



## Willingness-to-pay for colorectal cancer screening

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### Abstract

Willingness-to-pay (WTP) techniques are increasingly being used in economic evaluation, as a means of assessing the value of new health care technologies. This paper presents the results of a WTP investigation of two types of screening for colorectal cancer. A questionnaire was issued to a general population via general practitioners (GPs), yielding a sample of approximately 2000 cases for analysis. Regression models demonstrated that WTP was significantly influenced by factors such as gender, income, age, risk perceptions, illness experiences and health beliefs. The median WTP for screening emerged as being £30 or £50, depending on the method used to elicit WTP, but independent of the screening protocol. Combining the results with those from related research, it emerged, first, that WTP subjects offered higher values for flexible sigmoidoscopy screening than the costs actually incurred by revealed preference studies and, second, they offered WTP values similar to the likely resource costs of the screening procedures. © 2001 Elsevier Science Ltd. All rights reserved.

**Keywords:** Colorectal cancer; Faecal occult blood test; Screening; Sigmoidoscopy; Willingness-to-pay

### 1. Introduction

Colorectal cancer (CRC) is currently the most common cancer in the European Union, with over 213 000 incident cases recorded annually [1]. Tumours typically progress from normal mucosa, through an adenoma stage, to invasive carcinoma, with increasing spread and eventual metastasis. Patient prognosis is strongly correlated with disease progression at the time of initial diagnosis and treatment. Unfortunately, symptoms tend to present only at the advanced stages of the disease, when the prognosis is poor and patient management is expensive. These disease characteristics, coupled with recent developments in diagnostic technology, have made CRC a prime candidate for mass population screening [2].

Whilst regular endoscopic screening (colonoscopy) would maximise the detection rate, the procedure is infeasible as a mass screening tool, on the grounds of cost, clinic capacity and likely long-run non-compliance

with such an invasive procedure. Instead, research has been directed towards identifying cost-effective methods of filtering out the majority of subjects who will be at low risk, whilst identifying potential high-risk candidates for more sensitive and specific colonoscopic and/or radiological investigation. Although a variety of filtering strategies are available for general use in an asymptomatic population [3,4], much of the research to date has concentrated on just two.

Firstly, colorectal tumours are known to bleed. The blood so released will pass into the faeces, and its presence can be detected by a relatively inexpensive, self-administered, chemical test. The presence of faecal occult blood (FOB) therefore suggests a bowel abnormality and indicates a need for more detailed investigation. Major randomised controlled trials of screening using the FOB test have been undertaken in both Europe and the USA over the past 20 years [5]. The two longest-running European trials, conducted in Denmark and in the UK, offered biennial FOB screening to a population aged 50–74 years, and each has reported significant cumulative CRC mortality reductions in its screening arm [6,7]. Economic evaluations conducted in parallel with these trials have indicated

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that, if implemented, their protocols would prove cost-effective in principle [8,9]. In the light of the accumulating evidence, several US cancer organisations are recommending regular FOB testing for all persons aged 50 years and above [10], whilst pilot screening projects have been announced for the UK [11].

Second, and as noted above, regular colonoscopy would prove an un-affordable and intrusive form of screening. However, a case has been made for endoscopic screening using the shorter and safer flexible sigmoidoscope, on a once-only basis at age 60 years or thereabouts [12]. As with FOB testing, candidates identified as being at risk would be sent for further investigation, and such a protocol might well represent an acceptable balance between programme yield and programme cost. Experimental and modelling results for the use of sigmoidoscopy as the principle screening tool have already been published [13–15] and once-only screening is presently the subject of a major UK multi-centre randomised controlled trial [16]. For the purposes of this trial, the procedure is termed 'Flexi-Scope' (FS).

