Men's preferences for prostate cancer screening: a discrete choice experiment

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Background: Screening for prostate cancer (PC) may save lives, but overdiagnosis and overtreatment are serious drawbacks. We aimed to determine men's preferences for PC screening, and to elicit the trade-offs they make.

Methods: A discrete choice experiment (DCE) was conducted among a population-based random sample of 1000 elderly men (55–75-years-old). Trade-offs were quantified with a panel latent class model between five PC screening aspects: risk reduction of PC-related death, screening interval, risk of unnecessary biopsies, risk of unnecessary treatments, and out-of-pocket costs.

Results: The response rate was 46% (459/1000). Men were willing to trade-off 2.0% (CI: 1.6%–2.4%) or 1.8% (CI: 1.3%–2.3%) risk reduction of PC-related death to decrease their risk of unnecessary treatment or biopsy with 10%, respectively. They were willing to pay €188 per year (CI: €141–€258) to reduce their relative risk of PC-related death with 10%. Preference heterogeneity was substantial, with men with higher educational levels having a lower probability to opt for PC screening than men with lower educational levels.

Conclusion: Men were willing to trade-off some risk reduction of PC-related death to be relieved of the burden of biopsies or unnecessary treatments. Increasing knowledge on overdiagnosis and overtreatment, especially for men with lower educational levels, is warranted to prevent unrealistic expectations from PC screening.

Prostate cancer (PC) is a major health issue. Screening for PC based on the prostate-specific antigen (PSA) test has potential to save lives, but three out of every four men who undergo a biopsy have a negative biopsy, as the PSA test lacks specificity (Schroder et al, 2009). Additionally, the PSA test is poor at discriminating between men with clinically significant cancer vs those who have little to gain (Roobol et al, 2009). The PSA test may detect small cancers that would never surface clinically during lifetime. This overdiagnosis puts men at risk of treatment complications.

Current PSA screening is hence unattractive due to over-diagnosis and overtreatment. However, the decision to participate or not in any screening programme is preferably based on an individual decision-making process of weighting the test burden against the potential benefits of screening. A man will make trade-offs between what he perceives as the expected advantages and disadvantages, e.g., how negative it would be if he were to suffer from permanent erectile dysfunction due to PC screening.

Patients' preferences can have a major impact on their willingness to use health care services (Phillips et al, 2006). To improve patient-centred health care it is important to investigate men's preferences for PC screening. Additionally, obtaining insight into these preferences is relevant to inform clinicians and policy decision makers, and for planning screening programmes. However, quantitative studies investigating men's preferences for PC screening are lacking. We investigated the preferences of men aged 55–75 years for PC screening. We hereto used a discrete choice experiment (DCE), a quantitative approach that is increasingly used in health care (Ryan and Gerard, 2003; de Bekker-Grob et al, 2012).

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MATERIALS AND METHODS

Discrete choice experiment. In a DCE it is assumed that a medical intervention, such as a screening programme, can be described by its characteristics (attributes; e.g., screening interval) (Ryan, 2004). Those characteristics are further specified by variants of that characteristic (attribute levels; e.g., for screening interval: every 2, 3, and 4 years). A second assumption is that the individual's preference for a medical intervention is determined by the levels of those attributes (Ryan, 2004). The relative importance of attributes and the trade-offs that respondents make between them can be assessed by offering a series of choices between two or more medical intervention alternatives with different combinations of attribute levels (Hensher *et al*, 2005) (Appendix 1). In comparison with other stated preference techniques, a DCE presents a reasonably straightforward task and one which more closely resembles a real-world decision (Mangham *et al*, 2009).

Attributes and levels. We used literature (Draisma *et al*, 2003; Sennfalt *et al*, 2006; Andriole *et al*, 2009; Schroder *et al*, 2009; Hugosson *et al*, 2010), interviews with experts in the field of PC screening ($n = 8$) and men aged 55–75 years ($n = 8$; i.e., the target group) to obtain insights into PC screening attributes and their levels. We asked experts and men in the interviews to comment on and complete the list of PC screening attributes that was created from literature review. We also asked men to rank the attributes from most important to less important with respect to their preferences for PC screening. The number of attributes in a DCE is limited (because of impact on the random component variability), and the ranking results allowed us to make an a priori selection of the five most relevant attributes: risk reduction of PC-related death, screening interval, risk of unnecessary biopsies, risk of unnecessary treatments, and out-of-pocket costs (Table 1). Unnecessary biopsies and treatments are defined as unnecessary at the aggregate level.

