Preferred Product Attributes of Potential Multipurpose Prevention Technologies for Unintended Pregnancy and Sexually Transmitted Infections or HIV Among U.S. Women

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Abstract

Background: Multipurpose prevention technologies (MPTs) are being developed to simultaneously protect women from unintended pregnancy and sexually transmitted infections (STIs) or human immunodeficiency virus. This study aims to determine MPT characteristics desired by young women in the United States (U.S.).

Materials and Methods: This is a cross-sectional national survey administered online by MTurk. Eligibility criteria included female sex, age 18–29 years, U.S. residence, and sexual activity with a male partner in the past 3 months. MPT characteristics were rated for importance. Odds ratios were generated to explore associations between demographics, sexual behaviors, and prior contraceptive use and likelihood of using various MPT formulations.

Results: Of 835 women, the largest proportion reported being likely to use MPTs in the form of injectables (45.6%), followed by vaginal gels (33.7%), vaginal rings (26.3%) and diaphragms (17.3%). Women with prior experience using a specific method of contraception appeared more likely to try an MPT of the same form. Women concerned about STIs and unwanted pregnancy, or with a history of such undesirable outcomes, expressed higher likelihood of use for a broad range of products. Women indicated that safety and efficacy at preventing pregnancy were the most important product characteristics when choosing an MPT.

Conclusions: MPTs in the form of injectables are most highly desired, but many women would use vaginal methods, highlighting the importance of developing different delivery methods. Women desire safety and emphasize contraceptive efficacy over infection prevention. MPT preferences must be considered during product development to promote future acceptance among young women in the U.S.

Keywords: multipurpose prevention technology, contraception, HIV, STIs, unintended pregnancy

Introduction

EXCEPTIONALLY HIGH RATES of human immunodeficiency virus (HIV) infection among young women in sub-Saharan Africa, along with a growing interest in the linkages between HIV and pregnancy prevention, have led to the development of single or double agent products known as multipurpose prevention technologies (MPTs) designed to simultaneously protect against HIV or other sexually transmitted infections (STIs) along with unintended pregnancy.^{1,2}

In 2011, the Initiative for MPTs came together to create a target product profile (TPP) to prioritize specific aspects of MPT development. With the guidance of this target profile, including criteria such as efficacy, acceptable side effects, and dosage frequency, MPT development has progressed.³ As of 2016, one MPT, a tenofovir/levonorgestrel intravaginal ring, was in Phase 1 clinical testing. Other products, including a dapivirine-releasing diaphragm and various vaginal gels, are still undergoing laboratory testing, while long-acting injectables (LAIs) are under consideration.^{4,5}

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While the TPP is essential for successful product development, there is also a need to incorporate women's preferences into product design as MPT development continues.⁶⁻⁸ This concept is exemplified by the low adherence to oral and vaginal forms of pre-exposure prophylaxis (PrEP) seen among African women in HIV prevention trials.⁹⁻¹² This consistent issue demonstrates that interest and need do not always translate to acceptance and adherence.

We have previously published data demonstrating that young women in the U.S. are interested in potential MPTs; however, we currently have limited knowledge regarding preferred MPT characteristics among U.S. women to direct development.¹³ We do know factors that influence women's use of the separate components of MPTs, namely PrEP and contraception. Potential PrEP users from seven countries expressed a preference for bimonthly injections over a daily or pericoitally dosed pill.¹⁴ Potential PrEP users in the U.S. expressed concern regarding possible side effects and mentioned cost as a likely barrier to uptake.¹⁵⁻¹⁹ From a social perspective, study participants endorsed fear of HIV-related stigma and poor reaction from peers if they took a medication that could be misconstrued as treating HIV, suggesting that a discrete method might be found more favorable.^{15,16} Among a cohort of sexually active women at risk for unintended pregnancy in the U.S., the contraceptive characteristics ranked most important were effectiveness, safety, affordability, long lasting, and whether the method was "forgettable."²⁰ While the data on PrEP and contraceptive formulations are informative, no studies have looked at what specific product attributes U.S. women desire in a combined MPT product.

Based on preferences for PrEP and contraception, we expect that various factors will affect acceptance and adherence to MPTs. To improve future adherence among young U.S. women at risk of pregnancy, HIV, and STIs, this study aims to determine product preferences to influence future MPT acceptance.

