Title: *Measuring PrEP Preferences Among At-Risk Military Populations: Results of an Adaptive Choice Based Conjoint Analysis Study*

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Dr. Xiao-Bing Fu, Editor-in-Chief
Dr. Qing-Jie Li, Honorary Editor-in-Chief
Military Medical Research

July 27, 2020

Dear Drs. Fu and Li:

I am writing to submit our manuscript titled “Measuring PrEP Preferences Among At-Risk Military Populations: Results of an Adaptive Choice Based Conjoint Analysis Study” for consideration for publication as a research article within the Military Medical Research journal.

Pre-exposure prophylaxis (PrEP) is a medication that effectively prevents HIV infection when taken correctly yet is underutilized within the military health care system. For this study, we identified the preferred characteristics of an ideal PrEP delivery program within the military health care system through an anonymous, conjoint analysis survey of at-risk, U.S. military members. Our findings reveal that a military, on-base health care setting is most preferred for PrEP delivery, yet also indicate a need for quality clinical interactions that are sensitive to sexual identity, mental health, and decision autonomy.

Given the low uptake of PrEP by at-risk military members, we believe that the findings presented in our paper will appeal to key infectious disease stakeholders and policymakers who subscribe to Military Medical Research. Our results will allow your readers to understand which characteristics of a military PrEP delivery program are most attractive to the distinct preferences of this vulnerable population. In doing so, we hope our research will advance evidence-informed PrEP delivery programs within the military health care system tailored to the preferences of U.S. military members most at risk for acquiring HIV.

All listed authors confirm that this manuscript has not been previously published, nor is it currently under consideration by any other journal. Furthermore, all authors have approved the contents of this paper and have agreed to MMR’s submission policies.

Should our manuscript be selected for peer review, we would like to suggest the following reviewers that would be able to objectively evaluate our findings and interpretation based on their research background and expertise.

- **Liana Fraenkel, MD, MPH**, Yale University/Berkshire Medical Center, liana.fraenkel@yale.edu (expertise: conjoint analysis, decision science, preference behavior)
- **José A. Bauermeister, PhD, MPH**, University of Pennsylvania, b jose@upenn.edu (expertise: HIV/AIDS & PrEP science, health-seeking & sexual behaviors of at-risk populations)
- **Patrick W. Kelley, MD, DrPH**, Fairfield University, pkelley@fairfield.edu (expertise: military preventative medicine, global infectious disease control)

- **Jason F. Okulicz, MD**, Uniformed Services University of the Health Sciences/U.S. Air Force HIV Medical Evaluation Unit, jason.f.okulicz.mil@mail.mil (expertise: infectious diseases and PrEP use among military populations)

Each of the authors named on the manuscript has contributed to the development, interpretation and drafting of this manuscript. To the best of our knowledge, the named authors have no conflicts of interest.

Sincerely,

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48 **ABSTRACT**

49 **BACKGROUND.** Pre-exposure prophylaxis (PrEP) effectively prevents HIV infection,
50 yet its uptake remains low among U.S. military men who have sex with men (MSM).

51 Research shows that health services matching preferences produce favorable outcomes.
52 Therefore, an early step for planning program design is to characterize and identify
53 preferences for improved PrEP delivery within this population.

54 **METHODS.** HIV-negative military MSM were recruited through a closed, LGBT
55 military social media group. Participants completed an anonymous survey presenting five
56 experimentally varied attributes of interest related to PrEP administration (dosing
57 method, provider type, visit location, lab work evaluation location, and dispensing
58 venue). Relative importance and part-worth utility scores were generated using
59 Hierarchical Bayes (HB) estimation, and the randomized first choice model was used to
60 examine participation interest across eight possible PrEP program scenarios.

61 **RESULTS.** Among the 429 participants and the eight scenarios that varied the five
62 attributes into delivery profiles, the most preferred scenario (69.9%) featured a daily pill
63 or long-term PrEP injection, military provider, smartphone/telehealth visit, lab evaluation
64 on-base, and on-base medication pick-up. Responses indicated the need for providers to
65 familiarize themselves with PrEP prescription knowledge and to provide interactions
66 sensitive to sexual identity, mental health, and decision autonomy.

67 **CONCLUSION:** These results suggest that a military setting is preferred over a civilian
68 or off-site one, yet more importantly, it points to a high value placed on the quality of
69 clinical interactions. High interest in long-acting implants and injections also suggest
70 potential markets for future PrEP engagement.

71 **TRIAL REGISTRATION.** Not applicable.

72 **KEYWORDS.** Conjoint analysis, pre-exposure prophylaxis, PrEP, preference, decision
73 science, HIV, military health, infectious disease

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94 **BACKGROUND**

95 Each year, there are approximately 350 new cases of human immunodeficiency
96 virus (HIV) infections within members of the U.S. military; with those most affected
97 being younger, Black, and men who have sex with men.(1-5) When taken correctly, Pre-
98 exposure Prophylaxis (PrEP) effectively prevents HIV infection,(6-9) yet the current
99 PrEP cascade within the U.S. military suggests sub-optimal uptake; with an estimated
100 16% of eligible members taking PrEP and members of color remaining under-represented
101 in terms of treatment.(2) Identifying the factors that drive uptake within this population
102 remains a priority.

103 The field of PrEP science has explored multiple avenues of PrEP access
104 pathways, delivery mechanisms, and dosing methods to circumvent the geographic,
105 psychological, and adherence barriers that exist and impede PrEP engagement.(10-17)
106 Currently, military PrEP engagement depends on geographic proximity to a large medical
107 facility with specialty services, as evidenced by 41% of all military PrEP prescriptions
108 originating from military medical centers in three locations in the U.S. Additionally, 60%
109 of all military PrEP prescriptions occur only after consultation with an infectious disease
110 specialist.(2) Data are sparse on military MSM's most preferred program characteristics
111 within a PrEP delivery program.