Study design and questionnaire. The combination of five attributes with four levels each would result in 1024 (4^5) potential PC screening alternatives. As it is not feasible to present a single individual with all these alternatives, we generated a sample from all these 1024 alternatives. We used an efficient design by maximising D-efficiency (SAS software version 9.1, SAS Institute Inc., Cary, NC, USA) (Street *et al*, 2005). Thirty-two choice sets were constructed. As the cognitive burden may increase with the number of choice sets beyond a certain threshold, the 32 choice sets were blocked (Hensher *et al*, 2005) into two versions of questionnaires containing 16 choice sets each (Bech *et al*, 2011). Choice sets consisted of two PC screening alternatives and a 'no PC screening' option to allow respondents to 'opt out' (Appendix 1). The 'opt out' alternative was necessary as PC screening is a preventive intervention and, as in real life, respondents are not obliged to undertake PC screening. Respondents were asked to consider all three alternatives in a choice set as realistic alternatives and to choose the alternative that appealed most to them. The questionnaire further contained questions on background variables (e.g., age, educational level, generic health status) and a question assessing experienced difficulty of the questionnaire (five-point scale) (the complete questionnaire is available from the authors on request). We conducted a pilot study ($n = 10$) to ascertain respondents could manage the length of the questionnaire and to examine the intelligibility, acceptability, and validity of the questionnaire. As none of the respondents raised any problems, no alterations were made.

Study sample. A representative sample of 1000 men aged 55–75 years was randomly recruited using the population registry of the region Rijnmond in the Southwest of the Netherlands. Calculation

Table 1. Considered attributes and attribute levels for prostate cancer screening

Attributes[a]	Levels
Risk reduction of death from prostate cancer	3.5% → 3.2% (10% relative risk reduction) 3.5% → 2.8% (20% relative risk reduction) 3.5% → 2.5% (30% relative risk reduction) 3.5% → 1.8% (50% relative risk reduction)
Screening interval	Every year Every 2 years Every 3 years Every 4 years (reference level)
Risk of unnecessary biopsy	20% 40% 60% 80%
Risk of unnecessary treatment	0% 20% 50% 80%
Out-of-pocket costs	€0 €50 €100 €300

[a]All attributes entered the analyses as numerical variates, except the attribute 'screening interval'. This latter attribute was entered the analyses as a categorical variate with 'every 4 years' as reference level.

of optimal sample sizes is complicated as it depends on the true values of the unknown parameters estimated in the discrete choice models (Lancsar and Louviere, 2008). Earlier studies have shown that sample sizes of 300–400 respondents are sufficient for reliable statistical analyses (Bishop *et al*, 2004; Herbild *et al*, 2009; de Bekker-Grob *et al*, 2010a). Therefore, taking into account an expected response rate of 40% (Wordsworth *et al*, 2006; de Bekker-Grob *et al*, 2010b), we recruited a representative sample of $n = 1000$. We checked a posterior whether our sample size was sufficient to find significant differences for each attribute(level) at a 5% level using the true values of the estimated parameters and NGene software (http://www.choice-metrics.com/).

Invitation of subjects. Subjects were contacted by mail. They received a questionnaire and an information brochure about PC and PC screening. Individuals could return the questionnaire in a postage-paid envelope that was included in the mailing package. A reminder was sent 4 weeks later in case of non-response. Approval for the study was obtained from the Medical Ethics Committee, Erasmus MC (MEC-2010-316).

Statistical analyses. Several models exist to analyse discrete choice data (see De Bekker-Grob *et al.* (2012) for an overview). Taking our interest in preference heterogeneity into account, as well as our sample size, a mixed logit model or a latent class model were both good alternatives to analyse the choice observations. Although, the best mixed logit model had a somewhat better model fit for the choice observations than the best latent class model (pseudo-$R^2 = 0.42$ *vs* 0.41 using NLogit software (http://www.limdep.com/)), we preferred to use a latent class model due to its advantages (Swait, 1994). A latent class model can be used to identify the existence and the number of segments or classes, C, in the population (i.e., identifying different utility (preference)

functions across unobserved subgroups). Class membership is latent in that each respondent belongs to each class up to a modelled probability and not deterministically assigned by the analyst *a priori*. The model is flexible in that the probability that sampled respondents belong to a particular class can be linked to covariates (e.g., age, income), hence allowing for some understanding as to the make-up of the various class segments (see Appendix 2 for more details). This additional information can be really useful for physicians, and counterbalance the somewhat lower model fit compared with the best mixed logit model. Further, outside of the health care literature, there is growing anxiety as to the appropriate use of outputs from the mixed logit model (Daly *et al*, 2012). The use of the latent class model, overcomes this issue, while still allowing for all of the advantages of the mixed logit model.

