



A comparison of hypothetical versus real willingness to pay for ion-exchange water softeners in the context of childhood atopic eczema

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Abstract

Background: There have been few opportunities to observe real individual preferences in health care contexts. Instead economists have elicited stated preferences through contingent valuation methodology. This study compares empirical data on hypothetical and real preferences for ion-exchange water softeners in the context of childhood atopic eczema as a partial test of hypothetical bias.

Methods: As part of an HTA funded trial exploring the effectiveness and cost-effectiveness of ion-exchange water softeners in children with moderate to severe eczema living in hard water areas, 336 families had the device installed into their homes. All parents were asked their ex-ante hypothetical WTP value at baseline and given the opportunity to purchase the ion-exchange water softener at the end of the study for a reduced market price (£437).

Results: 333 families provided ex-ante hypothetical WTP values with a mean value of £506.68 (median £500, range £0-£3000). 180 (54%) families bought the study device. 175 respondents gave ex-ante hypothetical WTP values higher than the purchase price, of these 106 (61%) went on to purchase the device. Of the 161 with an ex-ante hypothetical WTP lower than the purchase price 88 did not purchase the device (56%). Factors respondents took into account in making their valuations will be examined.

Conclusion: A similar number of participants overestimated as underestimated. We will compare our results to the few other studies undertaken in the health care context to discuss potential reasons for any difference in findings and review the wider issues involved in undertaking such experiments.

INTRODUCTION

Contingent valuation and hypothetical bias

Contingent valuation (CV) is a survey-based method to derive monetary values for the benefits of goods that in the health context have no market values available. A hypothetical market is specified whereupon the provision of the good is 'contingent' upon the respondent's maximum willingness to pay (WTP) for it (or, in a minority of cases, the minimum compensation they are 'willing-to-accept' to be deprived of it). Individual values are aggregated to arrive at an overall societal value of the good. This aggregated value may then be compared with the societal cost of providing the good in a cost-benefit analysis (Smith and Sach, 2009a). Interest in CV reflects in part dissatisfaction with other outcome measures, especially quality-adjusted life years (QALYs), in two principal respects. First, QALYs are based on preferences for health outcomes only and second, CV values benefits in the same unit as costs which is required in order to assess whether the good represents an overall benefit in absolute terms (allocative efficiency), rather than a benefit relative to another option (technical efficiency) (Smith and Sach, 2009a). In 2001 Olsen and Smith reported "the distinct feeling of a huge mismatch between the theoretical glory of WTP and the usefulness for public health policy of the majority of surveys which have applied this method" after systematically reviewing CV studies in healthcare to that point (Olsen and Smith, 2001, p.47). More recent reviews have shown that, despite a growth in the numbers of empirical contingent valuation studies reported in the literature, this statement remains relevant today (Smith and Sach, 2009b). The theoretical advantages of CV may not be realised, in part due to a lack of realism.



One potential major limitation for the reliability of estimates of willingness to pay derived from contingent valuation studies is the hypothetical nature of the task which may result in hypothetical bias which has been defined as:

“The possibility that SP [stated preference] estimates may be biased upwards due to the hypothetical nature of the payment commitment” (Bateman et al, 2002, p.439)

“the phenomenon that people answer valuation questions differently when their answers are not financially binding” (Barrage and Sok Lee, 2010, p.140)

“Hypothetical bias is a persistent problem in stated preference studies. It arises when respondents are more willing to spend their money when asked non-consequential survey questions than when they respond to consequential questions about valuation or willingness to pay (WTP), i.e. questions resulting in the payment of real money” (Alfnes et al et al., 2010, p.148).

“The potential error induced by not confronting any individual with the real situation” (Mitchell and Carson, 1989, p. 216)

A growing literature around hypothetical bias in stated preference studies is developing, although this has tended to be in other sectors, notably the environmental sector, and using simulated markets in the lab. Very few stated preference studies examining hypothetical bias have been undertaken in the health context (Bhatia and Fox-Rushby 2003, Onwujekwe et al 2005, Loomis et al 2007, Blumenschien et al 2008, Bryan and Jowett 2010) and their results are mixed which may be due to the health contexts, methods and country settings employed. Reviews of the wider literature surrounding hypothetical bias have indicated that hypothetical values tend to be higher than actual values (by factors typically between 1 to 3), though this is not always the case (Murphy et al 2005, List and Gallet, 2001). Although a meta analysis by Carson et al (1996), which included 21 studies valuing small reductions in environmental or work-related health risks, found that for these studies the ratio of contingent values to revealed values was close to 1. The meta-analysis by List and Gallett revealed that the extent of hypothetical bias was influenced by whether the question was framed as WTP or WTA, public or private good, and by elicitation methods. However, Murphy et al. are more cautious in their interpretation highlighting that results were sensitive to model specification.