112 Health services designed around preferences in terms of product type, delivery
113 method, and location settings have been shown to produce improved treatment outcomes
114 and retention to care.(18-20) Stated preference methods, such as conjoint analysis,
115 quantify preference data of new market entrants and product characteristics; also called
116 *attributes*.(15, 16, 21-25) The central theory of conjoint analysis is that products or

117 programs are viewed as a composition of various attributes that possess a certain amount
118 of value (part-worth utility score) determined by preference. By quantifying this value
119 (part-worth utility scores) for preferred attributes, these scores can then be entered into
120 market simulation models to predict how respondents might respond to *any* potential
121 combination of attribute levels.(15, 16, 21-25) Using conjoint analysis, the purpose of
122 this study was to identify the preference factors that are most influential to at-risk U.S.
123 military MSM's decision to take PrEP within the military healthcare system.

124 **METHODS**

125 A convenience sample of self-reported HIV-negative, U.S. military MSM and
126 trans-individuals were recruited between March and April 2020 through a closed
127 Facebook group with an internal membership of over 7,000 LGBT U.S. military
128 members. The group administrators placed monthly advertisements describing the study
129 on the group's main forum. Those interested could click on a link to access an online
130 study disclosure form with a 'click to consent' procedure. An option to provide an e-mail
131 address that was not linked to survey responses was offered to participants who opted to
132 receive \$5 compensation for questionnaire completion. The study was approved by the
133 Yale University Institutional Review Board.

134 To collect and quantify respondent preference data, an adaptive choice-based
135 conjoint (ACBC) survey instrument was developed based on a review of the literature
136 and in-depth input from PrEP experts and U.S. military MSM.(2-5, 10, 11, 13, 14, 26-
137 35).(36-38) With a focus on modifiable PrEP program characteristics, the final survey
138 design was composed of five different PrEP program delivery attributes of interest that
139 included: **dosing method** (*daily pill, on-demand pill regimen [two pills before sex, one*

140 *pill for two days after*], *rectal douche [before sex]*, *injection [every 2 months]*, *implant*
141 *[once a year]*), **provider type** (*military, civilian*), **visit location** (*on-base, off-base,*
142 *smartphone app*), **dispensing venue** (*on-base, off-base, mail delivery*), and **lab**
143 **evaluation** (*on-base, off-base, home-based mail kit*). The survey was piloted with 11
144 members within the targeted social media group for concept testing, and the descriptions
145 and wording of three attribute categories and two attribute level choices were revised for
146 clarification based on feedback. Additionally, we collected demographical data to include
147 age, race, ethnicity, rank type (officer, enlisted or warrant officer), military branch,
148 geographic region, PHQ2(39) and HIRI-MSM risk score,(40) as well as measures to
149 explore levels of disclosure discomfort and anticipated stigma within interactions with a
150 health care provider.

151 **ANALYSIS**

152 The final survey instrument was loaded into Lighthouse Studio 9, and an
153 experimental design module was used to pre-test the design with 500 simulated
154 respondents for optimal choice task configuration. The final design produced a survey
155 where each level within an attribute was seen at least three times per respondent;
156 achieving a high degree of precision at the individual level with a standard of error of
157 <0.03 and all efficiencies reporting at 1.00.(41)

158 Table 1 displays the CONSORT diagram of respondent enrollment and exclusion.
159 To ensure the integrity of the data and eliminate random or duplicate responders, security
160 features within the Sawtooth software and servers recognize returning study participants
161 through the use of internet browser cookies and IP addresses. It also prevents repeated or
162 duplicate attempts to retake the survey.(42) Additionally, as extensive pilot testing

163 required at least 10 to 15 minutes, responses completed in less than 10 minutes (or if a
164 respondent selected the same answer for all items) were excluded. Also, the root
165 likelihood (RLH) fit statistic for each respondent was analyzed to evaluate within-
166 respondent choice consistency. RLH, which has a probability value from 0 to 1.0, was
167 used to discriminate between respondents who answered choice-questions consistently or
168 randomly.(43) The survey design was tested by 1,000 computer-generated mock
169 respondents to determine the median RLH for ‘random responders’ at the 95% percentile
170 (0.5178 RLH). Survey respondents with an RLH below this score were excluded, as the
171 inclusion of ‘random responders’ can affect the calculation of preference scores and
172 participation rates.(43)

173 For conjoint analyses, the Hierarchical Bayes (HB) procedure was used to
174 estimate part-worth utility scores (PWUS) on an individual level for its accuracy and
175 efficiency,(44, 45) and was used to analyze the PWUS of the aggregated sample across
176 all 16 attribute levels. The resulting PWUS of the levels under each attribute category are
177 zero-centered; meaning that the sum of the level scores under each attribute category
178 equal to zero. Scores that are further away from zero (0) indicate a stronger positive or
179 negative preference for the level choice in relation to the other level choices under the
180 same attribute.(38, 41, 45) After identifying each attribute level PWUS, the attribute
181 relative importance scores (RIS) can then be calculated to characterize the magnitude of
182 influence that each attribute category has on the respondents preference decision-making.
183 The RIS for this study was calculated by dividing the range of PWUS for levels under
184 each attribute by the sum of the ranges, and then multiplying by 100.(46, 47) Therefore,
185 if an attribute RIS is 45%, then this means that 45% of an individual’s decision making

186 for product engagement will be influenced by preferences within that attribute category.
187 The PWUS were then used to predict the rate of participation among eight hypothetical
188 PrEP program scenarios. PrEP program scenarios were configured after a variety of
189 currently available or currently feasible PrEP program models, as well as best- and worst-
190 case scenarios based on the highest and lowest PWUS among the attribute levels. For the
191 aggregate sample, participation rates for these PrEP scenarios were generated using the
192 randomized first choice model; in which PWUS are summed across the levels
193 corresponding to each option, and then exponentiated and rescaled, so they sum to
194 100.(46, 47) This approach is based on the assumption that respondents or consumers
195 will prefer a product with the highest composite utility (or value) adjusting for both
196 attribute and program variability.(46) The randomized choice model accounts for
197 variation in each participant's total utility for each option and error in point estimates of
198 the utility, and has been shown to have better predictive ability than other shares of
199 preference models.(47) All data analyses were performed using XLSTAT and Sawtooth
200 Lighthouse Studio 9.0.