We used a *panel* latent class model. A panel latent class model accounts for the panel nature of the data as each respondent completed 16 choice tasks. In order to determine the number of classes, we selected the model with the best fit based on the AIC criterion. We tested a number of different specifications for the utility function (e.g., categorical or numerical attribute levels, two-way interactions between attributes, several attribute transformations). The optimal utility function was:

$$
\begin{aligned}
V_{nsj|c} = & \beta_{0|c} + \beta_{1|c} \text{ reduction of deaths}_{nsj|c} + \beta_{2|c} \text{interval}(1\text{yr})_{nsj|c} \\
& + \beta_{3|c} \text{interval}(2\text{yrs})_{nsj|c} + \beta_{4|c} \text{interval}(3\text{yrs})_{nsj|c} + \beta_{5|c} \text{biopsy}_{nsj|c} \\
& + \beta_{6|c} \text{treatment}_{nsj|c} + \beta_{7|c} \text{costs}_{nsj|c} + \beta_{8|c} \text{reduction of deaths}_{nsj|c} \\
& \times \text{costs}_{nsj|c} + \beta_{9|c} \text{biopsy}_{nsj|c} \times \text{costs}_{nsj|c} + \beta_{10|c} \text{treatment}_{nsj|c} \\
& \times \text{costs}_{nsj|c} + \beta_{11|c} \text{reduction of deaths}_{nsj|c} \times \text{biopsy}_{nsj|c} \\
& + \beta_{12|c} \text{costs}^2_{nsj|c} + \beta_{13|c} \text{reduction of deaths}^2_{nsj|c}
\end{aligned}
\tag{1}
$$

where

$V_{nsj|c}$	represent the observable utility that respondent n belonging to class segment c has for alternative j in choice set s;
$\beta_{0|c}$	represents an alternative-specific constant for a certain class;
$\beta_{1-7|c}$	are class-specific parameter weights (coefficients) linearly associated with each attribute of the DCE;
$\beta_{8-11|c}$	are class-specific two-way interaction effects (i.e., an effect where the influence of one attribute depends on the level of another attribute); and
$\beta_{12-13|c}$	are class-specific parameter weights associated with attribute transformations.

In addition to the utility function, the final model allowed for several covariates (education, depressed/anxious feelings, and stated willingness to pay (WTP) for PC screening) to enter into the class assignment model (Appendix 2). The class assignment utility function for the final model was (see Equation (2)):

$$
V_{nc} = \beta_{0c} + \beta_{1c} \text{ higher education}_n + \beta_{2c} \text{ depression}_n + \beta_{3c} \text{ wtp(100 euros)}_n
\tag{2}
$$

For the class coefficients, the statistical significance of a coefficient (*P*-value ⩽ 0.05) indicates that conditional to belonging to that class, respondents considered the attribute important in making their choices in the DCE. The sign of the coefficient reflects whether the attribute has a positive or negative effect on utility. We expected that only the attribute 'risk reduction of PC-related death' and one or more levels of 'screening interval' would have a positive effect (i.e., a positive sign) (Hol *et al*, 2010; van Dam *et al*, 2010). In terms of the class assignment parameters, statistically significant parameter estimates indicate that the associate covariate can be used to help in understanding the different segments. For example, if the depression parameter associated with a particular class in the

assignment model is positive and significant, then this is indicative that people who suffer depression are more likely to belong to that particular class as given in Equation (1).