Given the evident clinical research interest in supplying CRC screening in the UK, we decided to explore whether a corresponding interest existed amongst the potential demanders of screening. To this end, we conducted a willingness to pay (WTP) or contingent valuation study of both FOB and FS amongst a general population. The use of WTP in health economics has proliferated over the past 10–20 years, as a means of obtaining a quantitative estimate of the values which individuals place on new or existing health care services [17,18].

## 2. Patients and methods

The data were collected using an eight-page A4 questionnaire, designed for self-completion without supervision. After initial construction, the instrument was piloted on thirty members of a general population, presented for ethical approval, and modified accordingly. We approached a regional collaborative research network of general practitioners (GPs) and 22 practices agreed to distribute copies of the instrument to their patients on our behalf. All participating practices were located within the Trent region of east-central England. As will be made clear shortly, two questionnaire formats were constructed, to enable us to assess the consequences of using alternative methods of eliciting contingent valuations.

GPs were requested to offer a questionnaire to any patient during a normal consultation, subject to three forms of exclusion. These were, first, persons under 25 years of age, on the grounds of likely perceived irrelevance of screening in that age group. Second, GPs were,

at their discretion, to exclude any subject with a recent diagnosis of colorectal cancer in the family, on the grounds of minimising distress. Finally, potential subjects with substantial reading, learning or language difficulties were to be excluded, on the grounds of incapacity to complete the questionnaire. Subjects were able to return their completed questionnaires either through their practice or individually by post (in pre-paid reply envelopes). It was anticipated that the majority of subjects would have no familiarity with colorectal cancer screening. However, we considered it probable that a modest proportion of our sample would have already been subjects in the FOB and FS clinical trials, which had included populations within the Trent region, or might have undergone either of the tests independently.

In addition to containing standard administrative details, such as contact information and a guide to completion, the first two pages of the instrument were devoted to descriptions of CRC, of the principle of screening and of the two screening options, FOB and FS. With respect to the latter, we chose descriptions essentially similar to those which had been employed in inviting subjects to participate in the Nottingham-based, UK FOB trial [7] and the UK multi-centre FS trial [16]. This information related to procedure, not to efficacy (which was, of course, under investigation). Following the descriptions, each subject was asked which test they would prefer. Thereafter, the nature of the WTP exercise was explained and subjects were invited to supply a valuation for each of the two screening options. Given the debate surrounding possible biases in elicitation methods, we constructed two contingent valuation formats which were offered to subjects on a random basis (each practice received a shuffled pile of questionnaires for distribution, containing equal numbers of each format). We chose two of the most popular formats and based our questions directly on those developed by earlier researchers [19,20]. The formats were the open-ended question and the payment scale.

In the open-ended format, subjects were offered spaces in which to write in their valuations of both a full set of biennial FOB tests and the once-only FS procedure. In the payment scale format, the space provided in the open-ended variant were replaced with vertically-arranged lists of 29 values. These values were, from top to bottom, £0, £5 and £10, thereafter to £100 in units of £10, to £200 in units of £20, to £500 in units of £50 and to £1000 in units of £100. Subjects expressing a valuation in excess of £1000 were requested to write in the appropriate amount (i.e. beyond the limit of the scale, the payment format defaulted to the open-ended format). Following convention, subjects were requested to encircle the maximum amount, whilst placing ticks against amounts they were sure they *would* pay and crosses against amounts they were sure they would not.

The remainder of the questionnaire, for both formats, requested routine socio-demographic and economic data, including gender, age, age on leaving formal education, employment status and household income (in four bands, starting at zero, band-width £10 000, ending £30 000 and above). We also requested information on whether any one of six diseases (stomach problems, haemorrhoids, heart disease, cancer, stroke and depression) had been experienced by the subject or the immediate family, and on perceived own-health status (four-point scale—poor, fair, good, excellent). The number of visits to the GP and dentist in the past 1 and 2 years, respectively, was requested, as was any screening history of any type over the previous 5 years (including screening for CRC).

