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Attribute development for a discrete choice experiment to examine preferences for long-acting HIV prevention products among pregnant and breastfeeding women

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The application of discrete choice experiments (DCEs) is gaining popularity as a means of exploring preferences on health-related issues. The quality and validity of DCEs largely depend on the formative phase of attribute development. This paper documents a systematic attribute development process for a DCE assessing preferences for long-acting HIV prevention products among pregnant and breastfeeding women (PBFW) in Kenya. We applied the Helter and Boehler four-stage attribute development framework, comprising raw data collection, data reduction, removal of inappropriate attributes, and appropriate wording. Through literature review and qualitative approaches, we identified twelve attributes for products formulated as oral tablets, injections, vaginal rings, and implants. Six of the twelve attributes were considered plausible, salient, and capable of being traded, namely dosing frequency, effectiveness in HIV prevention, ability to prevent pregnancy, ability to prevent sexually transmitted infections, product access location, and product cost. A pilot among thirty PBFW confirmed the clarity and relevance of the six attributes, informing their inclusion in the DCE. Documenting this transparent step-by-step process improves transparency and facilitates objective evaluation of the DCE's formative phase. These findings contribute to methodological rigour in DCE design and provide empirical evidence for expanding preference-based HIV prevention strategies that will benefit PBFW.

Keywords Discrete choice experiment, Attributes, Preferences, HIV prevention products, Pregnant and breastfeeding women, Kenya

Abbreviations

HIV	Human immunodeficiency virus
DCE	Discrete choice experiment
DPV-VR	Dapivirine vaginal ring
IDI	In-depth interviews
HF	Health facilities
KII	Key informant interviews
MNL	Multinomial logit model
PrEP	Pre-exposure prophylaxis

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STI	Sexually transmitted infections
TDF	Tenofovir disoproxil fumarate
UNAIDS	Joint United Nations Programme on HIV/AIDS
USFDA	U.S Food and Drug Administration
WHO	World Health Organization

Pregnant and breastfeeding women (PBFW) in high HIV prevalence settings face a significant risk of HIV acquisition[1]. For instance, a systematic analysis of 19 cohort studies showed pooled HIV incidence rates of 4.7 and 2.9 per 100 person-years during pregnancy and the postpartum period, respectively[2]. Susceptibility to HIV acquisition during these periods is linked to social and biological factors, including suppressed adaptive immunity, alterations in the genital tract microbiome, and trauma during delivery[3–5]. HIV acquisition during pregnancy not only impacts the woman's health but also increases the risk of vertical HIV transmission[6].

The Joint United Nations Programme on HIV/AIDS (UNAIDS) emphasizes the promotion of effective HIV prevention options for PBFW in high HIV incidence areas[7]. In 2015, the World Health Organization (WHO) recommended oral pre-exposure prophylaxis (PrEP) with Tenofovir Disoproxil Fumarate (TDF) and Emtricitabine (FTC), co-formulated as a daily pill, as an additional prevention option for persons at substantial risk of HIV infection as part of combination HIV prevention approaches[8]. When used as prescribed, oral PrEP reduces an individual's risk of acquiring HIV by 99%[9]. Evidence further supports the use of oral PrEP to reduce horizontal and vertical transmission of HIV among HIV-negative and lactating women[10,11]. However, adherence to oral PrEP among HIV-negative pregnant and lactating women in high HIV incidence areas is sub-optimal[12]. To address adherence challenges associated with daily oral PrEP, studies have recommended innovative approaches that do not require daily use[12,13], particularly formulations that act for a longer duration and require less user dependence[14].

Consequently, the HIV prevention landscape has greatly evolved with the development of long-acting and extended delivery HIV prevention products, which have shown promising preclinical and clinical results[14–16]. These products include extended-release implants, monthly oral regimens, vaginal rings, injectables administered every two months or longer, parenterally administered antibodies, and multidose vaccine regimens[17–19]. In 2021, the WHO endorsed the use of the Dapivirine Vaginal Ring (DPV-VR) as an additional biomedical prevention option for women at substantial risk of HIV acquisition[20]**.** Cabotegravir, a long-acting injectable PrEP that was ratified by the U.S. Food and Drug Administration (USFDA) on 20 December 2021 to prevent HIV infections in high-risk adults and adolescents, is another option for PBFW[21].