Trade-offs. We calculated the WTP values for each of the attributes. A WTP value represents how much one is willing to pay for a one unit change in the attribute of interest, and is calculated by taking the ratio of the parameter for attribute k to the parameter related to cost. For the latent class model however, several potential WTP measures can be derived. Firstly, it is possible to calculate the conditional class WTP values. In the model, each class will have a set of parameter estimates associated with Equation (1). As such, conditional to belonging to class c, the conditional WTP can be computed as

$$
WTP_{k|c} = \frac{\beta_{k|c}}{\beta_{7|c}}.
\tag{3}
$$

While of theoretical interest, the WTP measures derived from Equation (3) are likely to be of limited relevance to the analyst. This is because the model assumes that respondents belong to all classes up to a probability (and not to just one class). It is possible however to obtain overall WTP measures by weighting the conditional WTP values by the probability that respondents belongs to a given class (given by the class assignment probability in Equation (1)). That is (see Equation (4)):

$$
WTP_k = \sum_c^C P_c \frac{\beta_{k|c}}{\beta_{7|c}}
\tag{4}
$$

In the current paper, we compute the latter marginal WTP values. We also compute the confidence intervals based on the individual-specific WTP estimates using the Krinsky and Robb procedure (Krinsky and Robb, 1986).

RESULTS

Respondents. The response rate to the questionnaire was 459/1000 (46%, Figure 1). Respondents did not differ from non-respondents in age ($P = 0.62$) or marital status (0.44). Of the 459 respondents, 427 (93%) completed the DCE task. These respondents had a mean age of 63.3 years (s.d. = 5.2), one-third had a
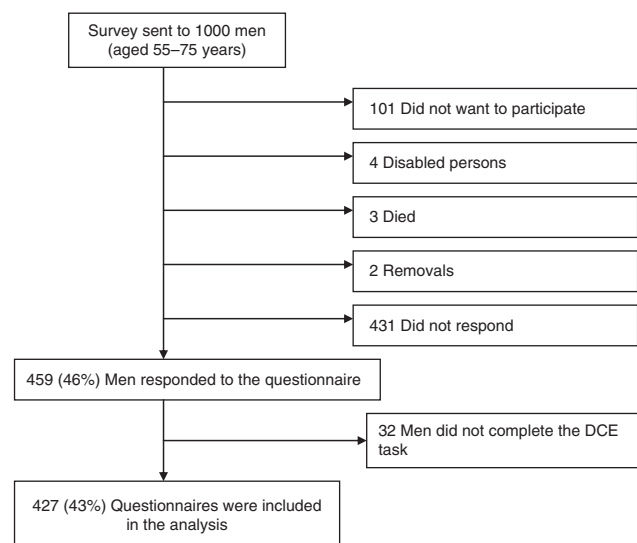

Figure 1. Overview of subjects accessing the study.

Table 2. Characteristics of respondents, who filled in the discrete choice experiment		
	Respondents (*n* = 427)	
Characteristics	Mean	s.d.
Age (years)	63.3	5.2
Educational level	*n*	%
Lower education	95	22.5
Intermediate education	188	44.4
Higher education	140	33.1
Household		
Single, no living in children	41	9.6
Single, one or more living in children	6	1.4
With partner/family member, no living in children	298	70.1
With partner/family member, one or more living in children	80	18.8
Income (€/month)		
0–999	8	2.0
1000–1999	80	20.1
2000–2999	157	39.4
3000–3999	97	24.4
>4000	56	14.1
Treated for prostate cancer		
Yes	13	3.1
No	407	96.9
Knowing someone affected by prostate cancer		
Yes	213	50.8
No	206	49.2
Anxious/depressed feelings		
Yes	48	11.2
No	377	88.3
Missing	2	0.5
Willingness to pay for prostate cancer screening		
Yes	339	79.4
No	76	17.8
Missing	12	2.8

higher educational level, and they lived predominantly together with a partner. Three per cent had been treated for PC (Table 2).

Discrete choice experiment results. Three classes were identified (Table 3). The average class probabilities within the sampled population were 60.8%, 23.0%, and 16.2% for latent class 1, 2, and 3 respectively. However, the probability to belong to a specific class depended on the educational level of the respondent, whether he had anxiety/depression feelings, and his stated WTP for receiving a PC screening programme (not to be confused with the derived WTP value obtained from the model; see Equation (3)). To be more precise, respondents who had a higher educational level, had a higher probability to belong to latent class 3; respondents, who were willing to pay for PC screening had a higher probability to belong to latent class 1; whereas respondents who had anxiety/ depression feeling had a higher probability to belong to latent class 3. Hence, taking all these patient characteristics into account, respondents, who had a lower educational level, did not have anxiety/depression feelings, and were willing to pay for PC screening, had a higher probability to belong to latent class 1 (68.1%, 21.4%, and 10.5% for latent class 1, 2, and 3 respectively).

