TITLE
Measurement of Unmet Need for Contraception: A Counterfactual Approach

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All data that are used for this study are available for free download after registering with the DHS Program at http://dhsprogram.com/data/.

Measurement of Unmet Need for Contraception: A Counterfactual Approach

Abstract

Unmet need plays a fundamental role in reproductive health research, evaluation, and advocacy. While conceptually straightforward, its estimation suffers from a number of methodological limitations, most notably its reliance on biased measures of women's stated fertility preferences. We propose a counterfactual-based approach to estimating unmet need at the population level. Using data from 56 countries, we calculate unmet need in a population as the difference between: 1) the observed contraceptive prevalence rate in the population; and 2) the calculated contraceptive prevalence rate in a sub-sample of women who are identified to be from "ideal" family planning environments. Women from "ideal" environments are selected on characteristics that signal their contraceptive autonomy and decision-making over family planning. We find significant differences between our approach and existing methods to calculating unmet need, and we observe variation across countries when comparing indicators. We argue that our indicator of unmet need is preferable to existing population-level indicators due to its independence from biases that are generated from the use of reported preference measures, the simplicity with which it can be derived, and its relevance for cross-country comparisons as well as context-specific analyses.

Introduction

An estimated 40 percent of pregnancies, or 99 million pregnancies, each year are unintended (Singh, 1998; Darroch, Sedgh and Ball, 2011; Bearak *et al.*, 2018), either because they are unwanted or mistimed at the time of conception (Brown and Eisenberg, 1995). The use of contraception may help women and couples to meet their desired fertility and to avert unintended pregnancies and unwanted births (Bongaarts, Mauldin and Phillips, 1990; Lloyd and Ross, 1992). However, up to 215 million women, or 26 percent of sexually active women of reproductive age, are not using a contraceptive method even when they want to avoid becoming pregnant - these women account for an estimated 82 percent of all unintended pregnancies (Darroch, Sedgh and Ball, 2011; Darroch *et al.*, 2017).

A high-quality family planning program is not only determined by the achievement of good reproductive health outcomes but also prioritizes helping women and couples maximize a complex and evolving set of preferences around future fertility, health, and well-being. For this reason, the demand for (and use of) contraception differs from most other interventions in health; while one can assume that individuals have a demand for health interventions that reduce their risk of morbidity and mortality, the same cannot be said for the demand for contraception since women and couples may seek to become pregnant over their lifetimes (Cleland, Harbison and Shah, 2014). As a result, it has become incumbent on family planning and reproductive health programs to:

1. Demonstrate that a demand for contraception and family planning exists; and
2. Measure the extent to which this demand for contraception is met.

The commitment to effectively quantify and meet demand for family planning has been enshrined in several global agendas, most recently (and notably) as a key target (target 3.7) in the 2030 Sustainable Development Goals (SDGs) (United Nations, 2018). A key measure of progress to achieving target 3.7 of the SDGs is indicator 3.7.1, which is calculated as the proportion of women of reproductive age (15-49 years) who have their need, or demand, for family planning satisfied by using modern methods of contraception. Conversely, unmet need, which aims to estimate the proportion of women who want to delay or stop childbearing but are **not** using contraception, plays an equally fundamental role in family planning research, evaluation, and advocacy and has received significant attention from

scholars from a range of fields, from human rights and reproductive justice to economics and demography (Cleland, Harbison and Shah, 2014).

Unmet Need: Current Definition and Measurement Challenges

Although the underlying concept of unmet need, the non-use of contraception among women stating a desire to avoid pregnancy, appears to be straightforward, its measurement is problematic and complex and has undergone multiple revisions in recent decades (Bradley and Casterline, 2014; Cleland, Harbison and Shah, 2014). In its latest iteration, unmet need is calculated as the proportion of fecund and sexually active women of reproductive age (WRA) who want to either limit or space their next birth for at least two years but are not using any contraceptive method (Bradley *et al.*, 2012). While this revision is a significant simplification from previous versions, its estimation still requires up to 15 items from survey responses are needed to capture a range of indicators related to: 1) a woman's potential exposure to the risk of pregnancy; 2) her sexual activity; 3) her physiological capacity to become pregnant (fecundity); and 4) the reliability of a woman's retrospective reporting of her preferences to space and limit births (Bradley *et al.*, 2012; Bradley and Casterline, 2014; Cleland, Harbison and Shah, 2014).

The current measure of unmet need is calculated as follows:

$$Unmet\ Need = \frac{WRA\ who\ want\ to\ limit/space\ births\ for\ 2+\ years\ AND\ are\ not\ using\ contraception}{Fecund\ and\ sexually\ active\ WRA\ (ages\ 15-49)}$$

In this measure, the denominator aims to capture the population of women who would be at risk of pregnancy and includes women who: 1) are either married or are in a sexual union; 2) report being sexually active; and 3) are fecund, and are therefore at risk of becoming pregnant. Among this population, women are classified into: 1) current contraceptive users, comprised of women who either have a "met need for limiting births" or a "met need for spacing births," or 2) non-users of contraception, comprised of non-pregnant, currently pregnant, or postpartum amenorrheic women who are classified to either have an "unmet need for limiting births," an "unmet need for spacing births," or "no unmet need." The categorization of women into met need, unmet need, or no unmet need, and hence their relative contribution to the numerator, is a function of women's reported preferences to space or limit future births (in the case of women who are not pregnant or postpartum amenorrheic) or of women's retrospective preferences to space or limit their current (if pregnant) or most recent (if postpartum amenorrheic) birth. Figure 1 presents a flow diagram of the classification algorithm (Bradley *et al.*, 2012).

Over the years, a number of methodological concerns related to the estimation of unmet need in survey data have been highlighted by scholars and practitioners alike. Key issues include:

1. The reliability of women's reported or assumed sexual activity, which serves as an indicator of exposure to the risk of pregnancy. For example, currently married women are assumed to be sexually active and exposed to the risk of pregnancy even if they report not using contraception because their partners are away or because they have no or infrequent sex. Including these women in the calculation of unmet need may therefore result in an overestimation of the measure (Bradley *et al.*, 2012; Bradley and Casterline, 2014). On the other hand, excluding unmarried but (potentially) sexually active women who demand contraception from the calculation would underestimate unmet need; Bradley and Casterline (2014) find a 3.4 percentage point (equivalent to a 16 percent) average decline in unmet need when these women are excluded from the unmet need calculation.

2. The inclusion of pregnant and postpartum amenorrheic women, many of whom might soon demand contraception following their transition out of their temporary state of insusceptibility to pregnancy. The length of postpartum amenorrhea, during which time a woman is free from the risk of pregnancy, continues to be a source of debate, and sensitivity analyses show that reducing the length of time during which postpartum amenorrhea is a reliable signal of inability to conceive from 24 months to 6 months has significant impacts on the range of estimates of unmet need, ranging from a 0.7 percentage point to a 6.4 percentage point (20 percent) increase in unmet need (Bradley and Casterline, 2014).
3. The identification and exclusion of infecund women, whose contraceptive use or non-use are independent from their risk of pregnancy. To this end, the measurement of fecundity from behavioral responses, and in the absence of biological indicators, is challenging and relies on questionable assumptions. Specifically, the revised algorithm assumes that women are infecund if they satisfy at least one of three criteria: (1) they first married five or more years ago, have not had a birth in the past five years, and have never used contraception; (2) they report having menstruated in the last 6 months and are not postpartum amenorrheic; or (3) they report that they are not able to become pregnant, are menopausal, or have had a hysterectomy (Bradley *et al.*, 2012). Evidence from other studies have shown that the potential misclassification of women who may, in fact, be able to conceive has a substantial impact on the measurement of unmet need, whereby unmet need would increase by an average of 3.7 percentage-points if infecund women were to be eligible to have an unmet need (Bradley and Casterline, 2014).

Perhaps the most problematic feature of the current measure, however, is its reliance on women's reported fertility preferences, and particularly the measurement of women's wantedness of births through direct retrospective recall. This recall is ascertained by asking women "At the time you became pregnant with [name of the most recent birth], did you want to become pregnant then, did you want to wait until later, or did not want (more) children at all?" This approach clearly suffers from the ex-post rationalization bias that is present in women's reluctance to declare a past pregnancy or birth as unwanted, and particularly when the past birth of interest refers to a child who is alive at the time of the interview (Bongaarts, 1990; Casterline and El-Zeini, 2007; Casterline, 2009). Many studies have demonstrated the significant bias of this approach to eliciting a woman's preferences and have proposed alternative measures for identifying fertility preferences, including:

1. Eliciting a woman's stated ideal number of children that she would want over her lifetime if she could go back to the time when she did not have children.
2. Eliciting fertility preferences prospectively using prospectively-oriented questions (e.g. "Would you like to have (a/another) child, or would you prefer not to have any (more) children?") in either cross-sectional or, preferably, longitudinal surveys where respondents are repeatedly interviewed.