Before introducing these long-term PrEP formulations, understanding potential users' preferences is crucial and may influence PrEP uptake and consistent use. Incorporating end-users' input during the early stages of product development can enhance the market fit of novel HIV prevention products[22]. A valuable method for obtaining preferences from potential users, such as PBFW, is the Discrete Choice Experiment (DCE). DCEs are attribute-based measures of benefit premised on the fact that services, policies, or interventions can be characterized by their attributes and that an individual's valuation depends on the attribute levels[23]. Individuals are presented with hypothetical alternative scenarios, each composed of several attributes, and the responses obtained reveal the influence and relative importance of the individual attributes[24,25]. In addition, defining distinct and realistic levels for each attribute ensures they are plausible and actionable, enabling respondents to make reasonable trade-offs when choosing among various options[26].

DCEs are increasingly gaining popularity in health research as an approach for quantifying preferences[27,28]. In the field of HIV prevention, care, and treatment, DCEs have been used to explore preferences for HIV testing[29,30], HIV treatment[31,32], differentiated service delivery models for HIV care[33,34], HIV prevention[35–37], and PrEP delivery[38]. However, a notable lack of detailed explanations on the attribute development process for these studies remains, which is critical for quality assessment[27]. This paper addresses this research gap by documenting a systematic process for identifying attributes and attribute levels for a DCE to examine preferences for long-acting HIV prevention products among PBFW.

Methods

We conducted a substudy embedded within a larger cross-sectional study[39]. In the formative stage, we followed the generic framework for developing attributes of a DCE proposed by Helter and Boehler[40], which comprises four stages: (1) collection of raw data, (2) data reduction, (3) removal of inappropriate attributes, and (4) appropriate wording. An iterative process was followed to define the list of attributes and their corresponding levels. The attributes included in the final list met the criteria of being actionable, plausible, and capable of being traded[26]. The qualitative methods are reported in accordance wth the Consolidated Criteria for Reporting Qualitative Research guidelines[41] (See Supplementary material S1).

Raw data collection

Raw data collection was facilitated by a literature review and a qualitative study as a first step to identify attributes and their corresponding levels. The literature review facilitated the identification of conceptual attributes, while a qualitative study generated context-specific attributes, given that qualitative research is instrumental in selecting attributes and levels for a DCE[42,43]. During review of existing literature, we searched for articles that examined preferences for long-acting HIV PrEP among women of reproductive age in three electronic databases: PubMed, CINAHL, and EMBASE. The search focused on studies published in English language between January 2010 and April 2024. In addition, we conducted a manual search through the reference lists of articles that met the criteria for inclusion. In total, 20 studies reporting preferences for long-acting PrEP among adolescent girls and young women in low- and middle-income countries were included in the review.

The next step involved the identification of context-specific attributes through qualitative interviews. Two counties in Kenya were purposively selected, Kisumu and Kiambu, having a high and moderate prevalence of HIV, respectively. The Kenya HIV Estimates Report 2020 showed that the overall HIV prevalence in Kisumu County was 17.3% while that of Kiambu County was 2.7%[44]. Two study sites were selected in each county: Ahero Sub-County Hospital and Kisumu County Hospital in Kisumu County, and Thika Level 5 Hospital and Kiambu County Hospital in Kiambu County. A total of 80 in-depth interviews (IDIs) were conducted, 40 with pregnant and 40 with postpartum HIV-negative women attending Antenatal and Mother Child Health clinics, and had not participated in HIV PrEP research. Specifically, the interviews were split equally between the two study counties (40 in Kisumu and 40 in Kiambu). In addition, key informant interviews (KIIs) were conducted with 40 healthcare providers working in antenatal and post-natal clinics and had been involved in HIV care and prevention, including those who had previously prescribed oral PrEP, with 20 interviews in Kisumu County and 20 in Kiambu County.

SN, VO, and MG conducted the interviews. The interviews were audio-recorded and transcribed in English. On average, the IDIs and KIIs lasted 45 min. The data collection tools used during these interviews were designed to explore participants' experiences, perceptions, and preferences regarding long-acting HIV prevention products.

Ethics

This study was approved by the KEMRI Scientific and Ethics Review Unit (KEMRI/SERU/CPHR/49/4647) and followed the Declaration of Helsinki guidelines for medical research involving human participants. Written informed consent was obtained from all participants before data collection. In addition, participants' anonymity and the confidentiality of their personal information were ensured throughout the research process.