Although there “is no widely accepted theory of how people respond to questions about their WTP when it is hypothetical” (Loomis 2011, p.363), possible causes of hypothetical bias have been suggested, these include “lack of responder engagement” (Bryan and Jowett, 2010), framing of the WTP scenario or question (Onwujekwe et al. 2005), a failure to discuss the decision rule to determine if the public good will be provided or the likelihood of payment leading to respondent uncertainty (Mitani and Flores, 2010), and a respondent may change their mind, be yea-saying or undecided (Vossler and Kerkvliet 2003). However, it has also been argued that the concept of hypothetical bias is a “misnomer” since “there is no unique bias attributable to a scenario’s lack of realism” rather a lack of realism is argued to result in “random, directionless error” rather than bias (Mitchell and Carson, 1989, p.216). Clearly the issue remains controversial and ill-understood even in the broader literature.

Eczema and the SWET study

Eczema (also known as atopic dermatitis) has large cost implications for society and the individual families affected. In 1995-1996 the total annual U.K. cost of eczema in children



aged 5 years and under was estimated to be £47 million (or £79.59 per child), of which 64% was accounted for by NHS health care costs (Emerson et al 2001). A further UK study looking at a broader age range estimated the total annual cost to be in the order of £265 million, of which £125 million was incurred by the NHS, £297 million by the patients and £42 million by society in terms of lost working days (price year not reported but most likely to be 1994 or 1995 prices) (Herd et al 1996). Childhood eczema has been shown to have a similar impact on health-related quality of life as other common childhood conditions such as asthma and diabetes (Lewis-Jones 2006).

Current treatment consists predominantly of emollients, bath oils and topical corticosteroid creams, although some children may receive topical antibiotics, oral antibiotics, wet wraps, oral antihistamines, and special dietary products. It was hypothesised at the outset of the SWET trial that should ion-exchange water softeners be effective, this may result in a reduction in the use of these products, and in the number of consultations, such that there might be potential cost savings for the NHS. Likewise, if effective, the costs incurred by families may also decline.

Before this trial, there was no scientific evidence about the effectiveness or cost-effectiveness of ion-exchange water softeners for the treatment of eczema. As a result, the national health care system in the UK does not currently fund this technology. One of the aims of the economic component of this trial was to assess whether the NHS should consider funding this technology. In terms of the approach taken in the economic evaluation of this trial it was recognised that there was currently no best practice approach to valuing child health within a cost-utility framework (given our sample population would be aged 6 months to 16 years and current health-related quality of life instruments as used in economic evaluations have not been developed or validated for very young children) (Ungar, 2010). It should be noted such an approach was used but how this was done is not the focus of this paper so not discussed further. It was also noted that ion-exchange water softeners are currently a private good in the UK; individual consumers are free to choose whether or not to purchase a unit out of their own disposable income and that they were known to have benefits beyond any hypothesised health benefits for the household. This together with the fact the manufacturers providing the machines for the study had indicated that they would sell them to participants at the end of the study for a reduced price made an opportunity to employ contingent valuation methodology and partially test hypothetical bias.

Full details of the trial have been published elsewhere (Thomas et al 2011a&b, 2003) but in brief figure 1 presents an overview of the design. 336 children with moderate to severe eczema were randomised and the primary outcome measure was Six Area, Six Sign Atopic Dermatitis (SASSAD) score as measured by research nurses blinded to treatment group at week 12. Based on this outcome our randomised controlled trial failed to find any objective evidence of effectiveness of ion-exchange water softeners for improving eczema severity for the population studied. However, three of four unblinded outcomes showed small statistically significant differences in favour of the ion-exchange water softener.