Subjects were asked to note whether they were particularly worried about colorectal cancer (four-point scale—not at all, a bit, quite, very) and to identify their perceived chances of eventually suffering the condition, compared with men and women of their own age (five-point scale—much lower, lower, same, higher, much higher). Finally, we requested an indication of the importance attached to a fruit-rich diet, regular exercise, breast screening and cervical screening in maintaining good health (five-point scale in each of the four cases—not at all, somewhat, moderately, very, extremely). These data were coded 1–5, respectively, and a mean score across the four dimensions was calculated. We took this score as a measure of the subject's 'health motivation' [10], representing the degree of belief in the efficacy of established health promotion measures. Clearly, a higher score would imply stronger belief in the merits of health promotion.

The data were analysed using logistic and linear regression techniques, with WTP as the dependent variable. Two separate models were constructed, to explain zero and positive values, respectively. Although it would have been feasible to estimate a single Tobit model for the full sample, earlier researchers have found that this two-part specification performs better with WTP data [21]. For each model, all other variables were initially entered as potential independents and were chosen or rejected by stepwise selection. Only the final models are presented below. This mode of analysis required several of the variables to be re-coded as binary dummies. We constructed a dummy variable from the age data, for ages up to 45 years. Our prior hypothesis was that younger persons, being more distant from eligibility for either test, might have a reduced interest in the procedures.

### 3. Results

A total of 2767 completed questionnaires were returned, comprising 1366 (49.4%) of the open-ended format and 1401 (50.6%) of the payment scale variant.

In spite of completing all, or virtually all, other parts of their questionnaires, 553 respondents (20.0%) failed to complete either of the WTP questions, and a further 293 (10.6%) completed only one. The FOB question received more replies than did the FS question (2156 versus 1979 replies, respectively).

The sample of those offering at least one WTP response ( $n=2214$ ) was 63.2% female, with a median age of 49 years (inter-quartile range 37–60 years). Of this sample, 38.4% fell into the Age 1 category (under 45 years). The distribution across the household income cohorts, from lowest to highest, was 24.8, 34.3, 22.3 and 18.5%, respectively. For comparison, the UK distribution is approximately 33, 27, 20 and 20%, respectively [22]. Our sample therefore slightly over-represents the middle range of household incomes (£10 000–30 000), but matches the division between the two highest cohorts combined ( $\geq £20 000$ ) and the two lowest cohorts combined ( $< £20 000$ ) almost exactly.

Of the sample, 8.5% had experience of colorectal cancer screening, 20.6% were quite or very worried about getting bowel cancer and 12.2% felt that their chances of developing the disease were higher than average. The median health motivation score was 4.25, within an inter-quartile range of 4–4.5. With respect to test preferences amongst those providing at least one WTP, 859 (38.8%) expressed no preference, 1025 preferred FOB (46.3%) and 305 (13.8%) preferred FS, whilst 25 (1.1%) did not answer this question.

The distributions of WTP values had skew coefficients of 22.3 and 39.0 for FOB and FS, respectively (a normal distribution has zero skew). As implied by these coefficients, the ranges were considerable, with the second percentile being £10 and the ninth being £200, in each case. At the extreme, 9.3 and 11.0% offered zero WTP values for FOB and FS, respectively, whilst 4.3% and 2.7% offered values equal to or more than £500. Given the skews and ranges, transformations to natural logarithms seemed appropriate prior to analysis. Such transformations necessarily require the exclusion of zero values for the dependent variables. Zero values are not uncommon in WTP studies, although it has been suggested that the use of positive values only in regressions can yield better estimates than those in which zeros are included [21]. Table 1 presents the final results of two logistic regression models, predicting the likelihood of subjects providing zero WTP values. Use of the payment scale elicitation method evidently increases the likelihood of a zero value, as does the subject being well below the age of eligibility for CRC screening, male, and from a household with low income. More regular dental visits and familiarity with cancer reduce the likelihood of a zero response.