Materials and Methods

Data collection

The data analyzed in this study were collected as part of a national cross-sectional online survey assessing U.S. women's interest in MPTs. The study methodology was published previously.¹³ In brief, participants were recruited using Amazon's Mechanical Turk (MTurk), an online task exchange marketplace. Prior research has shown that the MTurk participant pool provides an equally diverse population compared with standard internet samples and the data collected have been found similarly reliable in relation to more traditional methods.^{21,22} The task was available to all members of MTurk who earned a certain quality level on prior tasks. We aimed to recruit 850 participants as per our power calculations related to the MPT interest portion of the study.¹³ Eligibility questions, positioned before the beginning of the survey, included self-identified female sex, 18-29 years of age, living in the U.S., and sexual activity with a male partner in the past 3 months. A total of 3361 potential participants followed the MTurk link to the survey and were included or excluded in a stepwise manner based on their answers to the eligibility questions. Specifically, excluded participants included all men and women outside the desired

age range. After accounting for participant withdrawal, 858 women completed the survey. Of those, 8 were excluded due to lack of corresponding completed task in MTurk, 4 reported specific age (in years) outside the required range, and 11 reported HIV-positive status, leaving 835 surveys suitable for analysis. We received approval from the Emory University Institutional Review Board before enrollment.

Measures

Demographic data included age, race, education, and zip code. Race was divided into three categories for analysis: white/Caucasian, black or African American, and other. Zip codes were categorized into regions and coded as urban versus rural based on 2010 U.S. Census Bureau data.²³⁻²⁵

Behavioral characteristics included sexual behaviors such as relationship status, recent vaginal, oral, and anal intercourse with a male partner in the past 3 months, history of STI or unintended pregnancy, and frequency and type of contraception used ever and used within the past 3 months. HIV risk was assessed by inquiring about high-risk sexual behaviors as defined by the Centers for Disease Control and Prevention (CDC): lack of condom at last sex, sex with a casual partner, greater than one sexual partner in the past 3 months, sex with a known HIV-positive male partner, and anal sex without a condom.²⁶ We assessed self-perceived risk of HIV and unintended pregnancy using the Worry About Sexual Outcomes scale adapted from Sales et al.²⁷

MPTs were introduced as "a form of birth control (other than a condom) that protects you against both unplanned pregnancy and infection with HIV/other STIs." Our primary outcome investigated women's preferred MPT delivery method from a variety of nonoral options currently under development. Specifically, this included pericoitally placed vaginal gels and diaphragms, monthly vaginal rings, and LAIs with repeat dosing every 3 months.⁴ Women were asked to rate their likelihood of using these forms from "very unlikely" to "very likely." Women then indicated ever or recent use (within the past 3 months) of contraceptive methods from the following list: condoms (male and female), diaphragms, vaginal rings, birth control pills, patches, shots, implants, and intrauterine devices.

To assess features important to women in a potential MPT, participants were asked to rate the importance of product characteristics on a scale from one (not at all important) to three (very important). Evaluated attributes were adapted from Madden et al.²⁰ in relation to contraceptive product characteristics and included efficacy, safety, affordability, long lasting, forgettable, having a monthly period, side effects, privacy, partner's opinion, and friends' opinions. Finally, women were given a list of STIs (chlamydia, gonorrhea, Hepatitis B, herpes simplex virus, HIV, human papilloma virus, and syphilis) and asked to pick the two against which they would most like protection, along with how much they would be willing to pay per month for such a dual-purpose product.

Statistical analysis

Descriptive statistics, including frequencies and mean with standard deviation (SD), were used to characterize demographic and behavioral characteristics as well as outcome variables such as preferred form of MPT, STIs against which

