406 (43%)	410,024 (74%)	143,382 (26%)	<2	553,406 (43%)	410,024 (74%)
2-5	10,350 (1%)	7,467 (72%)	2,883 (28%)	2-5	10,350 (1%)	7,467 (72%)
5-9	2,479 (0%)	1,765 (71%)	714 (29%)	5-9	2,479 (0%)	1,765 (71%)
10-14	422,420 (33%)	337,857 (80%)	84,563 (20%)	10-14	422,420 (33%)	337,857 (80%)
15-19	290,894 (23%)	222,334 (76%)	68,560 (24%)	15-19	290,894 (23%)	222,334 (76%)
20+	12,125 (1%)	8,766 (72%)	3,359 (28%)	20+	12,125 (1%)	8,766 (72%)
Current marital status						
Divorced	15,123 (1%)	10,932 (72%)	4,191 (28%)	15,123 (1%)	8,426 (56%)	6,697 (44%)
Living with partner	54,707 (4%)	30,879 (56%)	23,828 (44%)	54,707 (4%)	33,681 (62%)	21,026 (38%)
Married	852,526 (66%)	682,566 (80%)	169,960 (20%)	852,526 (66%)	387,257 (45%)	465,269 (55%)
Never in union	310,236 (24%)	219,478 (71%)	90,758 (29%)	310,236 (24%)	114,326 (37%)	195,910 (63%)
No longer living together/separated	23,104 (2%)	15,104 (65%)	8,000 (35%)	23,104 (2%)	13,146 (57%)	9,958 (43%)
Widowed	35,978 (3%)	29,254 (81%)	6,724 (19%)	35,978 (3%)	18,258 (51%)	17,720 (49%)

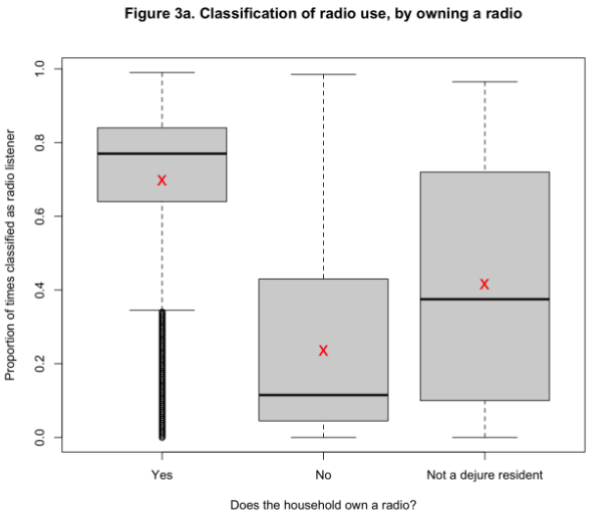
Note: Table 3 utilizes row percentages to compare between frequent and non-frequent media users.

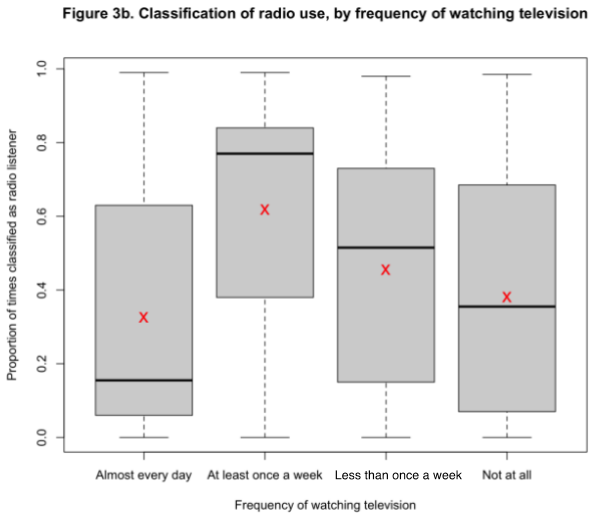
Figure 2. Variable importance plot for determining radio use from random forest

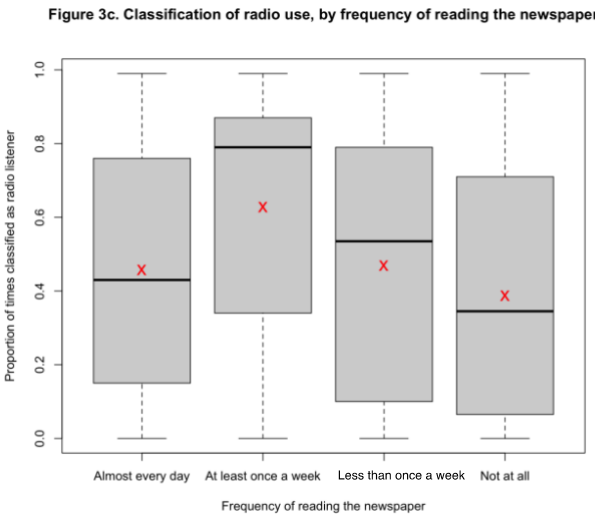


Note: Mean Decrease Accuracy (MDA) represents how much relative predictive accuracy is lost by the removal of the variable in question. MDA-based variable importance is mainly used to rank the predictive usefulness of all variables. Isolated interpretation of the absolute values of variable importance is not recommended.

Figure 3. Classification of radio use, based on four most important variables







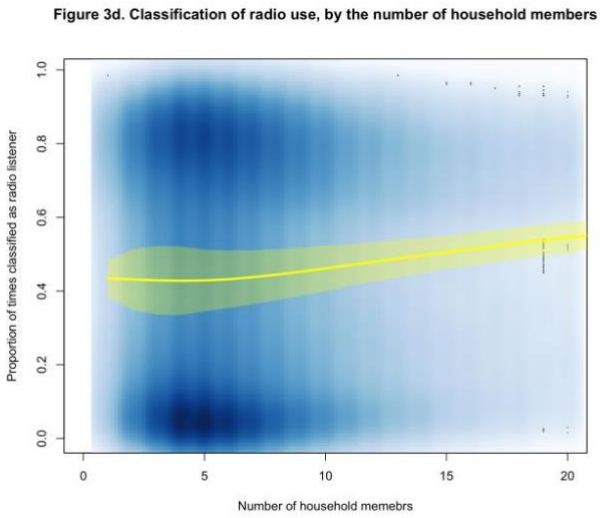
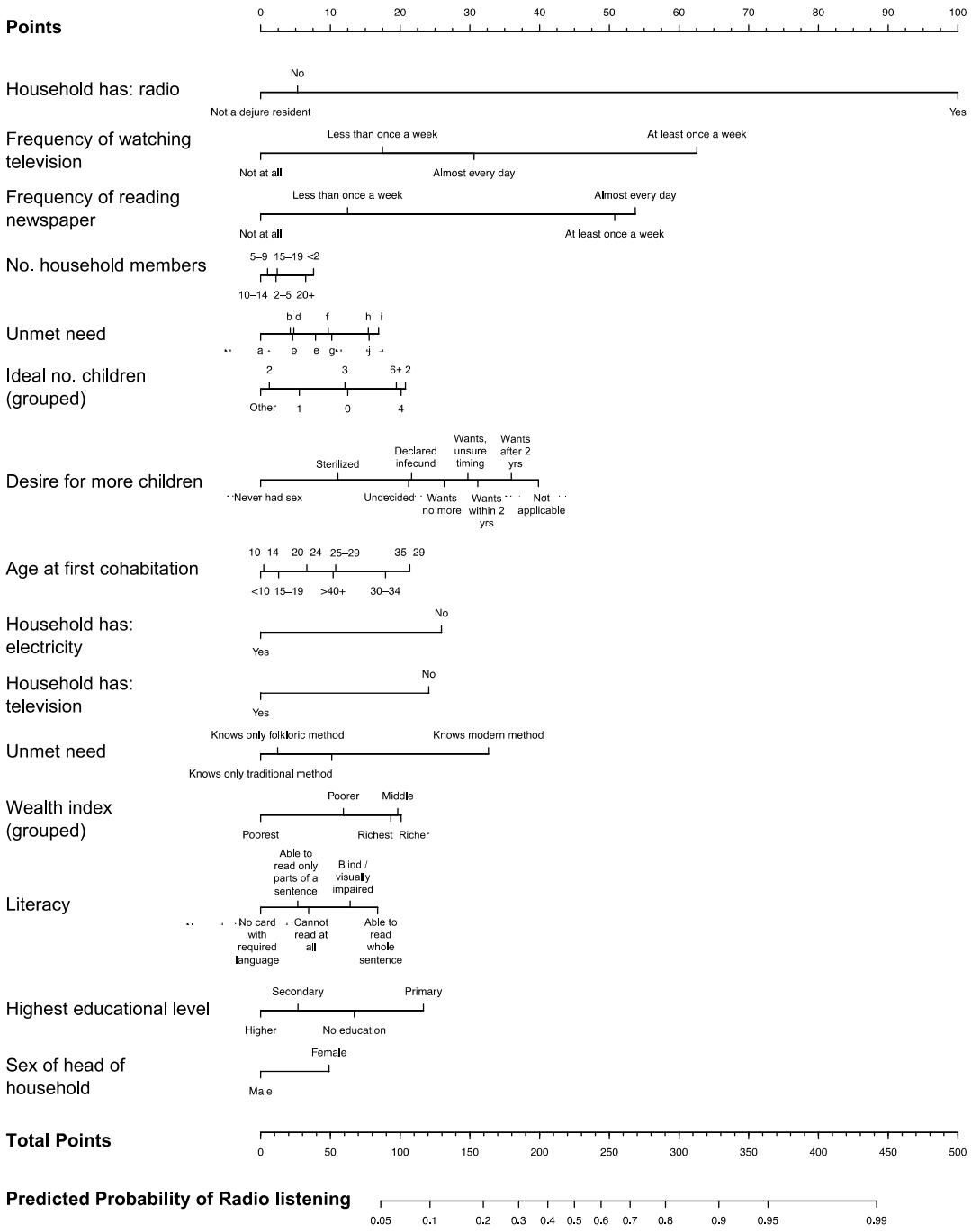
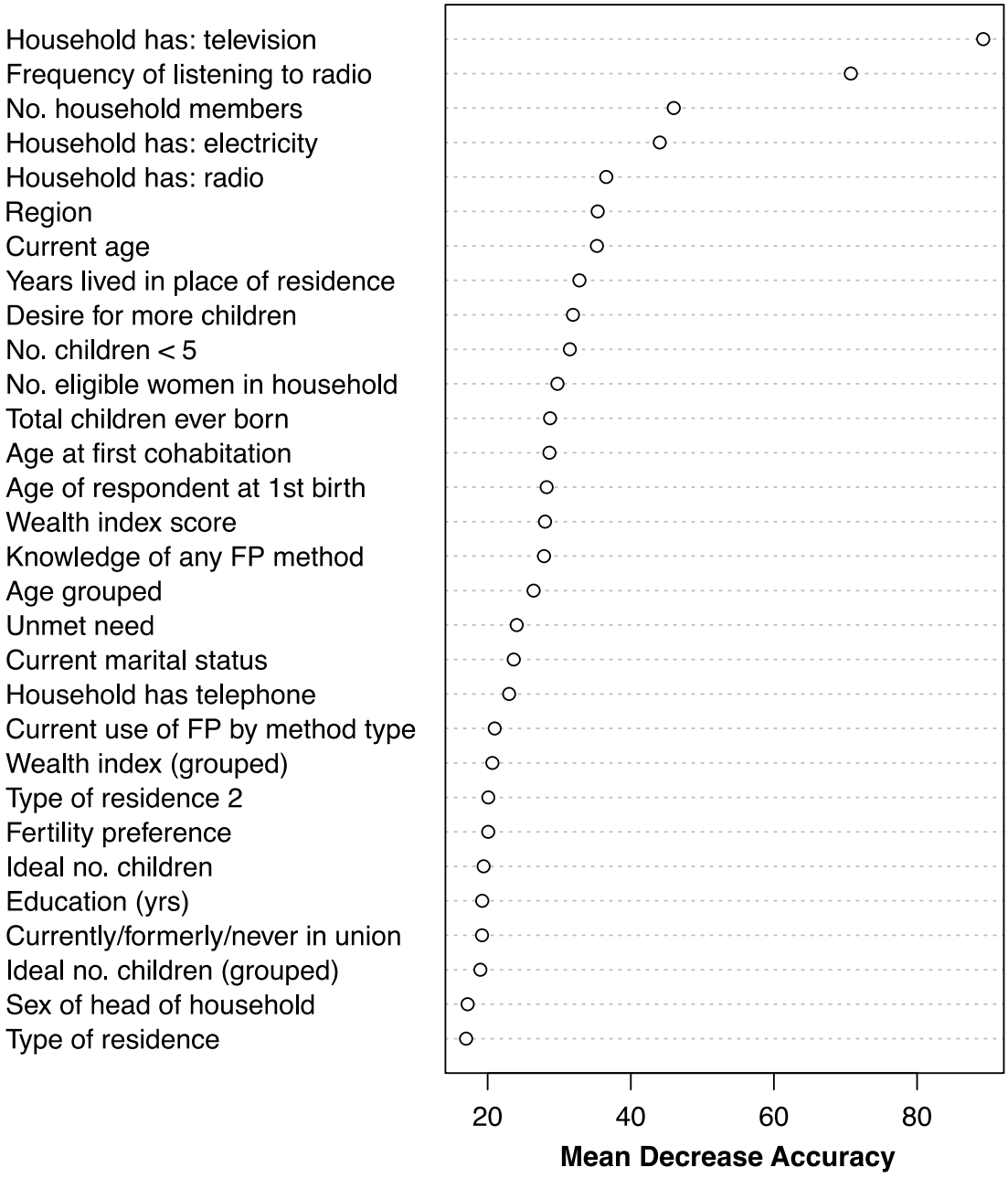


