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Using choice experiments to improve equity in access to socially marketed HIV prevention products

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ABSTRACT

Designing strategies to introduce new HIV prevention technologies requires balancing equitable access with sustainable distribution, particularly in resource constrained settings with high HIV prevalence. This paper explores how knowledge of preference heterogeneity can guide the equitable targeting of HIV prevention products using differentiated advertising and product placement to balance increased access with sustainability.

A discrete choice experiment elicited 1016 women's preferences for distribution of HIV prevention products in South Africa. Qualitative research guided the experimental design which considered distribution outlet, collection method, advertising message, and price. A range of choice models, including random parameters logit, latent class and latent class random parameters logit models, were compared for fit.

A latent class model showed the best fit and distinguished two classes of women: Class 1 were significantly more likely to be cohabiting and unemployed, who preferred products advertised for HIV prevention distributed through clinics and were highly price sensitive. Class 2 significantly preferred distribution through pharmacies and advertising around women's empowerment, while price was not a key factor.

This analysis suggests that equity in access to new products could be advanced through exploiting preference heterogeneity between groups. The identified groups can be then used to design social marketing differentiated distribution strategies. Distributing free products promoted for HIV prevention could discourage 'leakage' of highly subsidised products to women with some capacity to pay, while priced products marketed for women's empowerment through pharmacies could encourage cost recovery with minimal reductions in coverage among employed women.

1. Background

Achieving high levels of access and uptake of preventive health interventions is challenging. Capitalising on the potential of health prevention requires changes in behaviour among populations who do not feel ill or perceive themselves to be at risk, or who face

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barriers to changing their behaviours. More generally, access to health involves demand and supply factors including: 'approachability, acceptability, availability and accommodation, affordability and appropriateness' (Levesque et al. 2013). Social marketing aims to use private sector marketing methods to stimulate positive behaviour change across a range of social issues, including public health. Social marketing aims to increase demand for public health goods, intervening on both sides of the market, summarised by a focus on the four P's: product, price, placement, and promotion (Grier and Bryant 2005). Learning from private sector marketing, social marketing often uses market segmentation to understand how populations vary in order to develop tailored behaviour change strategies, i.e. it aims to identify homogenous groups of consumers with similar tastes (market segments) and willingness to pay within the full population (Kubacki et al. 2017). Social marketing may also have social objectives including addressing health inequalities by reaching the poor. In a vertical product differentiation approach, products would be priced, rather than provided free to reduce wastage, with price signalling differences in quality and lay the foundation for some degree of cost recovery in the longer term, and may also generate space for cross-subsidisation, where higher price products subsidise the cost of distributing other very low priced public health products (Kubacki, Dietrich, and Rundle-Thiele).

In public health, the identification of market segments often relies primarily on qualitative market research with potential users and quantitative analysis of target groups' health prevention needs, based on simple cross tabulations of populations by user characteristics or cluster analysis (Kubacki et al. 2017; Berg 2000). However, it does not tend to analyse user preferences, critical for stimulating demand. This paper demonstrates how discrete choice experiments (DCEs) can be used to identify market segments across those more and less able to pay, using a case study on HIV prevention products for women in South Africa.

The 2010's saw substantial progress in the fight against HIV. Of the 38 million people living with HIV globally, nearly 80% knew their status and 62% of those had initiated treatment (UNAIDS 2019). South Africa is home to individuals with 20% of the global HIV burden and has the world's largest HIV treatment programme, with 4.7 million people on treatment in 2018 (UNAIDS 2019). HIV prevalence, and the need for treatment, continues to rise. In South Africa, each year 0.9% of adults become infected with HIV, two-thirds of whom are women (UNAIDS 2019). To ensure long-term sustainability of treatment programmes, it is critical to reduce new HIV infections. The discovery that HIV anti-retroviral treatment could be used as oral pre-exposure prophylaxis (PrEP) was thought to be a game changer (Chou et al., 2019), supplementing male and female condoms as the only other HIV prevention products available. However low uptake and poor retention have been widely observed (Stankevitz et al., 2019; Yun et al., 2018), suggesting the product or distribution characteristics do not meet users' needs. Ultimately this will reduce the impact on the HIV epidemic. Though more products are in the pipeline, discovery of products is not enough: distribution programmes need to identify how to target prevention products to efficiently reach a broad range of users.