TABLE 1. SUBJECT DEMOGRAPHICS, SEXUAL BEHAVIORS, AND CONTRACEPTIVE USE

<i>Subject demographics—no. (%)</i>	
Age in years—mean (SD)	25.4 (2.63)
Race or ethnicity	
White/Caucasian	549 (66)
Black or African American	197 (24)
Other	89 (11)
Hispanic/Latino (<i>n</i> =833)	71 (9)
Highest level of education	
Less than bachelor's degree	401 (48)
Bachelor's degree or higher	434 (52)
United States region (<i>n</i> =788)	
Northeast	76 (10)
South	329 (42)
Midwest	174 (22)
West	199 (26)
Type of community (<i>n</i> =759)	
Urban	699 (92)
Rural	60 (8)
Sexual behaviors—no. (%)	
Sexual activity with a male partner in the past 3 months (<i>n</i> =831–833)	
Vaginal sex	817 (98)
Oral sex	731 (88)
Anal sex	221 (27)
Relationship status	
Single	169 (20)
In a relationship	666 (80)
History of unintended pregnancy	199 (24)
History of STI(s)	136 (16)
HIV Risk behaviors	
No condom at last sex (<i>n</i> =833)	485 (58)
Sexual partners >1	158 (19)
Casual partner (<i>n</i> =831)	218 (26)
Known HIV+ male partner (<i>n</i> =833)	21 (3)
Anal sex without a condom (<i>n</i> =833)	175 (21)
Any HIV risk behavior	641 (77)
Contraceptive use—no. (%)	
Frequency of contraception use during sex in the past 3 months (<i>n</i> =833)	
All of the time	462 (56)
Some of the time	238 (29)
Never	133 (16)
Forms of birth control used ever:	
Condoms	737 (88)
Diaphragm	33 (4)
Vaginal ring	90 (11)
Pills	641 (77)
Patch	68 (8)
Injections	109 (13)
Implant	55 (7)
IUD	96 (12)
None	21 (3)
Forms of birth control used in the past 3 months	
Condoms	487 (58)
Diaphragm	13 (2)
Vaginal ring	31 (4)
Pills	367 (44)
Patch	13 (2)
Injections	32 (4)
Implant	41 (5)

(continued)

TABLE 1. (CONTINUED)

<i>Subject demographics—no. (%)</i>	
IUD	57 (7)
None	122 (15)

Demographic information of the survey subjects along with sexual behaviors and history of contraceptive use; *n*=835 unless otherwise specified.

SD, standard deviation; HIV, human immunodeficiency virus; STI, sexually transmitted infection; IUD, intrauterine device.

protection was most desired, and acceptable cost. MPT attribute importance scores were computed by calculating the overall mean (out of 3) for each attribute.

Associations between demographic characteristics, risk behaviors, and self-perceived risk of HIV and unintended pregnancy, and preferences for potential forms of MPTs, as indicated by women's reports of being "likely" or "very likely" to use a specific method, were calculated using the Pearson's Chi-square test and reported as odds ratios (OR) with 95% confidence intervals (CI). Associations between women's ever and recent use of a variety of contraceptive methods and preferences for potential forms of MPTs were calculated and reported in the same manner. Reported use of any contraceptive method ever was excluded from this analysis as >97% of the total survey population had used some form of contraception in the past. Use of contraceptive diaphragms (*n*=13) and patches (*n*=13) within the past 3 months was endorsed by fewer than 2% of the survey population and was excluded from this portion of the analysis.

All statistical analyses were completed using SPSS for Macintosh, Version 23.²⁸

Results

The demographic characteristics of the survey respondents are shown in Table 1. The mean age was 25.4 years (SD $\pm$ 2.63), two thirds of women identified as white (66%), while one quarter (24%) identified as African American, and approximately half (52%) had earned a Bachelor's degree or higher. The largest proportion of women came from the Southern U.S. (42%) and the vast majority (92%) lived in urban communities.

The sexual and contraceptive behaviors of the subjects are also listed in Table 1. Over three-quarters (80%) of subjects reported being in a relationship. Almost one-quarter (24%) had an unintended pregnancy in the past, while 16% had ever been diagnosed with an STI. A majority of subjects (77%) reported at least one HIV risk behavior with 295 (46%) of those qualifying only for not using a condom at last sex. A small portion of subjects (3%) had high HIV worry scores, while a slightly larger portion (12%) had high pregnancy worry scores. Just over half of women (56%) reported using contraception "all of the time," while 16% reported not having used contraception at all in the past 3 months. The majority of women (88%) reported ever using condoms and 76% reported ever using pills. Patterns were similar within the past 3 months, with condoms used most commonly (58%), followed by pills (44%). Fewer than 10% of women reported recent use of an intrauterine device (7%), implant

(5%), injectable contraceptive (4%), vaginal ring (4%), diaphragm (2%), or patch (2%).

Preferred MPT delivery method

The likelihood of use of four potential forms of MPTs is shown in Figure 1. Women found an injectable MPT most favorable with 46% of women saying they would be “likely” or “very likely” to use such a product. Pericoitally applied vaginal gel was the second most favorable form (34%), followed by a monthly vaginal ring (26%). Diaphragms were least favorable with 17% of women saying they would be likely to use such a product. Among all women, 66% reported likely use of at least one MPT method, with 34%, 16%, and 6% of women reporting likely use of two, three, or all four potential forms, respectively.