Thus this paper is a work in progress, hence a desire to share it at HESG and seek feedback on the shape it might finally take. A number (probably too many for the space) of issues are looked at primarily with methodological interest. Firstly, we report ex-ante WTP values for an ion-exchange water softener and seek to identify what factors help determine this value. Secondly, we examine whether respondents who gave an ex-ante WTP value equal to or greater than the real asking price actually went on to purchase the device and what factors might explain who did and did not purchase the device. Thirdly, we look at a subset of respondents who provided ex-ante WTP, ex-post WTP, and made the decision to purchase or not for real in order to see if experience of the device influenced hypothetical WTP values. Finally we discuss our findings in the light of similar research, in particular in health



economics, and reflect on future directions for health economists interested in researching the issue of hypothetical bias.

METHODS

Sample characteristics

Participants were recruited between May 2007 and June 2009, all lived in England and gave WTP values using pounds sterling. Details of the sample and the variables for use in this analysis are reported in table 1. It should be noted that one of the eligibility criteria to participate in the trial was that the household did not currently have an ion-exchange water softener or similar device installed (which by definition means they had hitherto been unwilling to pay to buy one on the basis of the non-health benefits alone).

Contingent valuation study measuring willingness to pay

This study presented a unique opportunity to compare hypothetical willingness to pay, with actual willingness to pay, for a (health) intervention that is not currently available from the NHS. As a result, a willingness to pay (WTP) questionnaire was included in the assessments (see Appendix, it was designed based on previous contingent valuation questionnaires used by researchers at Nottingham University and was reviewed/revised by researchers involved in the pilot SWET study). We provided information to parents about the likely benefits for their home of having a water softener, and the uncertainty surrounding whether or not water softeners help to improve skin conditions before asking the WTP question. Information was also provided on the lifespan and typical cost of the device. Participants were also given a 2 sided A4 leaflet about water softeners as part of the trial (this can be found on the trial website: <http://www.swet-trial.co.uk/>). Participants were asked to state a one-off out of pocket payment for the device using an open-ended question. There is a lack of consensus in health economics about which elicitation format is best (Frew, 2010, p.102) we used an open ended format largely for practical reasons because it took up less space in the questionnaire booklet and could be administered in person or by mail. The presence of hypothetical bias has been shown to be unrelated to choice of elicitation format (Liljas and Blumenschein, 2000). A one-off payment for the machine (excluding salt and installation) was chosen to reflect the actual purchase decision.

Hypothetical willingness to pay prior to using the water softener

Willingness to pay elicited prior to use of the ion-exchange water softener (therefore measuring compensating variation) was measured at the baseline visit face to face by a research nurse. Mean (median/SD) willingness to pay was estimated and the distribution of willingness to pay bids illustrated graphically (this represents the demand curve for water softeners for the treatment of childhood eczema). The mean (median/SD) willingness to pay value is also estimated by group for intervention group (which should not affect values given ex-ante WTP), whether the water softener was purchased or not, household gross annual income group, WTP/Purchase category (Purchased and WTP, Purchased and not WTP, Not purchased but WTP or not purchased and not WTP), and difficulty (where <4 found WTP easy and 4 or above found WTP difficult) and the Wilcoxon-Rank sum test was performed to test whether the two being compared were identical (where there were more than two categories a Kruskal-Wallis test was performed).

A multivariate linear regression analysis was undertaken to estimate how willingness to pay for the water softener device before the trial varied according to a number of independent variables as defined in table 1. Both a full and parsimonious model are presented. Multicollinearity was checked for using the Variance Inflation Factor (VIF) to ensure the precision of the estimated model coefficients. In order to check the reasonableness of the models assumptions we examined the standardised and studentised residuals. To explore



whether there was any leverage or influential observations in our model we estimated Leverage, Cook's distance, DFITS and DFBETAS. These measures of influence only detect single-observation influence and leverage (Montgomery et al. 2006). The results of these checks are not reported due to space constraints. The adequacy of the final model is reported as an adjusted R^2 .

Hypothetical willingness to pay at 12 weeks

The WTP question was administered by post at 12 weeks for a sub-sample of parents, to elicit the maximum ex-post (for those in the intervention arm) and second ex-ante (if in usual care arm) hypothetical WTP for an ion-exchange water softener device. The questionnaire was identical to the ex-ante version shown in the appendix.