While both alternatives have certain advantages, each approach falls well short of its goal to effectively and unbiasedly measure women's fertility preferences. In particular, the direct elicitation of a woman's ideal number of children, for the same reason as the retrospective recall approach, is limited in that women are likely to ex-post rationalize their past births and are therefore unlikely to report an ideal number of children that is less than their current number of living children. Moreover, empirical evidence on the measurement of this variables has shown that a considerable proportion of survey respondents are either unsure about their ideal number of children or do not provide a numeric response to the question (Casterline and El-Zeini, 2007). While arguments have been made to use prospective measures of stated preferences and intentions, these measures are typically elicited

through a single question: "Do you want another child?" As Müller et al (2022) note, the presentation of this question to respondents, without a temporal referent or presentation of additional alternative counterfactual futures in which childbearing may be more or less desirable, may lead to incorrect inference when directly linking this response to subsequent behavior. This may particularly be the case for women whose observed fertility behavior appears to be "inconsistent" based on the data but who may have, in fact, succeeding in fulfilling their latent fertility preferences, which are outside the frame of the researchers' scope of inquiry (Müller *et al.*, 2022).

On the other hand, the elicitation of preferences for future births using prospective questions and longitudinal data methods can be appealing for its forward-looking approach (thereby eliminating any biases induced by retrospective inquiry) and in its potential to infer women's preferences for births occurring between survey rounds. Unfortunately, conducting longitudinal data collection is costly, requires tracking and follow-ups with respondents, and suffers from a new set of empirical concerns that limits inference, including attrition and non-response between waves, time-in-sample bias, compounded mismeasurement and selection bias, etc. (Hsiao, 1985). For these reasons, most large-scale surveys of fertility and health (e.g. Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS), World Fertility Surveys (WFS), etc.) are cross-sectional. Conceptually, the use of longitudinal measures also assumes that fertility preferences are stable over time and particularly between survey rounds; the stability of fertility preferences over time has been questioned, with studies demonstrating that both women's contraceptive and fertility preferences are likely to be malleable and unstable over relatively short intervals (Trinitapoli and Yeatman, 2018; Karra and Zhang, 2021; Müller *et al.*, 2022).

A review of the literature on the links between prospective fertility preferences and behavior found the following (Cleland, Machiyama and Casterline, 2020):

1. Fertility preferences seem to be correlated to subsequent fertility behavior but mainly among women who state a preference for wanting to have another child, but significantly less so among women who state a preference for limiting childbearing.
2. Evidence of the relationship between baseline fertility preferences for spacing and postponement and subsequent fertility behavior is weak and mixed.
3. There is significant uncertainty in women's reported stated fertility preferences and considerable variation in preference stability and strength across context and over time.

Taken together, the findings from the review further raise questions as to whether static stated preferences, as they are currently measured, may be meaningful for inference. More recently, a study by Müller *et al* (2022) highlights the complexity and uncertainty with which fertility preferences are shaped, changed, and reconciled over time. Using a multi-year panel sample from Kenya, the authors find: 1) substantial variation in fertility preferences over multiple points in time; 2) the significant extent to which women's current expectations of future fertility outcomes are frequently misperceived; 3) a lack of precision with which women are able to recall their own past fertility intentions and preferences; and 4) the asymmetric nature with which women anchor at their current preferences. Taken together, the authors conclude: "While the illusion of stable and effective preferences was held by many of our research subjects, we see no reason why we as researchers should share this illusion." (p. 186).

More generally, unmet need's reliance on women's stated (reported) preferences as a proxy for their true (revealed) fertility preferences may itself be problematic. One of the main criticisms of using stated preferences is that their measurement typically relies on surveys in which respondents face hypothetical choice problems to elicit individual valuations over alternatives. As a result, respondents

may not make the same choices in a hypothetical situation as they would in real life (Ami, Aprahamian and Luchini, 2017). In the case of fertility, this "hypothetical bias" implies that respondents may be willing to state a preference for more or fewer children when asked in a survey than they would if the opportunity to realize this preference were to truly present itself. This bias is generated both from a lack of incentive to tell the truth in a survey and from the difficulty that the respondent faces from projecting herself into a hypothetical situation that may not be directly familiar to her – this is particularly true for eliciting stated preferences when costs or constraints cannot directly be internalized. For example, women who have never been pregnant may be more likely to not internalize the costs of pregnancy and childbearing and may therefore be more likely to misreport (in this case, overstate) their ideal fertility. On the other hand, respondents who identify and internalize the costs of alternatives might narrow their choice set *a priori* even if these costs are misperceived. For example, women who have experienced difficulty conceiving in the past may anchor their fertility potential to this constraint and may therefore underreport their true desired fertility (Rosenzweig and Wolpin, 1993).

The challenges to inferring latent preferences from stated preference data, whether retrospectively or prospectively collected, have been highlighted in studies in behavioral and cognitive science, to the extent that some studies have argued that fertility preferences may not even exist except when respondents are prompted, at which time people instead report on preferences that are constructed from information that is available and salient to them when they are asked (Bachrach and Morgan, 2013; Bhrolcháin and Beaujouan, 2019). These findings are concordant with a growing literature in behavioral economics and cognitive science on the presence of projection bias, where individuals incorrectly extrapolate the extent to which their future preferences and behavior will resemble their current tastes based on how they believe their tastes will change, even over relatively short periods of time (Loewenstein, O'Donoghue and Rabin, 2003). This bias can be observed in a range of consumer behavior, e.g. purchasing more groceries than one eventually would consume when one enters the store hungry, but is understudied in the literature on fertility preferences and behavior. Taken together, while a respondent's stated fertility preferences are likely to be correlated with her true latent preferences, the gap between these preference measures is likely to be significant, to the extent that the utility of the stated preference measure is unclear.

Conceptualizing Unmet Need with Counterfactuals: A Step Back and a Way Forward

In light of the conceptual, empirical, and operational challenges to estimating unmet need, combined with the numerous revisions and debates around its validity and usefulness as a measure over the years, it would be incumbent upon the family planning field to take a step back and remind ourselves of its potential utility and aim as a measure. The primary objective of unmet need is to estimate the proportion of women at an aggregate (population)-level who are not using contraception but who have a preference for limiting or spacing births.

Equivalently, unmet need can be understood through the following counterfactual thought experiment. Let us define the *current contraceptive prevalence rate* CPR_{ct} as the proportion of women in a country c at time t (where time, in this study, is indicated by the survey year) who use contraception under the current state of the world. Now, let us define the *ideal contraceptive prevalence rate* $iCPR_{ct}$ as the proportion of women in country c at time (survey year) t who use contraception in the state of the world where family planning and fertility preferences in this population can be fully realized without constraint. In this hypothetical state of the world, women would face no barriers, costs, or constraints of any kind to identifying and realizing both their preferences for contraception as well as

for limiting and spacing pregnancies over their lifetimes. Features of this state of the world include, but are not limited to: 1) women's ability to completely control their family planning and reproductive health decisions, including full, free, and informed choice over their contraceptive use, non-use, and type of use (i.e. complete choice over methods and method type) (Newman and Feldman-Jacobs, 2015; Senderowicz, 2020); 2) women's capability to realize any changes to preferences that they make over fertility and childbearing; and 3) a lack of social, structural, emotional, or physical barriers that women face to forming, identifying, and executing their contraceptive and fertility decision-making, with complete support from their partners, families, and communities on all reproductive decisions.

Unmet need for contraception for a country c at survey year t can be simply calculated as the difference between the ideal contraceptive prevalence rate and the current contraceptive prevalence rate, i.e.

$$Unmet\ Need_{ct} = iCPR_{ct} - CPR_{ct}$$

In reflecting on this calculation, we recognize that while CPR_{ct} is relatively more straightforward to infer with reported survey data, the identification of the ideal contraceptive prevalence rate $iCPR_{ct}$ is, by construction, a hypothetical measure. To estimate this rate, previous estimators of unmet need have relied on first estimating women's latent family planning and fertility preferences, measured with stated preferences, and then inferring the extent to which contraceptive use concords with these preferences. We propose an inverse approach: first, we infer the ideal environment under which all preferences can be realized, and we then estimate the contraceptive prevalence in this environment. This approach hinges on the premise that the contraceptive prevalence under this ideal environment would reflect women's revealed preferences and, by extension, their demand for contraception. If such a counterfactual environment could be identified, then this approach has a distinct advantage over traditional estimators in that it captures women's level of contraceptive empowerment and capability over decision-making without the need for any direct elicitation or estimation of preferences. Similar approaches have been utilized in the child development literature, where studies have constructed "ideal" reference populations and have conducted comparative analyses that identify gaps in child growth and stunting relative to the reference group (Karra, Subramanian and Fink, 2017).