The associations between demographic, behavioral, and risk characteristics and preferences for future MPTs are shown in Table 2. Race was not associated with preferences for any potential forms of MPTs, while higher vs. lower education was associated with a slight preference for vaginal rings (OR 1.37, 95% CI 1.00–1.87). Single women were more likely to prefer an MPT in the form of an injection (OR 1.57, 95% CI 1.11–2.20) than women in a relationship. Women who had used any birth control in the past 3 months reported they were more likely to use an MPT in the form of a diaphragm (OR 2.59, 95% CI 1.36–4.93), vaginal ring (OR 1.97, 95% CI 1.21–3.21), or injection (OR 1.93, 95% CI 1.30–2.85), but were not more likely to use a vaginal gel (OR 1.32, 95% CI 0.88–1.99) compared to women who had not used birth control in the past 3 months. Women with high pregnancy worry scores were more likely to use MPTs in the form of vaginal gels (OR 1.81, 95% CI 1.12–2.77), diaphragms (OR 1.95, 95% CI 1.20–3.16), and vaginal rings (OR 1.63, 95% CI 1.05–2.55), but were not more likely to use an injection (OR 1.22, 95% CI 0.81–1.86). Women with a high HIV worry score were more likely to use MPTs in the form of vaginal gels (OR 2.40, 95% CI 1.06–5.42) and diaphragms

(OR 3.00, 95% CI 1.28–6.99), but were not more likely to use vaginal rings (OR 2.05, 95% CI 0.90–4.68) or injections (OR 0.85, 95% CI 0.37–1.93). There was no difference in preferences for potential MPTs among women with and without HIV risk behaviors.

The association between past contraceptive use and preferences for future MPTs is shown in Table 3. Women who had ever used injectable contraception were more likely to try an injectable MPT in the future compared to women with no experience with this form of contraception (OR 1.76, 95% CI 1.17–2.65). Women who reported recent use (past 3 months) of injectable contraception were nearly four times as likely to try such an MPT (OR 3.75, 95% CI 1.67–8.46). Women who had experience ever using pericoitally administered methods were more likely to try the pericoitally applied vaginal gel than women without experience with pericoitally administered products such as condoms (OR 1.65, 95% CI 1.02–2.68) and diaphragms (OR 3.65, 95% CI 1.77–7.53). Similarly, women who had ever used vaginal rings were significantly more likely to be interested in an MPT in this form (OR 6.04, 95% CI 3.80–9.60) compared to women who had no experience with a vaginal ring. Women who had ever used a hormonal patch were also more likely to be interested in the vaginal ring (OR 2.64, 95% CI 1.59–4.39). Finally, women who reported previous use of a diaphragm were more likely to try such an MPT (OR 6.42, 95% CI 3.15–13.07).

Factors affecting MPT acceptance

Women were asked to pick the two STIs against which they most wanted protection. HIV was ranked in the top two by 87% of women. Protection from herpes was desired next most frequently (41%), followed distantly by HPV (22%). Protection from chlamydia (13%) and gonorrhea (11%) ranked in the top two least frequently.

When asked to rate the importance of 12 attributes to consider when choosing an MPT, women indicated that

FIG. 1. Percent of women likely to use potential forms of MPTs. Women indicated their likelihood of using various forms of MPTs. The likelihood distribution for each potential form is shown in the figure from very unlikely (*left*) to very likely (*right*). MPTs, multipurpose prevention technologies. Color images are available online.

TABLE 2. ASSOCIATIONS BETWEEN DEMOGRAPHICS AND HUMAN IMMUNODEFICIENCY VIRUS/PREGNANCY RISK FACTORS AND PREFERENCES FOR POTENTIAL MULTIPURPOSE PREVENTION TECHNOLOGY METHODS

	<i>Vaginal gel</i>	<i>Diaphragm</i>	<i>Vaginal ring</i>	<i>Injection</i>
Race				
White/Caucasian	—	—	—	—
Black or African American	1.48 (0.93–2.34)	0.81 (0.43–1.56)	0.80 (0.46–1.37)	1.31 (0.84–2.05)
Other	1.18 (0.71–1.97)	0.57 (0.28–1.14)	0.60 (0.33–1.08)	1.33 (0.80–2.20)
Education: Bachelor's Degree or higher	1.00 (0.75–1.33)	1.08 (0.75–1.54)	1.37 (1.00–1.87)	1.17 (0.89–1.54)
Relationship status: single	1.32 (0.93–1.87)	1.10 (0.71–1.70)	1.20 (0.82–1.74)	1.57 (1.11–2.20)
Use of any birth control (3 months): yes	1.32 (0.88–1.99)	2.59 (1.36–4.93)	1.97 (1.21–3.21)	1.93 (1.30–2.85)
HIV risk: yes	0.77 (0.55–1.08)	0.72 (0.48–1.07)	1.08 (0.74–1.55)	0.92 (0.67–1.27)
History of STI: yes	1.09 (0.74–1.60)	1.45 (0.92–2.28)	1.55 (1.04–2.29)	1.15 (0.80–1.66)
History of unplanned pregnancy: yes	1.52 (1.09–2.11)	1.73 (1.17–2.56)	1.67 (1.18–2.35)	1.08 (0.78–1.48)
HIV Worry: yes	2.40 (1.06–5.42)	3.00 (1.28–6.99)	2.05 (0.90–4.68)	0.85 (0.37–1.93)
Pregnancy worry: yes	1.81 (1.12–2.77)	1.95 (1.20–3.16)	1.63 (1.05–2.55)	1.22 (0.81–1.86)