To avoid influencing data collected in the ex-ante 'Willingness to Pay' (WTP) questionnaire at baseline, the actual reduced price (£437 including VAT) was not given to parents before their child's recruitment visit. From May 2007 to October 2008 this information was only given out after their child's 12-week assessment visit, once they had completed the second Willingness to Pay questionnaire. Feedback indicated a number of parents were unhappy with the short time between learning the reduced price and being asked to decide if they wished to purchase the water softener. Therefore, from November 2008, parents were informed of the reduced price in the letter sent out immediately after their child's recruitment into the trial, and the second Willingness to Pay questionnaire was abandoned since once this information was divulged this question was felt to be inappropriate.

The ex-ante WTP data analysis was repeated for this subset but we also examined differences in ex-ante and 12 week hypothetical data using the Wilcoxon signed-rank test for matched data.

Actual willingness to pay

The number actually willing to pay for a water softener at the discounted price (or market price if they bought a non-trial device) was estimated as a proportion of those who were hypothetically willing to pay the actual asking price at baseline and presented in 2x2 contingency tables, an approach used by Bhatia and Fox Rushby (2003) and Bryan and Jowett (2010). The difference in hypothetical and actual willingness to pay is reported.

A logistic regression analysis was undertaken to see which independent variables explained a parent's decision to purchase the water softener or not. The dependent variable was categorised into those who bought the device at the end of the trial (coded as 1), and those who did not buy the device (coded as 0). The independent variables included in the model are defined in table 1.

The above analyses were conducted using a complete case analysis where individuals with any missing data were excluded. The final models presented in this paper however, include all individuals with all data for the covariates included. The statistical package STATA version 11 was used for all analyses, p-values <0.05 were deemed statistically significant. This analysis enables a partial examination of the issue of hypothetical bias in contingent valuation in health care. However, it should be noted that since participants were offered a single price at the end of the trial, we are not able to estimate the actual real maximum willingness to pay for the water softener using this approach.

RESULTS

Willingness to pay for water softeners before the trial

The majority of participants (333/336, 99.1% response rate, 298 were mothers or female careers) provided an answer to the contingent valuation question, which asked parents to estimate the financial value of an ion-exchange water softener to them (the 3 not answering



were all in group A). The mean (median/SD) willingness to pay value was £506.68 (£500/£387.73) with a range from £0 to £3000 (see figure 2 for distribution of willingness to pay responses). Just five (1.5%) participants (3 in group A and 2 in group B) gave a value of zero and all were genuine zeros. Reasons given by these parents included not being willing to pay anything until proven to be of benefit for eczema, and the child's eczema not currently causing problems. There were no protestors (those who gave zero due to moral or political reasons). The qualitative reasons given for being WTP or not for a water softener are presented in table 2. The mean (median/SD) willingness to pay values by groups can be seen in table 3 (by intervention), 4 (by purchase decision), 5 (by income), table 6 (by WTP/purchase category) and table 7 (by difficulty). It can be seen *ex ante* WTP was significantly differently distributed between those who purchased and those who did not (see also figure 3); by income group, where those with the highest incomes were WTP almost £250 more on average than those in the lowest income group; and by difficulty, where those finding the WTP question easy were WTP more.

Results of the multivariate linear regression analysis where hypothetical willingness to pay was the dependent variable are reported in table 8. The statistically significant variables associated with a positive relationship with willingness to pay included participants stating that their value reflected the anticipated benefits of the ion-exchange water softener (such participants were willing to pay on average £126.74 more than those not stating this reason), those households with an income of less than £30,000 were willing to pay £173.72 less on average than those with a household income over £50,000 and those in the income group £30,000-£50,000 were willing to pay £155.10 less on average than those with a household income over £50,000, and number of nights at home (those with more nights at home willing to pay more). Participants who found the willingness to pay task difficult, or who stated that their willingness to pay reflected their ability to pay reported significantly lower values of *ex-ante* willingness to pay.

Willingness to pay for water softeners after the trial

At 12 weeks a subsample of 146 respondents (those recruited first to the study), were asked the same willingness to pay question as at baseline to see if experience influenced valuations. Of these only 97 (66%) provided a value (in addition two respondents stated "priceless"). Only 43 of the 97 had been in the intervention arm and thus the other 53 were in effect still providing a WTP value prior to use of the water softener and theoretically should therefore still have the same WTP value as at their baseline visit.