Data reduction

Data reduction involved identifying emerging themes from the studies included in the literature review and concepts from excerpts of the IDIs and KIIs. The literature review revealed various attributes of long-acting HIV prevention products, such as product form (injectable, implant, or vaginal ring), effectiveness, and ability to offer additional protection from pregnancy or sexually transmitted infections (STIs). Inductive and deductive content analytic approaches were then used to synthesize the qualitative data, guiding the identification of key themes related to specific attributes[45].

The interviews were analyzed following the six steps of the thematic analysis approach described by Braun and Clarke[46]. The recordings from the interviews were initially fully transcribed verbatim. During the initial coding stage, three research team members (SN, MG, and VO) identified and deliberated on discrepancies until a consensus was reached. Once consensus was reached, the research team independently read all the transcripts and coded the data using an agreed-upon codebook. The data were then categorized into broader themes and subthemes related to attributes respondents considered important. The coding process was supported by Dedoose software (version 8.3.35, Sociocultural Research Consultants, LLC, Los Angeles, California, USA).

Removal of inappropriate attributes

To ensure respondents can effectively consider all attributes when making a choice, it is recommended that a DCE should contain fewer than 10 attributes[25]. To reduce the number of attributes, we engaged a panel of five experts involved in HIV PrEP research. Initially, an unlabelled experimental design was considered during the study's conceptualization. In the unlabelled design, alternatives in the choice sets are referred to generically as alternative A, alternative B, and so on[47]. However, following consultation with experts, we determined that a labelled design was more appropriate because of the distinct differences between the products and the would-be respondents' familiarity with the alternatives. The alternatives were given product labels, namely, oral, injection, vaginal ring, and implant. The experts opined that using real-life labels would provide realistic perspectives of respondents' preferences, thereby enhancing the validity of the results and supporting policy decision-making. This approach allows labels to communicate relevant information to the respondents regarding the choice set, enabling the study of the main effects of the labels[47]. Transitioning from an unlabelled to a labelled design reduced the number of attributes, as some inherent characteristics were incorporated into the product labels.

Appropriate wording

The interim list of six attributes was pilot-tested among a separate group of 30 PBFW attending antenatal and Maternal Child Health clinics in two facilities in Kisumu and Kiambu Counties. These participants were not involved during the raw data collection phase. This was done to ensure that feedback from the pilot reflected the views of PBFW, who had not been involved in the raw data collection phase, thereby providing assurance of independence of the pilot data. From the literature, we established that there is no formal guidance on a pilot sample size, but 30 is deemed sufficient to generate usable data[48,49]. Thus, a sample of 30 respondents was selected to facilitate econometric analysis of the pilot data to provide priors for use in a D-efficient design[50], which maximizes statistical information from a limited number of choice tasks while improving precision of parameter estimates. Four attributes, namely frequency, effectiveness, pregnancy prevention, and STI prevention, had two levels, while two attributes (product access location and cost) had four levels. A combination of attributes and their corresponding attribute levels yielded 256 combinations ($4^2 * 2^4$). The existing literature suggests that presenting too many choice sets places a cognitive burden on respondents[25]. Following a D-efficient design, a total of 12 choice sets were generated for the pilot using the Ngene software[51]. The pilot aimed to assess the clarity of the wording, respondents' understanding of the attributes and levels, the suitability of the defined levels, and whether respondents could manage the number of attributes without undue cognitive burden. Additionally, it evaluated the comprehensibility of the choices presented. Respondents were presented with 12 choice sets (each

No	Attribute	References
1	Product type/form (injectable, implant, or vaginal ring)	37,56–58
2	Effectiveness in HIV prevention	52–54
3	Duration of effectiveness/Dosing frequency	52–54
4	Route of administration	37,52,57
5	Discreetness/secrecy	53,56,59
6	Ancillary benefits/dual-protection (STI and pregnancy prevention)	36,56,60
7	Low toxicity/safety during pregnancy and lactation	53,58
8	Reversibility/removability	53,57
9	Side effects	56,61,62
10	Ease of use	52,56,63
11	Product access (self-administered or dispensed in a clinic)	52
12	Cost	58

Table 1. Preferred attributes of long-acting PrEP products.