Preferences for potential MPTs determined by women's reports of being "likely" or "very likely" to use a specific method. Subjects were considered at risk for HIV if they reported one or more of the following high-risk sexual behaviors as defined by the Centers for Disease Control and Prevention: lack of condom at last sex, sex with a casual partner, greater than one sexual partner in the past 3 months, sex with a known HIV-positive male partner, and anal sex without a condom.²⁵ Worry scores were calculated using a modified version of the Worry About Sexual Outcomes scale.²⁶ Significant associations noted in bold.

MPT, multipurpose prevention technology.

safety and effectiveness at preventing pregnancy were the two most important factors with overall scores of 2.82 and 2.78 out of 3, respectively. These were followed closely by potential side effects (2.60) and affordability (2.60). Effectiveness at preventing STIs (2.58) and HIV (2.56) was considered slightly less important. Having a monthly period (1.79), partner's opinion (1.86), and friends' opinions (1.29) were seen as the least important factors. Table 4 lists these factors in descending order of mean importance score. Among all respondents, the majority (53%) reported that they would be willing to pay between \$10 and \$50 per month for such a dual-purpose product. The next largest group (23%) found less than \$10 acceptable, while 5% were willing to pay over \$100/month.

Discussion

We found that women were more likely to use a long-acting MPT in the form of an injection, while fewer women were likely to use vaginal gels, rings, and diaphragms. Specifically, single women and those who had used birth control recently were likely to use an injectable MPT. This finding is consistent with preferences for delivery of HIV prophylaxis among women in the U.S. and worldwide.^{14,15} A qualitative study conducted at multiple U.S. sites found women preferred PrEP in the form of an injectable, while fewer were interested in the vaginal ring.¹⁵ In our population, vaginal gels were deemed the second most popular option. In particular, women who expressed concern regarding potential HIV infection or unintended pregnancy and those with a

TABLE 3. SIGNIFICANT ASSOCIATIONS BETWEEN CONTRACEPTIVE USE AND PREFERENCES FOR POTENTIAL MULTIPURPOSE PREVENTION TECHNOLOGY METHODS

	<i>Contraceptive method</i>	
MPT method	Use: ever OR (95% CI)	Use: 3 months OR (95% CI)
Injectable	Injectable: 1.76 (1.71–2.65)	Injectable: 3.75 (1.67–8.46) Any: 2.11 (1.40–3.19)
Vaginal gel	Diaphragm: 3.65 (1.77–7.53) Vaginal ring: 1.90 (1.22–2.96) Condoms: 1.65 (1.02–2.68)	Injectable: 2.03 (1.00–4.12) Condoms: 1.84 (1.36–2.49)
Vaginal ring	Vaginal ring: 6.04 (3.80–9.60) Patch: 2.64 (1.59–4.39) IUD: 1.75 (1.12–2.75)	Vaginal ring: 4.76 (2.27–9.97) Any: 1.99 (1.20–3.30) Condoms: 1.49 (1.08–2.06)
Diaphragm	Diaphragm: 6.42 (3.15–13.07) Vaginal ring: 2.93 (1.82–4.73) Condoms: 2.20 (1.08–4.47) Patch: 2.15 (1.24–3.76)	Vaginal ring: 3.21 (1.52–6.76) Condoms: 2.95 (1.94–4.49) Any: 2.60 (1.33–5.10)

Subjects were asked to indicate all types of contraception they had used at any time in the past and within the past 3 months from the following list: condoms, diaphragms, vaginal rings, birth control pills, patches, injectables, implants, and intrauterine devices. Preferences for potential MPTs determined by women's reports of being "likely" or "very likely" to use a specific method. Reported use of any contraception in the past excluded from the analysis (endorsed by >97% of the survey population). Recent use of contraceptive diaphragms and patches was excluded from the analysis (endorsed by <2% of total survey population); significant associations between contraceptive use and preferences for potential MPT methods are listed.