201 **RESULTS**

202 ***Participants.*** Table 2 shows the descriptive statistics of the 429 respondents that
203 met the required elapsed survey time and RLH consistency cut-off. Overall, mean age
204 was 30 years old, 96.7% identified as cis-gendered male (2.6% identified as trans-female,
205 and 0.7% identified as trans-male), 72% were white, 72.5% were of non-Hispanic
206 ethnicity, 46.4% were of officer rank, 54.1% had at least a bachelor's degree or above,
207 and 48.7% were within the U.S. Army branch. Overall, 62.7% screened positive for

208 depressive symptoms, 89.3% were defined as having a high objective risk for acquiring
209 HIV,(40) and 83.0% reported condomless receptive anal sex within the prior six months.

210 In interactions with their primary care provider (PCP), 36.8% were “somewhat-”
211 or “extremely” uncomfortable with talking about sex with their PCP, 48.1% were
212 “somewhat” or “very” fearful of being judged by their PCP for their gay/MSM identity,
213 and 45.2% were fearful for becoming mistreated by their PCP for their gay/MSM identity
214 as well. Furthermore, 64.1% of respondents found it “somewhat” or “very” important that
215 their PCP affirms or show interest in the participant’s sexual identity concerning their
216 care, and 78.4% of members found it important that their PCP provides a high degree of
217 medication decision-making autonomy for taking PrEP.

218 Table 3 shows the relative importance scores (RIS) of the five attributes, and
219 Table 4 shows the part-worth utility scores (zero-centered) for each attribute level. For
220 this study, the *dosing method* was the most critical attribute among the participants with a
221 relative importance score (RIS) of 45.2%; suggesting that the participant’s decision-
222 making process to participate in a PrEP program is most influenced by the level choice
223 within the *dosing method* attribute. For *dosing method*, a daily pill was the most preferred
224 option, although the bi-monthly PrEP injection and yearly implant were also preferred to
225 a slightly lesser degree. The on-demand pill regimen and before-sex rectal PrEP douche
226 were less preferred within the aggregate sample.

227 The *provider type* attribute was the second most important attribute to
228 respondents, although to a much lesser degree at 15.8% (RIS). Looking at level within
229 this attribute, there was a higher preference for a military than a civilian healthcare
230 provider. The *PrEP visit location* attribute was the third most important attribute

231 (RIS=14.5%). Respondents preferred to have a virtual medical visit through a smartphone
232 app or on-base location more than an off-base visit location the most. For the *laboratory*
233 *evaluation location* attribute (RIS=13.4%), participants preferred to provide specimens
234 for assays to initiate or continue PrEP on-base rather than a location off-base, or through
235 a self-collected, home-based mail-in kit. *PrEP dispensing venue* had the least influence
236 on participants' decision-making (RIS=11.0%), with participants preferring to receive or
237 pick-up their PrEP medication on-base over a mail delivery service or a location off-base.

238 We utilized the randomized first choice model to estimate the participation
239 interest rate that individuals would have towards a variety of hypothetical PrEP program
240 configurations.(47) For this study, the relative importance and part-worth utility scores
241 were used to construct eight PrEP program scenarios for currently available or feasible
242 PrEP program models (Scenarios 1 through 5), and hypothetical PrEP program models
243 for dosing methods still in development at the time of the survey (i.e., PrEP injection,
244 implant, rectal douche) (Scenarios 6 through 8).

245 Table 4 describes the eight PrEP program scenarios and displays the rates of
246 participation interest across the individual PrEP program configurations. These same
247 eight scenarios are also referenced in Tables 5 and 6.

248 Scenario 1 and 2 represent on-base military PrEP delivery. Scenario 1 (Standard
249 Military Daily Pill) best represents the current state of an on-base, daily pill PrEP
250 program within the military healthcare system today; scoring a total participation rate of
251 66.4% for the aggregate sample. Scenario 2 (Standard Military Daily Pill + Smartphone)
252 utilized the smartphone app option within the current daily pill military PrEP program;
253 resulting in a 3% increase in projected participation to a total of 69.6%.

254 Scenario 3 (Best Case Military On-Demand) introduces an on-demand pill
255 regimen within a best-case military setting (military provider, smartphone app visit, on-
256 base location for lab work, and on-base location to receive PrEP medication); resulting in
257 a 67.6% participation rate. Scenario 4 (Military Home-Based PrEP) is a distance-based
258 program configured for military members whose personal or work-related circumstances
259 compel the individual to see a military provider via a smartphone app and mail-delivery
260 options; resulting in a participation rate of 65.2% among the total sample.

261 Scenario 5 (Standard Civilian Daily Pill) was configured to represent a civilian-
262 equivalent, off-base, daily pill PrEP program that circumvents the military and on-base
263 aspects of a PrEP program; with 57.7% of the aggregate sample interested in such a
264 program.

265 Scenarios 6 through 8 (Best Case Military Injection, Best Case Military Implant,
266 Best Case Military Rectal Douche, respectively) are hypothetical scenarios that utilize
267 conceptual PrEP dosing methods currently in development.(10, 14) By presenting each of
268 these dosing methods within a best-case delivery scenario (military provider, smartphone
269 app visit, on-base location for lab work, and on-base location to receive medication),
270 respondents reported a higher participation rate of 69.6% for Scenario 6 (Best Case
271 Military Injection) and 68.5% for Scenario 7 (Best Case Military Implant). Conversely,
272 Scenario 8 (Best Case Military Rectal Douche) scored the lowest participation rate of all
273 scenarios at 51.6%.