For condoms and new HIV prevention products to fulfil their public health potential they must be used widely and effectively; this requires both ensuring consistent and accessible supplies and implementing effective promotional approaches, including mass media, interpersonal communication and packaging. A review on utilization of ART for HIV patients in South Africa, for example, finds that utilization differs by such varied factors as marital, educational and employment status of individuals (Tromp et al., 2014).

A systematic review of social marketing interventions found mixed evidence of their impact on health behaviours (Firestone et al., 2017). Within the HIV field, two systematic reviews make cautious inference that social marketing (including mass communication) campaigns decrease higher risk sexual behaviour or increase HIV testing, yet the low number and poor quality of studies precludes generalisable conclusions (Sweat et al., 2012; Noar et al., 2009). Terris-Prestholt and Windmeijer's (2016)(2016) econometric analysis of condom social marketing focuses on drivers of demand and concluded that the design and distribution strategies must consider both product and target population characteristics. A review of STI testing and prevention campaigns found stronger evidence of programme impact, with some sustained effects observed among study cohorts with uncontaminated control groups and sufficiently exposed intervention groups (Friedman et al., 2016; Eaton et al., 2013). This suggests there may be a need for distribution through both the public and private sectors, including social marketing, to support uptake across the wealth quintiles. This approach is also called the total market approach, and builds on both the public and private sectors (Mozumdar et al., 2019). Targeting uptake in the public sector with highly subsidised public health products may reach those who cannot afford to pay, while using the private sector to deliver products for a fee to those with some ability to pay (Hanson et al. 2007). By differentially marketing products, the aim is to use self-selection rather than applying a means testing approach at an individual or group level to support uptake across the wealth quintiles (ibid). The advantage of this is that it greatly reduces administrative costs of direct targeting, while increasing product uptake across quintiles and reducing subsidising the better off (ibid).

This paper presents a complementary approach for designing promotion and distribution systems for new public health products that could stimulate their access while aiming to generate sustainable distribution models. We use the latent class (LC) model as Alemi et al. (2018), and extend this using the latent class random parameters logit (LCRPL) model, as Zhuo and Bridges (2019), to analyse data from a discrete choice experiment (DCE) and identify market segments with observed characteristics and remaining unobserved heterogeneity. DCEs have been shown to be suitable for exploring the impact of promotional messaging on uptake of reproductive health products, identifying heterogeneity in preferences and have good predictive validity (de Bekker-Grob et al., 2020; Hole 2008; Knox et al., 2013). Using the case of over-the-counter public health products with positive externalities in South Africa, we extend both these analyses to show how discrete choice experiments can guide the design of a distribution strategy to balance equity and sustainability objectives, specifically, how analysis of preference heterogeneity can inform product introduction strategies reaching populations with varying abilities to pay, while allowing for some cost recovery.

2. Methods

2.1. The study context

The user preference survey aimed to elicit women's preferences for product characteristics and their distribution. The results of the analysis of product preferences are presented elsewhere (Terris-Prestholt et al., 2013). That study elicited preferences for new and existing products: male and female condoms that were available at the time; the diaphragm that existed only for family planning and a potential new HIV prevention vaginal gel (microbicides). That study thus covered both available and familiar products as well as unfamiliar products. These data were collected in 2005 in Ekurhuleni Municipality, South Africa, in the context of a randomised control trial of PRO2000 microbicide (also referred to as topical PrEP), the Microbicide Development Programme 301 (MDP301)), conducted in South Africa, Zambia, Uganda, and Tanzania (McCormack et al., 2010). At the same time trials were underway to test the efficacy of the diaphragm in preventing HIV acquisition (Padian et al., 2007). Neither of these trials among women showed an impact on HIV acquisition (McCormack et al., 2010). Subsequent trials have since identified oral and long-acting injectable PrEP as highly effective in preventing HIV acquisition (Chou et al., 2019; Landovitz et al., 2020) and the dapivirine ring as partially effective (Baeten et al., 2016). In addition, there are a range of public health self-diagnostics, such as HIV self-testing for which policy making is underway to balance broad and equitable access with sustainability. In sum, while this study was done to guide distribution of new HIV prevention products there are a range of over the counter public health products for which these same questions are relevant.