As an attempt to identify this counterfactual environment, we could imagine that contraceptive prevalence under an "ideal" environment would be the prevalence among the sub-population of women who are situated in "ideal" conditions in which they have full, free, informed choice over their contraceptive use and are capable of acting on their preferences to the greatest possible extent – this approach broadly speaks to the Sen capability approach to welfare gain and on subsequent developments in women's empowerment in reproductive decision-making (Nussbaum and Sen, 1993; Anand, Hunter and Smith, 2005). To identify this "ideal" sub-population, we narrow down the sample of women based on characteristics that are more likely to signal their level of contraceptive and reproductive empowerment. These observable characteristics can be selected based on the set of determinants been theorized to be correlated with women's contraceptive autonomy, access, and reproductive decision-making. Obvious characteristics for selection include women's socioeconomic status (those from the topmost income or wealth echelons), educational attainment (those who are the most educated), knowledge of family planning (those who are the most informed about contraceptive methods), autonomy (particularly those who have autonomy to make decisions and seek their own health care), familial and social support (those who have their partner's and community's approval to use / not use contraception), and access (those who are able to receive the full range of contraceptive methods without constraint). These are but a few of the characteristics that would

approximate an "ideal" enabling environment for women; however, a key advantage in this approach is that women who live in these selective environments can be identified using routine survey data (e.g. DHS, MICS).

Testing a New Unmet Need Measure: Empirical Evidence

We estimate this new approach to estimating unmet need using data on 2,073,523 women from 80 DHS surveys that cover 56 countries from 2010 to 2019. We then identify the subsample of women who meet the following five criteria:

1. They belong to the highest wealth quintile, a proxy for their socioeconomic status. Women who belong to this group are less likely to face access or cost constraints and are more likely, in general, to be empowered to follow through on their contraceptive preferences.
2. They are either currently married or have been sexually active for the past month. These two variables serve as part of the selection criteria that is used to define the population of women who are at risk of pregnancy.
3. They have attained at least a tertiary level of schooling, which selects on those women who are less likely to have information or access barriers.
4. They know at least one contraceptive method, which also serves as a proxy for being informed about family planning and reproductive health services.
5. They do not report distance to a facility as being a significant problem in their access to health care. This measure of perceived access is likely to be correlated with true access and may be more likely to impact a woman's care-seeking behavior.

When filtering the full sample of women by these five criteria, we are left with a sample of 55,318 women from 52 countries across 73 DHS surveys, which constitute 2.71 percent of the full sample of women. Table 1 presents the distribution of women who are selected from ideal environments within each DHS survey.

Table 2 presents descriptive statistics of the full sample and the selected sample of women from ideal environments. We find significant differences between women from the full sample and women who were selected to be from ideal environments. In particular, women from ideal environments are:

1. More likely to reside in urban settings (80.7 percent) compared to women in the full sample (37.6 percent).
2. More likely to be older, on average (33.1 years) compared to women in the full sample (29.6 years).
3. Have fewer children, on average (1.7 children) than women in the full sample (2.3 children).
4. Are married to husbands who are significantly more likely to have a tertiary level of education (74.7 percent) compared to women in the full sample (11.4 percent).
5. Are more likely to earn as much or more than their husbands / partners (37.1 percent) compared to women in the full sample (26.6 percent).

Figures 2 and 3 present estimates for $iCPR$ by country and estimates for changes in $iCPR$ over time by country, respectively. Estimates for $iCPR$ vary significantly by country, ranging from a low of 20 percent in Chad to more than 81 percent in Honduras. Among countries that have multiple DHS survey rounds represented (though we note that no country had more than two surveys), we calculate the changes to $iCPR$ over time by country. $iCPR$ varies over time within country; for some countries, we find declines in $iCPR$ over time by as much as 14 p.p. in Gabon, while $iCPR$ was found to increase by as much as 21 percent in other countries such as Tanzania.

Table 3 presents descriptive statistics comparing the newly calculated measure of unmet need and the currently used measures of unmet need. Unmet need using the new counterfactual-based measure is, on average, 5 to 6 percentage points (30 percent) higher than the standard measures of unmet need that are currently used by the DHS. Moreover, we find that the variation in unmet need, as indicated by the standard deviation, is also higher with our new counterfactual measure as compared to traditional measures of unmet need. This implies that the distribution of unmet need measures using the counterfactual approach is wider, yielding more extreme estimates of unmet need on both the lower and higher end; Figure 4 corroborates this implication by plotting the distributions of predicted unmet need under the various methodologies.

When disaggregating the comparative analysis of unmet need at the DHS survey (country-year) level (Table 4), we observe a lot of variation across the surveys; in some cases, we see that our approach estimates a significantly higher (up to 30 percentage points higher) unmet need than what is currently estimated with the DHS methodology, while in other cases, our approach yields significantly lower estimates (up to 20 percentage points lower) of unmet need compared to the DHS. Figure 5 plots the differences between the counterfactual unmet need measure and the currently used DHS measures. In the survey-based calculations of unmet need, we also note that several calculations of the measure were conducted using small samples of women from identified ideal environments (fewer than 100 women) – the lack of sample in some surveys poses an empirical concern over the extent to which we have enough statistical precision to estimate ideal contraceptive prevalence.

To estimate the relative contribution of each selecting factor to ideal contraceptive use, we calculate the proportion of the variation in ideal contraceptive use that could be attributed to each of the five key selecting factors that were used for defining the ideal family planning environment. We estimate a logistic model of contraceptive use on these factors together and take the product of the estimated factor coefficients, each of which captured the association between that particular factor and contraceptive use, and the proportion of the pooled DHS sample who did not exhibit that factor. Table 5 presents the results from this analysis. We find that selecting on socioeconomic status (proxied by wealth) and current sexual activity explain the most variation in ideal contraceptive use in women who live in ideal environments relative to the general sample of women. For example, up to 40 percent of the variation in ideal contraceptive use can be attributed to selection into higher socioeconomic status. Interestingly, we find that the correlation between high education and ideal contraceptive use to be small and negative, highlighting: 1) a potentially inverse association between educational attainment and contraceptive use at high levels of educational attainment, which has been observed in high-income settings (Kravdal, 2001); and 2) the relatively small variation in ideal contraceptive use that can be attributed to high educational attainment compared to other factors.

Calculating Unmet Need by Matching: An Extension

An assumption of the counterfactual approach to calculating unmet need is that the sample of women from an ideal family planning environment should be representative of the full population of women on characteristics that are "nonmodifiable," such as age, religion, or ethnicity, which define the population. Specifically, one would expect that the distribution of age, religion, ethnicity, and other such invariant characteristics should be the same (not statistically different) between women from ideal environments and the general population of women. Given limited sample sizes, however, it may be the case that a comparison in the empirical distributions between women from ideal environments and the general population of women may yield differences. To account for these potential sampling differences, we extend our analysis as follows:

1. Within each DHS survey, we pair each woman from ideal family planning environments with a woman from non-ideal environments on age and ethnicity using nearest-neighbor exact matching with the propensity score as the distance metric (Rosenbaum and Rubin, 1983; Becker and Ichino, 2002; Leuven and Sianesi, 2003). Matching on these two characteristics would guarantee that the empirical distributions of these two characteristics are identical between groups.
2. Following matching, we can proceed to calculate unmet need as before by calculating the difference in contraceptive prevalence rates between women from ideal family planning environments and the matched subgroup of women who are not from ideal environments.

Table 6 presents estimates of unmet need using the matching approach, and Figure 6 compares the distributions of predicted unmet need between the matched counterfactual methodology against the current DHS methodologies. Similar to the previous results, we find that the distribution of estimates of unmet need under the matched approach is wider than the distributions under the traditional measures of unmet need, implying that the matched approach yields more extreme estimates of unmet need. However, we observe that the variation in the estimates of unmet need under the matched approach is less dispersed than under the first counterfactual approach that was presented in Table 3 and Figure 2, implying that matching would likely have improved the efficiency in the estimator's approach to calculating unmet need.

Conclusions

Unmet need has been a key indicator in family planning and reproductive health for more than four decades. It is an indicator that holds significant policy and programmatic weight and serves an important role in advocacy, resource allocation, and agenda setting in family planning. At the same time, it is recognized to be a biased measure that is difficult to conceptualize both theoretically and empirically. As a result, a number of definitions of unmet need have been used over time and have resulted in estimates that are not comparable with each other and have limited scope for unbiased inference.

In this study, we use a counterfactual approach to derive a simplified definition of unmet need that can be consistently applied over time and across countries. In conducting a number of empirical analyses of our new indicator, we find significant mean differences between our approach and existing DHS approaches to calculating unmet need, whereby our country-level unmet need estimates are on average 5 to 6 percentage points higher than the estimates that are calculated with the current DHS algorithm. In addition, we observe significant variation across countries when comparing the estimates that are generated by the different approaches, which should be noted when interpreting what our higher estimates could mean for the design of policies and programs aimed to address unmet need.

Our indicator is preferable to existing measures due to:

1. its conceptual appeal and grounding in revealed preference theory through observed behavior;
2. its independence from biases that are generated through the use of reported preferences and other problematic assumptions that typically form the foundation of such indicators, instead exclusively relying on observable characteristics or behavior;
3. its simplicity in its derivation, which is based on only 6 routinely collected survey items that do not require additional preference-specific modules; and
4. its flexibility to be both generalizable for cross-country comparisons as well as tailored for context-specific analyses.