Figure 4. Nomogram plot for determining the predicted probability of frequent radio use from multiple binary logistic regression (main effects)



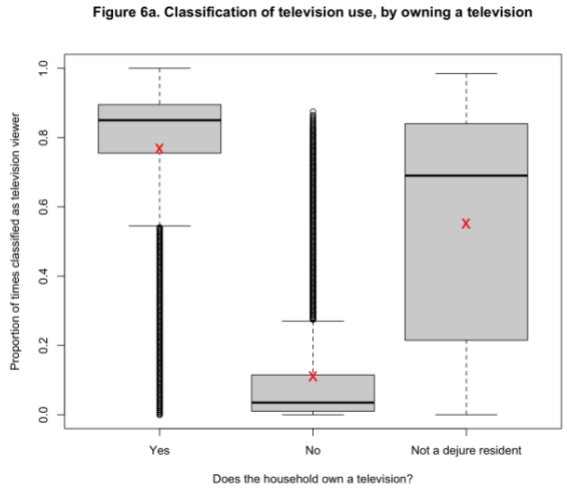
Note: Points (scale on top) are to be added up for each individual variable realization and the predicted probability corresponding to the total sum of points can be read from the two scales at the bottom of the nomogram.

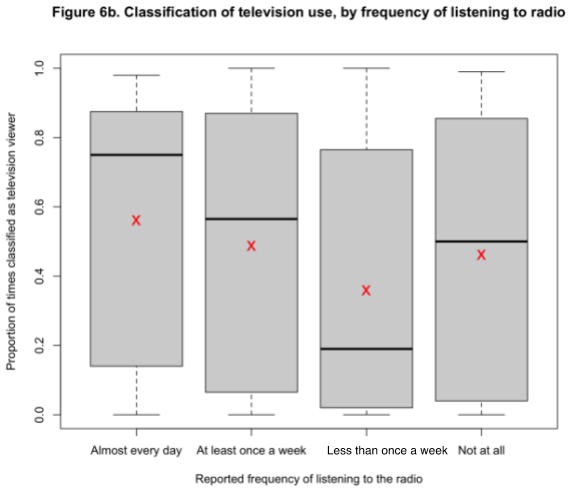
Figure 5. Variable importance plot for determining television use from random forest

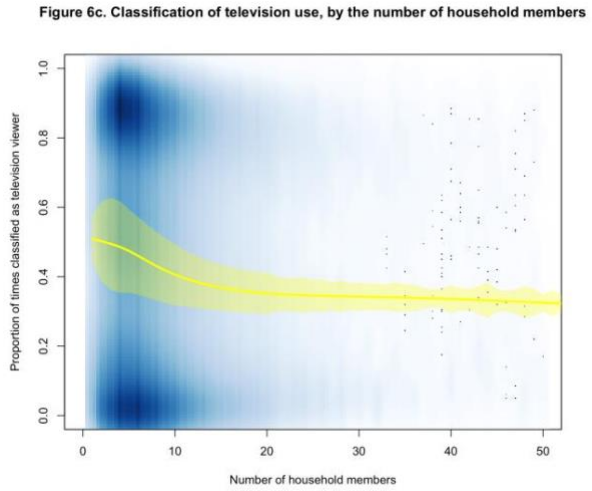


Note: Mean Decrease Accuracy (MDA) represents how much relative predictive accuracy is lost by the removal of the variable in question. MDA-based variable importance is mainly used to rank the predictive usefulness of all variables. Isolated interpretation of the absolute values of variable importance is not recommended.

Figure 6. Classification of television use, based on four most important variables







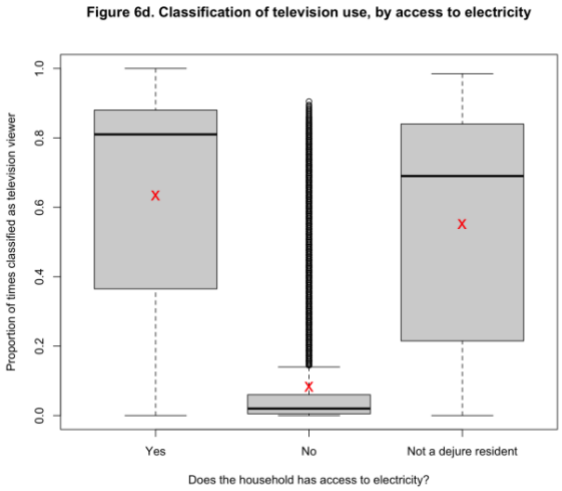
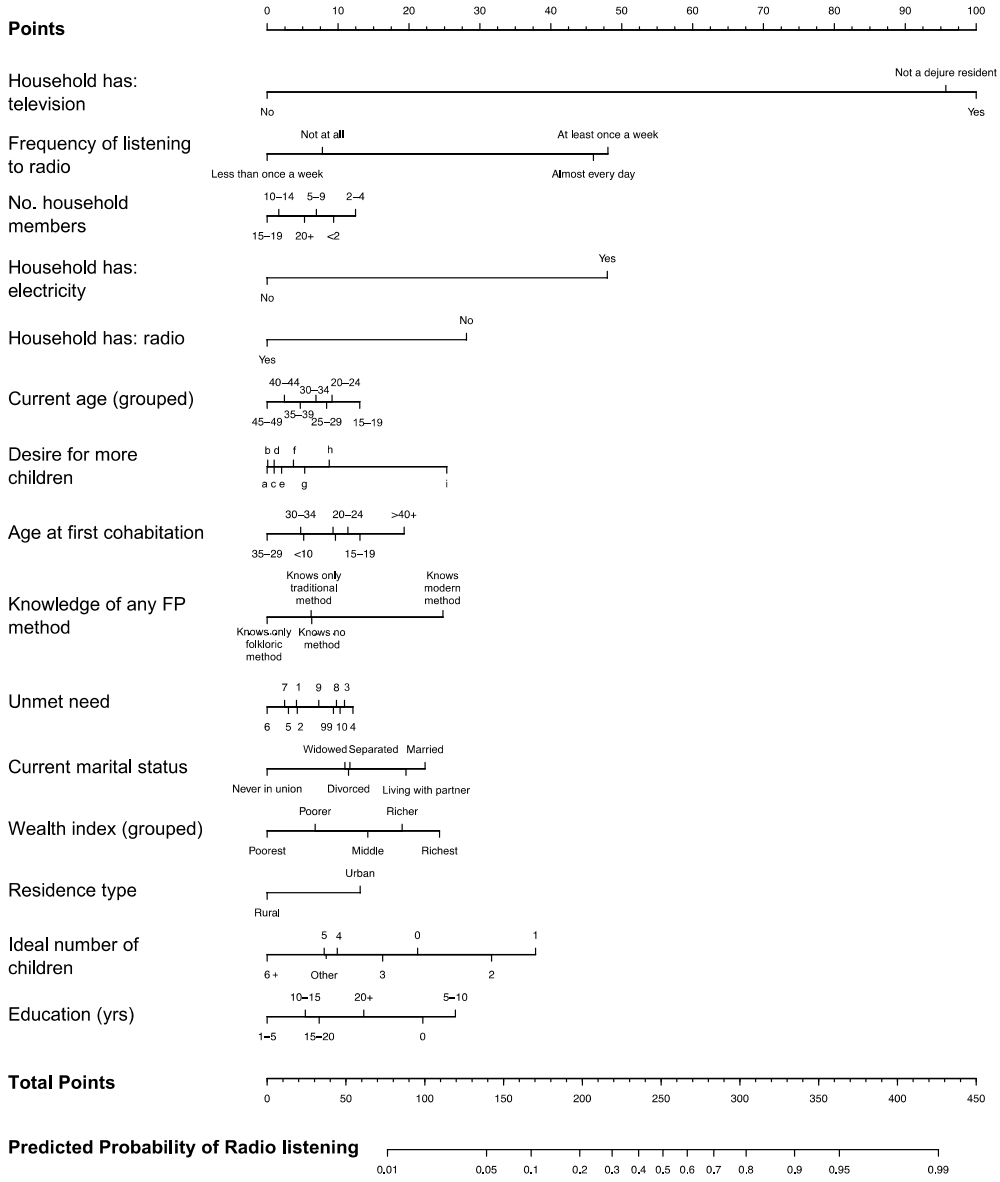


Figure 7. Nomogram plot for determining the predicted probability of frequent television use from multiple binary logistic regression (main effects)



Note: Points (scale on top) are to be added up for each individual variable realization and the predicted probability corresponding to the total sum of points can be read from the two scales at the bottom of the nomogram.

CHAPTER 5: CONCLUSION

Following the United Nations Universal Declaration of Human Rights and the UN SDG Universal Health Coverage Goal 3.8 (4, 25), this thesis was approached from the perspective that access to healthcare is a basic and fundamental right of all humans. Globally, there is a big shortage of access to skilled, salaried, supervised and supplied healthcare workers, resulting in a gap of services, and an urgent need to improve the state of healthcare globally. One method to improve health that was explored throughout this thesis is media-based health education and promotion. The approaches to this thesis were interdisciplinary, involving different qualitative and quantitative research methods. Overall, the aim of this thesis was to better understand the relationship between mass media and reproductive health knowledge and behavior, particularly as it relates to topics of reproductive health and primary care.