2.2. Development of the discrete choice experiment

The DCE was developed based on an intensive qualitative phase including individual and group interviews. This phase aimed to inform the design of the DCE scenarios and identify appropriate attributes and levels. Using decision mapping (Michaels-Igbokwe et al., 2014), we found that preferences for product characteristics and distribution characteristics were separate decisions. This phase further entailed identifying realistic distribution outlets in this urban South African setting and a range of potential marketing messages. Over a period of three months, 10 focus group discussions (FGDs) were held among older and younger women (five among each). Weekly FGD topic guides were finalised based on the findings from the preceding week. The FGDs aimed to understand challenges women face accessing and using male and female condoms and family planning services in the public and private sector, women's opinions of different promotional messages used for such products and their most appropriate representation in pictorial format. Subsequently, two attribute reduction workshops were held, where individual questionnaires were completed by women in a group interview setting with the aim of identifying the most important attributes of distribution strategies from the long lists generated in the FGDs. Women were asked to rank lists of characteristics based on their most and least preferred options, and the interpretation of alternative questionnaire wording and pictorial representations of attribute descriptions were explored (Terris-Prestholt 2010). Finally, 10 individual pilot interviews were undertaken to understand women's interpretation of the scenarios presented. Results from the qualitative phase can be found in MacPhail et al. (2009). In the final design of the qualitative research, policy objectives and likely realistic levels of distribution attributes were considered; the final four attributes, their levels, and pictorial representation are shown in Table 1. In this setting, all combinations were considered plausible.

The most prominent distribution outlets for condoms in the local area were included, as were corresponding ways of obtaining products from them. Advertising messages were combined from women's suggestions together with input from those already involved in condom promotion activities. Prices were developed based on suggestions from FGD participants for the various products and prices of condoms distributed through the public, social marketing and private sector distribution channels in South Africa (Free, US$0.54, US$1.04, and US$2.08 (South African Rand (R)0, R5, R10, R20)) (OANDA 2013). Though diaphragms are reusable, for consistency between products, the diaphragm was framed as a disposable product, increasing the frequency of collection and thus the importance of the outlet.

An orthogonal design was generated using the ORTHOPLAN procedure in SPSS (2005) [2]. This generated 60 choice tasks that were blocked over 20 blocks of three scenarios. Attribute levels were chosen such that all combinations would be realistic, removing the need to remove unrealistic scenarios. Orme (1998) suggests that a minimum sample size is estimated as $N > 500c/(t*a)$, where n is the number of respondents, t is the number of tasks, and a is the alternatives per task and c is the largest number of levels that any of the attributes have. For this study the minimum sample size to estimate all main effects would be: a sample size of larger than 333 (=500*4/(3*2)) people. To estimate all two-way interactions 1333 respondents would be required. We aimed to achieve a sample of 1000 adult (18–45 years of age) women who had been sexually active in the past six months.

2.2.1. The choice task

In the survey instrument, this unlabelled DCE with two alternatives followed a DCE on HIV prevention product attributes (Terris-Prestholt et al., 2013). In that section, women were asked to make choices between HIV prevention products and their characteristics. The product options were: male condom, female condom, diaphragm or microbicide. While male and female condoms were available for HIV prevention the diaphragm and microbicide were not. Based on the product they thought they would be most likely to choose for their own use, the task was then framed in the context of collecting their self-reported preferred single use product, e.g. if the

[2] The authors recognise that experimental design methods have advanced significantly since then.

Table 1
DCE attributes and levels included in the survey.

Outlet type			
 Chemist	 Spaza shop	 Clinic	 Supermarket
Collection method			
 In a private room	 From a person behind a counter	 From a dispensing machine or box	 From a shelf
Advertising message			
 Women's Empowerment	 Pregnancy Prevention	 Extra Pleasure	 HIV Prevention
Price			
Free, **0 Rand**	 5 Rand	 10 Rand	 20 Rand

respondent stated that their preferred product would be the diaphragm, each task in the experiment started with the questions, which of these distribution and advertising strategies would you prefer for your single use diaphragm? This task had a forced choice format, i.e. there was no option to choose neither, thus preferences are conditional preferences based on the assumption of a demand for one of the products, either now or sometime in the future. Please see Appendix A1 for an example choice set.

2.2.2. Sampling and data collection procedures

A representative sample of 1 016 sexually active adult women (18–45 years of age) was drawn from within the Ekurhuleni Metropolitan Municipality south-east Johannesburg. Details of the sampling approach can be found in Appendix A2. This paper-based survey was administered by 17 locally recruited and trained female fieldworkers.