OR, odds ratio; CI, confidence interval.

TABLE 4. MULTIPURPOSE PREVENTION TECHNOLOGY ATTRIBUTE IMPORTANCE SCORES

<i>MPT attribute</i>	<i>Importance score (out of 3)</i>
Safety	2.83
Efficacy—preventing pregnancy	2.78
Side effects	2.60
Affordability	2.60
Efficacy—preventing STIs	2.58
Efficacy—preventing HIV	2.56
Long lasting	2.43
Forgettable	2.20
Privacy	2.16
Partner's opinion	1.86
Having a monthly period	1.79
Friends' opinions	1.29

Subjects indicated the importance of each of the above attributes when choosing a potential MPT product. Individual scores were averaged to obtain the mean importance score (out of 3) for each attribute; $n = 832$ – 835 .

history of unintended pregnancy were likely to try an MPT in the form of a vaginal gel. However, past clinical trial experiences with vaginal gel formulations for HIV prophylaxis have demonstrated low adherence, exemplifying the fact that hypothetical product preference may not reflect future adherence, and raising concern that an MPT in this form might ultimately suffer from low usage rates in practice.^{10,11,29} Notably, two-thirds of women reported they were likely or very likely to use at least one MPT modality. Our findings add to the literature emphasizing the importance of having multiple formulations available to increase options for women and broaden opportunities for use.

Despite low overall interest in the vaginal ring, we found that women who had used a vaginal ring in the past were more willing to use an MPT of the same form. In addition, women from specific groups, including those with higher education, recent birth control use, history of an STI or unplanned pregnancy, and concern for pregnancy, reported higher likelihood of use of a vaginal ring. Finally, despite receiving the lowest support, we found that women who had previous experience with diaphragms were far more likely to use this type of MPT in the future than women who had never used such a product. In general, women with prior experience using a specific method of contraception appeared more likely to try an MPT of the same form. Overall, the women concerned about STIs and unwanted pregnancy, or with a history of such undesirable sexual outcomes, expressed higher likelihood of use for a broader range of products.

Efficacy in general was found to be of utmost importance, with protection from pregnancy seen as more important than protection from HIV or other STIs. This indicates that for women using a dual-purpose product such as an MPT, pregnancy prevention remains the top priority. Consistent with this finding, prior research has shown that women are most concerned with pregnancy prevention when choosing a contraceptive method.³⁰ It is interesting to note that vaginal gels, a major contender in MPT development and among the forms preferred by the women in our study, demonstrate low contraceptive efficacy with typical use.³¹ Given limitations with user-dependent and coitally dependent methods on ad-

herence, these findings support the development of long-term MPT options, such as LAIs and implants.

Along with efficacy, the women in our study prioritized safety, closely mirroring the findings of a survey investigating the influence of various contraceptive attributes on women's decision making.²⁰ Our respondents were also concerned about potential side effects, echoing the sentiment of women considering potential uptake of PrEP.^{15,16} There is uncertainty regarding a possible interaction between some antiretroviral mediations and hormonal contraception.³² In our population of women who are most concerned with pregnancy prevention, the possibility of a decrease in contraceptive efficacy could influence their decision to use an MPT product. Finally, affordability of MPTs was a major concern for the women in our study as it was for both contraception and PrEP in prior studies.^{15,16,19,20}

The results of this study must be interpreted in the context of the survey population in regard to actual and perceived risk of HIV infection. First, our population is biased toward urban women living in the southern U.S. As per the current HIV Surveillance Report published by the CDC, most HIV diagnoses among heterosexual women in the U.S. come from this region.³³ In addition, a majority of our population reported at least one sexual behavior putting them at risk for HIV infection. Thus, our results incorporate a population of women who may be at higher than average risk for HIV and would potentially benefit more from MPTs designed toward their needs. Consistent with this, protection from HIV was seen as a top priority. The survey did not inquire about use of PrEP, missing an opportunity to specifically investigate a population with high self-perceived risk of HIV infection. However, the national rate of PrEP usage is low, especially among women.^{34,35} Furthermore, less than 3% of the survey population reported worry about their own personal risk for HIV infection. Together, these facts suggest that the small number of survey participants using PrEP is unlikely to affect our results. It is important to note that the lack of perceived risk of HIV infection may have led to lower reported likelihood of use of potential MPTs compared to a population with higher perceived risk.