Chapter 3 presented a mixed-methods systematic review of the literature regarding the effectiveness of current media interventions to increase dissemination of family planning and contraception knowledge, and potentially also use. The objective of this chapter was to understand current literature in this field, including strengths and weaknesses of current programming, in order to guide prospective research and programming on family planning and contraception education. Based on the reported data in the included systematic review, there appears to be associational evidence that media interventions may be effective at improving population-level outcomes relating to family planning and contraception (105, 127, 132). In fact, the vast majority of observed associations suggest positive effects, however, with varying degrees of estimate precision and conclusiveness. Nevertheless, after aggregating the numerical information using inferential statistics i.e. 95% prediction intervals, the overall evidence remains plausible yet inconclusive in answering whether or not mass media interventions have a relevant impact on increased knowledge or use of contraceptives. The range of reported effects (prevalence ratios) for the association between media exposure and contraceptive knowledge varies from 0·97 to 1·41 (95% PI: 0·51, 2·36), while the range of reported effects for the association between media exposure and contraceptive use is from 0·96 to 3·09 (95% PI: 0·55, 3·19). This lack of precision of expected associations in future studies is primarily due to the limited quality of evidence available, i.e. absence of rigorous study designs (e.g. RCTs) and inadequate methods for confounding control.

Additionally, the results of the qualitative analysis may help shed some light on some of these potential factors. The findings indicate that there are barriers to contraceptive uptake at the level

of individual knowledge (due to demographic factors such as whether the individual lives in urban or rural settings and preconceived notions), and programming (including lack of participatory approaches). These socio-cultural factors be should accounted for when designing media interventions, in order to increase their success.

While great effort was extended to extract as much information as possible from the currently available evidence, the systematic review found topic is severely lacking rigorous quality research. Within the meta-analysis, this systematic review demonstrated an approach to addressing and aggregating data with a great deal of heterogeneity between studies and high potential for confounding. Moreover, because there have not been any rigorous RCTs published on this topic, the review was limited to qualitative, cross-sectional and pre-post studies, meaning that it is not possible to infer causal relationships between exposure to mass media and contraceptive use.

Chapter 4 provided an in-depth cross-national analysis of large representative DHS data from 41 countries to examine the factors associated with mass media usage, in order to be used to better understand target populations when designing health education programs. Two prediction model approaches, binary logistic regression (classic statistical approach) and random forests (relatively new machine learning approach), were employed to determine which variables are most relevant for predicting frequent radio and television use. The overall accuracy for correctly classifying non-frequent and frequent media users was high (TV: 86.2% random forest, 85% logistic regression; radio: 78.2% random forest, 74.7% logistic regression). When comparing the performance of both logistic regression and random forest modelling, random forests demonstrated somewhat superior prediction accuracy over the classic statistical modelling. Because random forest modelling allows greater flexibility in fitting the prediction model to the data, allowing the data to speak for themselves rather than imposing a model on the data, it has greater opportunity to be accurate at predicting outcomes than classic statistical prediction models (155, 156). Through the implementation and comparison of both outcome prediction approaches, this manuscript has confirmed the utility of newer statistical approaches based on machine learning. As a result, it paves a way forward for the recommended use of modern machine learning approaches to better inform programming for public health.

The multi-country analysis also demonstrated that between 2010-2016 there are just over twice as many people in many low- and middle-income countries who report frequent television use, compared to those who report frequent radio use. However, the percentage of individuals who

reported frequent radio and television use were quite different across continents, with more frequent radio users in Africa and Latin America and the Caribbean than frequent television users. This suggests that radio programming may have a higher coverage than television programming in Africa and Latin America and the Caribbean, while television programming would have a higher coverage in Asia-Pacific (particularly India, where the majority of cases for the Asia-Pacific region were located). Moreover, the results suggest that the individuals with the highest reported frequency of media use are slightly younger, urban-residing, more educated and of a higher wealth status. Programs may therefore wish to use different media sources (i.e. radio vs. television) depending on which continent the program is being implemented, and may also wish to consider which populations would be most likely to be exposed to the media programs.

Chapter 4 also demonstrated that for each media method (radio and television) owning either a radio or television respectively was the most important predictor of media use. This implies that wealth and ownership are a rate-limiting step for increasing exposure to media, which correlates with the findings that individuals of higher wealth statuses have a higher frequency of reporting media use than those of lower wealth statuses. Moreover, the second most important variable for determining use of both media methods was the respondent's reported frequency of engaging with the other media source (i.e. television or radio). The reported frequency of reading the newspaper was also shown to be the third most important variable for determining frequent radio use. This indicates that those who engage with one media source are more likely to engage with other sources, implying the potential existence of 'cultures of media use'.

Overall, when people are educated about their bodies and their health, they are better positioned to make informed decisions and therefore have greater autonomy over their health, life and future. Yet, it is important to acknowledge that there are a variety of factors beyond education that influence peoples' self-determination with respect to their health. As a global community, it is important to be critically reflective of the research and information that is currently available pertaining to sexual and reproductive health. In order to produce robust results of the effectiveness of media health education programs, future research studies should employ rigorous mixed methods designs, incorporating pragmatic (cluster) randomized controlled trials, to evaluate the impact of various mass media education approaches to improve contraceptive knowledge and use, across heterogeneous populations. This would produce more robust evidence and potentially allow researchers and programing teams to infer causality between the exposure to various mass media

mediums and increased health knowledge and healthy behaviors. Moreover, it is also recommended that qualitative studies be undertaken in order to better understand barriers to health education and autonomy. Finally, because media interventions do not directly reach entire populations, it is also important to continue implementing all relevant strategies needed to reach these groups and thus achieve universal coverage.

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APPENDIX A: WEB APPENDICES TABLES & FIGURES FOR CHAPTER 3

Web Appendices Table 1. MEDLINE Search Strategy combining contraceptive and mass media interventions

[Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily 1946 to Present]
1. exp Contraception/ 2. Contraception Behavior/ 3. Reproductive Health/ 4. Family Planning Services/ 5. contracept*.mp. 6. "family planning".mp. 7. reproductive health.mp. 8. 1 or 2 or 3 or 4 or 5 or 6 or 7
9. edutainment.mp. 10. mass media/ or radio/ or television/ 11. infotainment.mp. 12. info tainment.mp. 13. enter educat*.mp. 14. "entertainment education".mp. 15. edu tainment.mp. 16. radio.mp. 17. comic book*.mp. 18. storytell*.mp. 19. (television or tv).mp. 20. folk theatre.mp. 21. film.mp. 22. cell phone*.mp. 23. (text messag* and educat*).mp. 24. soap opera*.mp. 25. Access to Information/ 26. Advertising as Topic/ 27. Answering Services/ 28. Health Communication/ 29. Information Seeking Behavior/ 30. communication intervention*.mp. 31. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30
32. 8 and 31

Web Appendices Table 2. Websites screened during data collection for systematic review

Websites screened by hand
• Studies Family Planning • World Health Organization (WHO) Library Database (WHOLIS) • United Nations Population Fund (UNFPA) Library Database • United States Agency for International Development (USAID) Library, and other government development websites • Demographic & Health Survey (DHS) Library

Web Appendices Table 3. Quality appraisal of studies included in systematic review by study design

Quasi-Experiment (Author, yr) (N=17)	**Questions (TREND for quasi-experimental research)**																				**TOTAL/22**	**Quality**
	1	2	3	4	5	6	7	8	10	11	12	13	14	15	16	17	18	20	21	22		
Agha & Meekers, 2010	1	1	1	1	1	1	0	0	1	1	1	1	1	1	0	1	1	1	0	1	16	Medium
Babalola et al., 2001	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19	High
Beaudoin et al., 2016	1	1	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	0	1	16	Medium
Braun et al., 2016	1	1	1	1	1	1	0	0	0	0	1	0	1	0	0	1	1	1	0	1	12	Medium
Daniel et al., 2008	1	1	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	0	1	16	Medium
Gupta et al., 2003	0	1	1	0	1	1	1	0	1	1	1	1	1	1	0	1	1	1	0	1	15	Medium
Hutchinson & Meekers, 2012	1	1	1	1	1	1	1	0	1	1	1	0	1	1	0	1	1	1	1	1	17	High
Jato et al., 1999	1	1	1	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1	0	1	13	Medium
Kane et al., 1998	1	1	0	1	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	13	Medium
Kim et al., 2007	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	19	High
L'Engle et al., 2013	1	1	0	1	1	1	0	0	1	1	1	1	1	0	1	1	0	1	1	1	15	Medium
Rogers et al., 1999	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	16	Medium
Sharma et al., 2011	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	16	Medium
Speizer et al., 2014	1	1	0	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	0	1	16	Medium
Underwood & Kamhawi 2014	1	1	1	1	1	1	0	0	1	1	0	1	1	1	1	1	1	1	0	1	16	Medium
Van Rossem & Meekers, 2000	1	1	1	1	0	1	0	1	1	1	1	1	0	1	0	1	1	1	0	1	15	Medium
Vaughan, 2000	1	1	1	1	0	1	1	0	0	1	0	1	1	1	0	1	1	1	0	1	14	Medium

For all questions l = yes; 0 = no; Publications with a score < 10 were excluded; 11 – 16 = Medium; 17+ = High

Cross sectional (Author, yr) (N=37)	**Questions (Strobe for cross-sectional research)**																					**TOTAL/22**	**Quality**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Agha & van Rossem, 2002	0	1	1	1	1	1	1	1	0	0	1	1	1	0	1	0	1	1	0	1	1	1	16	Medium
Ajaero et al., 2016	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	18	High
Akufuah & Sossou, 2008	0	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0	1	0	0	14	Medium
Alemayehu et al., 2016	0	1	1	1	1	1	1	0	0	1	1	1	0	1	1	1	0	1	0	1	0	0	14	Medium
Arora et al., 2013	1	1	1	1	0	1	1	0	0	1	1	1	1	1	1	1	1	1	0	1	0	1	17	Medium
Bajoga et al., 2015	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	21	High
Banerjee et al., 2015	1	1	1	1	1	0	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	0	18	High
Bankole, 1996	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	1	0	0	16	Medium
Barker et al., 2013	1	1	1	1	1	0	0	1	0	0	1	1	1	0	1	1	0	1	1	1	0	0	14	Medium
Boulay et al., 2002	1	1	1	1	1	1	1	1	0	1	0	0	1	1	1	0	1	1	0	1	1	1	17	Medium
Char et al., 2011	1	1	1	1	1	1	1	1	0	1	0	0	1	1	1	0	1	1	0	1	1	1	17	Medium
de Oliveira et al., 2014	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	21	High
Dixit et al., 2013	0	1	1	1	1	1	1	1	0	0	1	1	0	1	1	1	0	1	0	1	0	0	14	Medium
Habibov & Zainddinov, 2015	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	0	0	18	High
Islam & Kabir, 1998	0	1	1	1	1	0	0	0	0	1	1	1	0	1	1	1	1	1	0	1	0	0	13	Medium
Islam et al., 2009	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	0	18	High
Jin & Jeong, 2010	1	1	1	1	1	0	1	0	0	0	1	1	0	0	0	1	1	1	1	1	1	0	14	Medium
Kabir & Islam, 2000	0	1	1	1	1	1	1	1	0	1	0	0	0	1	1	1	1	1	0	1	1	0	15	Medium
Koringa et al., 2015	0	0	1	1	1	0	0	1	0	0	1	1	0	1	1	0	1	1	0	1	0	1	12	Medium
Kulkarni, 2003	0	0	1	0	1	1	1	1	0	1	1	1	0	1	1	0	1	1	0	1	0	0	13	Medium
Meekers et al., 2007	1	1	0	1	1	1	1	1	0	0	1	1	0	1	1	1	1	1	1	1	0	1	17	Medium
Melka et al., 2015	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	20	High
Nanavati et al., 2006	0	1	1	1	1	1	0	1	0	1	1	1	0	1	1	0	1	1	0	1	0	1	15	Medium
Nawaz et al., 2012	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	1	0	0	16	Medium
Okeowo & Olujide, 2014	0	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	0	1	1	1	18	High