However, if respondents had a lower educational level, had anxiety/ depression feelings and were not willing to pay for PC screening, the probability to belong to latent class 2 was the highest (28.3%, 40.1%, and 31.6% for latent classes 1, 2, and 3, respectively). Respondents with a higher educational level, who had anxiety or depression feelings, and were not willing to pay for PC screening, had the highest probability to belong to latent class 3 (20.8%, 30.7%, and 48.6% for latent class 1, 2, and 3 respectively).

The estimated coefficients for each latent class had the expected sign and were significant in most cases (Table 3) and showed, therefore, theoretical validity. The positive sign given to the coefficient 'risk reduction of PC-related death' indicated that men preferred a PC screening programme generating a higher reduction of PC-related death over a PC screening programme that generates a lower reduction of PC-related death. The negative signs for 'risk of unnecessary treatment and biopsy' and 'out-of-pocket costs' indicate that men preferred a PC screening programme with a low risk of unnecessary treatment and biopsy, and low out-of-pocket costs.

All five PC screening aspects significantly influenced men's preferences, although the preference heterogeneity was substantial. Nevertheless, irrespective of the latent class respondents belong to, risk reduction of PC death, risk of unnecessary treatment and biopsy, as well as costs, they were all important for respondents' preferences, whereas screening interval was not. Respondents who belong to latent class 1 showed a strong preference for a shorter screening interval. Although respondents who belong to latent class 3 also showed a preference for screening every 2 years over screening every 4 years, such respondents significantly preferred screening every 4 years over screening every year. In contrary, for latent class 2 the screening interval did not have an influence on preferences for PC screening at all.

Assuming a realistic PC screening programme (i.e., 20% risk reduction of PC-related death, screening interval every 4 years, 60% risk of an unnecessary biopsy, 50% risk of an unnecessary treatment, and no out-of-pocket costs) the utilities were 2.7, 4.6, and −0.6 based on latent class 1, 2, and 3 respectively (see Equation (1) and Table 3). That is, respondents belonging to latent class 1 or 2 preferred this realistic PC screening scenario over no screening ($V = 2.7 > V = 0$; and $V = 4.6 > V = 0$ respectively). However, respondents belonging to latent class 3 did not prefer this PC screening programme over no screening ($V = −0.6 < V = 0$). More general, assuming realistic attribute levels of PC screening, men with a lower educational level had a higher probability to prefer PC screening over no PC screening compared with men with a higher educational level, all else being equal. The same conclusion can be made for men who were willing to pay for PC screening or for men without anxiety/depressed feelings. That is, men who were willing to pay for PC screening and/or did not have anxiety/depressed feelings, had a higher probability to prefer PC screening over no PC screening compared with men who were not willing to pay for PC screening and/or had anxiety/depressed feelings, all else being equal.

Trade-offs

Willingness to pay. Based on the expressed preferences, men were willing to pay €188 per year (CI: €141–€258) to reduce their relative risk of PC-related death with 10% (Table 4). They were willing to pay €33 per year (CI: €23–€48) to decrease their risk of unnecessary biopsy with 10%, €38 per year (CI: €27–€53) to decrease their risk of unnecessary treatment with 10%, or €87 per year (CI: €48–€137) to get a PC screening programme with a screening interval of every 2 years instead of every 4 years. The wide range of CIs showed that the difference in WTP was considerable, which proved the existence of preference heterogeneity.

Table 3. Men's preferences for prostate cancer screening based on a panel latent class logit model with three latent classes