The community survey questionnaire consisted of four sections. The first collected data on respondents' background, including employment status (as a proxy for individual liquidity), and whether they were cohabiting with a partner. The second section collected reproductive histories, including experience with existing HIV prevention technologies i.e. what they used, where they obtained it, if they had or had not used a condom in their last sex-act. The reproductive histories also included information about contraceptive use, life stage questions (current type(s) of sexual partnership(s) and desire for pregnancy), and the respondent's perceived HIV risk. The third section presented an introduction to the range of HIV prevention technologies and elicited preferences for product and distribution attributes. The last section consisted of questions evaluating the interview and eliciting participant feedback on the questionnaire (Terris-Prestholt et al., 2013). The questionnaire was translated into the two most common non-English languages in the recruitment areas (Sesotho and isiZulu); then back translated for validation.

2.2.3. Ethics statement

This study was approved by the ethics committees of the University of the Witwatersrand in South Africa and the London School of Hygiene and Tropical Medicine, UK. Written informed consent was obtained from all study participants.

2.3. Statistical analysis: model specification

We now formally analyse the choice problem of our participants based on the Random Utility framework, which postulates that individuals choose the alternative with the greatest utility, and hence the probability of selecting an alternative rises as the utility associated with it increases.

The utility U to individual i ($i = 1 \ldots I$) from choosing alternative j ($j = 1,2$) in choice task c ($c = 1, \ldots,3$) consists of a systematic component – a vector of design attributes, X – and a random error term ε:

$$U_{ijc} = X_{jc}^{'}\beta + \varepsilon_{ijc} \tag{1}$$

where β is a vector of utility values, and c is a subset of the 60 choice tasks in the full experimental design and ε is the error term.

The basic workhorse for operationalising Equation (1) is the multinomial logit (MNL) model which assumes that the error term is Gumbel distributed (McFadden 1974). This estimates the probability P of individual i choosing alternative j in choice task c as a function of design attributes X.

$$P_{ijc} = \frac{\exp(X_{ijc}^{'}\beta)}{\sum_{L}\exp(X_{ilc}^{'}\beta)} \tag{2}$$

Starting with the MNL model in Equation (2), one can consider alternative models that relax its assumption on preference homogeneity. The first option is to accommodate potential preference heterogeneity by allowing the utility weights to interact with various individual characteristics. This approach can however be unsatisfactory in practice because it assumes that all the variation in preferences is explainable along observable characteristics (see, for e.g., Iragüen and de Dios Ortúzar (2004)). As is common in DCEs, we use the MNL model as a starting point for initial estimation and exploration, and then to evaluate improvements associated with applying the more sophisticated econometric models presented below.

The random parameters logit (RPL) model is a popular alternative to the MNL model as it allows for unobserved heterogeneity. Following the common practice in the literature (Brownstone and Train 1998; Zhou and Bridges 2019; Hess and Train 2017), one can allow for unobserved heterogeneity by assuming that the vector of utility weights, β, is distributed across individuals; the distribution is often assumed normal, but can be specified with a range of distributions. The vector of utility weights of individual i, β_i, is defined as the sum of the mean and a random deviation from its mean $\overline{\beta}(w_i)$. The latent class model is also a random coefficients model, but with a discrete coefficient distribution. The basic latent class model does not require parameter distributional assumptions to be imposed by the analyst. We assume that there are a number of discrete latent classes k, (k = 1 … K) within the sample, which differ with respect to the parameters of the utility function. We define the class-specific vector of utility weights as β_k. Thus, the unconditional probability of individual i choosing alternative j in choice set c is:

$$P_{ijc} = \sum_{k=1}^{K}\pi_{ik}\frac{\exp(X_{ijc}^{'}\beta_k)}{\sum_{l}\exp(X_{ilc}^{'}\beta_k)} \tag{3}$$

The probability of respondent i belonging to class k is π_{ik}. Class membership is unobservable; however the probability of class membership can be specified as a function of observable (sociodemographic) characteristics such that:

$$\pi_{ik} = \frac{\exp(Z_i^{'}\delta_k)}{\sum_{k=1}^{K}\exp(Z_i^{'}\delta_k)} \tag{4}$$

with Z_i being a vector of individual characteristics and δ_k being a vector of estimated coefficients. Note that one of the vetores in δ_k is normalised to zero for identifcation purposes.

An extension to the basic latent class model is the latent class random parameters logit (LCRPL) model, which allows for heterogeneity both within and across classes (Bujosa et al., 2020; Greene and Hensher 2013). In the LCRPL the vector of utility weights of individual i in class k, β_{ik} is given by the sum of the class specific vector of utility weights, β_k and a random deviation from the mean, w_i.