From a perspective of implementation, our method presents a more attractive approach to calculating unmet need for these and a number of other related reasons. The simplicity of the method and ease with which unmet need can be calculated relative to the current algorithm are particular advantages. That our method arguably presents a more intuitive understanding of unmet need as a gap between current contraceptive practice and a conceptually ideal reference point also facilitates its adoption by policymakers and practitioners alike. The fact that our approach compares the current state of contraceptive use to a reference point that is calculated based on proposed determinants of empowerment highlights the central role that reproductive and contraceptive autonomy should play in the determination of unmet need. Specifically, the process for selecting factors to identify women from "ideal" environments reorients researchers, policymakers, and practitioners to recognize that the standard of comparison that should be achieved is a state of the world where women are fully empowered to make their own contraceptive and reproductive choices.

Previous studies of unmet need have raised a key question: "What is desirable contraceptive coverage in the 'perfect contracepting' society, and what principles should guide the answer to this large question?" (Bradley and Casterline, 2014). Our study answers this question by estimating what contraceptive coverage would be in an environment where women have the capability to "perfectly contracept" if they choose. We define an approach for identifying this environment, and the proportion of women who belong to this environment, using observable factors related to reproductive empowerment and well-being as a proxy for this ideal environment. We then propose that contraceptive coverage in such an environment would reflect the ideal level of contraceptive use.

We note that taking this approach highlights an important conceptual distinction between our measure of unmet need and the current standard. By defining unmet need as the gap between women's observed contraceptive (non-)use and their desire to space or limit births, the current standard establishes an inextricable equivalence relation between women's preferences for spacing or limiting pregnancies and their contraceptive preference. Specifically, it considers a functional mapping correspondence where all possible fertility preferences can be identified as a countable set that contains each unique preference as an element, and where every unique fertility preference can be mapped to at most one contraceptive preference, which can be defined generally in terms of preferences over (non-)use and over methods. In the standard framework, the set of fertility preferences can effectively be collapsed to the following mutually exclusive elements: 1) a preference for spacing births; 2) a preference for limiting births; or 3) a preference for neither spacing nor limiting, i.e. having children soon.

Under the injective function mapping, a woman who prefers to space or limit births would necessarily have a demand for contraception to meet this fertility preference; conversely, a women who prefers to not use contraception would not have a preference for limiting or spacing births for at least two years (that is, she has revealed her preference to have children soon through her non-use). However, one can identify counterexamples where 1) women who prefer to space or limit births also have well-defined preferences for not using contraception (e.g. due to religious opposition, fear of contraceptive-related side effects, etc.), and 2) women who have a preference for using contraception currently may also have a preference for having children soon. Each of these counterexamples are considered to be violations of a "rational" function mapping where fertility preferences are outcomes to which contraceptive preferences are expected to align. More generally, it is also possible to conceive of reasons for women's contraceptive use that are neither causes nor consequences of fertility control. For example, women may choose to use barrier methods of contraception specifically for preventing sexually transmitted diseases. If this is true, then the conceptualization of the set of outcomes on

which contraceptive preferences are mapped would need to be expanded beyond fertility, to the extent that contraceptive preferences and demand would need to be decoupled from fertility preferences, thereby establishing a case for the examination of preferences for contraception independently of fertility intention. By extension, the use of an unbiased measure of fertility preferences, even if such an indicator could be estimated, to calculate unmet need may therefore be incorrect.

In critically reflecting on our approach, a first order of concern is that over our choice of selecting variables. In theory, we would aim to and be able to select on as many variables that, together, identify the subset of women in a population who likely face no constraints to their family planning and reproductive health decision-making. While conceptually appealing, one of the challenges to identifying these women in surveys like the DHS is that there may be very few women who fit into this highly selective sub-population, which would limit the statistical precision with which prevalence can be estimated in some surveys. To this end, there is a direct trade-off between the marginal utility from including a characteristic to screen and select women in "ideal" environments and the resulting size of the sub-sample of women who belong to these more selective environments. With this said, if obtaining larger samples, with larger potential to identify highly empowered women, were feasible, then we can be more confident that our estimates of ideal contraceptive prevalence, and hence unmet need, would converge to the true value of unmet need.

Our indicator of unmet need in this exercise is not without its own conceptual limitations. Given that our estimate is derived using point prevalence measures, we are only able to generate unbiased inference at the moment when women's revealed preferences, as indicated by their current contraceptive use, is reported in the survey. Specifically, our estimate implies that at the time of interview, the contraceptive use for women who are identified to live in ideal environments reflect their true contraceptive preferences at that moment. To this end, our approach, as well as current approaches to measuring unmet need, limits the extent to which we are able to interpret contraceptive use over time, when preferences can vary – this may likely be the key cost that we pay for simplicity and ease of calculation. Our approach is comparable to recent approaches that estimate unmet need as a point prevalence (Moreau *et al.*, 2019); however, we deliberately do not include measures of fertility preference and/or contraceptive intention, both of which are likely to be biased in traditional survey data.

Like other approaches, our metric for unmet need does not account for husband or partner preferences for contraception. To the extent that male preferences can be included using the women's DHS datasets, we run a sensitivity analysis that selects ideal women based on whether they had a partner who supported them in their contraceptive use / non-use. The inclusion of partner approval of contraception does not seem to significantly change our empirical estimates of unmet need. On a broader conceptual note, however, it is not clear as to how one would in fact calculate unmet need by including male preferences, particular in the case where there is discordance in preferences between men and women (Ashraf, Field and Lee, 2014; Karra and Zhang, 2021) – would a couple have an unmet need for contraception if women want to use contraceptive methods but their male partners do not? What about the converse? In a sense, the (lack of) inclusion of male preferences in the unmet need measurement speaks to the tension between women's reproductive rights over contraceptive choice and male involvement in contraceptive decision-making that the field continues to debate.

Given that our approach questions the utility of direct preference elicitation through surveys, our findings also call for a critical review of existing surveys and a reprioritization of survey questions that are currently asked as part of large-scale data collection efforts, like the DHS. Our study specifically

calls for the substitution away from the use of problematic fertility preference questions that are known to be biased from the onset and towards a wider and more inclusive range of observable metrics that would serve to capture latent constructs related to reproductive empowerment, family planning access, and well-being. In the absence of any changes to the current data collection efforts, we encourage future efforts in this domain to continue testing a wider range of factors that capture women's ideal reproductive health environments to determine the extent to which ideal contraceptive use, and by extension unmet need, are sensitive to these choices.

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Figures and Tables

Table 1: Total Sample of Women, Sample of Women from Ideal Environments

	Full *N*	Full Pct.	Ideal *N*	Ideal Pct.
Afghanistan	29,461	1.45	214	0.39
Albania	15,000	0.74	429	0.78
Armenia	12,038	0.59	818	1.48
Angola	14,379	0.71	186	0.34
Bangladesh	55,739	2.74	0	0.00
Burkina Faso	17,087	0.84	69	0.12
Benin	32,527	1.60	285	0.52
Burundi	26,658	1.31	167	0.30
DRC	18,827	0.92	191	0.35
Congo, Republic	10,819	0.53	84	0.15
Cote d'Ivoire	10,060	0.49	99	0.18
Cameroon	30,103	1.48	506	0.91
Colombia	92,239	4.53	0	0.00
Dominican Republic	9,372	0.46	481	0.87
Egypt	21,762	1.07	1,548	2.80
Ethiopia	32,198	1.58	744	1.34
Gabon	8,422	0.41	78	0.14
Ghana	9,396	0.46	179	0.32
Gambia	10,233	0.50	127	0.23
Guinea	20,016	0.98	147	0.27
Guyana	25,914	1.27	623	1.13
Honduras	22,757	1.12	449	0.81
Haiti	29,800	1.46	515	0.93
India	699,686	34.34	25,539	46.17
Indonesia	95,234	4.67	4,315	7.80
Jordan	26,041	1.28	1,240	2.24
Kenya	31,079	1.53	490	0.89
Cambodia	36,332	1.78	453	0.82
Comoros	5,329	0.26	115	0.21
Kyrgyz Republic	8,208	0.40	508	0.92
Liberia	9,239	0.45	108	0.20
Lesotho	6,621	0.32	253	0.46
Mali	20,943	1.03	175	0.32
Maldives	7,699	0.38	99	0.18
Malawi	47,582	2.34	473	0.86
Mozambique	13,745	0.67	177	0.32
Nigeria	80,769	3.96	3,350	6.06
Niger	11,160	0.55	54	0.10
Namibia	9,176	0.45	267	0.48
Nepal	25,536	1.25	824	1.49
Philippines	41,229	2.02	2,531	4.58
Pakistan	25,922	1.27	2,035	3.68
Rwanda	27,168	1.33	346	0.63
Sierra Leone	32,232	1.58	543	0.98