Table 2 presents the linear regressions explaining the positive WTP values. The payment scale method yields higher WTP values on average than does the open-

Table 1  
Logistic regressions predicting WTP of zero (zero value = 1)

	FOB			FS		
	b	SEM	exp(b)	b	SEM	exp(b)
Method (payment scale = 1)	0.381	0.172	1.464	0.347	0.165	1.415
Gender (male = 1)	0.408	0.174	1.504	0.431	0.169	1.539
Aged under 45 years (yes = 1)	0.487	0.177	1.627	0.685	0.171	1.985
Income < £10 000 (yes = 1)	0.566	0.186	1.761	0.486	0.182	1.626
Number of dental visits in previous 2 years	-0.103	0.052	0.902	-0.107	0.050	0.899
Own/family experience of cancer (yes = 1)				-0.382	0.191	0.682
(Constant)	-3.119	0.247		-0.297	0.247	
Adjusted R-squared	0.034			0.045		

WTP, willingness to pay; SEM, standard error of the mean; FOB, faecal occult blood; FS, 'Flexi-Scope'.

ended instrument, a result observed before although in a different context [19]. Males, and those with more formal education, are evidently willing to pay more in both cases (even though the former were also more likely to offer zero values). A positive association between expressed WTP and ability to pay is evident, consistent with the normal economic model of superior goods. Indeed, the income effects are exactly as theory would predict: respondents drawn from the lowest household income class stated significantly lower WTPs, with the reverse being the case for the higher income classes. Again, this result is consistent with previous research findings [23]. A high health motivation score, above-average perceived CRC risk, frequent dental visits and experience of haemorrhoids predict a higher WTP value, other things remaining equal. These associations appeal to intuition—we should expect an interest in screening to be related to a positive attitude to health behaviour, perceived risk and experience of related health problems, albeit relatively minor. Furthermore, it should be noted that male gender and regular visits to the dentist were positive predictors of actual compliance in the UK FS trial [24], whilst dental visits and higher

socio-economic class were positive predictors of actual compliance in the Nottingham FOB trial [25].

Table 3 presents summary data for WTP for both FOB and FS, by elicitation format. The value of the trimmed mean (which excludes 5% of observations equally at the two extremes of the distribution) indicates that the true mean is influenced significantly by small numbers of very high WTP values. From the frequency distributions of the WTP values, it is possible to map demand curves for CRC screening. By convention, a demand curve plots price (WTP in our case) on the vertical axis, against the cumulative proportion of the sample willing to pay a sum up to any given price. Fig. 1 displays the demand curves for the two screening methods. In generating these curves, the open-ended and payment scale data have been combined. The inflections in the curves arise both from the discontinuities of the payment scale and from the propensity of subjects completing the open-ended instrument to record WTP values as 'natural numbers', for example, £50 or £60, but rarely values in between.

As is evident, the demand curves are extremely similar to one another, as are the median values for the two

Table 2  
Linear regression: positive WTP values (natural logarithms)

	FOB		FS	
	b	SEM	b	SEM
Method (payment scale = 1)	0.220	0.057	0.520	0.052
Gender (male = 1)	0.166	0.061	0.103	0.056
Age on leaving full-time education (years)	0.009	0.005	0.019	0.005
Income < £10 000 (yes = 1)	-0.224	0.077	-0.165	0.071
Income £20 000–30 000 (yes = 1)	0.173	0.076	0.160	0.069
Income > £30 000 (yes = 1)	0.380	0.082	0.401	0.074
Number of dental visits in previous 2 years	0.055	0.018	0.060	0.017
Health motivation score	0.134	0.051	0.092	0.047
Own/family experience of haemorrhoids (yes = 1)	0.125	0.058	0.092	0.052
Chances of getting CRC? (above average = 1)	0.422	0.086	0.319	0.076
(Constant)	2.238	0.256	2.178	0.236
Adjusted R-squared	0.075		0.126	

WTP, willingness-to-pay; FOB, faecal occult blood; CRC, colorectal cancer; SEM, standard error of the mean; FS, 'Flexi-Scope'.