Our study has strengths and some limitations. MTurk has been used frequently for social science research, but it is a relatively new tool in behavioral science. While the MTurk platform has been shown to be similar to other high-quality internet surveys in terms of gender, racial, and geographic breakdown, although with lower average age, our study may remain limited by potential selection bias for those who have participated and have limitations of external validity.²² Despite these potential issues, we chose to use the task marketplace model as it allowed us to quickly, efficiently, and cost-effectively collect data from a specific yet sizeable subset of women from across the U.S. By nature, survey responses are self-reported and as such, suffer from recall bias, which can influence results. In addition, it is worth noting that this online recruitment method limits our sample to women with the means to access the internet. Despite the size of our survey population, certain contraceptive methods, including injections, rings, and diaphragms, exhibited low overall usage. As these methods overlap with the potential MPT formulations, this low usage limits our ability to interpret the results in terms of future use of similar products.

Conclusions

Our data show that young, sexually active, U.S. women are most interested in MPTs in the form of LAIs to protect them from unintended pregnancy and HIV/STIs. However, subgroups within the total survey population were also likely to use vaginal gels, rings, and diaphragms with greater likelihood based on past and current sexual behaviors, as well as prior experience with comparable forms of contraceptives. This finding highlights the importance of developing a suite of products to meet the needs and demands of a diverse population of women. In addition, a highly safe, efficacious, and affordable product was deemed most acceptable to our population of young U.S. women. Although we have identified desirable characteristics for hypothetical products, this may not predict future uptake and continued use of MPTs. As we know from PrEP studies in Africa, interest and acceptance do not necessarily correspond with adherence.^{9–12,36} These preferences should be used as development guidelines to be adjusted when data on actual product usage are available. In addition, exploring women's product preferences is only one piece in a much more complex development puzzle, which includes determining appropriate pharmaceutical ingredients and finding the correct dosage for each form, followed by safety and efficacy testing, product approval, and ultimately marketing and product release. As MPT development continues, it will be important to study the complex interplay of factors affecting adherence to a multipurpose product to maximize the potential benefit in protecting women from sexual and reproductive health risks.

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References

- Malcolm RK, Boyd P, McCoy CF, Murphy DJ. Beyond HIV microbicides: Multipurpose prevention technology products. *BJOG* 2014;121 Suppl 5:62–69.
- Schelar E. Global mapping of STI, HIV and unplanned pregnancy: Where do these epidemics intersect? *Sex Transm Infect* 2015;91:A21.
- Romano J, Manning J, Hemmerling A, McGrory E, Holt BY. Prioritizing multipurpose prevention technology development and investments using a target product profile. *Antiviral Res* 2013;100 Suppl:S32–S38.
- Friend DR. An update on multipurpose prevention technologies for the prevention of HIV transmission and pregnancy. *Expert Opin Drug Deliv* 2016;13:533–545.
- Friend DR, Clark JT, Kiser PF, Clark MR. Multipurpose prevention technologies: Products in development. *Antiviral Res* 2013;100 Suppl:S39–S47.
- Brady M, Tolley E. Aligning product development and user perspectives: Social-behavioural dimensions of multipurpose prevention technologies. *BJOG* 2014;121 Suppl 5: 70–78.
- Woodsong C, Holt JD. Acceptability and preferences for vaginal dosage forms intended for prevention of HIV or HIV and pregnancy. *Adv Drug Deliv Rev* 2015;92:146–154.
- Boonstra H, Barot S, Lusti-Narasimhan M. Making the case for multipurpose prevention technologies: The socio-epidemiological rationale. *BJOG* 2014;121 Suppl 5:23–26.
- Van Damme L, Corneli A, Ahmed K, et al. Preexposure prophylaxis for HIV infection among African women. *N Engl J Med* 2012;367:411–422.
- Marrazzo JM, Ramjee G, Richardson BA, et al. Tenofovir-based preexposure prophylaxis for HIV infection among African Women. *N Engl J Med* 2015;372:509–518.
- Rees H, Delaney-Moretlwe SA, Lombard C, et al. FACTS 001 Phase III trial of pericoital tenofovir 1% gel for HIV prevention in women *Conference on Retroviruses and Opportunistic Infections*. Seattle, WA:(Abstract 26LB), 2015.
- Sheth AN, Rolle CP, Gandhi M. HIV pre-exposure prophylaxis for women. *J Virus Erad* 2016;2:149–155.
- Hynes JS, Sales JM, Sheth AN, Lathrop E, Haddad LB. Interest in multipurpose prevention technologies to prevent HIV/STIs and unintended pregnancy among young women in the United States. *Contraception* 2017;97:277–284.
- Eisingerich AB, Wheelock A, Gomez GB, Garnett GP, Dybul MR, Piot PK. Attitudes and acceptance of oral and parenteral HIV preexposure prophylaxis among potential user groups: A multinational study. *PLoS One* 2012;7: e28238.
- Auerbach JD, Kinsky S, Brown G, Charles V. Knowledge, attitudes, and likelihood of pre-exposure prophylaxis (PrEP) use among US women at risk of acquiring HIV. *AIDS Patient Care STDS* 2015;29:102–110.
- Smith DK, Toledo L, Smith DJ, Adams MA, Rothenberg R. Attitudes and program preferences of African-American urban young adults about pre-exposure prophylaxis (PrEP). *AIDS Educ Prev* 2012;24:408–421.
- Flash CA, Stone VE, Mitty JA, et al. Perspectives on HIV prevention among urban black women: A potential role for HIV pre-exposure prophylaxis. *AIDS Patient Care STDS* 2014;28:635–642.
- Goparaju L, Experton LS, Praschan NC, Warren-Jeanpiere L, Young MA, Kassaye S. Women want pre-exposure prophylaxis but are advised against it by their HIV-positive counterparts. *J AIDS Clin Res* 2015;6:1–10.
- Wingood GM, Dunkle K, Camp C, et al. Racial differences and correlates of potential adoption of preexposure prophylaxis: Results of a national survey. *J Acquir Immune Defic Syndr* 2013;63 Suppl 1:S95–S101.
- Madden T, Secura GM, Nease RF, Politi MC, Peipert JF. The role of contraceptive attributes in women's contraceptive decision making. *Am J Obstet Gynecol* 2015;213: 46.e41–e46.