	Full *N*	Full Pct.	Ideal *N*	Ideal Pct.
Senegal	15,688	0.77	41	0.07
Chad	17,719	0.87	25	0.05
Togo	9,480	0.47	96	0.17
Tajikistan	9,656	0.47	552	1.00
Timor Leste	25,744	1.26	393	0.71
Turkey	9,746	0.48	0	0.00
Tanzania	23,405	1.15	91	0.16
Uganda	27,180	1.33	793	1.43
Yemen	25,434	1.25	0	0.00
South Africa	8,514	0.42	116	0.21
Zambia	30,094	1.48	797	1.44
Zimbabwe	19,126	0.94	580	1.05
Total	**2,037,523**		**55,318**	

Table 2: Descriptive Statistics, Woman Characteristics

	Mean	SD	*N*
Full Sample			
Outcome and Selection Characteristics			
Contraceptive use (1 = Yes)	0.337		681,542
Highest wealth quintile (1 = Yes)	0.199		406,073
Currently married (1 = Yes)	0.686		1,396,560
Sexually active (1 = Yes)	0.664		752,338
Tertiary education (1 = Yes)	0.106		212,751
Knows 1+ FP method (1 = Yes)	0.958		1,884,897
Distance to facility not problem (1 = Yes)	0.652		1,206,110
Other Characteristics			
Place of residence (1 = Urban)	0.376		766,643
Age (years)	29.608	9.830	
Children ever born	2.329	2.336	
Husband has tertiary education (1 = Yes)	0.114		115,262
Respondent earns more than husband (1 = Yes)	0.266		101,328
Observations	**2,037,523**		
Ideal Environment Sample			
Contraceptive Use (1 = Yes)	0.521	32,786	
Place of residence (1 = Urban)	0.807		44,655
Age (years)	33.168	7.495	
Children ever born	1.705	1.278	
Husband has tertiary education (1 = Yes)	0.747		24,200
Respondent earns more than husband (1 = Yes)	0.371		7,141
Observations	**55,318**		

Notes: The unit of observation is the woman.

Table 3: Descriptive Statistics, Unmet Need

	Mean	SD	Min	Max
Unmet Need, New Definition	0.216	0.088	0.021	0.510
Unmet Need, Definition 1	0.161	0.060	0.053	0.279
Unmet Need, Definition 2	0.152	0.059	0.010	0.271
Difference 1 (New – Def. 1)	0.051	0.102	-0.193	0.338
Difference 2 (New – Def. 2)	0.060	0.101	-0.184	0.348
N	**80**			

Notes: The unit of observation is the DHS survey round. The variable "Unmet Need, New Definition" is defined as the difference in CPR between the subsample of WRA who are from "ideal" environments (highest wealth quintile, highest educational attainment, currently married, and knows of at least one FP method) and CPR for all WRA. The variable Unmet Need, Definition 1 is calculated using the categorical unmet need variable (v624) in the DHS survey round, which classifies women to fall into one of the following categories: 1) no unmet need; 2) an unmet need for spacing; 3) an unmet need for limiting; 4) having a spacing failure or limiting failure; or 5) infecund. The variable Unmet Need, Definition 2 is calculated using a second categorical unmet need variable (v626) in the DHS survey round. The variable Difference 1 is the calculated difference between the new Unmet Need variable and the Unmet Need, Definition 1 variable. The variable Difference 2 is the calculated difference between the new Unmet Need variable and the Unmet Need, Definition 2 variable.

Table 4: Unmet Need by DHS Survey

DHS Survey Round	Country	Year	$iCPR_{ct}$	CPR_{ct}	Unmet Need, New Def.	Unmet Need (Def. 1)	Difference (New - Def. 1)	Unmet Need (Def. 2)	Difference (New - Def. 2)
AF7	Afghanistan	2015	36.92%	19.52%	17.39%	25.38%	-7.99%	24.82%	-7.43%
AL7	Albania	2018	49.88%	29.13%	20.76%	12.72%	8.03%	12.39%	8.36%
AM6	Armenia	2010	58.20%	33.32%	24.88%	13.64%	11.24%	13.64%	11.24%
AM7	Armenia	2016	60.84%	37.46%	23.38%	8.24%	15.15%	7.75%	15.63%
AO7	Angola	2016	42.47%	10.15%	32.32%	25.54%	6.78%	24.57%	7.75%
BF6	Burkina Faso	2010	63.77%	15.69%	48.08%	19.72%	28.36%	19.09%	28.99%
BJ6	Benin	2012	38.24%	13.81%	24.43%	24.87%	-0.45%	24.31%	0.12%
BJ7	Benin	2018	35.52%	14.55%	20.97%	25.52%	-4.55%	24.88%	-3.91%
BU6	Burundi	2010	33.64%	17.46%	29.33%	17.94%	11.39%	17.52%	11.81%
BU7	Burundi	2017	43.33%	14.01%	16.19%	16.50%	-0.32%	15.85%	0.34%
CD6	DRC	2014	52.36%	16.86%	35.50%	21.63%	13.87%	20.64%	14.86%
CG6	Congo, Republic	2012	61.90%	42.37%	19.53%	14.30%	5.24%	13.96%	5.58%
CI6	Cote d'Ivoire	2012	36.36%	18.79%	17.58%	22.27%	-4.69%	21.57%	-3.99%
CM6	Cameroon	2011	43.09%	20.26%	31.72%	18.26%	13.46%	17.35%	14.36%
CM7	Cameroon	2018	55.38%	23.67%	22.83%	17.63%	5.20%	16.72%	6.11%
DR6	Dominican Republic	2013	71.52%	55.99%	15.53%	8.11%	7.42%	7.82%	7.71%
EG6	Egypt	2014	60.66%	53.63%	7.03%	9.53%	-2.50%	9.51%	-2.47%
ET6	Ethiopia	2011	58.31%	17.93%	40.38%	15.10%	25.28%	14.42%	25.96%
ET7	Ethiopia	2016	54.12%	21.12%	33.00%	11.96%	21.04%	11.58%	21.42%
GA6	Gabon	2012	50.00%	28.98%	21.02%	22.20%	-1.19%	20.81%	0.20%
GH6	Ghana	2014	35.75%	22.16%	13.60%	19.79%	-6.20%	18.68%	-5.08%
GM6	Gambia	2013	22.83%	6.68%	16.15%	17.59%	-1.44%	17.05%	-0.90%
GN7	Guinea	2018	31.97%	10.83%	21.14%	17.07%	4.07%	16.38%	4.76%
GU6	Guyana	2015	76.24%	38.89%	37.35%	7.93%	29.42%	7.75%	29.60%
HN6	Honduras	2012	81.07%	48.13%	32.93%	6.81%	26.13%	6.62%	26.32%
HT6	Haiti	2012	38.68%	23.33%	15.35%	24.64%	-9.29%	23.45%	-8.09%
HT7	Haiti	2017	30.15%	23.99%	6.15%	25.42%	-19.26%	24.60%	-18.44%
IA6	India	2016	51.98%	37.34%	14.64%	10.29%	4.35%	9.66%	4.98%
ID6	Indonesia	2012	58.06%	42.42%	13.38%	6.49%	6.89%	6.44%	6.94%
ID7	Indonesia	2017	56.54%	43.16%	15.64%	6.10%	9.54%	5.91%	9.73%
JO6	Jordan	2012	49.57%	47.44%	7.60%	9.05%	-1.45%	8.71%	-1.12%
JO7	Jordan	2018	65.86%	58.26%	2.14%	13.82%	-11.69%	13.31%	-11.17%
KE6	Kenya	2014	64.08%	38.71%	25.37%	12.31%	13.06%	11.81%	13.56%
KH5	Cambodia	2010	58.19%	37.37%	33.34%	13.39%	19.95%	12.90%	20.44%
KH6	Cambodia	2014	60.68%	27.34%	20.82%	8.51%	12.31%	0.97%	19.84%
KM6	Comoros	2012	30.43%	14.49%	15.95%	21.84%	-5.89%	20.12%	-4.17%
KY6	Kenya	2012	41.54%	26.56%	14.98%	11.73%	3.24%	11.18%	3.80%
LB6	Liberia	2013	32.41%	20.26%	12.15%	27.83%	-15.68%	26.36%	-14.21%
LS6	Lesotho	2014	67.98%	48.56%	19.43%	10.94%	8.49%	10.59%	8.84%
ML6	Mali	2013	38.24%	10.59%	27.64%	18.84%	8.80%	18.35%	9.29%