Okigbo et al., 2015	1	1	1	1	1	0	1	1	0	0	1	1	0	1	1	1	1	1	1	1	1	1	18	High
Paek et al., 2008	1	1	1	1	1	0	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	0	16	Medium
Schwandt et al., 2015	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	0	1	19	High
Shrestha et al., 2014	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	0	0	1	0	1	0	0	13	Medium
Somba et al., 2014	1	1	1	1	1	0	0	1	0	1	1	0	1	1	1	0	0	1	1	1	1	0	15	Medium
Tebeje & Rajan, 2015	1	1	1	1	1	1	0	1	0	1	1	1	0	1	1	1	1	1	0	1	0	1	17	Medium
Thompson & Harutyunyan, 2006	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	20	High
Valente & Poppe, 1996	0	1	1	1	1	1	0	1	0	1	0	0	0	1	1	1	1	1	1	1	0	0	14	Medium
Westoff & Koffman, 2011	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	0	19	High
Westoff et al., 2011	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	0	19	High
Westoff, 2012	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	0	19	High
Wosu, 2013	1	1	1	1	1	0	1	0	0	1	1	1	0	1	1	1	1	1	1	1	0	1	17	Medium

For all questions l = yes; 0 = no; Publications with a score < 12 were excluded; 12 – 18 = Medium; 18+ = High

Qualitative (Author, yr) (N=6)	**Questions (JBI for qualitative research)**										**TOTAL/8**	**Quality**
	1	2	3	4	5	6	7	8	9	10		
Barker et al., 2013	1	1	1	1	1	0	0	1	1	1	8	Medium
Dutta & Basnyat, 2008	1	1	1	1	1	1	0	1	1	1	9	High
Kagurusi, 2013	1	1	1	1	1	1	0	1	1	1	9	High
Khan et al., 2008	1	1	1	1	1	0	0	1	1	1	8	Medium
Ochako et al., 2015	1	1	1	1	1	0	0	1	1	1	8	Medium
Paz Soldan, 2004	1	1	1	1	1	1	1	1	1	1	10	High

For all questions l = yes; 0 = no; Publications with a score < 5 were excluded; 6 – 8 = Medium; 9 – 10 = High

Web Appendices Table 4. Characteristics of all studies included in systematic review

Author, Year	Study Design	Setting [Country]	Continent	Dates	Participants	Sample Size	Data Collection	Intervention	Results Summary	Quality Appraisal
Agha & Meekers, 2010	Quasi-Experi.	[Pakistan]	Southern Asia	April-June 2009	Married Men, 15-49	N= 627; Random selection	Cross-sectional survey	Marketing: Media advertisement on condom use	Nearly ½ men surveyed never used a condom with wives, and almost 13% consistently use condom. 15% of men were aware of Touch ad, 15% had unconfirmed awareness of FP ads.	Medium
Agha & van Rossem, 2002	Cross-sectional	[Tanzania]	Eastern Africa	Dec. 1999	Sexually experienced men and women	N= 2712	Survey at shops that sell female condom	Marketing: (radio & newspaper) on use of female condoms	About 6% exposed to peer education, 6% had given an explanation by provider on use of female condom. 38% had been exposed to mass media campaigns promoting female condom. Mass media exposure increased likelihood that a man or woman would discuss use of female condom with partner.	Medium
Ajaero et al., 2016	Cross-sectional	[Nigeria]	Western Africa	2013	Women, 15–49	N=38,948	DHS cross-sectional	Regular family planning education programs (Radio, TV, NP)	Access to mass media messages increases the likelihood of the use of family planning; and people with higher socioeconomic status & those from the Southern part of the country make more use of family planning.'	High
Akufuah & Sossou, 2008	Cross-sectional	[Ghana]	Western Africa	2008	Men, 19-65	N= 200; Non-random and convenient sampling	Demographics survey & face-to-face interviews	Regular family planning education programs (Radio, TV, NP)	Demographic factors such as education, religion, types of marital relationship, and exposure to mass-media education have significant effects on the participants' increased knowledge, changing attitudes, and family planning and reproductive decision-making.	Medium

Alemayehu et al., 2016	Cross-sectional	Afar region [Ethiopia]	Eastern Africa	Jan-13	Women, 15–49	N=602	DHS cross-sectional	Regular family planning education programs (Radio, TV, NP)	The low coverage of family planning in the region could be due to the influence of husband, religious and clan leader. Attitude of women towards family planning methods, possession of radio, monthly income, and educational status were associated with family planning utilization. Health facilities were the main source of information for the respondents 150(40.2 %).'	Medium
Arora et al., 2013	Cross-sectional	Universities in Dehli [India]	Southern Asia	2013	Female students	N=220	Cross-sectional survey	Regular family planning education programs (Radio, TV, NP)	Awareness about emergency contraceptive pills is quite high but knowledge regarding the correct timing and usage is poor, and there is a fear of side effects	Medium
Babalola et al., 2001	Quasi-Experi.	[Cameroon]	Middle Africa	1998-1999	Women	N= 571	1998 DHS and SFPS	CHW: Family planning promotion at delivery sites	More than 1/3 women exposed to Gold Circle campaign, 52% of whom mentioned being exposed through TV. Women with primary or secondary education were 4 and 6 times (respectively) as likely as those who weren't exposed. Exposure associated with significant increase in level of family planning ideation and increased likelihood of using modern contraceptive method (80%).	High

Bajoga et al., 2015	Cross-sectional	Abuja, Ilorin, Kaduna, Zaria, Benin & Ibadan [Nigeria]	Western Africa	2010	Women, 15–24	N=5765	Baseline survey of NURHI	Regular family planning education programs (Radio, TV, NP)	Approximately 71% of our sample was exposed to FP messages in the media within the three months preceding the survey. The main sources of media exposure were mobile phones (48%), radio (37%), and television (29%). Controlling for relevant factors, recent media exposure to FP messages predicted both sexual experience and use of modern contraceptive methods, although there were city-level differences.'	High
Banerjee et al., 2015	Cross-sectional	Jharkhand [India]	Southern Asia	2012	Women, 15-49	N=1381	Cross-sectional survey	Programs: Youth-focused interventions	Lack of knowledge about sexual and reproductive health in this context indicates that young rural Indian women would benefit from a youth-friendly SRH intervention to improve the women's self-efficacy and decision-making capacity regarding their own health. A communication intervention using outreach workers may be a successful method for delivering this intervention.	High
Bankole, 1996	Cross-sectional	[Nigeria]	Western Africa	1990 & 1993	Nigerian women	N=6696; N=1221	DHS 1990; & follow-up interviews	Regular family planning education programs (Radio, TV, NP)	37% of women who heard or seen media messages intended to use contraception in future, compared to only 19% of those who were not exposed to media messages.	Medium

Barker et al., 2013	Cross-sectional & Qualitative	[Rwanda]	Eastern Africa	2007 – 2009	Women, 15-49 at two hospitals and four health centres	N=299	Cross-sectional survey	Radio: Entertainment-education soap opera	The results showed that the radio soap opera led to a reduced mean desired family size among listeners (3.61 to 2.94, p<.001), and listeners were more likely to talk to their spouse about FP, and were more likely to know where to obtain male & female condoms. The qualitative focus groups found that listeners "noted that they had learned from the programme, and had found it entertaining and meaningful on a personal level"	Medium
Beaudoin et al., 2016	Quasi-Experi.	[Pakistan]	Southern Asia	April 2009 – June 2010	Women, 15–49	N=1012	N/A	Marketing: Touch Condom Media Campaign (TV ad for condom brand)	"Effectiveness of the Touch condom media campaign is documented in the beneficial changes in condom-related out-comes across the three waves along with the specification of the effects of confirmed Touch ad recall on these outcomes"	Medium
Boulay et al., 2002	Cross-sectional	Dang District [Nepal]	Southern Asia	Nov-97	Women, 15–49	N=667	Semi-structured interviews	Indirect Exposure: to Radio Communication Project	"While direct exposure to the radio program appeared to influence family planning knowledge, indirect exposure was more strongly associated with contraceptive use. These findings suggest that program evaluations that ignore indirect exposure underestimate the impact of a mass media program on behavior."	Medium

Braun et al., 2016	Quasi-Experi.	Dar se Salaam region [Tanzania]	Eastern Africa	13-Jan	Community health workers & clients	N=25 (CHW); N=175	Semi-structured interviews & surveys	Mobile Phones: Mobile technology to support community health workers	Mobile phones can be effective tools to support CHWs with FP counseling, screening and referrals, data collection and reporting, and communication	Medium
Char et al., 2011	Cross-sectional	Rural regions [India]	Southern Asia	Mar-05 – Sept-05	Unmarried men, 17-22	316 (survey); 38 (interview)	Semi-structured interviews	Marketing: DKT India, contraceptive social marketing campaign	Young unmarried men in rural India are underserved with regard to SRH information and services, because they are not recognized as key targets under the public health system, and they receive their limited knowledge and information mainly from the mass media	Medium
Daniel et al., 2008	Quasi-Experi.	Bihar [India]	Southern Asia	2002-2003; 2004	Women, <25 with no more than 1 child	N=199; N=2080	Semi-structured interviews	Programs: PRACHAR Project (various communication interventions)	"Culturally appropriate, community-based communication programs that target youth and those who influence their decisions can create demand for contraception among young couples and lead to increased contraceptive use."	Medium
de Oliveira et al., 2014	Cross-sectional	[India]	Southern Asia	2005 – 2006	Men & women, 15-54	N=198754; random sampling	National Family Health Survey – in depth interviews	Regular family planning education programs (Radio, TV, NP)	The persistent dominance of sterilization in the Indian family planning programme is largely determined by socioeconomic conditions. Reproductive health programmes should address the socioeconomic barriers and consider multiple cost-effective strategies such as mass media to promote awareness of modern temporary methods.	High

Dixit et al., 2013	Cross-sectional	Slums in Jaipur [India]	Southern Asia	Jun-12 – Oct-12	Married men, 18-49	N=400	Semi-structured interviews	Regular family planning education programs (Radio, TV, NP)	There is a gap in knowledge between attitudes towards family planning between men & women; men should equally participate of efficient results in family planning programs	Medium
Dutta & Basnyat, 2008	Qualitative	[Nepal]	Southern Asia	1995 – 2008	N/A	N/A	Narrative analysis	Radio: Entertainment-education soap opera	"Practitioners adopting the participatory framework for health education projects ought to examine the ways in which the cultural context and the voices of cultural participants are reflected... Projects that have a predetermined agenda and seek to use participatory platforms to diffuse this agenda... are fundamentally top-down projects in which participation is used as another communication tool for achieving predetermined change"	High
Gupta et al., 2003	Quasi-Experi.	[Uganda]	Eastern Africa	1995 – 1999	Women and men living in DISH districts, Women: 15-49, Men: 15-54	N=2316 women; N=663 men	Nationally representative survey	Programs: DISH behavior change communication programs (logo, radio & TV entertainment education, posters)	"Results indicate that exposure to BCC messages was associated with increased contraceptive use and intention to use. Some evidence of self-reported bias is found, and the pathways to fertility-related behavioral change appear different women and men."	Medium