The unconditional probability of individual i choosing alternative j in choice set c is then given by Equation (3), where $\beta_k = \sum_{w_i}(\beta_k + w_{ik})$.

In each class of model, we explore specifications with interaction terms. We use the likelihood ratio test[3] to test for the joint significance of the interaction terms within each model. We evaluate across these models using the Bayesian Information Criteria (BIC) to guide the choice across the appropriate model, with the smallest BIC indicating the best balance between overall model fit and parsimony (Greene 2000; Rigby et al., 2015).

The simplest form of the model incorporates only design attributes in the utility function, i.e. main effects, here: outlet type (clinic (CLN), pharmacy (PHR), supermarket (SMK), or Spaza (township corner store) (SPZ)); collection mode: private room (PVT), from a person behind a counter (CNT), from a free box or dispensing machine (BOX), or from on a shelf (SLF); advertising messages: HIV prevention (AHI), pregnancy prevention (APR), enhanced pleasure (APL), women's empowerment (AWO); and Price (PRIC). Interaction terms between attributes and socio-demographic characteristics (SDC) test whether preference for attributes varies by women's characteristics, here: employment status (EMP), and cohabiting (COH), or their preferred product (microbicide (MCD), diaphragm (DGM) in contrast to existing barrier methods (male and female condoms)).

The estimated utility function for the main effects model is:

$$\begin{aligned} V_{main} = {} & \beta_{cli}{*}\boldsymbol{CLI} + \beta_{phr}{*}\boldsymbol{PHR} + \beta_{smk}{*}\boldsymbol{SMK} + \left(-1{*}\left(\beta_{cli} + \beta_{phr} + \beta_{smk}\right){*}\boldsymbol{SPZ}\right) \\ & + \beta_{pvt}{*}\boldsymbol{PVT} + \beta_{cnt}{*}\boldsymbol{CNT} + \beta_{box}{*}\boldsymbol{BOX} + \left(-1{*}\left(\beta_{pvt} + \beta_{cnt} + \beta_{box}\right){*}\boldsymbol{SLF}\right) \\ & + \beta_{ahiv}{*}\boldsymbol{AHI} + \beta_{apr}{*}\boldsymbol{APR} + \beta_{apl}{*}\boldsymbol{APL} + \left(-1{*}\left(\beta_{ahiv} + \beta_{apr} + \beta_{apl}\right){*}\boldsymbol{AWO}\right) \\ & + \beta_{price}{*}\boldsymbol{PRIC} \end{aligned} \tag{6}$$

Effects coding has been used for categorical variables. This means that the coefficients must be interpreted as divergence from the mean for that attribute. Not including a constant in the estimation imposes a mean attribute utility weight of 0[4] (Cohen et al., 2003), with coefficient values representing the relative strength of preferences. NLOGIT 5.0 software was used for estimation (Econometric Software Inc 2012).

3. Results

In this sample of 1016 adult sexually active South African women, one-third reported having used a condom in their last sex-act. We start with reporting the directly elicited preferences. Next, we present how the DCE adds to the analysis of user preference profiles.

As part of familiarising women with the choice tasks and its images, women were asked their preferred level of each attribute. When directly elicited, almost half of the women reported clinic as their preferred distribution channel (48%) followed by pharmacy (chemist) 39%, while supermarket and corner shop (spaza) preferred by few: 7% and 5%, respectively. Discreet collection methods were preferred: in a private consulting room (38%) and a box or dispensing machine (28%) preferred over off a shelf or from a person behind a counter, 17% each. Finally, HIV prevention (46%) and women's empowerment (29%) were popular promotional messages, while pregnancy prevention less so (17%), with a small minority in favour of marketing these products for pleasure (7%).

Table 2 presents the main estimation results; full estimation results, including interaction terms and random parameter distributions, are presented in Appendix A3. The models differ by how they account for varying degrees of preference heterogeneity for the whole sample. Models 1, 3,5,7 (reported in the first panel of Table 2) are without interactions. Model 1 does not account for preference heterogeneity; Models 3, 5, and 7 accommodate varying degrees of unobserved preference heterogeneity. Model 2, 4, 6 and 8 (reported in the lower panel of Table 2) are the counterparts of those reported in the first panel but with interactions. And they also allow for observed preference heterogeneity by product type, and women's cohabitation and employment status.