DHS Survey Round	Country	Year	$iCPR_{ct}$	CPR_{ct}	Unmet Need, New Def.	Unmet Need (Def. 1)	Difference (New - Def. 1)	Unmet Need (Def. 2)	Difference (New - Def. 2)
ML7	Mali	2018	35.51%	14.53%	20.99%	22.29%	-1.30%	18.09%	2.90%
MV7	Maldives	2017	22.22%	14.61%	7.61%	26.81%	-19.20%	24.25%	-16.64%
MW5	Malawi	2010	55.92%	45.57%	23.11%	18.85%	4.26%	18.30%	4.80%
MW7	Malawi	2016	58.52%	35.41%	10.34%	13.38%	-3.04%	12.76%	-2.42%
MZ6	Mozambique	2011	46.89%	15.42%	31.47%	18.77%	12.70%	17.93%	13.54%
NG6	Nigeria	2013	44.65%	15.98%	28.66%	13.24%	15.43%	12.59%	16.07%
NG7	Nigeria	2018	34.64%	13.49%	21.15%	15.13%	6.02%	14.44%	6.71%
NI6	Niger	2012	48.15%	13.65%	34.50%	14.69%	19.81%	14.31%	20.19%
NM6	Namibia	2013	68.91%	50.41%	18.50%	8.71%	9.79%	8.41%	10.09%
NP6	Nepal	2011	61.36%	40.89%	21.21%	19.58%	1.63%	19.38%	1.83%
NP7	Nepal	2016	59.45%	38.24%	20.47%	18.52%	1.95%	18.24%	2.23%
PH6	Philippines	2013	49.91%	34.15%	15.76%	11.58%	4.17%	10.61%	5.15%
PH7	Philippines	2017	45.96%	33.63%	12.33%	11.67%	0.66%	10.41%	1.92%
PK6	Pakistan	2012	53.83%	34.30%	19.53%	20.68%	-1.16%	20.61%	-1.08%
PK7	Pakistan	2018	46.06%	31.54%	14.52%	18.29%	-3.77%	18.06%	-3.54%
RW6	Rwanda	2010	60.12%	29.62%	30.50%	10.22%	20.27%	9.79%	20.70%
SL6	Sierra Leone	2013	37.16%	23.84%	28.18%	20.03%	8.15%	18.59%	9.59%
SL7	Sierra Leone	2019	50.71%	22.53%	13.32%	19.79%	-6.47%	18.70%	-5.37%
SN6	Senegal	2011	36.59%	8.63%	27.95%	21.26%	6.70%	20.56%	7.40%
TD6	Chad	2015	20.00%	3.98%	16.02%	18.38%	-2.36%	17.63%	-1.61%
TG6	Togo	2014	41.67%	19.27%	22.39%	25.08%	-2.69%	24.28%	-1.88%
TJ6	Tajikistan	2012	40.58%	19.18%	21.40%	15.91%	5.49%	15.37%	6.03%
TL5	Timor Leste	2010	35.87%	13.50%	22.37%	18.52%	3.85%	18.35%	4.01%
TL7	Timor Leste	2016	30.90%	15.68%	15.22%	20.48%	-5.27%	12.83%	2.39%
TZ5	Tanzania	2010	54.55%	29.07%	50.98%	17.21%	33.77%	16.22%	34.75%
TZ7	Tanzania	2016	76.00%	25.02%	25.48%	16.04%	9.44%	15.30%	10.18%
UG6	Uganda	2011	51.04%	29.28%	32.43%	20.59%	11.84%	20.18%	12.25%
UG7	Uganda	2016	55.30%	22.87%	21.76%	18.94%	2.82%	18.70%	3.07%
ZA7	South Africa	2016	60.34%	47.28%	13.07%	10.40%	2.67%	9.94%	3.13%
ZM6	Zambia	2014	57.83%	34.46%	23.37%	14.60%	8.77%	14.26%	9.11%
ZM7	Zambia	2018	49.48%	35.18%	14.29%	13.31%	0.98%	12.54%	1.75%
ZW6	Zimbabwe	2011	71.93%	41.25%	30.68%	8.92%	21.76%	8.63%	22.06%
ZW7	Zimbabwe	2015	75.06%	48.91%	26.15%	7.51%	18.64%	6.29%	19.86%

Note: The surveys that are highlighted in red text are those that have more than a 15 percentage point difference (in either direction) between the new definition of unmet need and the current working definitions of unmet need. The surveys highlighted in yellow indicate those waves in which the new definition of unmet need is calculated with fewer than 100 observations, indicating a potential sample size (power) concern in the calculation of the new measure.

Table 5: Estimated Ideal Contraceptive Use and Attributable Variation by Selection Criteria, Global Analysis

	(1)	(2)	(3)	(4)
	Ideal contraceptive use	Proportion of sample without factor	Attributable ideal contraceptive use variation from factor adjustment	% of total variation
Highest quintile	0.082***	0.801	0.066	41.12%
	0.062 - 0.103			
Currently married	0.0077	0.314	0.0024	1.50%
	-0.039 - 0.055			
Sexually active in last month	0.208***	0.336	0.070	43.61%
	0.192 - 0.224			
High education	-0.0054	0.894	-0.0048	-2.99%
	-0.037 - 0.026			
Knows a FP method	0.333***	0.042	0.014	8.72%
	0.331 - 0.335			
Distance to facility is not a problem	0.037***	0.348	0.0129	8.04%
	0.031 - 0.043			
		Total attributable	**0.161**	
Observations	**970,943**	**variation to ideal**		
R-squared	**0.151**	**contraceptive use**		

Notes: The table presents results from a multivariable logistic regression model using the full analytic sample of women. Estimates of the predicted probabilities are presented in Column 1 with 95% confidence intervals below. The regression includes survey (country-year) fixed effects, and coefficient standard errors are clustered at the survey level. Column 2 presents the proportion of the full analytic sample that does not have the particular factor for which the coefficient estimate is calculated; for example, 89.4 percent of women in the analytic sample do not have a tertiary level of education. Column 3 presents the attributable variation in ideal contraceptive use that would be gained after having adjusted for the particular factor. The attributable variation in ideal contraceptive use for a given factor is calculated by taking the product of the factor's coefficient estimate obtained from column 1 and the proportion of the analytic sample without that factor from column 2. The total attributable variation in ideal contraceptive use is calculated by summing up the attributable variation estimates from each of the five factors, and Column 4 presents the proportion of the total variation that can be attributed to that particular factor, which is calculated by taking the ratio of the attributable variation from that factor as a percentage of the total attributable variation.

Table 6: Matched Unmet Need by DHS Survey

DHS Survey Round	Country	$iCPR_{ct}^{MATCH}$	CPR_{ct}^{MATCH}	Unmet Need, Matched	Matched - Original	Matched - Def. 1	Matched - Def. 2
AF7	Afghanistan	36.92%	20.56%	16.36%	1.04%	-9.03%	-8.46%
AL7	Albania	49.88%	35.66%	14.22%	6.54%	1.49%	1.83%
BF6	Burkina Faso	63.77%	28.99%	34.78%	13.30%	15.07%	15.69%
BJ6	Benin	38.24%	13.73%	24.51%	-0.08%	-0.37%	0.20%
BJ7	Benin	35.52%	14.75%	20.77%	0.21%	-4.76%	-4.12%
CD6	DRC	52.36%	21.47%	30.89%	4.61%	9.26%	10.25%
CG6	Congo, Republic	61.90%	52.38%	9.52%	10.01%	-4.78%	-4.43%
CI6	Cote d'Ivoire	36.36%	20.20%	16.16%	1.41%	-6.11%	-5.40%
CM6	Cameroon	55.81%	36.43%	19.38%	12.34%	1.12%	2.03%
CM7	Cameroon	43.20%	28.53%	14.67%	8.16%	-2.97%	-2.06%
ET6	Ethiopia	58.31%	26.78%	31.53%	8.85%	16.43%	17.11%
ET7	Ethiopia	54.12%	33.18%	20.94%	12.07%	8.97%	9.36%
GA6	Gabon	52.78%	27.78%	25.00%	-3.98%	2.80%	4.19%
GH6	Ghana	35.75%	23.46%	12.29%	1.31%	-7.50%	-6.39%
GM6	Gambia	22.83%	8.66%	14.17%	1.98%	-3.42%	-2.88%
GN7	Guinea	31.97%	10.88%	21.09%	0.05%	4.02%	4.71%
GU6	Guinea	76.24%	53.93%	22.31%	15.04%	14.38%	14.56%
HN6	Honduras	81.07%	57.46%	23.61%	9.33%	16.80%	16.99%
IA6	India	51.96%	49.63%	2.34%	12.30%	-7.95%	-7.32%
JO7	Jordan	49.57%	48.01%	1.56%	0.57%	-12.26%	-11.75%
KE6	Kenya	64.08%	55.51%	8.57%	16.80%	-3.74%	-3.24%
LB6	Liberia	32.41%	20.37%	12.04%	0.11%	-15.79%	-14.32%
ML6	Mali	38.24%	13.24%	25.00%	2.64%	6.16%	6.65%
ML7	Mali	35.51%	21.50%	14.02%	6.97%	-8.27%	-4.07%
MW5	Malawi	58.52%	41.48%	17.04%	6.07%	-1.81%	-1.26%
MZ6	Mozambique	46.89%	28.25%	18.64%	12.82%	-0.13%	0.71%
NG6	Nigeria	44.69%	30.46%	14.22%	14.44%	0.99%	1.63%
NG7	Nigeria	34.64%	22.10%	12.54%	8.61%	-2.58%	-1.89%
NP6	Nepal	59.45%	49.62%	9.82%	11.39%	-9.76%	-9.55%
NP7	Nepal	61.36%	45.20%	16.16%	4.31%	-2.36%	-2.08%
PH6	Philippines	49.91%	47.92%	1.98%	13.77%	-9.60%	-8.63%
PH7	Philippines	45.96%	44.46%	1.50%	10.83%	-10.17%	-8.91%