Habibov & Zainddinov, 2015	Cross-sectional	[Kyrgyzstan] & [Tajikistan]	Central Asia	2012-2014	Women, 15–49	N=3041; N=3437	DHS cross-sectional	Regular family planning education programs (Radio, TV, NP)	"Viewing family planning messages on TV improves the chances of using modern contraception for a woman who actually saw the messages by about 11 and 8 per cent in Kyrgyzstan and Tajikistan, respectively...By contrast, the effect of hearing family planning messages on radio is not significant in both countries."	High
Hutchinson & Meekers, 2012	Quasi-Experi.	[Egypt]	North Africa	2004-2005	Men & women in villages	N=2088	2 waves of Menya Village Health Surveys	Marketing: multimedia health communication campaign 'Your Health, Your Wealth'	All of the estimators find positive effects of the 'Your Health, Your Wealth' campaign on reproductive health outcomes, though the magnitudes of those effects diverge, often considerably	High
Islam & Kabir, 1998	Cross-sectional	[Bangladesh]	Southern Asia	1993	Currently married women, under 50	N=3100	In-depth interviews	Regular family planning education programs (Radio, TV, NP)	Age, number of living children, religion, radio ownership, approval of FP are important determinants affecting use of modern contraception. Policy implications in sense that mass media will play an important role in future MCH-FP	Medium
Islam et al., 2009	Cross-sectional	Modhupur & Haluaghat [Bangladesh]	Southern Asia	Dec-07 – Feb-08	Indigenous peoples (Garos), XX	N=223; purposive sampling	Semi-structured interviews	Regular family planning education programs (Radio, TV, NP)	Television was most significant form of mass media, more than radio and newspapers. About 80-6% heard of FP messages through TV, Radio was 55-3%, and Newspapers was 22-7%. Contraceptive prevalence rate is higher (79-5%) in study area than national level (55-8%).	High

Jato et al., 1999	Quasi-Experi.	[Tanzania]	Eastern Africa	1991-1994	General population	N=4225	DHS & Tanzania Knowledge, Attitude & Practice Survey	Regular family planning education programs (Radio, TV, NP)	More types of media women exposed to, more likely they are to practice contraception. Women who listened to 6 media sources of FP messages were 11 times likely to use modern contraception.	Medium
Jin & Jeong, 2010	Cross-sectional	[Korea]	Eastern Asia	2005 – 2007	Men & women, 17-31; college students	N=176	Content analysis & survey	Television: Entertainment-education soap opera	"Results indicated that the perceived prevalence of having fewer children in married life was significantly affected by exposure to dramas which positively feature single life and having fewer children in married life on television."	Medium
Kabir & Islam, 2000	Cross-sectional	[Bangladesh]	Southern Asia	1996-1997	Married women; <50	N=871; random sample	DHS 1996-1997	Regular family planning education programs (Radio, TV, NP)	Mass media family planning messages on the radio are more effective than those on TV, yet the likelihood of using contraception is higher if the women had access to any type of mass media on family planning messages	Medium
Kagurusi, 2013	Qualitative	East Africa	Eastern Africa	2008-2012	Journalists	N=60	Semi-structured interviews & focus groups	Programs: 3 short courses on behaviour change communication for journalists	The barriers to behaviour change communication (BCC) regarding family planning were observed to be insufficient BCC skills, journalists' conflict of interest, interests of media houses, inaccessible sources of family planning information, editorial ideologies and absence of commercially beneficial demand.	High

Kane et al., 1998	Quasi-Experi.	[Mali]	Western Africa	Nov-92 – Aug-93	General population; Men: 15-59, Women: 15-49	N=824; N=868	Surveys	Programs: multimedia FP education (via traditional theatre, music, radio, TV, etc.)	High level of exposure to and agreement with messages. Dramatic drop found in proportion of men and women who believe that Islam opposes family planning. Logistic regression indicate contraceptive knowledge and use and more favourable attitudes toward family planning are positively associated with intensity of exposure.	Medium
Khan et al., 2008	Qualitative	[India]	Southern Asia	2007 – 2008	Youth boys and girls, 13-24	N= 234 boys, 189 girls	Semi-structured interviews	Regular family planning education programs (Radio, TV, NP) -- Effects on community gatekeepers	Parents as well as other gatekeepers are worried about rapid changes in aspiration, expectation, and behaviour of young men. Most of them concerned about increasing drinking habit, use of drugs, and changing values of sexuality leading to various risk behaviours among young men	Medium
Kim et al., 2007	Quasi-Experi.	West Java [Indonesia]	South-Eastern Asia	2003	Married women, 18-49	N=1200; random selection	Population-based household survey	Programs: Smart Patient, Smart Community (waiting room intervention) & Sahabat (health worker training)	Ave. respondents were 32. 40+% in each study were 25-34, majority had 2 children. Large proportion of women in intervention had attended secondary education than in control areas.	High

Koringa et al., 2015	Cross-sectional	Urban slums in Jamnagar, Gujarat [India]	Southern Asia	2013	Women, 15-49	N=450; cluster sampling	Structured interviews	Regular family planning education programs (Radio, TV, NP)	There is a need for constant interaction of health functionaries with the eligible couple for boosting family planning program; strengthening behavior change communication (BCC) activities within health department and non-health department; improving knowledge, attitude, and practice in the community toward family planning practices	Medium
Kulkarni, 2003	Cross-sectional	Goa [India]	Southern Asia	1997	Married women, 15-45;	N=250; stratified random sampling	Pre-designed & tested questionnaire	Regular family planning education programs (Radio, TV, NP)	Current use of FP practice by women was 48.4$, use of FP methods found to be positively correlated with women's exposure to information on FP methods in television, radio, and newspapers. Hindus comprised 66.4%, 26.4 were Christians, 13.2% were Illiterates, 11.6% had primary level education, 22% had secondary education, and 53.2% had secondary and more. 79.2% of women had access to television, 46.8% to radio, and 46.3% to newspapers.	Medium
L'Engle et al., 2013	Quasi-Experi.	[Tanzania]	Eastern Africa	2005	Married men with at least 1 child	N=600; representative sample	Cross-sectional survey	Mobile Phones: Automated family planning information	Outreach through mobile phones & text messaging is an effective method of delivering family planning information to younger people, women and men of reproductive age	Medium

Meekers et al., 2007	Cross-sectional	[Malawi]	Eastern Africa	2004	Women, 15–49; Men, 15-54	N=11698; N=3261	DHS cross-sectional	Radio: Programs on family planning & health	"The radio programs were found to have a significant impact on family planning discussion with one's partner. The programs' effect on condom use was limited, however... This limited impact suggests that such radio communication campaigns need to be informed by research identifying the specific constraints to current condom use in Malawi."	Medium
Melka et al., 2015	Cross-sectional	[Ethiopia]	Eastern Africa	Apr-14	Married women, reproductive age	N=1003; multistage sampling	Cross-sectional survey	Regular family planning education programs (Radio, TV, NP)	Efforts need to be aimed at women empowerment, health education, and encouraging open discussion of family planning by couples	High
Nanavati et al., 2006	Cross-sectional	Urban and rural regions [India]	Southern Asia	2005 – 2006	School girls, 15-17	N=200, sample respondents	Cross-sectional questionnaire survey	Regular family planning education programs (Radio, TV, NP)	Television main source of knowledge about contraceptives in both rural and urban areas for school girls, 60% of rural girls had knowledge of availability, only 31% in urban areas. 81% rural girls preferred marriage between 18-20, only 41% of urban girls did. 59% of urban preferred marriage after 21. Many girls didn't approve of premarital sexual relations.	Medium
Nawaz et al., 2012	Cross-sectional	Punjab [India]	Southern Asia	2005	Urban and rural men	N=600; random sampling	Semi-structured interviews	Regular family planning education programs (Radio, TV, NP)	For general acceptance of contraceptive use, men along with women should be include in the target group as most of the decisions regarding family planning and contraception necessitate prior approval of male partners	Medium

Ochako et al., 2015	Qualitative	[Kenya]	Eastern Africa	Apr-12	Sexually active women, 15-24	N=34	Purposive sampling; in-depth interviews	Programs: Youth focused behaviour change communication campaign	"Findings from this research confirm that awareness and knowledge of contraception do not necessarily translate to use. The main barriers to modern contraceptive uptake among young women are myths and misconceptions. The findings stress the influence of social network approval on the use of family planning, beyond the individual's beliefs. In such settings, family planning programming should engage with the wider community through mass and peer campaign strategies."	Medium
Okeowo & Olujide, 2014	Cross-sectional	Rural regions in Ogun State [Nigeria]	Western Africa	2008	Women, 18-50	N=120	Cross-sectional survey	Regular family planning education programs (Radio, TV, NP)	Reliable sources (health personnel) were being utilised for information on family planning, which gave them adequate knowledge of the subject and consequently led to high utilisation of family planning methods among them, however many misconceptions about contraceptives persist	High

Okigbo et al., 2015	Cross-sectional	[Kenya], [Nigeria], [Senegal]	Eastern & Western Africa	2012-2013	Men, 15-59	N=696; N=2311; N=1613	Cluster representative sampling	Programs: Urban Reproductive Health Initiative (URHI)	"In Kenya, those who participated in URHI-led community events had four times higher odds of reporting use of modern methods (aOR: 3.70; $p < 0.05$) while in Senegal, exposure to URHI-television programs (aOR: 1.40; $p < 0.05$) and having heard a religious leader speak favorably about FP (aOR: 1.72; $p < 0.05$) were associated with modern contraceptive method use. No such associations were observed in Nigeria."	High
Paek et al., 2008	Cross-sectional	[Uganda]	Eastern Africa	2001	Mean age: 31.65, People who live 5-km from a health center	N= 350	Delivery of Improved Services for Health (DISH) Survey	Regular family planning education programs (Radio, TV, NP) -- Effect on FP gender norms	All four variables were significant predictors of family planning behaviour. Interpersonal communication was positively related to family planning behaviour, exposure to health-related radio planning was not significant predictor of dependent variable.	Medium
Paz Soldan, 2004	Qualitative	Mangochi District [Malawi]	Eastern Africa	Mar-02 – Jun-02	Men and women in rural district	N=47	Semi-structured interviews & focus groups	Indirect Exposure: Interpersonal communication on mass media and behaviour change	Women's knowledge was based on conversations with other women, men "knew" about practices from observations of others' family size and child spacing. Main trigger for men and women for FP discussions was gossip. Women generally heard about FP at hospital, men first heard from radio or health-drama group.	High

Rogers et al., 1999	Quasi-Experi.	[Tanzania]	Eastern Africa	1993-1997	General population	N=2750 households	5 annual surveys	Radio: Entertainment-education soap opera	The entertainment-education radio soap opera (Radio Tanzania) had a significant effect on listener's family planning adoption, self-efficacy regarding family planning and influenced listeners to discuss family planning with their spouse	Medium
Schwandt et al., 2015	Cross-sectional	[Nigeria] & [Egypt]	Northern & Western Africa	2011; 2004-2007	Men, 15-59; Women 15-49	N=5551 (N-m); N=16144 (N-w); N=2240 (E-w)	NURHI data & Egyptian longitudinal MVHS data	Regular family planning education programs (Radio, TV, NP) -- Integrated Gateway Model	"The key gateway behavior identified in both datasets was spousal communication about family planning, whereas the key gateway factor was exposure to family planning messages."	High
Sharma et al., 2011	Quasi-Experi.	[Nepal]	Southern Asia	1996, 2001, 2006	Individuals, households, communities & programs	N= 8428; N=8726; N=10793; Nationally representative	Nepal Family Health Survey & DHS	Regular family planning education programs (Radio, TV, NP)	Exposure of women to family planning messages through health facilities, family planning workers, radio, and television increased the odds of using modern contraceptives; impact of family planning information on contraceptive use varied according to ethnicity	Medium
Shrestha et al., 2014	Cross-sectional	Dkulikhel [Nepal]	Southern Asia	2013 – 2014	Couples 15-49	N=515 couples	Survey & follow-up	Regular family planning education programs (Radio, TV, NP)	Education plays a vital role in acceptance of family planning; various media (radio, television) tend to make people aware of methods of family planning	Medium