Mean (median/SD) willingness to pay at the end of the trial was £375 (£300/£282) with a range from £0 to £1,500. Values for the same 97 participants prior to the trial were £475 (£400/£346 with range £0 to £1,500). On average, experience of using the water softeners lowered their mean willingness to pay by £82.32 (SD 257.54, range -1100 to 750). Overall, 25% gave higher willingness to pay values at the end of the trial, 30% gave the same value and 45% gave a lower value. The reasons given for willingness to pay values after the trial are summarised in table 2. The mean (median/SD) willingness to pay values by groups can be seen in table 9 (by intervention, where it can be seen that both groups *ex post* values declined but more so in the usual care group), 10 (by purchase decision), 11 (by income), table 12 (by WTP/purchase category) and table 13 (by difficulty). A multivariate linear regression analysis where hypothetical *ex-post* willingness to pay was the dependent variable was estimated but not reported. This showed that reason c ($p=0.001$), and difficulty ($p=0.051$) were statistically significant determinants of *ex-post* WTP with baseline SASSAD ($p=0.064$), Number of medications ($p=0.066$), baseline water hardness ($p=0.069$), reason a: fair amount ($p=0.065$) showing a trend towards significance (Adjusted $R^2=0.1519$, F -value=1.76, $P<0.05$). Given the small sample size the power to detect significant relationships is small however.



Hypothetical versus real willingness to pay for an ion-exchange water softener

Table 14 shows the number (percentage) of participants who stated a hypothetical willingness to pay value that was either above or below the actual discounted price they were offered at the end of the study (rows) and whether they actually chose to purchase the ion-exchange water softener (either a study device or private device - columns). Table 15 and 16 shows the same information for the sub sample with both baseline and 12 week values. Although the percentage who indicated a hypothetical willingness to pay above the actual asking price and bought the device and those giving a willingness to pay below the actual asking price and not buying the device account for over 50% of the relevant participants, clearly a large number changed their preferences during the trial; some changing in favour of buying the device, and others choosing not to purchase, despite initially indicating they thought the device might be worthwhile. Both groups account for a similar percentage of respondents. Tables 14-16 report the sensitivity (proportion of those who purchased a water softener identified correctly by their hypothetical WTP values) and specificity (proportion of those who did not purchase a water softener that were correctly identified by their hypothetical WTP values). It can be seen that sub sample have higher specificity than the full sample, but in comparing the sensitivity and specificity just for the subsample ex-ante and ex-post it can be seen that ex post WTP had a lower sensitivity but slightly higher specificity than ex-ante WTP values which suggests that given the larger drop in sensitivity, ex-ante hypothetical values were more likely to correlate to actual purchase decisions than ex-post values. The fact that specificity is higher may reflect the fact that the device in this study was found not to be effective.

To try to understand what influenced the decision to purchase or not, a binary logistic regression analysis was conducted. The results are shown in table 17 for the full sample. Only the number of medications at baseline, water hardness at baseline, and household income were significant determinants. An increase in the former two explanatory factors making it more likely an ion-exchange water softener would be purchased (although the odds ratio for water hardness was close to 1), and in the case of income a household income less than £30,000 per annum made it less likely that an ion-exchange water softener was actually purchased. Although not presented here, it is interesting to note that for the sub sample similar analyses showed that either ex-ante WTP ($p=0.029$) or ex post WTP ($p=0.026$) were significant determinants of whether the device was purchased or not whereas income was not statistically significant. Difficulty was also statistically significant and “reason C: benefits I think my child with eczema might get” showed a trend towards significance. However, as before the small sample size limits our ability to draw firm conclusions. The reasons parents gave for purchasing the water softener are shown in table 18, and show some belief that the water softener had eased their child’s eczema.

The ratio of hypothetical to actual payment in this study was 2.17/1.14 if mean/median ex-ante WTP for the full sample is used, 2.21 if mean baseline WTP values used for the sub sample or 1.81 if 12 week mean WTP values are used for the subsample. Although given these are based on real values of either £0 or £437, these probably overestimate the ratio compared to had a maximum real WTP been stated.