274 **DISCUSSION**

275 The significant findings from this study reveal that respondents prefer the
276 convenience of daily pill PrEP services on-base over civilian and off-base settings, yet

277 also indicate a priority to address MSM-specific needs in the context of their care.
278 Despite an overall willingness to disclose same-sex activity, almost half of respondents
279 were fearful of being judged or mistreated by their PCP for their gay/MSM identity.
280 Additionally, over half of the respondents had a positive screening score for depressive
281 symptoms, and the majority of members engage in risk behaviors that categorize them as
282 having a high risk for acquiring HIV. With a growing body of literature suggesting a link
283 between depression and sexual risk behaviors among MSM,(48-50) it may be beneficial
284 for healthcare providers to provide PrEP clinics that are sensitive and inclusive to sexual
285 identity and to remain vigilant to address factors related to mental and sexual health. Also
286 important to members is valuing a high level of medication decision-making autonomy
287 for taking PrEP. Thus, healthcare providers' efforts to offer military members with the
288 necessary information and support about PrEP medication, without pressuring the
289 member into making a specific choice, may enhance the interaction experience for an
290 individual seeking PrEP within the military healthcare setting.

291 Results of the conjoint experiment found the *dosing method* attribute to be the
292 most critical and influential preference factor within a PrEP delivery program. The strong
293 preference for a daily pill (and when available, the PrEP injection and PrEP implant)
294 suggests that a demand remains for alternative short and long-acting PrEP methods
295 within this population. The apparent benefit to long-acting agents is that it lifts the burden
296 of a daily pill from a user; an advantage for an individual with adherence concerns or an
297 unpredictable work schedule. Military service's expeditionary nature often entails
298 military members to relocate, deploy, or miss regular follow-up appointments due to
299 specific duties.(51, 52) Therefore, the availability of alternative PrEP modalities that can

300 sustain a protective level of medication with fewer, longer medication administrations
301 may be an attractive component for members interested in PrEP. While not as important
302 as the dosing methods, respondents additionally preferred seeing a military provider,
303 interacting through a smartphone telehealth visit, and utilizing on-base locations for
304 laboratory evaluation and medication pick-up.

305 A preference to see a military provider for PrEP services remains prevalent
306 among the total sample; suggesting that it is the military healthcare provider that will be
307 central to the success of a military PrEP program. In a survey of military health care
308 providers regarding PrEP knowledge and prescription habits, 49% of them rated their
309 knowledge as poor and only 29% had ever prescribed it. Additionally, 60% of members
310 received their PrEP prescription after seeing an infectious disease specialist;(2)
311 suggesting that military primary care providers may not feel comfortable prescribing
312 PrEP or may be referring members to specialists for PrEP services. Therefore, supporting
313 primary care providers with the necessary training and resources to comfortably prescribe
314 PrEP may help members engage in services; particularly since it's been shown that an
315 increase in PrEP knowledge has been associated with an increase in prescribing
316 habits.(53)

317 This study has limitations. First, this study utilized self-report measures from a
318 convenience sample recruited from an online social media group comprised of U.S.
319 military members who identify as LGBT. While there was no way to verify actual
320 eligibility for inclusion/exclusion criteria due to the anonymous nature of the survey, the
321 literature examining MSM recruitment via online methods versus in-person had found
322 similar samples of HIV/STI prevalence and HIV-testing patterns among MSM.(54, 55)

323 However, these findings may not be generalizable to at-risk military members who do not
324 identify as being MSM or LGBT. Additionally, while quantifying preferences does not
325 guarantee intention or ultimately behavior, it can be an innovative first step and provide a
326 foundation to successfully inform PrEP initiatives.

327 **CONCLUSION**

328 This study provides an initial description of the preferences and interest for PrEP
329 by U.S. military service members with a high risk of acquiring HIV. Our results indicate
330 that PrEP interest among this population is most likely to be successful when PrEP is
331 offered as a daily pill, injection, or implant, with a medical visit performed with a
332 military healthcare provider through a telehealth smartphone app. Additionally, allowing
333 on-base locations to provide laboratory samples and to receive PrEP medication can also
334 facilitate program preference. PrEP engagement will further be enhanced by ensuring
335 that medical providers and facilities are knowledgeable and comfortable prescribing PrEP
336 services. Offering an affirming environment sensitive to health care concerns related to
337 mental and sexual health will also be important, as well as provide participants the
338 decision autonomy to take PrEP without pressure. Consequently, key populations,
339 stakeholders, and policymakers will be better equipped for scale-up of PrEP among at-
340 risk populations within the U.S. military.

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347 **LIST OF ABBREVIATIONS**

348 PrEP (Pre-exposure prophylaxis), MSM (men who have sex with men), HIV (human
349 immunodeficiency virus), LGBT (lesbian, gay, bi & transgender), HB (Hierarchical
350 Bayes), ACBC (adaptive choice-based conjoint), PHQ2 (Patient Health Questionnaire-2),
351 HIRI-MSM (HIV Incidence Risk Index for men who have sex with men), CONSORT
352 (Consolidated Standards of Reporting Trials), IP (internet protocol), RLH (root
353 likelihood), PWUS (part-worth utility scores), RIS (relative importance score), PCP
354 (primary care provider)

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383 **DECLARATIONS**

384 **ETHICS APPROVAL & CONSENT TO PARTICIPATE.** The study was approved

385 by the Yale University Institutional Review Board (IRB Protocol ID: 2000024612).

386 Social media group administrators placed monthly advertisement links describing the

387 study on the group’s main forum. Interested participants could click on a link to access an

388 online study disclosure form with a ‘click to consent’ procedure.

389 **CONSENT FOR PUBLICATION.** Not applicable.

390 **AVAILABILITY OF DATA & MATERIALS.** The datasets used and/or analyzed

391 during the current study are available from the corresponding author on reasonable

392 request.

393 **COMPETING INTERESTS.** The authors declare that they have no competing interests.

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397 view of NIH.

398 **AUTHORS CONTRIBUTIONS.** JG, AD, and FA analyzed and interpreted the

399 preference data regarding PrEP delivery program preferences, as well as demographical

400 descriptive statistics. JG and DV were major contributors in writing the manuscript. All

401 authors read and approved the final manuscript.