Table 3  
WTP summary statistics (£)

	5% trimmed			Percentiles		
	Mean	Mean	Mode	25	50	75
Open-ended method						
FOB	129.6	66.3	50	10	30	100
FS	86.1	43.4	50	10	30	50
Payment scale method						
FOB	93.1	68.3	50	20	50	100
FS	90.8	70.1	100	20	50	100

FOB, faecal occult blood; FS, 'Flexi-Scope'; WTP, willingness-to-pay.

types of test, for each format. This is essentially because almost half of the sample (48.1%) recorded the same WTP value for both tests. It is therefore probable that, in spite of the fact that the screening technologies as described to the subjects appeared to be quite different, the subjects perceived that they were actually 'buying' the same end product, namely, early disease detection by screening. Both demand curves approximate to simple logarithmic functions, with coefficients of variation in excess of 0.92. Curves of these general shapes are frequently encountered for commodities other than health care, suggesting that the WTP demand curve for CRC screening is neither atypical or unusual.

#### 4. Discussion

WTP exercises are akin to market research, both in conduct and in use. They are attempting to establish in advance the extent to which a new technology, if implemented, would be valued by the public. Any translation from an average estimate, derived under hypothetical circumstances, to what the public really believes a service is worth in practice, is inevitably problematic, if only because of methodological uncertainties, for example, under- or over-estimation using different methods of value elicitation. However, in the case of CRC screening, we have additional data to bring to bear, to aid interpretation of the results.

First, the UK trial of FS screening required an actual, rather than hypothetical, WTP exercise on the part of those subjects who elected to participate. In order to receive the test, each subject was obliged to attend a clinic, and thereby to incur time and travel costs. Based on a sample of approximately 3500 subjects drawn from 12 trial sites across the UK, median time and travel costs were estimated at £19.0 per attendance, within an inter-quartile range of £11.8 to £29.4 [26]. These average costs incurred by screening subjects—which can be interpreted as valuations by revealed preference—are of the same order of magnitude as the average WTP values elicited in our sample, although somewhat lower. Naturally, had the reverse been the case, we would have had

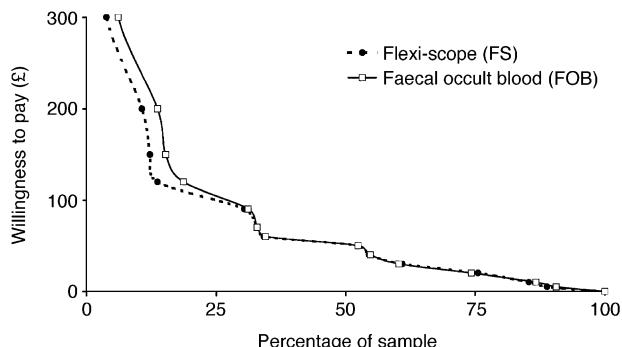


Fig. 1. Demand for FOB and FS testing.

grounds for suspecting that the stated WTP values were under-estimates of public valuation, given the revealed value information.

Second, although neither FOB or FS screening has been fully operationalised, estimates of the resource cost entailed by both protocols have been made. The 1989 cost of three rounds of FOB screening, using the Nottingham trial protocol, was estimated to be £14.3 [27]. Given the age range for eligibility, the maximum number of rounds a person might be screened under the protocol as presented in the WTP questionnaire would be thirteen, implying a total programme cost of around £62 per subject. The cost of a sigmoidoscopy investigation was estimated at approximately £30 in 1989, although this figure ignored the costs of the administration of screening [28]. Even allowing for inflation over the past decade, it is evident that the median WTP values expressed by our sample would be quite similar to the probable cost of the services, were they to be introduced.

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