Attribute	Latent class 1		Latent class 2		Latent class 3	
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Constant	3.16***	9.71	4.67***	13.50	− 0.65*	− 1.90
Risk reduction of PC death (per 10%)	0.93***	8.63	0.40***	2.90	0.82***	5.24
Screening interval						
Every year	0.10**	1.99	− 0.05	− 0.77	− 0.20**	− 2.43
Every 2 years	0.20***	3.97	0.09	1.47	0.21***	2.89
Every 3 years	− 0.02	− 0.31	− 0.02	− 0.24	− 0.07	− 0.84
Risk unnecessary biopsy (per 10%)	− 0.10**	− 2.57	− 0.27***	− 6.09	− 0.03	− 0.70
Risk unnecessary treatment (per 10%)	− 0.10***	− 5.30	− 0.04*	− 1.77	− 0.17***	− 8.67
Out-of-pocket costs (per €100)	0.07	0.40	− 1.32***	− 5.40	− 1.10***	− 4.65
Risk reduction PC death × costs	0.06***	2.72	− 0.01	− 0.09	0.02	0.59
Biopsy × costs	0.07***	3.37	0.04	1.61	0.03	1.12
Treatment × costs	− 0.01	− 0.35	0.05**	2.33	0.05***	3.09
Risk reduction PC death × biopsy	− 0.02**	− 1.99	0.07***	5.59	− 0.03**	− 2.29
Costs^2	− 0.07***	− 5.16	0.01	0.28	0.10**	2.19
Risk reduction PC death^2	− 0.18***	− 5.98	0.03	1.55	− 0.06***	− 3.33
Class probability model						
Constant	1.62***	7.03	0.69***	2.68	—	—
Higher eduction	− 0.74**	− 2.35	− 0.70*	− 1.86	—	—
Depression	− 1.73***	− 3.88	− 0.45	− 1.00	—	—
Willingness to pay (per €100)	0.25**	2.97	0.02	0.29	—	—
Class probability						
Average	0.608		0.230		0.162	
Model fits						
Log-likelihood	− 4334.89					
AIC	1.32					
BIC	1.37					
Pseudo R-squared	0.41					

Abbreviations: Coeff. = coefficient; PC = prostate cancer. ***, **, * denotes significance at 1%, 5%, and 10%, respectively. Effects coded variable used for frequency of a blood test (reference level = screening every 4 years; the value of this level equals the negative sum of the coefficients of the included attribute levels). Number of observations = 6.669.

Table 4. Willingness to pay to achieve an improvement in one of the prostate screening attributes

Attribute	WTP (€; CI)	To receive a screening programme
Mortality reduction	187.6 (140.6 to 257.8)	With 10% more prostate cancer-related mortality reduction
Screening interval	9.7 (− 24.9 to 46.5)	Every year instead of every 4 years
	86.9 (48.2 to 136.8)	Every 2 years instead of every 4 years
	− 12.0 (− 50.2 to 27.4)	Every 3 years instead of every 4 years
Unnecessary treatment	37.6 (26.7 to 53.0)	With 10% less risk of unnecessary treatments
Unnecessary biopsy	33.4 (22.5 to 48.4)	With 10% less risk of unnecessary biopsies

Abbreviations: CI = confidence interval; € = euro; WTP = willingness to pay. CI = 95% confidence interval based on the Krinsky Robb method adjusted for class probabilities. The average values of the interactions are taken into account (i.e., costs = €112.50; mortality reduction = 27.5%; unnecessary treatment = 37.5%; unnecessary biopsy = 50%).

Willingness to trade of risk reduction of PC-related death. Men were willing to trade-off 2.0% (CI: 1.6%–2.4%) risk reduction of PC-related death to decrease their risk of unnecessary treatment with 10%, 1.8% (CI: 1.3% to 2.3%) to decrease their risk of unnecessary biopsy with 10%, or 4.6% (CI: 2.8% to 6.4%) to get a PC screening programme with an screening interval of every 2 years instead of every 4 years (Table 5). Again, the wide range of CIs regarding the willingness to trade of risk reduction of PC-related death proved the existence of preference heterogeneity.

DISCUSSION

Risk reduction of PC-related death, screening interval, risk of unnecessary biopsies and treatments, and out-of-pocket costs, all influenced men's preferences for PC screening. However, sub-stantial preference heterogeneity existed. Assuming a realistic PC screening programme, men with a lower educational level had a higher probability to opt for PC screening than men with a higher

Table 5. Willingness to trade mortality risk to achieve an improvement in one of the prostate screening attributes

Attribute	Willingness to trade mortality risk (%; CI)	To receive a screening programme
Unnecessary treatment	2.0 (1.6 to 2.4)	With 10% less risk of unnecessary treatments
Screening interval	0.5 (− 1.3 to 2.4)	Every year instead of every 4 years
	4.6 (2.8 to 6.4)	Every 2 years instead of every 4 years
	− 0.7 (− 2.8 to 1.4)	Every 3 years instead of every 4 years
Unnecessary biopsy	1.8 (1.3 to 2.3)	With 10% less risk of unnecessary biopsies
Out-of-pocket costs	5.5 (3.9 to 7.1)	With €100 lower out-of-pocket costs

Abbreviations: CI = confidence interval; WTP = willingness to pay. CI = 95% confidence interval based on the Krinsky Robb method adjusted for class probabilities The average values of the interactions are taken into account (i.e., costs = €112.50; mortality reduction = 27.5%; unnecessary treatment = 37.5%; unnecessary biopsy = 50%).