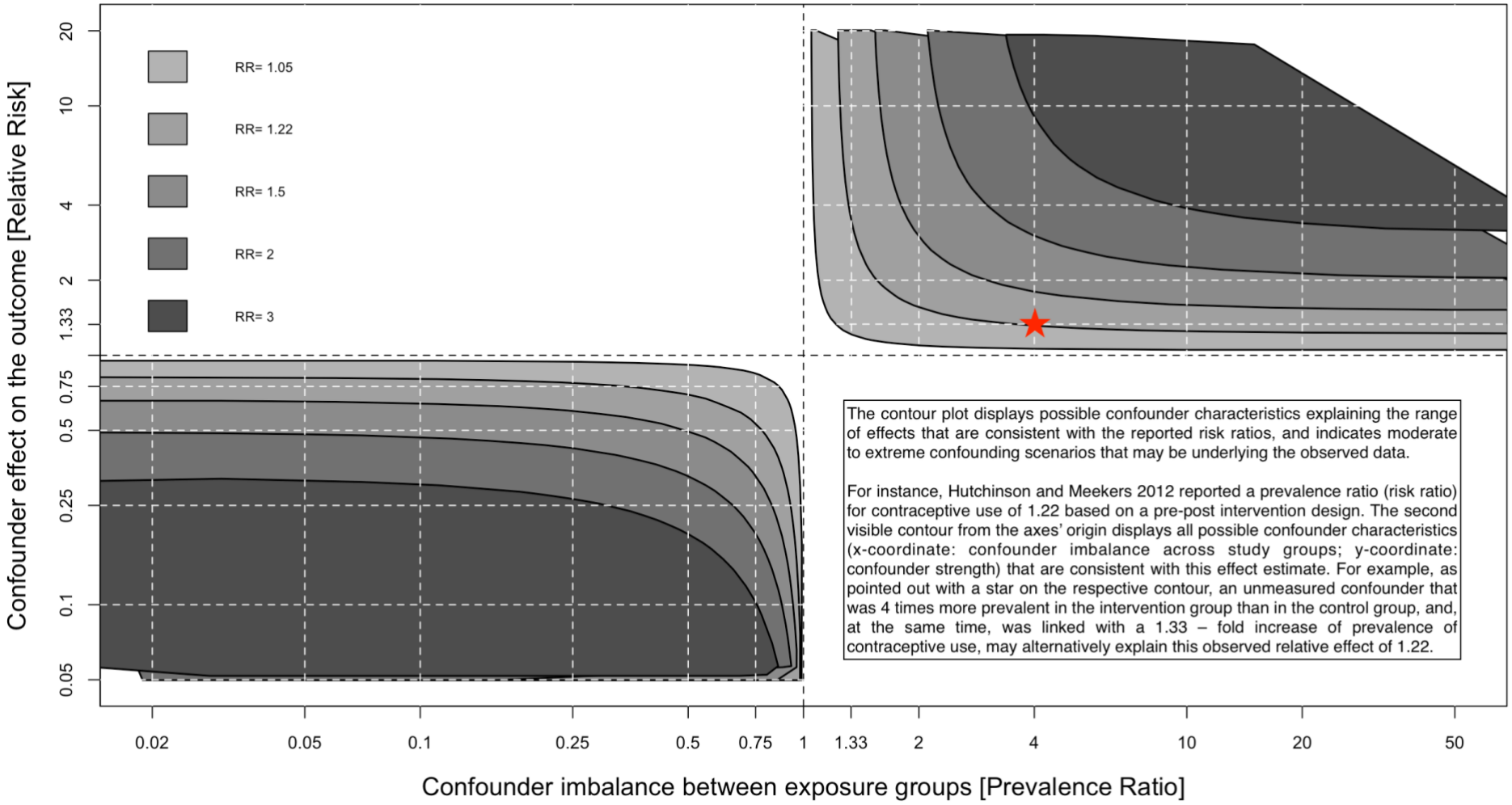
Somba et al., 2014	Cross-sectional	Universities in Dar se Salaam region [Tanzania]	Eastern Africa	Jun-13 – Oct-13	Women, 19-37	N=253	Cross-sectional survey	Regular family planning education programs (Radio, TV, NP)	Most of the students were sexually active and had knowledge of contraception, however, rate of contraception use is still low. There is a need for advocacy for adolescence reproductive health education to promote the use of the available contraceptive services amongst university students.	Medium
Speizer et al., 2014	Quasi-Experi.	[India, Kenya, Nigeria, Senegal]	Multi-country	2010 – 2013	Women, 15+	N=13075; random sample	DHS & in-depth interviews	Programs: Urban Reproductive Health Initiative (URHI)	Targeted, multilevel demand generation activities can make an important contribution to increasing modern contraceptive use in urban areas and could maternal and child health and access to reproductive health	Medium
Tebeje & Rajan, 2015	Cross-sectional	Rural regions in Dugda Woreda [Ethiopia]	Eastern Africa	2012	Couples	N=240; purposive sampling	Semi-structured interviews	Regular family planning education programs (Radio, TV, NP)	Husband's educational status, desire for male child, family size preference, spousal communication, wife participation in decision making, fear of the side effects, mass media exposure, information seeking behavior and couples' perception of FP are significant factors in determining contraceptive use	Medium

Thompson & Harutyunyan, 2006	Cross-sectional	[Armenia]	Western Asia	1997	Married couples	N=1212 couples	Cluster representative sampling	Programs: Entertainment Education (Green Path Campaign for Family Health)	"Exposure to the campaign was associated with significant increases in factors associated with contraceptive behavior change: knowledge, favorable attitudes toward modern methods, favorable attitudes toward family planning services, and information seeking and utilization of family planning services."	High
Underwood & Kamhawi 2014	Quasi-Experi.	[Jordan]	Western Asia	2011	Religious leaders & mosque attendees	N=390 RL; N=857 attendees	Baseline & Endline Surveys	Programs: FP education program for religious leaders	Intervention mosque goers who recalled messages were more likely to report taking relevant actions; trained RLs compared with their counterparts were more effective in message dissemination	Medium
Valente & Poppe, 1996	Cross-sectional	[Peru]	South America	1993 - 1994	Peruvian population; 15-45	N=1500; random sampling	Semi-structured interviews	Indirect Exposure: Interpersonal communication on mass media and behaviour change	Those who initiated contraceptive use recently were more likely to discuss messages with physicians than those who never used contraceptives.	Medium
Van Rossem & Meekers, 2000	Quasi-Experi.	[Cameroon]	Middle Africa	Jul-96 – Nov-97	General population	N=1633; cluster sampling	Structured interviews	Marketing: Adolescent reproductive health program	91% of respondents reported hearing program. 5% were familiar with program. 2/3 respondents reported to having form of personal contact with HJ program, 28% were actively involved, only 60% talked to HJ member, 47% attended at least 1 meeting	Medium

Vaughan, 2000	Quasi-Experi.	[St. Lucia]	South America	Jan-95 – Sep-98	General population	N=1238	Semi-structured interviews	Radio: Entertainment-education soap opera	35% had listened to Apwe Plezi, 12% who listened 1/week. 16% knew a slang word for condoms, non-listeners were more likely to trust FP workers and considered having lower number of children. 14% listeners reported having used FP method because of listening.	Medium
Westoff & Koffman, 2011	Cross-sectional	[Multi-country]	Multi-country	2000 – 2008	Men & women, 15-49 in 48 developing countries	N>0.5 million women	DHS cross-sectional	Regular family planning education programs (Radio, TV, NP)	"Television viewing in particular is strongly associated with reproductive behavior: the more that women watch television, the fewer children they want (including young never-married women as well as married women), the more they use modern contraceptives, and the fewer children they have."	High
Westoff et al., 2011	Cross-sectional	[Multi-country]	Multi-country	2000 – 2008	Men & women, 15-49 in 48 developing countries	N>0.5 million women	DHS cross-sectional	Regular family planning education programs (Radio, TV, NP)	"Television viewing in particular is strongly associated with reproductive behavior: the more that women watch television, the fewer children they want (including young never-married women as well as married women), the more they use modern contraceptives, and the fewer children they have."	High
Westoff, 2012	Cross-sectional	[Multi-country]	Multi-country	2001 – 2012	Women, 15-49 in 52 developing countries	N=787,919	DHS cross-sectional	Regular family planning education programs (Radio, TV, NP)	"General exposure to radio and television shows positive effects in various countries, while media messages promoting family planning seem less important except in West and Middle Africa and in poorer countries elsewhere."	High

Wosu, 2013	Cross-sectional	Lagos Metropolis [Nigeria]	Western Africa	Nov-09 – Feb-10	Men & women in Lagos metropolis	N=1026; multistage sampling	Cross-sectional survey	Regular family planning education programs (Radio, TV, NP)	Positive media sexual health content is likely to promote sexual health among adolescents but negative contents can put adolescents' sexual health in danger	Medium

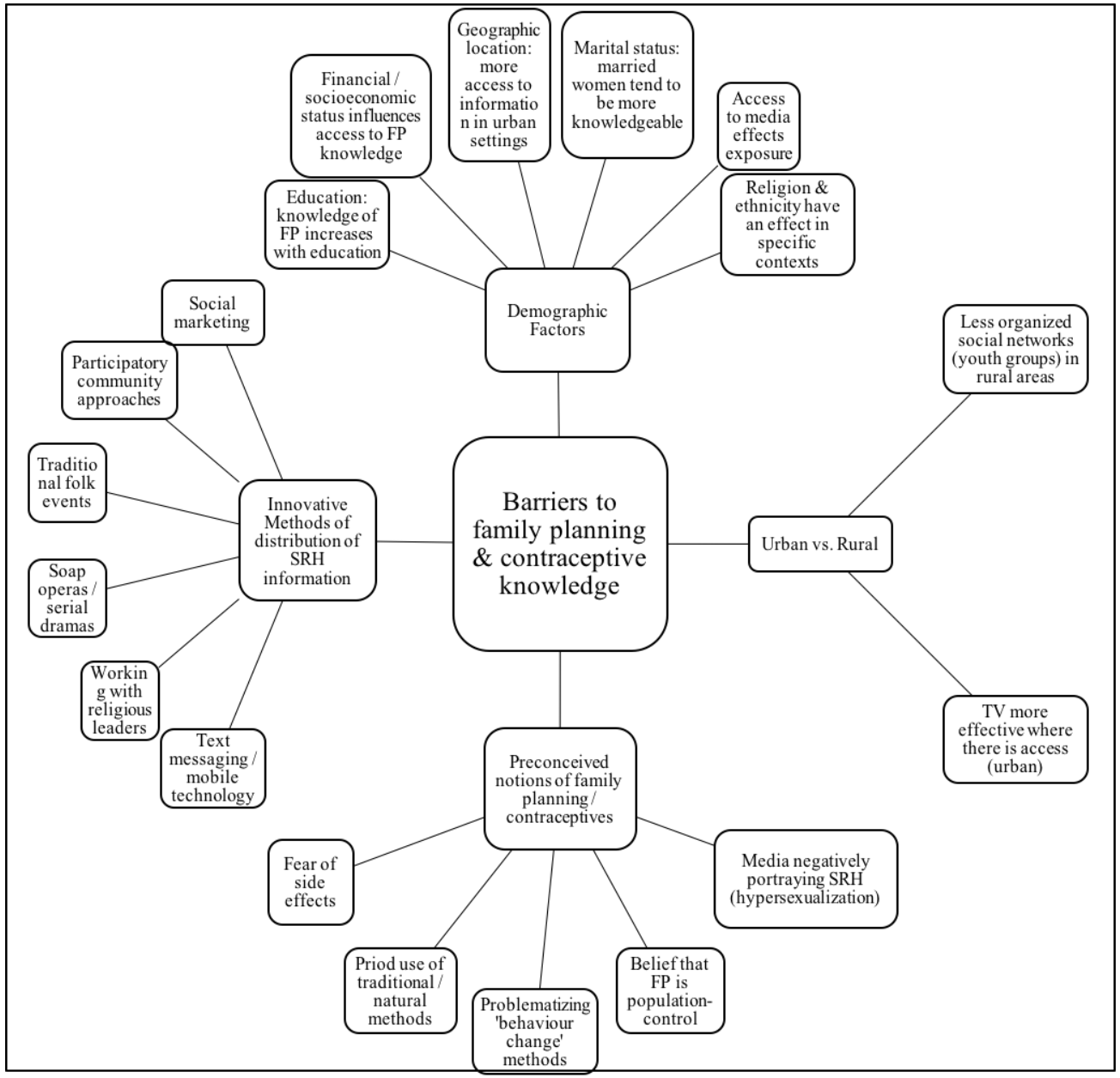
Web Appendices Figure 1. Possible confounder characteristics explaining various estimated exposure-associated risk ratios (RRs)