The main effects are consistent across these models showing a preference for pharmacy distribution, followed by clinic, with supermarket and spaza least preferred. For collection methods there appear to be strong positive preferences for private room collection and strong negative preferences for 'from a person behind a counter', while 'box and shelf collection' are insignificant drivers of distribution choices. Though pregnancy prevention appeared to be a fairly neutral promotional message in this urban South African population, HIV prevention and women's empowerment were positively received. Pleasure was quite unattractive to most women in our study. This was supported by the qualitative work, where women said that if it was advertised too sexually "*it would be like bringing home pornography*" (30–45 year olds, attribute identification workshop) (Terris-Prestholt 2010). These preferences are also consistent with the directly elicited preferences.

Using the likelihood ratio test, we test for the joint significance of the interactions introduced for the observed sociodemographic characteristics that are introduced (bottom of Appendix A3). We conclude that the interaction terms are jointly significantly different from zero for all specifications, i.e. in all cases the models that accommodate observed heterogeneity outperform those without accommodating observed heterogeneity. From here onwards we focus on the results of the models with interactions (lower panel of Table 2).

To further explore heterogeneity but now in discrete groups, latent class models were estimated (Model 5, 6, 7), with the last

[3] LLR test: $(-2{*}(LLR_{restricted} - LLR_{unrestricted})$ with a χ^2 distribution (and degrees of freedom are the number of additional parameters in the unrestricted model).

[4] A constant is used for labelled experiments to capture the mean utility value of the label, however for generic experiments this is meaningless since A and B have no intrinsic meaning, and would solely capture a preference for the left hand side option over the right hand side alternative.

Table 2
Main estimation results.

No Interactions	1.MNL		3.RPL		5.LC				7.LCRPL			
					LC1	0.41	LC2	0.59	LC1	0.32	LC2	0.68
Variables	Beta	Sign.	Beta	Sign.	Beta	Sign.	Beta	Sign.	Beta	Sign.	Beta	Sign.
Clinic (CLN)	0.289	***	9.798	***	0.468	*	0.224	*	−0.618		0.661	***
Pharmacy (PHR)	0.334	***	8.861	***	0.130		0.521	***	0.244		0.398	***
Cornerstore (SPZ)	−0.425	***	−11.226	***	−0.081		−0.702	***	0.564	*	−0.870	***
Supermarket (SMK)	−0.198	***	−7.433	***	−0.517	***	−0.043		−0.190	*	−0.189	
Box or vending machine (BOX)	0.038		−0.390		0.090		−0.004		0.448	*	−0.146	
Person behind a counter (CNT)	−0.176	***	−5.334	***	−0.260	*	−0.155	*	−0.353	*	−0.150	*
Private room (PVT)	0.113	**	4.376	**	0.195		0.058		−0.090		0.213	
Of a shelf (SLF)	0.025		1.348		−0.025		0.100		−0.005		0.083	
Advertised for HIV prevention (AHI)	0.103	**	3.058		0.515	**	−0.087		0.530	**	−0.028	
Advertised for pregnancy prevention (APR)	0.064		2.624	*	0.151		0.017		0.424		−0.069	
Advertised for pleasure (APL)	−0.297	***	−11.434	***	−0.375		−0.319	***	−1.054	***	−0.110	
Advertise for women's empowerment (AWO)	0.129	***	5.752	***	−0.290		0.389	***	0.100		0.207	
Price (PRIC)	−0.036	***	−1.245	***	−0.130	***	0.010		−0.115	***	−0.017	*
Distns. of RPs			See appendix 3									
d.f.	10		20		21				41			
Llr	−1951		−1940		−1894				−1923			
BIC	39,821		40,391		39,551				41,741			
With interactions	**2.MNLX**		**4.RPLX**		**6.LCX**				**8.LCX_RPL**			
					LC1	**0.52**	**LC2**	**0.48**	**LC1**	**0.54**	**LC2**	**0.46**
Main effects	Beta	Sign.	Beta	Sign.	Beta	Sign.	Beta	Sign.	Beta	Sign.	Beta	Sign.
CLN	0.302	***	9.456	***	0.456	***	0.188		0.466	***	0.160	
PHR	0.371	***	9.568	***	0.175		0.578	***	0.190		0.577	***
SPZ	−0.452	***	−11.076	***	−0.146		−0.804	***	−0.163		−0.821	***
SMK	−0.221	***	−7.948	***	−0.485	***	0.038		−0.493	***	0.084	
BOX	0.028		−1.162		0.273	**	−0.186		0.247	*	−0.205	
CNT	−0.193	***	−5.207	***	−0.239	**	−0.145		−0.248	**	−0.124	
PVT	0.141	***	4.736	**	0.078		0.166		0.111		0.159	
SLF	0.025		1.632		−0.113		0.165		−0.110		0.170	
AHI	0.104	**	3.674	*	0.336	**	−0.069		0.320	**	−0.082	
APR	0.019		0.796		0.239	*	−0.098		0.220	*	−0.099	
APL	−0.301	***	−11.247	***	−0.321	**	−0.365	***	−0.301	**	−0.390	***
AWO	0.177	***	−7.948	***	−0.254		0.532	***	−0.239		0.571	***
PRIC	−0.034	***	−1.170	***	−0.096	***	0.017		−0.094	***	0.019	
Heterogeneity	See Appendix 3		See Appendix 3									
Distns. of RPs			See Appendix 3						See Appendix 3			
Class membership												
Constant					−0.056				0.081			
MDX|1					−0.178				−0.248			
DGX|1					−0.086				−0.115			
EMP|1					−0.483	***			−0.449	***		
COH|1					0.257	**			0.171			
d.f.	50		60		25				45			
Llr	−1910		−1899		−1885				−1914			
BIC	42,211		42,780		39,700				41,891			