		Kisumu (N = 40)	Thika (N = 40	All (N = 80)
Age	Mean (SD)	25.6 (7.22)	24.3 (6.52)	25.0 (6.87)
	Median [Q1, Q3]	25.5 [19.8,30.5]	23.0 [19.5,29.3]	24.0 [19.8,30.0]
Marital status	Married	27 (67.5%)	24 (60.0%)	51 (63.8%)
	Single	13 (32.5%)		
	16 (40.0%)	29 (36.3%)		
Level of education (years)	Mean (SD	11.3 (2.87)	11.6 (2.25)	11.5 (2.57)
	Median [Q1, Q3]	11.0 [10.0,12.0]	12.0 [10.0,13.0]	12.0 [10.0,12.3]
Pregnant or Lactating	Lactating	23 (57.5%)	20 (50.0%)	43 (53.8%)
	Pregnant	17 (42.5%)	20 (50.0%)	37 (46.3%)
Parity	Mean (SD)	1.55 (1.52)	1.30 (1.02)	1.43 (1.29
	Median [Q1, Q3]	1.00 [0, 2.00]	1.00 [1.00, 2.00]	1.00 [0, 2.00]

Table 2. Sociodemographic characteristics of pregnant and breastfeeding women.

with five alternatives) and were prompted to choose one option (alternative) from each of the tasks. We included an opt-out option, given that some respondents could choose not to use any HIV prevention product. The pilot data were analyzed using a main effects multinomial logit (MNL) model. See Supplementary Table S2 for the choice set used in the pilot.

Results

Raw data collection and data reduction

Literature review

From the review of literature, long-acting products were preferred over short-acting ones[52–55]. Twelve attributes associated with the products were identified as influencing the preferences, with product form (injectable, implant, or vaginal ring) being the most popular[37,56–58]. Table 1 shows the attributes identified from the literature review.

Qualitative findings

Sociodemographic characteristics of PBFW

Of the 80 PBFW who participated in the IDIs, 53.8% were breastfeeding. Participants had a median age of 24 years (interquartile range [IQR]: 19.8–30.0 years). The majority (63.8%) were married, and the median number of years of education completed was 12 (IQR: 10.0–12.3), equivalent to completion of high school. The median parity was 1.0 (IQR: 0–2.0), indicating that most participants had between zero and two previous births (Table 2).

Sociodemographic characteristics of healthcare providers

A total of 40 healthcare providers participated in the KIIs. The majority were female, 33(82.5%). The median age was 38.5 [IQR:31.0, 55.3]. Regarding professional cadre, nurses were the majority, 28 (70.0%), followed by clinical officers, 8 (20.0%). The participants had a median of 16.0 years of professional experience (IQR: 7.0–30.0). These findings are summarized in Table 3.

Qualitative data revealed 10 attributes that respondents considered important. These were product type, frequency, effectiveness, mode of administration, pain, side effects, safety, discreteness, ancillary benefits, and cost.

		Kisumu (N = 20)	Thika (N = 20)	All (N = 40)
Age	Mean (SD)	37.7 (9.23)	46.4 (11.8)	42.1 (11.4)
	Median [Q1, Q3]	37.0 [31.0,40.5]	51.0 [35.0,57.3]	38.5 [31.0,55.3]
Gender	Female	15 (75.0%)	18 (90.0%)	33 (82.5%)
	Male	5 (25.0%)	2 (10.0%)	7 (17.5%)
Job title	Clinical officer	4 (20.0%)	4 (20.0%)	8 (20.0%)
	In charge of ANC/FP RH Clinic	1 (5.0%)	0 (0%)	1 (2.5%)
	Nurse	14 (70.0%)	14 (70.0%)	28 (70.0%)
	Pharmaceutical Technologist	1 (5.0%)	0 (0%)	1 (2.5%)
	HIV testing services	0 (0%)	1 (5.0%)	1 (2.5%)
	Pharmacist	0 (0%)	1 (5.0%)	1 (2.5%)
Years of experience	Mean (SD)	14.9 (10.6)	20.4 (10.7)	17.7 (10.9)
	Median [Q1, Q3]	12.0 [6.75,25.8]	24.0 [11.5,30.0]	16.0 [7.00,30.0]

Table 3. Sociodemographic characteristics of healthcare providers.

Product type

PBFW were receptive to the different product formulations as they offered users the opportunity to choose products that met their preferences and needs. One participant noted:

> "I would prefer that they come in various forms because some people like the injections, others vaginal ring, and some oral pills…. I think it will be good." (IDI013, Breastfeeding woman, Kisumu)

However, the preference for product type varied between PBFW. For instance, pregnant women believed that the vaginal ring is not suitable for them because of the fear that it can interfere with pregnancy; rather, it would be more appropriate for breastfeeding women.