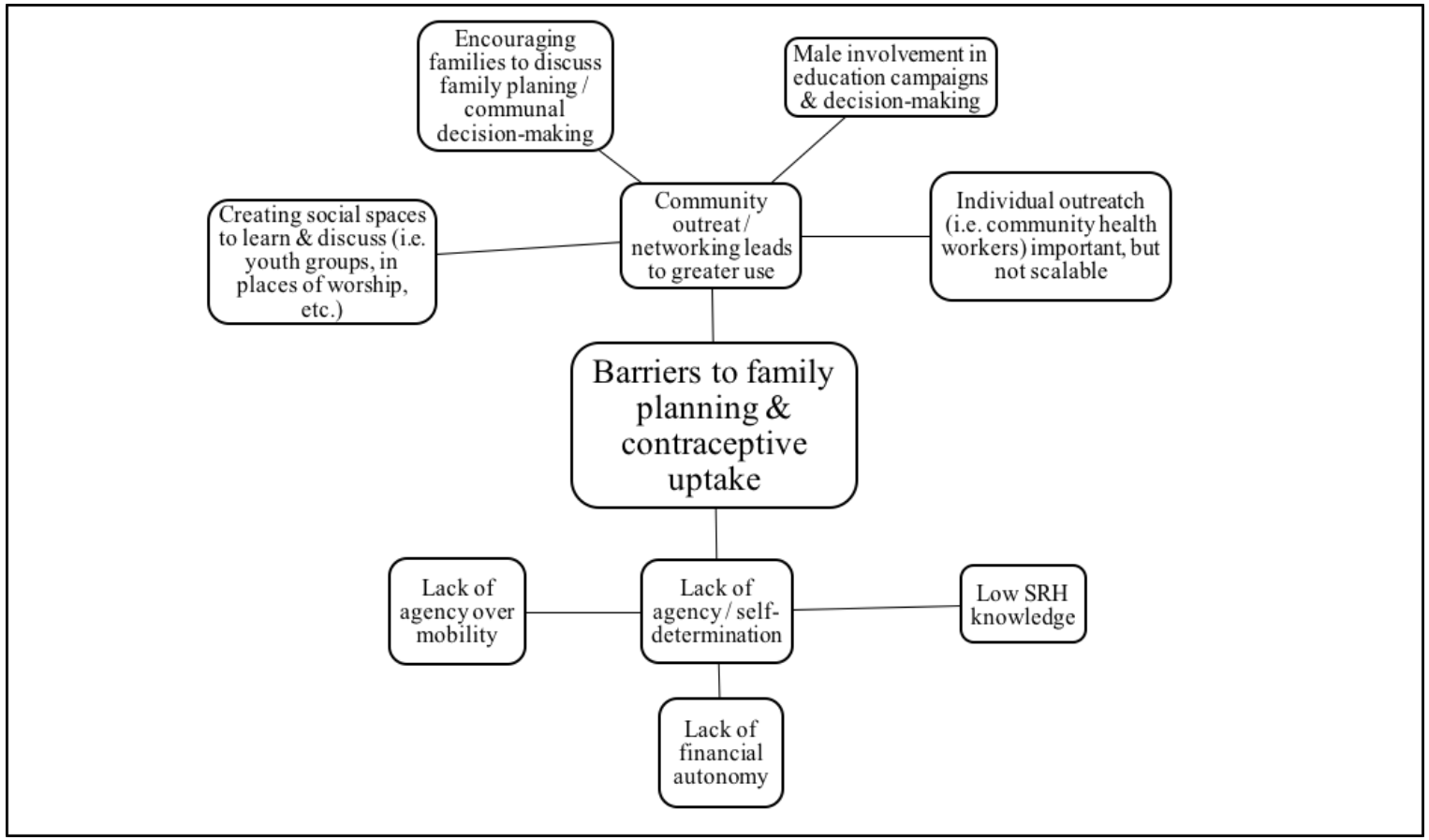


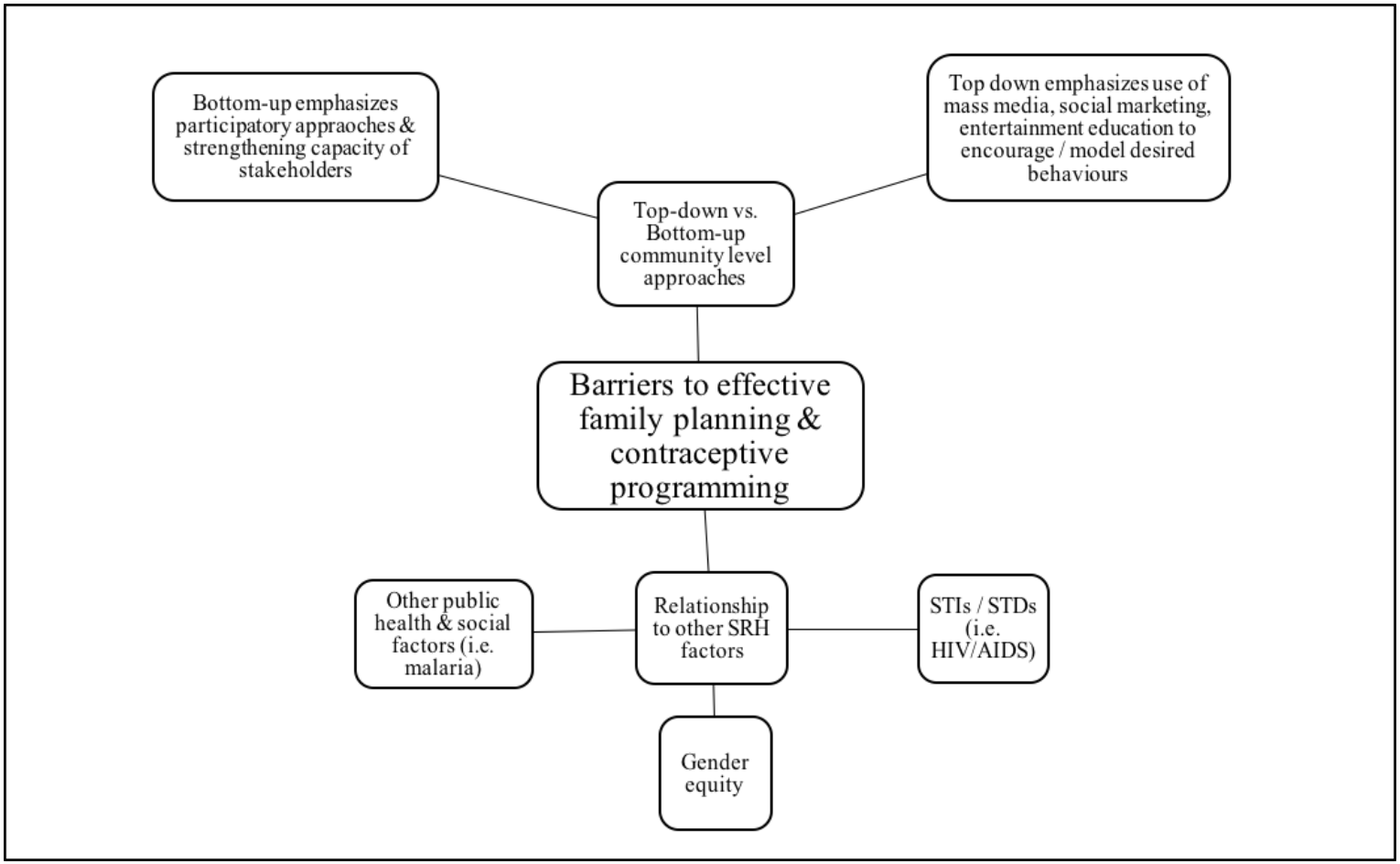
Web Appendices Table 5. Summary of prediction intervals by study design

Design	Outcome	Lower	Upper	Range
Pre-post	Contraceptive knowledge	0.90	1.23	0.33
Longitudinal	Contraceptive knowledge	0.45	2.23	1.78
All	Contraceptive knowledge	0.51	2.36	1.85
Cross-sectional	Contraceptive use	0.10	19.96	19.86
Pre-post	Contraceptive use	0.47	4.13	3.66
Longitudinal	Contraceptive use	0.37	2.74	2.37
All	Contraceptive use	0.55	3.19	2.64

Web Appendices Figure 2. Themes emerging from qualitative coding and thematic analysis




Encouraging families to discuss family planing / communal decision-making
Male involvement in education campaigns & decision-making
Creating social spaces to learn & discuss (i.e. youth groups, in places of worship, etc.)
Community outreat / networking leads to greater use
Individual outreatch (i.e. community health workers) important, but not scalable
Barriers to family planning & contraceptive uptake
Lack of agency over mobility
Lack of agency / self-determination
Low SRH knowledge
Lack of financial autonomy


Bottom-up emphasizes participatory appraoches & strengthening capacity of stakeholders
Top down emphasizes use of mass media, social marketing, entertainment education to encourage / model desired behaviours
Top-down vs. Bottom-up community level approaches
Barriers to effective family planning & contraceptive programming
Other public health & social factors (i.e. malaria)
Relationship to other SRH factors
STIs / STDs (i.e. HIV/AIDS)
Gender equity

APPENDICES B: WEB APPENDICES TABLES & FIGURES FOR CHAPTER 4

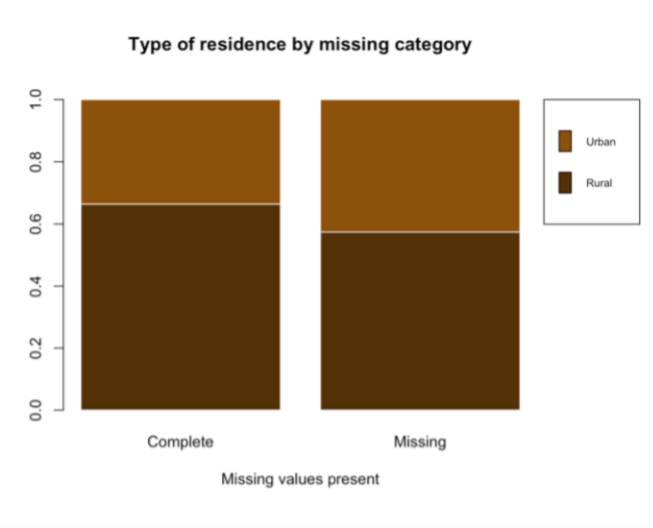
Web Appendices Table 1. Confusion matrix for radio listening random forest

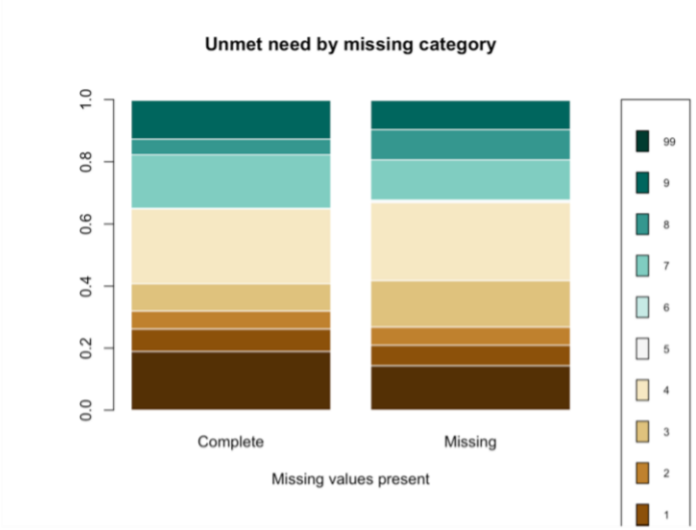
	Predicted: NO	Predicted: YES	Class error
Actual: NO	249, 831	53, 630	0.1767
Actual: YES	78, 396	225, 065	0.2583