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REFERENCES

1. Armed Forces Health Surveillance B. Update: Routine screening for antibodies to human immunodeficiency virus, civilian applicants for U.S. military service and U.S. Armed Forces, active and reserve components, January 2013-June 2018. *MSMR*. 2018;25(9):2-8.
2. Blaylock JM, Hakre S, Okulicz JF, Garges E, Wilson K, Lay J, et al. HIV Preexposure Prophylaxis in the U.S. Military Services - 2014-2016. *MMWR Morb Mortal Wkly Rep*. 2018;67(20):569-74.
3. Hakre S, Scoville SL, Pacha LA, Peel SA, Kim JH, Michael NL, et al. Brief Report: Sexual Risk Behaviors of HIV Seroconverters in the US Army, 2012-2014. *J Acquir Immune Defic Syndr*. 2015;70(4):456-61.
4. Patterson SB, Rivera D, Sunil TS, Okulicz JF. Evaluation of extragenital screening for gonorrhea and chlamydia in HIV-infected active duty Air Force members. *MSMR*. 2014;21(11):7-9.
5. Hakre S, Mydlarz DG, Dawson P, Danaher PJ, Gould PL, Witkop CT, et al. Epidemiology of HIV among US Air Force Military Personnel, 1996-2011. *PLoS One*. 2015;10(5):e0126700.
6. Thigpen MC, Kebaabetswe PM, Paxton LA, Smith DK, Rose CE, Segolodi TM, et al. Antiretroviral preexposure prophylaxis for heterosexual HIV transmission in Botswana. *N Engl J Med*. 2012;367(5):423-34.
7. Grant RM, Lama JR, Anderson PL, McMahan V, Liu AY, Vargas L, et al. Preexposure chemoprophylaxis for HIV prevention in men who have sex with men. *N Engl J Med*. 2010;363(27):2587-99.
8. Choopanya K, Martin M, Suntharasamai P, Sangkum U, Mock PA, Leethochawalit M, et al. Antiretroviral prophylaxis for HIV infection in injecting drug users in Bangkok, Thailand (the Bangkok Tenofovir Study): a randomised, double-blind, placebo-controlled phase 3 trial. *Lancet*. 2013;381(9883):2083-90.
9. Baeten JM, Donnell D, Ndase P, Mugo NR, Campbell JD, Wangisi J, et al. Antiretroviral prophylaxis for HIV prevention in heterosexual men and women. *N Engl J Med*. 2012;367(5):399-410.
10. Lykins WR, Luecke E, Johengen D, van der Straten A, Desai TA. Long acting systemic HIV pre-exposure prophylaxis: an examination of the field. *Drug Deliv Transl Res*. 2017;7(6):805-16.
11. Molina JM, Charreau I, Spire B, Cotte L, Chas J, Capitant C, et al. Efficacy, safety, and effect on sexual behaviour of on-demand pre-exposure prophylaxis for HIV in men who have sex with men: an observational cohort study. *Lancet HIV*. 2017;4(9):e402-e10.
12. Antoni G, Tremblay C, Delaunay C, Charreau I, Cua E, Rojas Castro D, et al. On-demand pre-exposure prophylaxis with tenofovir disoproxil fumarate plus emtricitabine among men who have sex with men with less frequent sexual intercourse: a post-hoc analysis of the ANRS IPERGAY trial. *Lancet HIV*. 2020;7(2):e113-e20.
13. Pines HA, Gorbach PM, Weiss RE, Hess K, Murphy R, Saunders T, et al. Acceptability of potential rectal microbicide delivery systems for HIV prevention: a randomized crossover trial. *AIDS Behav*. 2013;17(3):1002-15.

- 454 14. Hendrix CW. HIV Antiretroviral Pre-Exposure Prophylaxis: Development
455 Challenges and Pipeline Promise. *Clin Pharmacol Ther.* 2018;104(6):1082-97.
- 456 15. Dubov A, Fraenkel L, Yorick R, Ogunbajo A, Altice FL. Strategies to Implement
457 Pre-exposure Prophylaxis with Men Who Have Sex with Men in Ukraine. *AIDS*
458 *Behav.* 2018;22(4):1100-12.
- 459 16. Dubov A, Ogunbajo A, Altice FL, Fraenkel L. Optimizing access to PrEP based
460 on MSM preferences: results of a discrete choice experiment. *AIDS Care.* 2018:1-
461 9.
- 462 17. Touger R, Wood BR. A Review of Telehealth Innovations for HIV Pre-Exposure
463 Prophylaxis (PrEP). *Current HIV/AIDS Reports.* 2019;16(1):113-9.
- 464 18. Swift JK, Callahan JL. The Impact of Client Treatment Preferences on Outcome:
465 A Meta-Analysis. *J Clin Psychol.* 2009;65(4):368-81.
- 466 19. Adamson SJ, Bland JM, Hay EM, Johnson RE, Jones GT, Kitchener H, et al.
467 Patients' preferences within randomised trials: systematic review and patient level
468 meta-analysis. *Bmj-Brit Med J.* 2008;337.
- 469 20. Graff FS, Morgan TJ, Epstein EE, McCrady BS, Cook SM, Jensen NK, et al.
470 Engagement and Retention in Outpatient Alcoholism Treatment for Women. *Am*
471 *J Addiction.* 2009;18(4):277-88.
- 472 21. Ryan M, Farrar S. Using conjoint analysis to elicit preferences for health care.
473 *BMJ.* 2000;320(7248):1530-3.
- 474 22. Phillips KA, Maddala T, Johnson FR. Measuring preferences for health care
475 interventions using conjoint analysis: an application to HIV testing. *Health Serv*
476 *Res.* 2002;37(6):1681-705.
- 477 23. Viney R, Lancsar E, Louviere J. Discrete choice experiments to measure
478 consumer preferences for health and healthcare. *Expert Rev Pharmacoecon*
479 *Outcomes Res.* 2002;2(4):319-26.
- 480 24. Lancsar E, Louviere J. Conducting discrete choice experiments to inform
481 healthcare decision making: a user's guide. *Pharmacoeconomics.* 2008;26(8):661-
482 77.
- 483 25. Opuni M, Bishai D, Gray GE, McIntyre JA, Martinson NA. Preferences for
484 characteristics of antiretroviral therapy provision in Johannesburg, South Africa:
485 results of a conjoint analysis. *AIDS Behav.* 2010;14(4):807-15.
- 486 26. Anderson CW, Smith HR. Stigma and honor: Gay, lesbian, and bisexual people in
487 the US military. *Homosexual issues in the workplace.* 1993:65-89.
- 488 27. Biddix JM, Fogel CI, Perry Black B. Comfort levels of active duty gay/bisexual
489 male service members in the military healthcare system. *Mil Med.*
490 2013;178(12):1335-40.
- 491 28. Russell TG. An examination of stigma in the military. 2013.
- 492 29. Lloyd J, Papworth E, Grant L, Beyrer C, Baral S. Systematic review and meta-
493 analysis of HIV prevalence among men in militaries in low income and middle
494 income countries. *Sex Transm Infect.* 2014;90(5):382-7.
- 495 30. Hakre S, Blaylock JM, Dawson P, Beckett C, Garges EC, Michael NL, et al.
496 Knowledge, attitudes, and beliefs about HIV pre-exposure prophylaxis among US
497 Air Force Health Care Providers. *Medicine (Baltimore).* 2016;95(32):e4511.
- 498 31. Galea JT, Kinsler JJ, Salazar X, Lee SJ, Giron M, Sayles JN, et al. Acceptability
499 of pre-exposure prophylaxis as an HIV prevention strategy: barriers and