DHS Survey Round	Country	$iCPR_{ct}^{MATCH}$	CPR_{ct}^{MATCH}	Unmet Need, Matched	Matched - Original	Matched - Def. 1	Matched - Def. 2
PK6	Pakistan	53.83%	40.81%	13.02%	6.51%	-7.66%	-7.59%
SL6	Sierra Leone	50.71%	30.14%	20.57%	7.61%	0.53%	1.98%
SL7	Sierra Leone	37.16%	27.59%	9.58%	3.75%	-10.22%	-9.12%
SN6	Senegal	36.59%	17.07%	19.51%	8.44%	-1.75%	-1.04%
TD6	Chad	20.83%	12.50%	8.33%	7.68%	-10.05%	-9.29%
TG6	Togo	41.67%	18.75%	22.92%	-0.52%	-2.17%	-1.36%
UG6	Uganda	55.30%	28.79%	26.52%	5.91%	5.92%	6.34%
UG7	Uganda	51.04%	40.83%	10.21%	11.55%	-8.73%	-8.49%
ZA7	South Africa	60.34%	55.17%	5.17%	7.90%	-5.22%	-4.76%
ZM6	Zambia	57.63%	43.58%	14.04%	9.32%	-0.56%	-0.21%

Note: The surveys that are highlighted in red text are those that have more than a 10 percentage point difference (in either direction) between the new definition of unmet need and the current working definitions of unmet need. The surveys highlighted in yellow indicate those waves in which the new definition of unmet need is calculated with fewer than 100 observations, indicating a potential sample size (power) concern in the calculation of the new measure.

Figure 1: Current Methodology for Unmet Need Classification, DHS

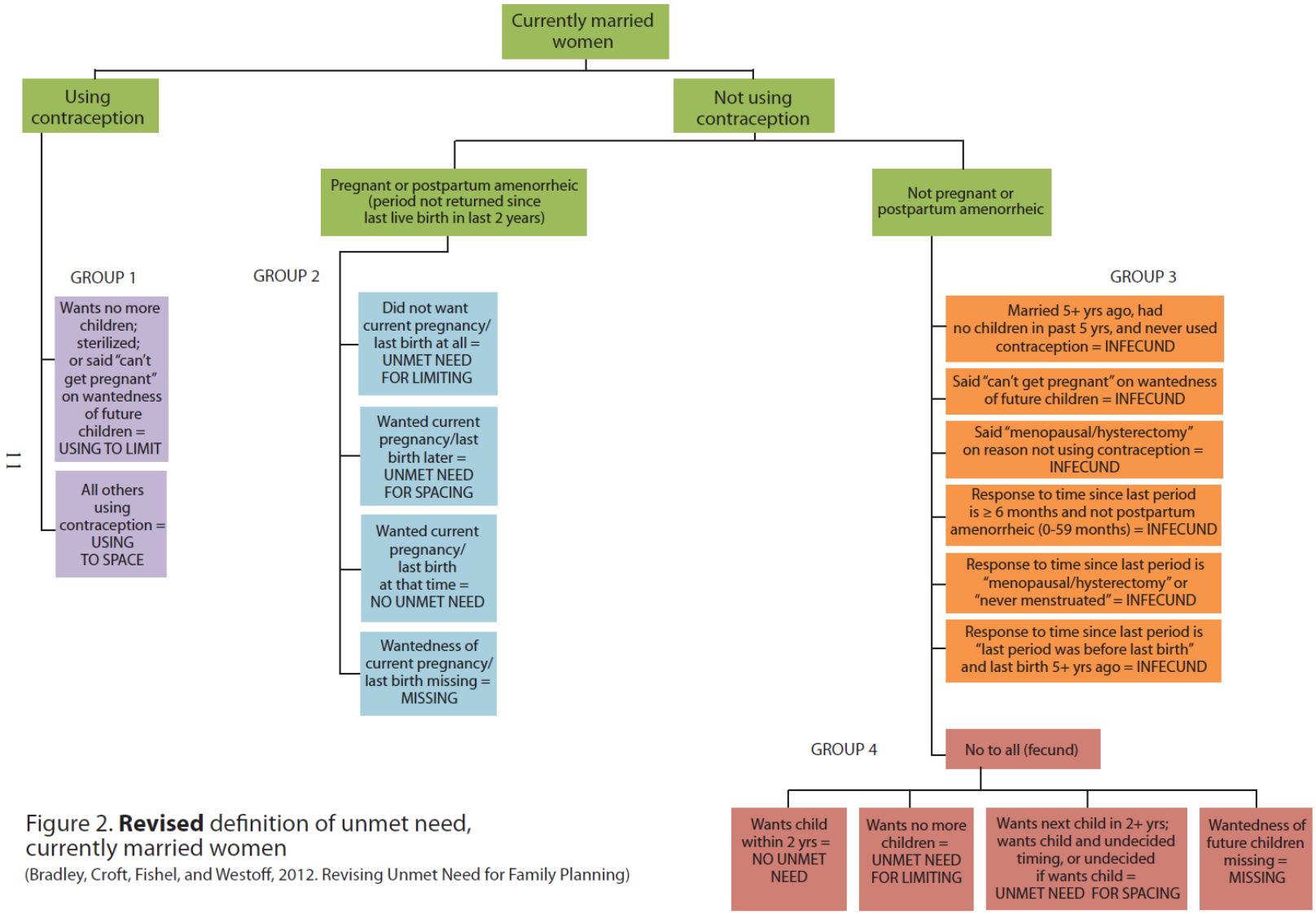
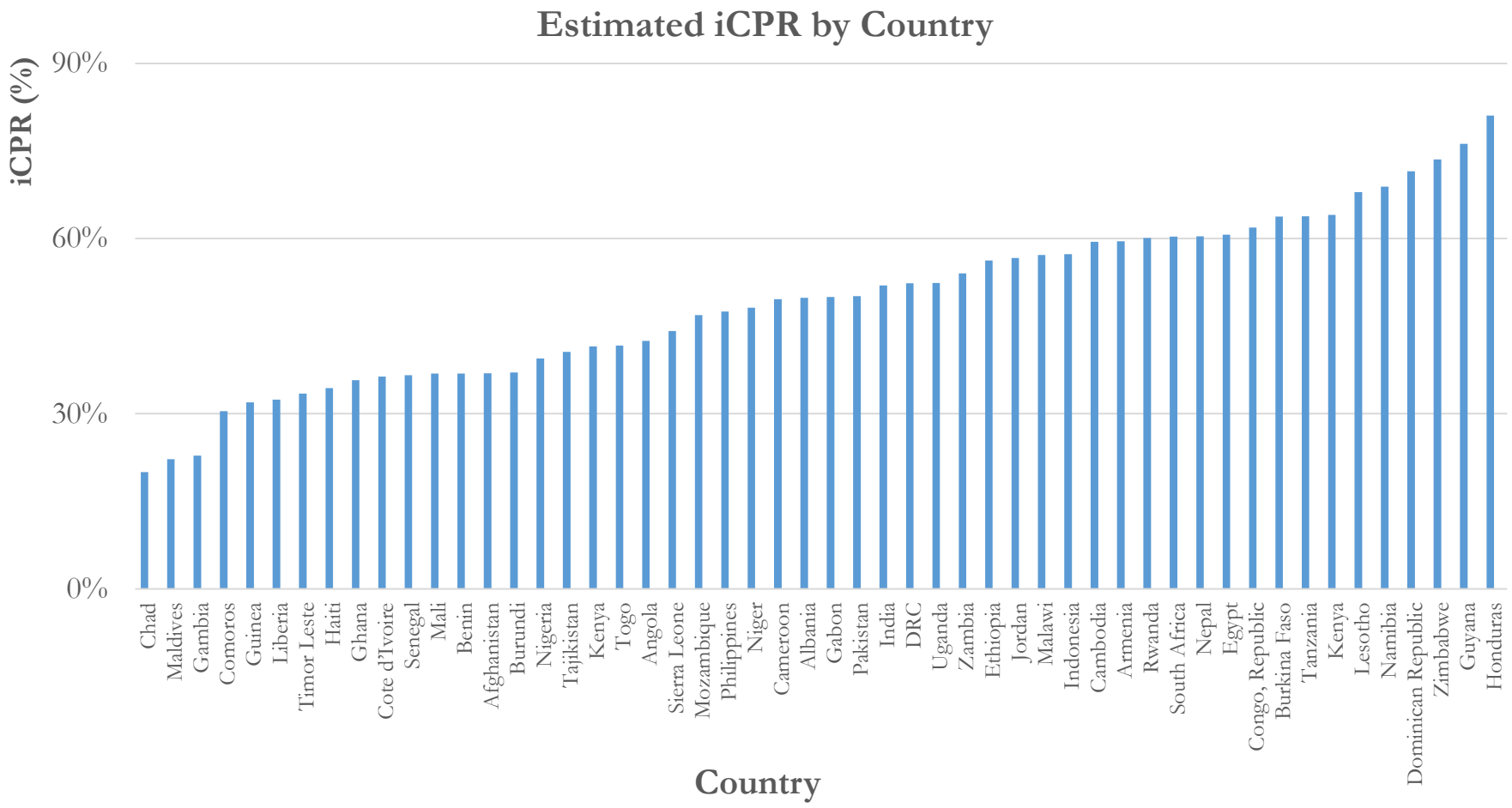


Figure 2. **Revised** definition of unmet need, currently married women

(Bradley, Croft, Fishel, and Westoff, 2012. Revising Unmet Need for Family Planning)

Figure 2: Estimated $iCPR_{ct}$ by Country



Notes: For countries with multiple survey rounds, country-level $iCPR$ rates are calculated by averaging survey-round $iCPR$ estimates.