> "Breastfeeding women would probably want to use the vaginal ring ... Ok, for them mentally they will know, this one is just for me, it is not going to affect the baby in any way. So maybe the vaginal ring will be a better choice for breastfeeding women." (IDI005, Pregnant woman, Kiambu)

> "Breastfeeding women can go for the vaginal ring because it will not alter the hormones." (IDI039, Pregnant woman, Kiambu)

Similarly, healthcare providers expressed enthusiasm about long-acting PrEP products. They reported that such products would reduce clinic visits and provide convenience to users, thereby improving adherence to PrEP.

> "I might recommend the injectable and the implant because they will not have to come back to the clinic now and then, and also there will be no issues of adherence." (KII016, Nurse, Kisumu)

Frequency

HIV PrEP products that could offer long-term protection received positive opinions from the women. Products with a longer duration of action were perceived to address adherence challenges, such as forgetting and reducing the frequency of hospital visits, thereby saving time.

> "If it is an injection, I don't think it would just protect you for a day, but it would go for a month or three months, so it would have saved my time and also saved me from forgetting." (IDI026, Pregnant woman, Kiambu)

Healthcare providers expressed similar opinions.

> Most of the mothers would wish to use a method that, once placed, may take even a year or a longer period of even six months, so that they are not disturbed." (KII005, Nurse, Kisumu)

In addition, healthcare providers reported that clients indeed expressed a need for products that do not require daily dosing due to challenges with the daily oral pill, and that products with less frequent dosing schedules would appeal to clients.

> "I know from the experience that we have discussed with several clients, I know one pill per month or injectable for 3 or 4 months, or even an implant that would go for 6 months to even one year. Those would be their priorities." (KII020, HIV testing services officer, Kiambu)

Effectiveness

PBFW are aware of the risk of contracting HIV and the repercussions of an infection to their babies. Therefore, products that could give them peace of mind without worrying about being infected or infecting their babies were welcome.

> "In that at least… you know a pregnant woman, it is easy for them to get illnesses, such as HIV and other illnesses. So, I would wish that they use it, so that even their kids don't get infected." (IDI006, Breastfeeding woman, Kiambu)

> "Those who are breastfeeding will be sure and guaranteed that they will be able to breastfeed their children, and the baby will be okay up to six months. You will breastfeed the baby without any worries, 'maybe I am infected with HIV', and I will pass it on to my child." (IDI039, Pregnant woman, Kiambu)

Mode of administration

The long-acting products considered in the study can be taken orally, injected into the body, inserted in the birth canal, or implanted via a skin incision. From these, women had reservations about taking the oral pill and preferred products that did not involve swallowing.

> "Personally, I fear swallowing drugs. That is why I prefer injection or the implant." (IDI026, Pregnant woman, Kiambu)

> "I do not like to take drugs (pills). That is why I prefer the injectable." (IDI002, Breastfeeding woman, Kiambu)

Pain

Pain associated with the administration of specific products was a concern among the women. However, they were willing to use a product if they considered the pain manageable or take an oral pill to avoid the pain, so long as the pill would serve them for a period of at least one month.

> "The process of it (implant) being infused on the arm is so easy, it is not painful, then you find that the doctors or nurses assigned can put it so easily and can be removed at any time." (IDI024, Breastfeeding woman, Kisumu)

> "I think the monthly pill can be okay because you take it once a month. There is no pricking of the skin like for the injection. Implant also requires a small surgery, so it has pain." (IDI012, Breastfeeding woman, Kisumu)

Side effects

Any drug or medicine can have additional effects beyond the desired action in the human body. Thus, the respondents in this study expressed a desire for the development of drugs that will have fewer side effects for the users, especially pregnant women who have to deal with nausea and vomiting.

> "I think the injectable will be easier for pregnant women, considering the nausea and vomiting, taking pills does not work well for them. The vaginal ring may also not be very advisable. I think the injection will be better." (KII017, Clinical officer, Kiambu)

> "Oral Pill will be preferred since once you use that pill, let's say it is monthly, within that month it gives you time, if it is short duration as compared to that one year, so it will help you even to change to another one if there is a side effect, yeah." (IDI026, Breastfeeding woman, Kisumu)

Safety

Concerns about product safety were raised by healthcare providers, with fears of adverse effects on the mother or the unborn baby.