500 facilitators to pre-exposure prophylaxis uptake among at-risk Peruvian
501 populations. *Int J STD AIDS*. 2011;22(5):256-62.

502 32. Eisingerich AB, Wheelock A, Gomez GB, Garnett GP, Dybul MR, Piot PK.
503 Attitudes and acceptance of oral and parenteral HIV preexposure prophylaxis
504 among potential user groups: a multinational study. *PLoS One*. 2012;7(1):e28238.

505 33. Wheelock A, Eisingerich AB, Ananworanich J, Gomez GB, Hallett TB, Dybul
506 MR, et al. Are Thai MSM willing to take PrEP for HIV prevention? An analysis
507 of attitudes, preferences and acceptance. *PLoS One*. 2013;8(1):e54288.

508 34. Shrestha R, Karki P, Altice FL, Dubov O, Fraenkel L, Huedo-Medina T, et al.
509 Measuring Acceptability and Preferences for Implementation of Pre-Exposure
510 Prophylaxis (PrEP) Using Conjoint Analysis: An Application to Primary HIV
511 Prevention Among High Risk Drug Users. *AIDS and behavior*. 2018;22(4):1228-
512 38.

513 35. Shrestha R, Altice F, Karki P, Copenhaver M. Developing an Integrated, Brief
514 Biobehavioral HIV Prevention Intervention for High-Risk Drug Users in
515 Treatment: The Process and Outcome of Formative Research. *Front Immunol*.
516 2017;8:561.

517 36. Toubia O, Hauser J, Garcia R. Probabilistic Polyhedral Methods for Adaptive
518 Choice-Based Conjoint Analysis: Theory and Application. *Marketing Science*.
519 2007;26(5):596-610.

520 37. Chapman C, Alford J, Johnson C, Weidemann R, Lahav M. CBC vs. ACBC:
521 comparing results with real product selection. *Sawtooth Software Conference*
522 *Proceedings*, Sequim, WA. 2009.

523 38. Cunningham CE, Deal K, Chen Y. Adaptive choice-based conjoint analysis: a
524 new patient-centered approach to the assessment of health service preferences.
525 *Patient*. 2010;3(4):257-73.

526 39. Lowe B, Kroenke K, Grafe K. Detecting and monitoring depression with a two-
527 item questionnaire (PHQ-2). *J Psychosom Res*. 2005;58(2):163-71.

528 40. Wilton J, Kain T, Fowler S, Hart TA, Grennan T, Maxwell J, et al. Use of an
529 HIV-risk screening tool to identify optimal candidates for PrEP scale-up among
530 men who have sex with men in Toronto, Canada: disconnect between objective
531 and subjective HIV risk. *J Int AIDS Soc*. 2016;19(1):20777.

532 41. Software S. Lighthouse Studio v9.0 (Formerly SSIWeb). Orem, UT: Sawtooth
533 Software; 2016.

534 42. Software S. Hosting Security Information 2018 [Available from:
535 [https://www.sawtoothsoftware.com/88-services/hosting/1457-hosting-security-](https://www.sawtoothsoftware.com/88-services/hosting/1457-hosting-security-information)
536 [information](https://www.sawtoothsoftware.com/88-services/hosting/1457-hosting-security-information).]

537 43. Orme B. Consistency Cutoffs to Identify "Bad" Respondents in CBC, ACBC, and
538 MaxDiff. *Sawtooth Software Research Paper Series*. 2019.

539 44. Lenk P, Desarbo W, Green P, Young M. Hierarchical Bayes Conjoint Analysis:
540 Recovery of Partworth Heterogeneity from Reduced Experimental Designs.
541 *Marketing Science*. 1996;15:173-91.

542 45. Rao V. *Applied Conjoint Analysis* 2013. 1-389 p.

543 46. Herrmann A, Gustafsson A, Huber F. *Conjoint Measurement: Methods and*
544 *Applications*. University of StGallen. 2007.