educational level. This same phenomenon was found for men who were willing to pay for PC screening and/or did not have anxiety/depressed feelings. Men were willing to pay €188 per year (CI: €141–€258) for each 10% reduction in their relative risk of PC-related death with 10%, or €87 per year (CI: €48–€137) to get PC screening every 2 years instead of 4 years. Men were willing to trade-off 2.0% (CI: 1.6%–2.4%) or 1.8% (CI: 1.3%–2.3%) risk reduction of PC-related death to decrease their risk of unnecessary treatment or unnecessary biopsy with 10%, respectively.

There are no previous DCEs investigating how characteristics of PC screening determine men's preferences for participation in PC screening. However, a study that investigated the influence of information on preferences among men aged 50–70 years for introducing PC screening in Denmark, found that regardless of information level a PC screening programme was valued highly (Pedersen et al, 2011). These results are in line with our findings, which show that in general men had a positive attitude towards PC screening. Our finding that men were prepared to give up life expectancy to avoid side-effects of medical intervention was also found by a DCE who focused on patients' preferences for the management of non-metastatic PC (Sculpher et al, 2004).

Although PC screening intervals may differ among countries, the most widely used screening interval is screening every 4 years (Schröder et al, 2009). Our study showed that men preferred a shorter screening interval over a longer screening interval. These results are in line with other studies. In a cancer screening context, a DCE showed that people aged 50–75 years significantly preferred colorectal cancer screening intervals shorter than 10 years over a 10-year screening interval (van Dam et al, 2010). Preferring a shorter screening interval over a longer screening interval was also found in another DCE study (Wordsworth et al, 2006), where women preferred more frequent cervical cancer screening. Several studies have shown that reassurance may be a motivation for and/or a result of undergoing cancer screening (Cantor et al, 2002; Whynes et al, 2007). This stresses the importance of adequate information provided to potential screeners.

Men included in our study population showed preference heterogeneity for PC screening aspects. Information about preference heterogeneity may help physicians to understand individuals' preferences for screening. Awareness of and explicit addressing differences in personal values regarding screening in general may have a positive effect on the process and outcomes of

screening initiation in individual patients. For example, our results showed that men with lower educational levels had a higher probability to prefer PC screening than men with higher educational levels. The implications are that physicians (1) should be aware that patients may overestimate their benefit of PC screening due to numeracy problems, (2) can have a role to prevent unrealistic expectations from PC screening, and (3) are able to reach an optimal shared decision-making regarding PC screening. Additionally, information about preference heterogeneity may also be useful to inform policy decisions. Tailored PC screening programmes may result in a better informed decision-making for screening. Noteworthy, as physicians and patients may differ on the desirability for PC screening, which may hamper the process and outcome of shared decision-making, further research about determining and comparing physicians' and men's preferences for prostate screening is recommended.

The present study had several limitations. First, the response rate of 46% was higher than expected and similar to other DCE studies (Ratcliffe et al, 2002; Hundley and Ryan, 2004; Wordsworth et al, 2006; de Bekker-Grob et al, 2010b), but this response rate is still not optimal. We cannot exclude selection bias, although our respondents did not differ from non-respondents in age or marital status. Additionally, the proportions of different educational levels in our study sample were quite similar with the general population. Second, the inclusion of numbers and rates in our DCE might have caused problems with understanding the choice task. However, 93% of the respondents passed the rationality test that was included in the questionnaire, and 76% of the respondents did not find the DCE questions difficult. We hence believe that this has not influenced the results to a large extent. Finally, the current results could gain credibility if it were possible to compare the stated preferences of men with their actual behaviour in a PC screening programme.

In conclusion, men are willing to trade-off some risk reduction of PC-related death to be relieved of the burden of biopsies or to avoid unnecessary treatments. Men with lower educational levels have a higher probability to prefer PC screening than men with higher educational levels. Increasing knowledge on overdiagnosis and overtreatment, especially for men with lower educational levels, is hence warranted to prevent unrealistic expectations from PC screening.