> "I still have my fears if they have adverse effects, especially on the unborn baby and the mother. In the long term, like the injection, how do you remove it from the body? It may have adverse events. And like the short term, if it is a ring, because we cannot give it to an expectant mother because of the effects it may have on the cervix, it might even cause premature labour. So, you find that the ring is limited, the pregnant mothers are limited, and they might not use it." (KII008, Nurse, Kiambu)

It was also evident that these concerns need to be addressed before the products are approved for use in this population to ensure safety.

> "I think it is good to be oriented about it, to know how it works, if there are any side effects that can even affect the unborn baby, any side effects to the user. Another thing is at what gestation stage mothers should take it comfortably without affecting the unborn baby. Any side effects should be ruled out as much as we are preventing HIV". (KII005, Nurse, Kiambu)

Discreteness

Women expressed a desire for a product they could use without anyone, including their male partners knowing. The use of PrEP products was considered a personal matter.

> "I would consider it because I would not want someone like my male partner to know, so it will be private, because it is being inserted on the arm." (IDI037, Breastfeeding woman, Kisumu)

> "You can also consider the person you are with. Sometimes, he would not want you to use things like those, so you consider using something secretive or personal. No one will know about it". (IDI026, Pregnant woman, Kiambu)

The same was reported by a healthcare provider.

"I just go to the clinic; I get injected, then I return home. Nobody will know what I'm using." (KII005, Nurse, Kisumu).

Ancillary benefits

Women are aware of the existence of sexually transmitted infections (STIs) that affect them in addition to HIV, and yet there are no measures to address them.

"I would consider the injection, but the disadvantage is that it's only protecting us from HIV, leaving other infections that come along with HIV. When somebody has warts, and this person is suffering from HIV, you prevent yourself from getting HIV, and you remain with warts or maybe herpes. So I feel apart from only basically being on HIV prevention, they should maybe try and make it more useful… meaning protecting me from other venereal diseases." (IDI015, Pregnant woman, Kisumu)

"STIs are things that are there; you can get them from anyone, even from your partner, so if that product can be there, then it will help us to not get into the risk of getting HIV, STIs, and even unwanted pregnancy." (IDI019, Breastfeeding woman, Kisumu)

Consequently, the demand for multipurpose products that can address several health needs, including the prevention of HIV, STIs, and also for family planning, was expressed by the women and healthcare providers.

"It is what people would want. Because after delivery, you will still use family planning, so if there was a product that prevents both pregnancy and HIV, that would be much better instead of using two implants, it is better to have one." (IDI003, Pregnant woman, Kiambu)

"I think when you have a product that you can use for many things…that would be good; even I would choose that. You can imagine coming to the clinic, then you are given different drugs, maybe for family planning, like an implant on your left, then PrEP on your right, then you are injected for the STIs. So, if it caters to all these things, I would definitely offer that." (KII009, Nurse, Kisumu)

Cost

Women were willing to pay for the products, especially because they would use them for a long time. The women considered the benefits they would get from a product and suggested different rates for each.

"Because it is long-term, even if you pay a certain amount of money, you won't feel that your money has gone to waste. You feel that you have paid for something that will serve you for the long term." (IDI026, Pregnant woman, Kiambu)

"If it is one month, then, in one month, you may get a lot of illnesses, and in that one month, you are also capable of getting HIV, but if you are protected against HIV with KES 500 (approximately US$3.86), then it is okay. So, the monthly pill can cost KES 500 (approximately US$3.80), the injection, let's say KES 1,000 (approximately US$7.72), and the implant not more than KES 1,500 (approximately US$11.57). The vaginal ring…Mmh! … that is something I have never heard about, but we can say KES 1,000 (approximately US$7.72), to KES 1,500 (approximately US$11.57)." (IDI019, Pregnant woman, Kiambu)

Similarly, healthcare providers noted a need to assign a cost to the products.

"The monthly pill can be charged KES 500 (approximately US$3.80), the injection, let's say KES 1,000 (approximately US$7.72), and the implant not more than KES 1,500 (approximately US$11.57). The pill, if it is once a month, can cost approximately 100-200 KES (approximately US$0.77 – US$1.54). It is okay. Vaginal ring, they will pay five hundred." (KII003, Nurse, Kisumu)

In general, the context-specific attributes identified in the interviews aligned with those identified from the literature. The data reduction process generated twelve initial attributes, which were then subjected to expert review as described in the next section.