Cost benefit analysis

The most typical cost of an ion-exchange water softener is £600 but could range between £300 and £1,800 (based on industry opinion). Using the mean willingness to pay prior to using the water softener as a measure of benefit for the family, it can be inferred that families perceive the benefits of an ion-exchange water softener for their family to be a mean of £506.68. Since the scenario provided to families included a description of the likely non-eczema related cost savings (resulting from less lime scale and improved efficiency of household appliances leading to less fuel consumption and soap usage for instance) this



estimate of willingness to pay can be taken to mean that families would only find an ion-exchange water softeners to have a positive cost benefit ratio for the family at the lower price end of the market (i.e. where price is less than £506.68). The use of the ion-exchange water softener did not result in cost savings for the NHS (the intervention group faced higher costs of £198, $p < 0.001$ but this was entirely due to the cost of the intervention) or families (savings of £4 or £8 for the 12week period depending how it was estimated, NS) such that these are not considered here

DISCUSSION

Evidence from the contingent valuation study suggests that (i) Number of nights at home, household income, parental rating of the difficulty answering the WTP question, reasons for giving the WTP value based on fairness, likely benefits for the child, and ability to pay are significant determinants of ex-ante WTP for a water softener for eczema; (ii) experience of using a water softener during the trial reduced the average WTP by approximately £82. This is possibly to be expected, given that people who believed in the value of water softeners would have been more likely to take part in the trial, and belief in the benefits of the water softeners was a significant factor in determining how much participants felt that they would be willing to pay prior to experiencing the intervention. However, the fact that many families opted to purchase the units despite little objective improvement in the eczema suggests that other factors were also important. (iii) those who purchased the machine had a significantly higher distribution of WTP values both at baseline for the full sample and at 12 weeks for the sub sample.

Our results add to the body of evidence in this area, in particular we find that those who purchased the water softener gave significantly higher WTP values than those who did not, a finding in common with Bryan and Jowett (2010), like them the strongest predictor of purchase decision was WTP for the sub sample but not the full sample for whom the strongest predictor of whether the water softener was purchased or not was number of medications at baseline and household income not ex-ante WTP. For the full sample the sensitivity and sensitivity was slightly lower than that reported in other studies (Bryan and Jowett 2010 (0.74 and 0.66 respectively), Bhatia and Fox-Rushby 2003 (0.62 and 0.67). Unlike Uzochukwu et al (2010) we find that ex-post values for the intervention group were lower than their ex-ante values, but it should be noted our sample was small and the intervention was found to be ineffective in the treatment of eczema. In addition, comparisons to existing studies is difficult given the different contexts and types of interventions studied.

Our study presented a rare opportunity to partially examine hypothetical bias in the health care context, it is not a perfect test reflecting the methodological and practical challenges of conducting such work within the NHS. However, it values a good of reasonable value hypothetically and for real on the same participants in a real world setting overcoming the weaknesses identified by Liljas and Blumenschein (2000) who identified a reliance on non health goods of low value largely being valued by students in experimental settings. One strength of the study is that it valued a private good with an existing market in a new context, i.e. adding in a potential new health benefit, such that respondents would have believed in the realism of the task and have found the task relatively familiar to other types of market transactions they make. However the potential limitation of this is that hypothetical bias might be more extreme for more traditional health care goods and services and respondents may be unduly influenced by the current market price of the good (although in the case of water softeners there is a wide range of market prices available). The timing of the questions may also have been a limitation in that for the whole sample there would have been approximately a 16 week gap between being asked the hypothetical WTP and the real purchase question. To explore this issue we collected and analysed ex post willingness to pay data for a subsample and found that hypothetical WTP did decline over the trial but for both the intervention and



usual care groups. This might reflect two things, at the time of the baseline valuation participants had just enrolled in a trial offering the potential hope of a non-pharmacological intervention to help their child, this hope may have inflated values. In contrast by week 12 participants had been in the trial and those in the intervention arm may have noticed little difference in their child's eczema and thus revised down their estimates although this does not explain the larger change in the usual care group. A further limitation may be the use of a different question format between the hypothetical and real willingness to pay questions, with the former employing an open ended question and the latter a dichotomous choice question. This arose, in part, because at the outset of the study it was not clear exactly what price the manufacturer was going to charge participants to keep the water softener. Further it should be acknowledged that the survey was undertaken only with participants with a vested interest in the subject area and not a general population sample.