47. Orme B. Getting Started with Conjoint Analysis: Strategies for Product Design and Pricing Research. Second Edition ed. Madison, Wis.: Research Publishers LLC; 2010.
48. Millar BM, Starks TJ, Grov C, Parsons JT. Sexual Risk-Taking in HIV-Negative Gay and Bisexual Men Increases with Depression: Results from a U.S. National Study. *AIDS Behav.* 2017;21(6):1665-75.
49. Fendrich M, Avci O, Johnson TP, Mackesy-Amiti ME. Depression, substance use and HIV risk in a probability sample of men who have sex with men. *Addictive Behaviors.* 2013;38(3):1715-8.
50. Parsons JT, Grov C, Golub SA. Sexual Compulsivity, Co-Occurring Psychosocial Health Problems, and HIV Risk Among Gay and Bisexual Men: Further Evidence of a Syndemic. *American Journal of Public Health.* 2012;102(1):156-62.
51. Gleason JL, Beck KH. Examining Associations Between Relocation, Continuity of Care, and Patient Satisfaction in Military Spouses. *Military Medicine.* 2017;182(5-6):e1657-e64.
52. Brown RA, Marshall GN, Breslau J, Farris C, Osilla KC, Pincus HA, et al. Access to Behavioral Health Care for Geographically Remote Service Members and Dependents in the U.S. *Rand Health Q.* 2015;5(1):21-.
53. Blumenthal J, Jain S, Krakower D, Sun X, Young J, Mayer K, et al. Knowledge is Power! Increased Provider Knowledge Scores Regarding Pre-exposure Prophylaxis (PrEP) are Associated with Higher Rates of PrEP Prescription and Future Intent to Prescribe PrEP. *AIDS and behavior.* 2015;19(5):802-10.
54. Hernandez-Romieu AC, Sullivan PS, Sanchez TH, Kelley CF, Peterson JL, Del Rio C, et al. The comparability of men who have sex with men recruited from venue-time-space sampling and facebook: a cohort study. *JMIR Res Protoc.* 2014;3(3):e37.
55. Grov C, Westmoreland D, Rendina HJ, Nash D. Seeing Is Believing? Unique Capabilities of Internet-Only Studies as a Tool for Implementation Research on HIV Prevention for Men Who Have Sex With Men: A Review of Studies and Methodological Considerations. *J Acquir Immune Defic Syndr.* 2019;82 Suppl 3:S253-S60.
56. Whooley MA, Avins AL, Miranda J, Browner WS. Case-finding instruments for depression. Two questions are as good as many. *J Gen Intern Med.* 1997;12(7):439-45.

591 **APPENDIX**
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Table 1. Consort diagram for participant enrollment and exclusion, and part-worth utility scores (PWUS) of total sample with omitted responses due to RLH included.

<i>Enrollment</i>	<i>Exclusion</i>	<i>Total Sample PWUS with omitted responses due to RLH³</i>	
		<i>Attribute/Levels</i>	<i>PWUS</i>
1238 completed survey responses			
	Demographics Ineligibility (<i>n</i> =351) ¹	<i>Dosing Method</i>	
	• Cis-gendered women (<i>n</i> =139)	Daily pill	10.2
	• HIV-positive (<i>n</i> =66)	PrEP injection	11.2
	• No MSM activity (<i>n</i> =72)	PrEP implant	-3.6
	• Service impossibility ² (<i>n</i> =74)	On-demand	9.1
		Rectal douche	-26.9
		<i>Provider Type</i>	
		Military	3.8
		Civilian	-3.8
		<i>PrEP Visit Location</i>	
		Smartphone	3.2
		On-base	4.5
		Off-base	-7.8
		<i>Lab Evaluation</i>	
		On-base	15.0
		Off-base	-5.9
		Mail-in kit	-9.1
		<i>Dispensing Venue</i>	
		On-base	11.2
		Off-base	-2.0
		By mail	-9.2
		<i>NONE⁴</i>	-25.2
429 total completed responses included			
Notes: 1: Inclusion criteria demographics were assessed twice; at consent screen for eligibility, and again after conjoint experiment. 2: Omitted responses indicated a service impossibility, such as self-identifying as an Air Force warrant officer (does not exist) 3: PWUS calculated using omitted respondents due to RLH cut-off to examine differences in scores. 4: Increase in <i>NONE</i> utility score (up from -57.7), indicating that including the omitted responses with low RLH scores into the final sample affects the computation of PrEP participation rates calculated using the <i>NONE</i> utility score.			

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Table 2. Characteristics of the participants in the aggregate sample (N=429)					
<i>Variable</i>	<i>Frequency</i>	<i>%</i>	<i>Variable</i>	<i>Frequency</i>	<i>%</i>
<i>Age: Mean (±SD)</i>	29.9 (4.7)		<i>Condom Use with Casual Male Partner</i>		
<i>Gender</i>			Every time	46	10.7
Male	415	96.7	Often	156	36.4
Trans Female	11	2.6	Sometimes	127	29.6
Trans Male	3	0.7	Rarely	66	15.4
<i>Sexual Identity: Mean (±SD)^a</i>	7.0 (2.7)		Never	10	2.3
<i>Race</i>			No regular partner	24	5.6
White	309	72.0	<i># of Condom-less Receptive Anal Sex the Past 6 Months</i>		
Black	78	18.2	None	69	16.1
All Other Race	42	9.8	About once/month or less	249	58.0
<i>Ethnicity</i>			About once/week or more	111	25.9
Hispanic	118	27.5	<i>Comfort Level Discussing Sex with PCP</i>		
Non-Hispanic	311	72.5	Extremely	37	8.6
<i>Rank</i>			Uncomfortable		
Enlisted	161	37.5	Somewhat	121	28.2
Officer	199	46.4	Uncomfortable		
Warrant	69	16.1	Mostly Comfortable	209	48.7
<i>Education</i>			Extremely	62	14.5
High School	28	6.5	<i>How Fearful of PCP Judging You for being MSM?</i>		
AD or Some College	169	39.4	Very Fearful	62	14.5
Bachelor's Degree	188	43.8	Somewhat Fearful	144	33.6
Graduate/Prof Degree	44	10.3	Slightly Fearful	148	34.5
<i>Military Branch</i>			Not At All Fearful	75	17.5
Air Force	65	15.2	<i>How Fearful of PCP Mistreating You for being MSM?</i>		
Army	209	48.7	Very Fearful	79	18.4
Coast Guard	49	11.4	Somewhat Fearful	115	26.8
Marine Corps	48	11.2	Slightly Fearful	160	37.3
Navy	58	13.5	Not At All Fearful	75	17.5
<i>Region of Station^b</i>			<i>Decision Support Autonomy by PCP</i>		
Midwest	55	12.8	Not Important	4	0.9
Northeast	79	18.4	Slightly Important	89	20.7
Southeast	121	28.2	Somewhat Important	183	42.7
Southwest	40	9.3	Very Important	153	35.7
West	129	30.1	<i>Sexual Identity Affirmation by PCP</i>		
Other/OCONUS	5	1.2	Not Important	24	5.6
<i>Location Type of Station</i>			Slightly Important	130	30.3
Remote	33	7.7	Somewhat Important	199	46.4
Rural	77	17.9	Very Important	76	17.7
Suburban	150	35.0	<i>Depression PHQ Screening^c</i>		
Urban/City	169	39.4	≥1	269	62.7
<i>Condom Use with Regular Male Partner</i>			=0	160	37.3
Every time	51	11.9	<i>HIRI-MSM Risk Score^d</i>		
Often	144	33.6	≥10	383	89.3
Sometimes	111	25.9	<10	46	10.7
Rarely	68	15.9			