Removal of attributes

A panel of five experts in HIV prevention reviewed the conceptual and context-specific attributes identified from the literature review and interviews. The experts agreed to drop six attributes (product type/form, mode of administration, side effects, safety, reversibility/removability, and discreetness) to generate plausible choice sets. To simplify the choice tasks and reduce cognitive burden on the respondents, the number of levels per attribute was limited to three. Supplementary Table S3 summarises the experts' views on the initial attributes.

Wording of attributes

Removal of attributes resulted in six attributes, namely frequency, effectiveness, prevents pregnancy, prevents STIs, product access location, and cost of obtaining the product. Table 4 presents the final attributes and levels.

Piloting of these attributes revealed no major issues with the clarity and appropriateness of the choice sets. However, the following changes were made based on the feedback from the pilot study:

Estimated effectiveness

The levels were initially presented as percentages. However, respondents preferred descriptive narratives, finding them easier to understand than percentages. Consequently, the estimated effectiveness in HIV prevention was rephrased in narrative form. For example, a range of 90%-95% effectiveness was translated to "Out of 20

Attribute	Description of levels				Attribute type
	Oral	Injection	Vaginal ring	Implant	
Frequency	Weekly	Every 2 Months	Monthly	Every 6 Months	Continuous
	Monthly	Every 6 months	Every 3 months	Every 12 months	
Effectiveness	70–80%	85–90%	50–70%	80–90%	Continuous
	80–90%	90–95%	70–90%	90–95%	
Prevents pregnancy	No	No	No	No	Categorical
	Yes	Yes	Yes	Yes	
Prevents STIs	No	No	No	No	Categorical
	Yes	Yes	Yes	Yes	
Product access location	Public Health Facility (HF)	Public HF	Public HF	Public HF	Categorical
	Private HF	Private HF	Private HF	Private HF	
	Public and private HFs	Public and private HFs	Public and private HFs	Public and private HFs	
	Private Pharmacies				
Cost	KES 100	KES 500	KES 500	KES 500	Continuous
	KES 300	KES 1,000	KES 1,000	KES 1,000	
	KES 500	KES 1,500	KES 1,500	KES 1,500	

Table 4. Product attributes and their levels confirm which tables remain in the manuscript.

people, 18–19 will remain HIV negative," making the information more relatable and comprehensible for the respondents.

Product access location

During the pilot, three types of locations were considered: public health facilities, both public and private health facilities, and private pharmacies. Based on the feedback, a separate option for private health facilities was included. Additionally, the option of private pharmacies was restricted to the oral product, as it was not feasible to provide the vaginal ring, injection, and implant outside of a healthcare facility.

Cost

The pilot included three levels for the four products, namely KES 500, KES 1,000, and KES 1,500. However, after the pilot, the costs for oral products were rationalized to KES 100, KES 300, and KES 500.

During analysis of the pilot data ($n = 30$), categorical attributes were dummy-coded as binary variables ($0 = no$, $1 = yes$), while continuous attributes were coded numerically to facilitate regression analysis. The MNL model analysis results from the pilot test indicated that PBFW preferred using a PrEP product rather than not using one, as shown by the negative coefficient for the opt-out ($\beta = -1.056$, $p = 0.124$). The women also preferred implants ($\beta = 2.021$, $p < 0.001$), injectable products ($\beta = 1.461$, $p < 0.001$), products with contraceptive benefits ($\beta = 1.088$, $p < 0.001$), and products that could offer protection against STIs ($\beta = 0.739$, $p < 0.001$). On the contrary, they did not prefer the vaginal ring ($\beta = -0.378$, $p = 0.209$) or having to access the products from private pharmacies ($\beta = -0.137$, $p = 0.29$) (see Supplementary Table S4).

Development of final choice sets

For the final experimental design, we used a Bayesian approach, with priors from the pilot informing the final design. Full profiles containing all six attributes were constructed. Each choice set was composed of five alternatives: four labelled product alternatives and an opt-out option labelled 'none'. For each scenario, participants were first asked to choose one alternative from the five alternatives. Then, for those who selected 'none' of the products, they were further asked to make a forced choice across the remaining four alternatives. Supplementary Table S5 shows the final choice set.