X indicates observed heterogeneity is accounted for by: user report preference for Microbicides (MDX), Diaphragm (DGX); Employment (EMP); Cohabiting (COH).
Test for significance on socio demographic interactions: MDX, DGX, EMP, COH.

	MNLX versus MNL	RPLX versus RPL	LCX versus LC	LCX_RPL versus LC_RPL
chi2 value	82	82	18	18
Diff in DF	40	40	4	4
p-value	0.00	0.00	0.00	0.00

Sig.: ***p < 0.01, **p < 0.05; *p < 0.1.

(model 8) being a LCRPL model. First, the BIC was used to identify the appropriate number of classes. The model with two classes outperformed those with three, four and five classes (not shown). In the 2-class model with socio-demographic characteristics included in the class-membership part of the model (Model 6 LCX), 52% of the sample were predicted most likely to belong to LC1 and 48% to LC2, while the LCRPL with socio-demographics (Model 8 LCX_RPL) projects 54% to be part of LC1 and 46% in LC2. Whereas the estimates of these two models are consistent in terms of sign and significance of main effects, the BIC suggests that the LCX (Model 6, BIC: 39,700) outperforms the LCX_RPL (Model 8, BIC: 41,891), which includes 20 additional parameters. The main difference between the two is in the deteriminants of class membership: both have employment status as a significant class membership variable, while cohabiting comes up as significant without the random parameters but is no longer significant once random parameters are included. However, in the LCX_RPL model all random parameters loose significance, once the class membership is added; this is different from the RPLX model that addresses heterogeneity using interaction terms with the sociodemographic characteristics. As the LCX model also has a better fit relative to the RPLX (Model 4), from this point on we will focus the presentation of results on Model 6.

LC1 has strong preferences in favour of clinic-based and against supermarket-based distribution. LC1's preferred collection is from a box or dispensing machine; it dislikes collection from a person at a counter and is in favour of promotion for HIV prevention or pregnancy prevention but not pleasure and for whom increases in price will have a strong negative effect on uptake. LC2 prefers pharmacy distribution and strongly dislikes Spazas. LC2 is not very concerned about the collection mode or price but is attracted to products promoted for women's empowerment. Both groups dislike promotion for enhanced pleasure.

4. Discussion

This study used a DCE to estimate users' preferences for distribution strategies for potential HIV prevention products. It identified two key user groups. The first, LC1 is characterised by women without much financial liquidity (unemployed) who live with their partners. These women appear relatively content with existing HIV prevention product distribution systems: free distribution through clinics promoted for their health benefits (HIV and pregnancy prevention). The other group, LC2 is less likely to be cohabiting but more likely to be employed. They would prefer private market distribution through pharmacies, products promoted for women's empowerment, and are less price sensitive.

Though health facilities are likely to meet the needs of many women, to facilitate broader access to products while achieving some cost recovery, distribution through pharmacies should complement health clinic distribution. The study also showed women's preferences were consistent regardless of the product type, reducing the need for product specific distribution strategies, though this might be due to these products being in a narrow product category. Rather, it showed that advertising strategies combined with distribution outlets can be used to differentiate products distributed for free and products for sale. This approach, commonly part of a social marketing approach to commodity distribution, can be applied to encourage use of a variety of HIV prevention products by a wider range of women.