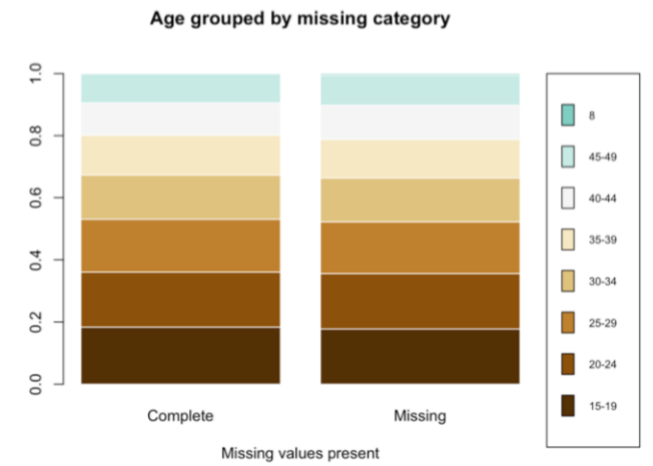
Web Appendices Table 2. Confusion matrix for television viewing random forest

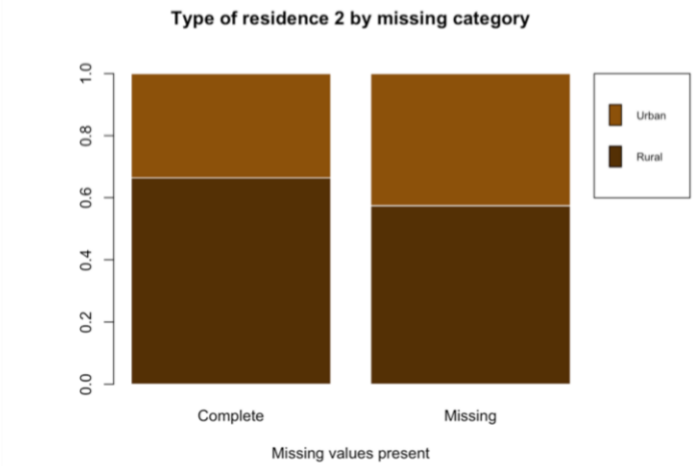
	Predicted: NO	Predicted: YES	Class error
Actual: NO	502, 225	72, 869	0.1267
Actual: YES	85, 307	489, 787	0.1483

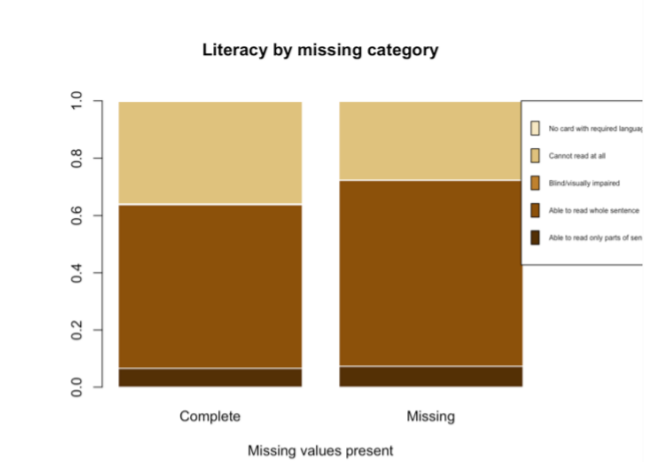
Web Appendices Figure 1. Marginal variable distributions comparison between cases with at least one missing data point and complete cases

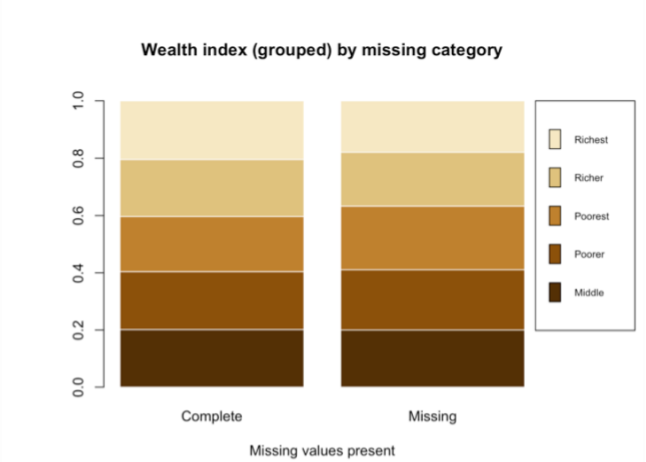


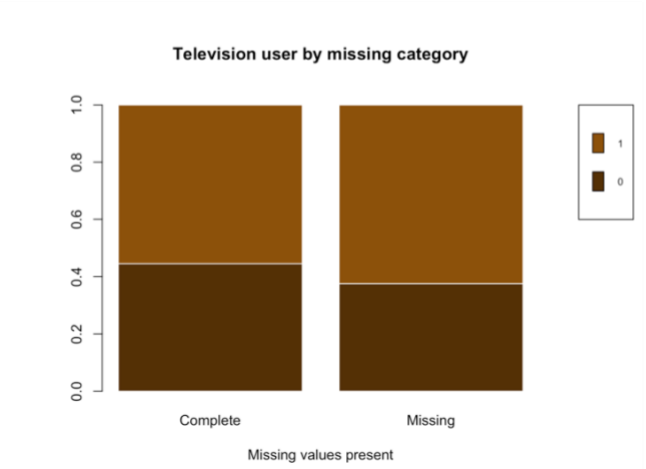




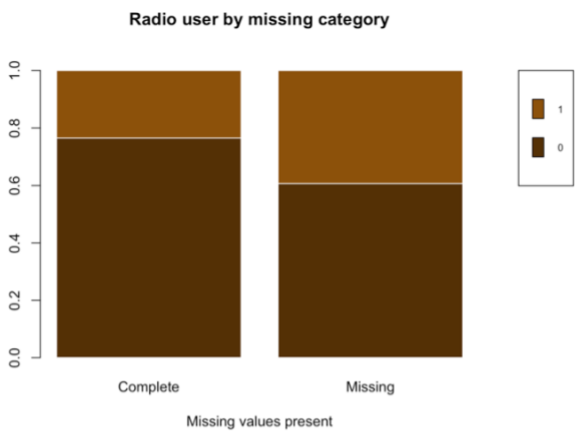


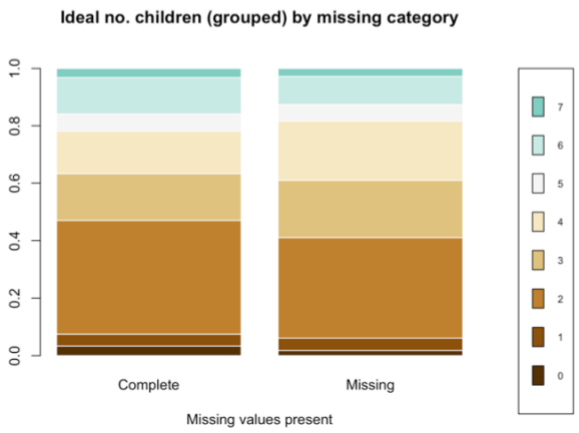

Literacy by missing category
0.0
0.2
0.4
0.6
0.8
1.0
No card with required languag
Cannot read at all
Blind/visually impaired
Able to read whole sentence
Able to read only parts of sen
Complete
Missing
Missing values present


Wealth index (grouped) by missing category
0.0
0.2
0.4
0.6
0.8
1.0
Richest
Richer
Poorest
Poorer
Middle
Complete
Missing
Missing values present

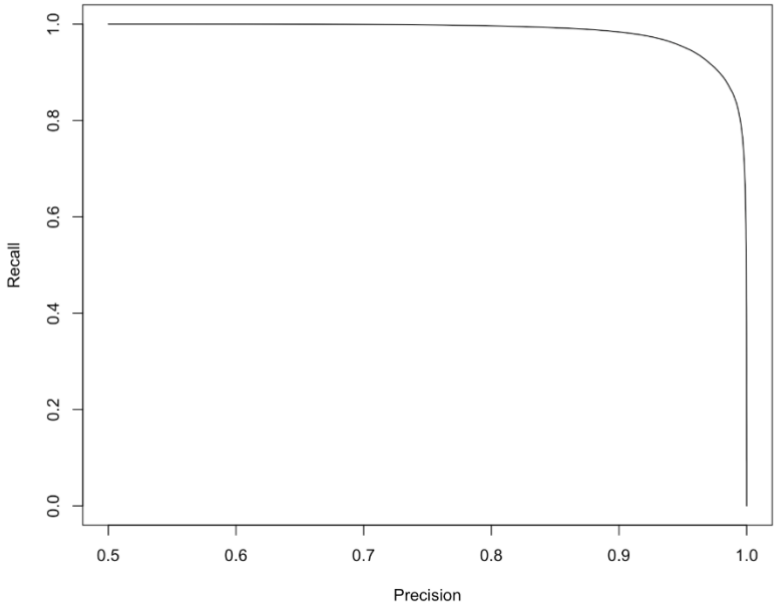

Television user by missing category
0.0
0.2
0.4
0.6
0.8
1.0
1
0
Complete
Missing
Missing values present

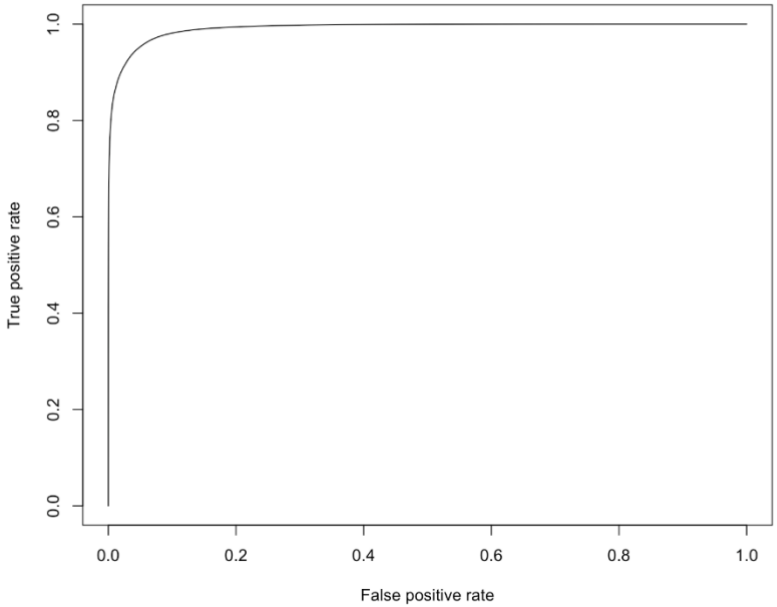

Continent by missing category
0.0
0.2
0.4
0.6
0.8
1.0
Latin America & Caribbean
Eastern Europe
Asia-Pacific
Africa
Complete
Missing
Missing values present


Radio user by missing category
0.0
0.2
0.4
0.6
0.8
1.0
Complete
Missing
Missing values present
1
0


Ideal no. children (grouped) by missing category
0.0
0.2
0.4
0.6
0.8
1.0
Complete
Missing
Missing values present
7
6
5
4
3
2
1
0

Web Appendices Figure 2. Precision curve and ROC curve for random forest model predicting radio use





Web Appendices Figure 3. Precision curve and ROC curve for random forest model predicting television use