Figure 3: Changes in $iCPR_{ct}$ Over Time, by Country

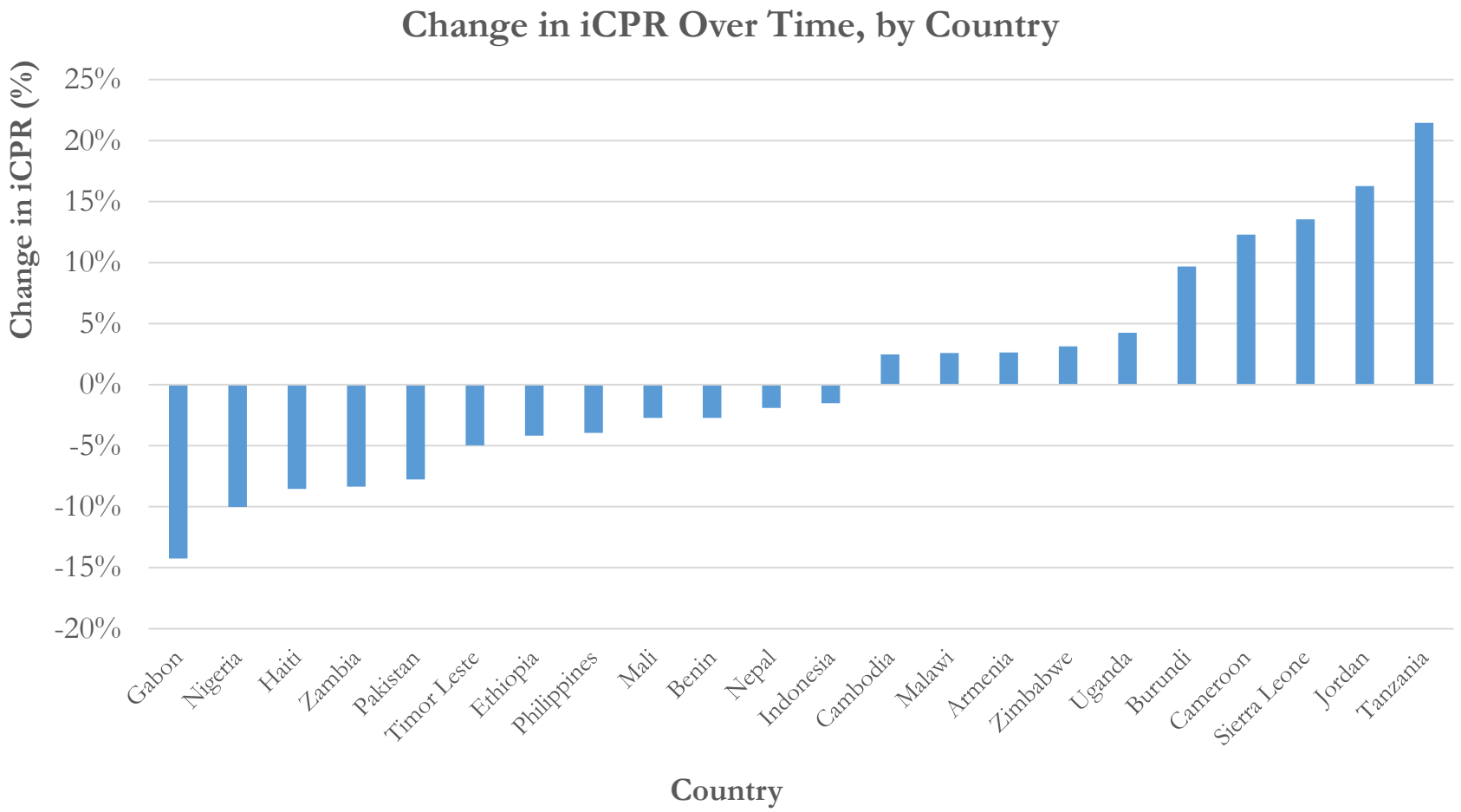


Figure 4: Kernel Density Plots, Unmet Need Across Definitions

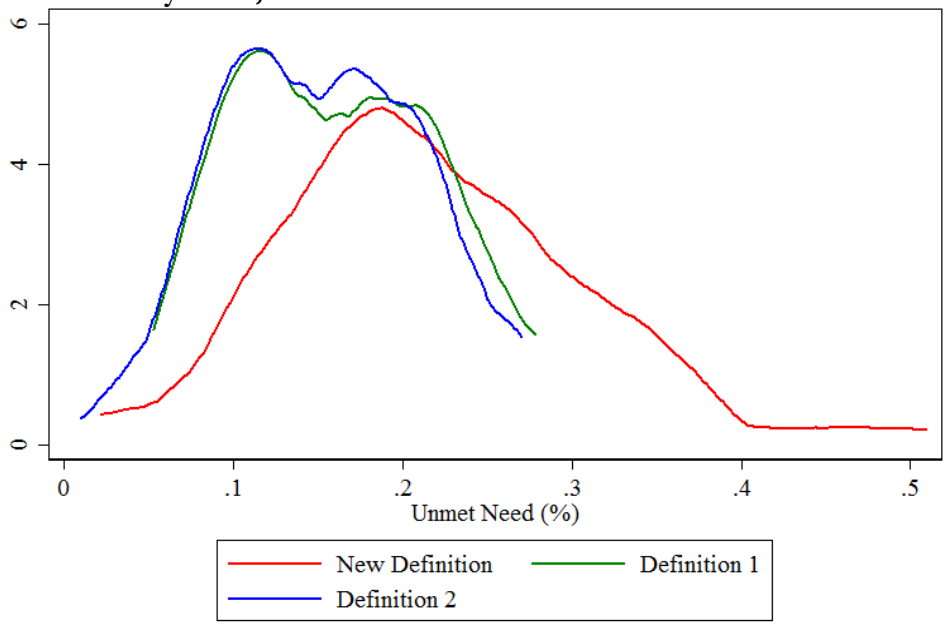


Figure 5: Kernel Density Plots, Difference between the New and Old Unmet Need Measure

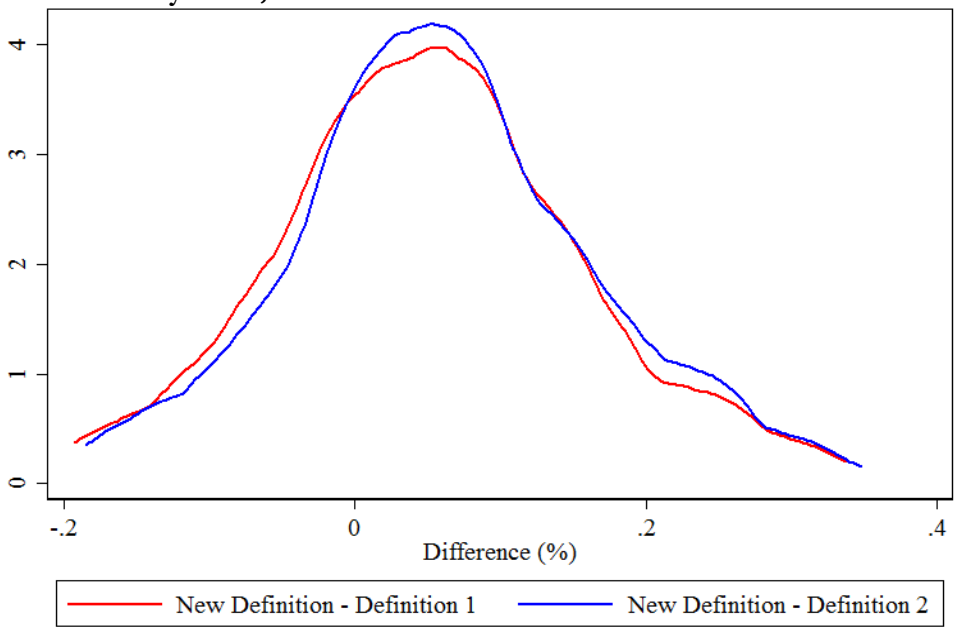


Figure 6: Kernel Density Plots, Matched Unmet Need Across Definitions