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APPENDIX 1

Example of a choice set

Thirty-five out of every 1000 men that will die is caused by PC. Which alternative do you prefer to reduce your risk to die from PC: no screening, screening programme 1, or screening programme 2? *(please, tick one box)*

	NO SCREENING	PROGRAM 1	PROGRAM 2
Amount of men per 1,000 men that will **die** from prostate cancer	**35 deaths** (0 deaths prevented)	**25 deaths** (10 deaths prevented)	**18 deaths** (17 deaths prevented)
Frequency of a **blood test**	**No** blood test	Every **4 year** a blood test	Every **3 year** a blood test
Amount of men per 1,000 men with an increased PSA that receive an **unnecessary biopsy** (=no cancer detected, although the blood test suggested that a biopsy was needed)	**Not applicable**	**400 unnecessary biopsies** (600 correct biopsies)	**800 unnecessary biopsies** (200 correct biopsies)
Amount of men per 1,000 treated men that receive an **unnecessary treatment** (=no increase in life expectancy, but there is a risk of remaining urine incontinence and erection problems due to treatment)	**Not applicable**	**0 unnecessary treatments** (1.000 correct treatments)	**500 unnecessary treatments** (500 correct treatments)
Out of pocket cost per year during the period of the screening programme	**0 euro per year**	**100 euro per year**	**50 euro per year**
Which alternative would you choose?	☐	☐	☐

APPENDIX 2

Methodology

Latent class model. The probability that respondent n belongs to class segment c, is given by a class assignment model. The class assignment probability is

$$P_{nc} = \frac{\exp(\theta_c q_{nc})}{\sum_{c=1}^{C} \exp(\theta_{c'} q_{nc'})} \qquad (i)$$

where q_{nc} represents covariates (e.g., age, income), and θ_c represents parameters to be estimated. If no covariates are included in the class assignment model, then the model can be estimated with constants only. In such a case, all respondents will have the same probability of belonging to a given class or segment. When covariates are included in the class assignment model, the class membership probability will differ depending on the

covariates included in the model. For model identification, the parameters (and/or constants) for one class are required to be set to zero, such that all the remaining parameters are interpreted as being relative to this class. Note that in estimating the model, the analyst must a priori determine the number of classes to be estimated.

Conditional on belonging to a given class c, the probability that individual n chooses alternative j in choice set s is given as

$$P_{nsj|c} = \frac{\exp\left(\beta_{k|c} x_{nsjk}\right)}{\sum_{i=1}^{J} \exp\left(\beta_{k|c} x_{nsik}\right)} \qquad (ii)$$

where $\beta_{k|c}$ represent class-specific parameter estimates to be estimated and x_{nsjk} represent the attributes associated with the alternatives described within the DCE.

Panel latent class model. *Panel* latent class model means that the model accounts for the pseudo panel nature of the DCE data as each respondent completed several choice tasks. In the DCE employed herein, each respondent completed 16 choice tasks. As such, the probability that a respondent is observed to make a particular sequence of choices over the 16 choice tasks, conditional on belonging to class c is given as

$$P^*_{n|c} = \prod_{s=1}^{S=16} \left(\frac{\exp\left(\beta_{k|c} x_{nsjk}\right)}{\sum_{i=1}^{J} \exp\left(\beta_{k|c} x_{nsik}\right)} \right)^{y_{nsj}}, \tag{iii}$$

Given Equation (iii), we use maximum likelihood estimation to locate the parameters of interest, θ_c and $\beta_{k|c}$. We do this maximising the log-likelihood function of the model, which is given as

$$LogL = \sum_{n=1}^{N} \ln \left(\sum_{c=1}^{C} P_{nc}\left(P^*_{n|c}\right) \right). \tag{iv}$$

where y_{njs} is an indicated variable equal to one if alternative j was observed to be chosen by respondent n in choice set s, or zero otherwise.

By making use of the product of the probabilities (Equation (iii)) in the log-likelihood function (Equation (iv)), as opposed to the individual choice set probabilities (Equation (ii)), the model estimates the probability of observing sequence of choices made over the 16 choice tasks. As such, the model accounts for the pseudo panel nature of the DCE data.

Class assignment utility functions. In addition to the conditional utility functions, the final model allowed for several covariates to enter into the class assignment model (Equation (i)). The class assignment utility function for the final model is given as Equation (v).

$$V_{nc} = \beta_{0c} + \beta_{1c} \text{ higher education}_n + \beta_{2c} \text{ depression}_n \\ + \beta_{3c} \text{wtp}(100 \text{ euros})_n \tag{v}$$

The parameter estimates of Equation (v) are obtained by maximising Equation (iv), given the data.