Table 2. Characteristics of the participants in the aggregate sample (N=429)					
Variable		Frequency	%	Variable	
Never		35	8.2		
No regular male partner		20	4.7		
Notes:					
a: 1-10 range (1=straight/heterosexual, 5=bisexual, 10=gay/homosexual)					
b: States within the U.S. Midwest (IA, IL, IN, KS, MI, MN, MO, ND, NE, OH, SD, WI), Northeast (CT, DC, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VT), Southeast (AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, VA, WV), Southwest (AZ, NM, OK, TX), West (AK, CA, CO, HI, ID, MT, NV, OR, UT, WA, WY), Other/OCONUS (overseas, out of country)					
c: Yes/No PHQ2 Version. Scores >=1 positive screen(56)					
d: 1-47 range. Scores >=10 defined as high risk for HIV(40)					

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Table 3. Relative importance scores (RIS) of PrEP attributes for the total sample ($N=429$) in decreasing order of preference

Attributes	Attribute RIS (%)	Standard Deviations
Dosing Method	45.2%	16.5
Provider Type	15.8%	11.5
PrEP Visit Location	14.5%	7.7
Lab Evaluation Location	13.4%	7.6
PrEP Dispensing Venue	11.0%	6.2

Attribute	RIS (%)
Dosing Method	45.2%
Provider Type	15.8%
Visit Location	14.5%
Lab Evaluation	13.4%
Disp. Venue	11.0%

Notes: Relative importance scores reflect the influence that each attribute has on a participant's decision-making (standardized to sum 100%).

Table 4. Part-worth utilities (zero-centered values) of PrEP program level choices of participants in the aggregate sample (N=429)

Attributes and Levels		Part-Worth Utilities (zero-centered) ^e	
<u>Dosing Method</u>			
Daily pill	21.75		Daily Tablet
PrEP injection	15.58		Injection
PrEP implant	14.05		Implant
On-demand regimen	8.99		On-Demand
PrEP rectal douche	-60.37		Rectal Douche
<u>Provider Type</u>			
Military	5.55		Military
Civilian	-5.55		Civilian
<u>PrEP Visit Location</u>			
Smartphone	7.69		Smartphone
On-Base	2.45		On-Base
Off-Base	-10.13		Off-Base
<u>Lab Evaluation Location</u>			
Provide labs on-base	12.65		On-Base
Provide labs off-base	-9.68		Off-Base
Home-based mail-in kit	-2.97		Mail-In Kit
<u>PrEP Dispensing Venue</u>			
Receive PrEP on-base	12.66		On-Base
Receive PrEP off-base	-8.42		Off-Base
Receive PrEP by mail	-4.23		Receive by Mail
NONE ^f	-54.7		

Notes:

e: Zero-centered part-worth utility scores imply the positive or negative magnitude of the participant’s preference for the level choice in relation to the other level options within the same attribute.

f: The “None” parameter represents the positive or negative magnitude in which a respondent is likely to select “None” (not willing to take PrEP in any scenario despite program configuration)

Notes:

e: Zero-centered part-worth utility scores imply the positive or negative magnitude of the participant's preference for the level choice in relation to the other level options within the same attribute.

f: The "None" parameter represents the positive or negative magnitude in which a respondent is likely to select "None" (not willing to take PrEP in any scenario despite program configuration)

Table 5. Individual Program Preferences. Acceptability (mean) of individual PrEP scenarios with different attributes among participants ($N=429$).*

PrEP Scenario	Participation Interest %	PrEP Attributes & Levels				
		<i>Dosing Method</i>	<i>Provider Type</i>	<i>Visit Location</i>	<i>Lab Evaluation</i>	<i>Dispensing Venue</i>
1: Standard Military Daily Pill	66.4%	Daily Pill	Military	On-base	On-base	On-base
2: Standard Military + Smartphone	69.6%	Daily Pill	Military	Smartphone	On-base	On-base
3: Best Case Military On-Demand	67.6%	On-Demand	Military	Smartphone	On-base	On-base
4: Military Home-Based PrEP	65.2%	Daily Pill	Military	Smartphone	Home kit	Mail Delivery
5: Standard Civilian Daily Pill	57.7%	Daily Pill	Civilian	Off-base	Off-base	Off-base
6: Best Case Military Injection	69.6%	Injection	Military	Smartphone	On-base	On-base
7: Best Case Military Implant	68.5%	PrEP Implant	Military	Smartphone	On-base	On-base
8: Best Case Military Rectal Douche	51.6%	Rectal Douche	Military	Smartphone	On-base	On-base

■ Participation Rate %

Notes:
 *1: Standard (Std) Military (Mil) Daily Pill (DP), 2: Standard Military + Smartphone (SP), 3: Standard Civilian (Civ) Daily Pill, 4: Best Case (BC) Military On-Demand (OD), 5: Military Home-Based (Home B) PrEP, 6: Best Case Military Injection (Inj), 7: Best Case Military Implant (Imp), 8: Best Case Military Rectal Douche (RD)