21. Buhrmester M, Kwang T, Gosling SD. Amazon's mechanical turk: A new source of inexpensive, yet high-quality data? *Perspect Psychol Sci* 2011;6:3–5.
22. Berinsky AJ, Huber GA, Lenz GS. Evaluating online labor markets for experimental research: Amazon.com's mechanical turk. *Pol Anal* 2012;20:351–368.
23. U.S. Census Bureau. Census Regions and Divisions of the United States. Washington, DC: Geography Division of the US. Census Bureau, 2015.
24. United States Zip Codes [Zip Code Database]. 2014. Available at: www.unitedstateszipcodes.org Accessed November 8, 2016.
25. U.S. Census Bureau. Urban and Rural Universe: Housing Units. Washington, DC: Online report from the United States Census Bureau, 2010.
26. Centers for Disease Control and Prevention. HIV Risk Reduction Tool. Available at: <https://wwwn.cdc.gov/hivnsk> Accessed November 8, 2016.
27. Sales JM, Spitalnick J, Milhausen RR, et al. Validation of the worry about sexual outcomes scale for use in STI/HIV prevention interventions for adolescent females. *Health Educ Res* 2009;24:140–152.
28. SPSS for Macintosh, Version 23.0. Armonk, NY: IBM Corporation, 2015.
29. Abdool Karim Q, Abdool Karim SS, Frohlich JA, et al. Effectiveness and safety of tenofovir gel, an antiretroviral microbicide, for the prevention of HIV infection in women. *Science* 2010;329:1168–1174.
30. Grady WR, Klepinger DH, Nelson-Wally A. Contraceptive characteristics: The perceptions and priorities of men and women. *Fam Plann Perspect* 1999;31:168–175.
31. Centers for Disease Control and Prevention. How effective are birth control methods? Available at: <https://www.cdc.gov/reproductivehealth/contraception> Accessed February 9, 2017.
32. Robinson JA, Jamshidi R, Burke AE. Contraception for the HIV-positive woman: A review of interactions between hormonal contraception and antiretroviral therapy. *Infect Dis Obstet Gynecol* 2012;2012:890160.
33. Centers for Disease Control and Prevention. HIV surveillance report, 2016. Atlanta, GA: Centers for Disease Control and Prevention, 2017.
34. Flash C, Landovitz R, Giler RM, et al. Two years of Truvada for pre-exposure prophylaxis utilization in the US. *J Int AIDS Soc* 2014;17(4 Suppl 3):19730.
35. Sullivan PS, Giler RM, Mouhanna F, et al. Trends in the use of oral emtricitabine/tenofovir disoproxil fumarate for pre-exposure prophylaxis against HIV infection, United States, 2012–2017. *Ann Epidemiol*. DOI: 10.1016/j.annepidem.2018.06.009
36. Kester LM, Zimet GD, Fortenberry JD, Kahn JA, Shew ML. A national study of HPV vaccination of adolescent girls: Rates, predictors, and reasons for non-vaccination. *Matern Child Health J* 2013;17:879.

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