Discussion

Various frameworks have been proposed to guide the development of attributes and level selection in DCEs, each emphasizing a systematic approach to identifying and refining attributes. These frameworks, which ensure that the final choice sets are relevant and salient to the target population and support meaningful trade-offs, include the Fohn and Nicolet 3-stage process[64], Helter and Boehler's 4-stage process[40], and Brun and Flynn's 5-stage process[65]. We employed the Helter and Boehler framework to identify attributes and their corresponding levels for a DCE to examine preferences for long-acting HIV prevention products among PBFW in Kenya. An iterative approach encompassing a literature review and qualitative interviews generated a list of attributes and their corresponding levels, which were used to design the DCE experiment.

Reduction and subsequent removal of inappropriate attributes resulted in six attributes of long-acting HIV prevention products that can be evaluated in a DCE involving PBFW. They include frequency, effectiveness, ability to prevent pregnancy, ability to prevent STIs, product access location, and cost of obtaining the product. The interviews with key stakeholders in the HIV care and management arena provided valuable insight into product attributes that may be feasible and acceptable for use by PBFW. Notably, although attributes such as mode of administration, side effects, safety during pregnancy and lactation, reversibility/removability, and

discreetness emerged as important themes in the qualitative phase, these attributes were dropped because they are closely linked to the specific PrEP product types and therefore could not vary independently when a labelled DCE design was adopted. It was evident that retaining them would have resulted in implausible choice sets, and the PBFW would not be able to make reasonable trade-offs between the products on these parameters. Healthcare providers revealed that PBFW are keen on protecting themselves and their unborn infants from HIV and STIs. Previous studies have also shown that young women are interested in products that not only prevent HIV but also have multiple benefits, such as pregnancy and STI prevention[36,66,67]. These preferences informed the decision to include attributes on pregnancy and STI prevention in the final choice set.

Regarding product access locations, the levels were limited to public and private health facilities, the options currently available in Kenya. We restricted the private pharmacy option to the oral product, as it is not realistic for long-acting products such as injections, rings, or implants to be administered in a pharmacy setting. Further, although including private health facilities as an access option improved the realism of the choice tasks, this specification has implications for equity. In many settings, including Kenya, fully private health facilities are mainly concentrated in urban areas, while rural women largely depend on public facilities. These considerations should be taken into account when translating preference evidence into policy and delivery models for PrEP.

Piloting is a critical step during the design of a DCE[65]. We conducted a pilot study to assess the attributes and levels for wording appropriateness, suitability, and understanding, and to ascertain whether the choice sets were cognitively burdensome for respondents. The results revealed that respondents were familiar with the alternatives in this DCE that used a labelled format. Given that the choice sets were more realistic and less abstract, the information obtained will be more relevant for decision-making. In addition, the piloting process and the changes made post-pilot have been documented in line with the recommendation to conduct a pilot, thereby increasing transparency of the DCE study.

This paper has some limitations. First, product-specific attributes, such as side effects, insertion site, or discreteness, were intentionally excluded to avoid implausible choice sets. This was done based on the panel's evaluation of these attributes. DCE thus has intrinsic limitations as a method and serves as a useful tool among other tools in public health policy creation.

Conclusion

The Helter and Boehler framework provided a systematic approach for an iterative and transparent process to develop attributes for a DCE to examine preferences for long-acting HIV prevention products among PBFW in Kenya. This rigorous process of attribute development and level selection improved the quality of the DCE by ensuring logic, accuracy, and consistency of the choice sets, thereby enhancing the reproducibility and transparency of our results. This paper advances the existing literature on attribute development and level selection for a DCE in HIV prevention research. A more holistic perspective is provided by the use of qualitative and quantitative methods. Researchers should employ robust methods in developing attributes and levels for DCEs to enhance the transparency and validity of these studies.

Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to the principle of confidentiality in qualitative studies, but are available from the corresponding author on reasonable request.

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Author contributions

SN and KN were involved in the study conception and design. KN, NT, JK, and VO provided guidance on the qualitative design. SN, VO, and MG were responsible for interviews with participants. SN, KN, VO, JK, PM, and NT were involved in the data analysis of qualitative and quantitative data. SN was responsible for coordinating the study and wrote the first draft of this manuscript. KN, JK, MG, VO, EE, VW and NT reviewed the first draft of the manuscript. All authors have read and approved the final version of the manuscript.

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Declarations

Competing interests

The authors declare no competing interests.

Ethics approval and consent to participate

Approval to conduct the study was granted by the KEMRI Scientific and Ethics Review Unit (KEMRI/SERU/CPHR/49/4647), and written consent was obtained from all study participants before data collection. Further, permission to conduct the study was obtained from the National Commission for Science, Technology and Innovation, Kenya.

Additional information

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