This analysis suggests that market segmentation on promotion messages and distribution outlet could increase efficiency by ensuring free, or partially subsidised, access for lower income women, while reducing leakage of subsidies to those who can pay and recovering some costs through priced products distributed in pharmacies. Cost recovery and sustainability is particularly critical as global funding bodies are reducing their direct funding for HIV, and looking to national governments to fund their programmes.

Because preferences differ significantly between socioeconomic groups, differentiating distribution and marketing strategies has the potential to increase vertical equity between groups, through self-selection. Where different groups have different needs, vertical equity is maintained through providing unequal access to health care products and services accordingly (Oliver and Mossialos 2004; Jones 2009). For example, providing products free-of-charge in public facilities would reduce an important barrier to use for lower income women. Women with a greater opportunity cost of time, i.e. employed and unable or unwilling to queue for products, would be more likely according to these results, to purchase products from a pharmacy. Alongside maximising vertical equity, a segmented marketing strategy could maintain cost recovery of new products through differential pricing and marketing across groups. The advantage of this approach is that, while there may be some leakage of the freely distributed products to higher socioeconomic groups, the administrative costs are far lower than for applying a means testing approach. By using a DCE we are able to characterise our populations in a way that is likely to maximise efficiency (higher coverage and low leakage) of the targeting approach.

Although a good deal of economic theory assumes homogenous products, similar goods can be differentiated through careful marketing strategies. In this instance, the same prevention product could be marketed highlighting HIV prevention and provided for free and sold elsewhere in pharmacies with a female empowerment frame. A vertical equity approach in HIV can be seen in programmes which allocate greater resources to prevention and treatment activities in key population groups such as female sex workers (FSWs) or injecting drug users (IDUs) (Gomez et al., 2013). Geographical variation has also been used to target prevention activities to particular areas, such as voluntary medical male circumcision (VMMC) (Verguet 2013).

While DCEs are rooted within a neoclassical economics framework, these findings speak to recent developments in the behavioural economics literature. A promising framework for designing behavioural interventions in public services is the EAST approach, which changes the choice architecture of public services such that desirable behaviours are made easy, attractive, social and timely (Behavioural Insights Team 2011). This study was carried out before the EAST approach was developed, however its design and results are consistent with some key themes of behavioural economics work. Most notably, displaying the right message on products for different groups (i.e. using HIV protection messaging rather than that of pleasure) ensures that products are attractive to potential users. As some respondents indicate that they would prefer not to interact with a member of staff to obtain prevention products, or would prefer a dispensing box, this is an example of making the access point for new products as "easy" as possible for consumers.

This paper is not without limitations. This proof-of-concept application uses DCE data from 2005 that were generated using the

experimental design approaches common at that time. The field of DCE design has moved on substantially since this primary research was carried out, and statistically efficient designs are now recommended/common (Henscher et al. 2005). The purpose of efficient designs is to estimate parameters more precisely than the orthogonal design used here, while allowing for smaller sample sizes. Thus, the parameter estimates in this paper are likely to have wider confidence intervals than if an efficient design had been used, making standard errors larger and inference more conservative. In addition, eliciting only three choice sets per respondent is smaller than many study designs. This may have made the estimation of individual effects in the panel models (RPL and LC) less robust. However, the sample size of 1 016 women is larger than is currently common practice. Because the sample was drawn from similar, yet adjacent, geographic communities within a single municipality, there may be some clustering or correlated error terms; future analyses of similar data may want to adjust for this to avoid any potential bias. Nevertheless, the objective of demonstrating this novel application of DCEs and the comparison of the LC and the LCRPL models provide useful insights. Although the results were generally consistent across models, some preference and class membership coefficients were not consistently statistically significant across all, hence the use of the objective criteria of BIC to guide us towards the most appropriate model. Additionally, the targeting literature identifies targeting by risk as important; in this analysis we have assumed risk is equal, thus we are aiming to increase the distribution quantity and have focussed on self-selection on socio-economic or socio-demographic status rather than on the health benefits.

We propose analysing preference heterogeneity for public health product distribution strategies. This method can support intervention designs to stimulate high uptake, while balancing equity and sustainability. This is becoming increasingly important in a context of shrinking development assistance, when health systems in the global South are becoming increasingly funded from domestic resources.

Author statement

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Declaration of competing interest

The authors have no conflict interest to declare.

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Appendix A. Supplementary data

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