Most research into hypothetical bias in contingent valuation studies has been undertaken in sectors other than health, most notably the environment but even here a recent paper identified a need to continue to research the size of the disparity and work towards understanding and generating an underlying theory of why behaviours differ (Loomis 2011). This conclusion seems just as appropriate in the health context. In addition, whereas other sectors have started to test different mechanisms for mitigating the effects of hypothetical bias, very little of this work has been conducted in health (with the exception of the use of cheap talk in a discrete choice experiment Ozdemir et al 2009 and cheap talk and a certainty approach test by Blumenshien et al 2008). This would also therefore seem an area for future potential in health. Techniques tested in the environmental literature include: ex-ante approaches (making the constructed market "consequential", using cheap talk, or thirdly by reducing uncertainty particularly with respect to the likelihood of payment) or ex-post approaches (calibration using a 1-10 certainty scale following the question)(Loomis 2011).

POTENTIAL DISCUSSION POINTS

- What are the implications for this analysis given the trial found that the intervention was ineffective?
- Clearly there is too much material presented for one paper – which bits are most interesting and worth developing in more detail?
- Given the 12 week questionnaire had to be stopped, the sample size at this point is small. Should this data be ignored?

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**TABLES**

Table1: Variable definitions used in the contingent valuation study

Variable	Definition (Number in each response category)[Non responders/missing data]
Willingness to pay prior to trial	Mean £506.68 (SD: 387.73; Median £500, range: 0-3000). [3]
Purchase	0) Not purchased (157) R; 1) Purchased (179). [0]
Child age	1) Under 3 years (98); 2) 3-under 7 years (123); 3) 7 and over years (115)R.[0]
Child gender	0) Female (143) R; 1) Male (193) [0]
Child baseline SASSAD	Mean 25.73 (SD: 13.71; range: 10-94). [0]
Child experienced a 20% reduction in SASSAD score	0) No (146) R; 1) Yes (177). [13]
Child Filaggrin status	0) No or unknown status (242)R; 1) positive filaggrin status (94). [0]
Number of nights at home	Mean 73.61 (SD: 11.36; range: 4-84). [2]
Number of medications at baseline	Mean 4.91 (SD: 2.12; range: 0-13). [0]
Household income (per annum)	1)<£30,000 (109); 2) £30,000 to £50,000 (102); 3)£50,000 and over (80)R. [45]
Intervention group	0) Group B (166)R; 1) Group A (170). [0]
Water hardness at baseline	Mean 308.55 mg L-1 calcium carbonate (SD: 54.11; range: 200-540). [0]
Number of residents at home	Mean 4.15 (SD: 0.96, range 2-8). [12]
Reason given: This is a reasonable or fair amount for me to pay	0) No (200)R; 1) Yes (136). [0]
Reason given: This is just a guess	0) No (227)R; 1) Yes (109). [0]
Reason given: This amount reflects the benefits I think my child with eczema might get from the water softener	0) No (176)R; 1) Yes (160). [0]
Reason given: This amount reflects the wider benefits of installing a water softener in my home	0) No (249)R; 1) Yes (87). [0]
Reason given: This is how much I think a water softener would cost	0) No (252)R; 1) Yes (84). [0]
Reason given: This is how much I can afford to pay	0) No (218)R; 1) Yes (118). [0]
Reason given: Other reasons	0) No (297)R; 1) Yes (39). [0]
Difficulty of WTP question	Mean 6.29 (SD: 2.52, range 0-10). [3]

R denotes that this group was used as the reference group when a categorical variable was included in the regression analysis



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Table 2: Reasons for willingness to pay for water softeners before and after the trial

WTP reason before the trial ^a		WTP reason after the trial ^a	
	Number (% of 336)	Number (% of 99)	
This is a reasonable or fair amount for me to pay	136 (40)	41 (41)	
This is just a guess	109 (32)	26 (26)	
This amount reflects the benefits I think my child with eczema might get from the water softener	160 (48)	43 (43)	
This amount reflects the wider benefits of installing a water softener in my home	87 (26)	24 (24)	
This is how much I think a water softener would cost	84 (25)	24 (24)	
This is how much I can afford to pay	118 (35)	56 (57)	
	Number		Number
Other reasons:	39	Other reasons:	11
Pay more if proven to be effective but given unsure this is maximum WTP/wouldn't buy it for other benefits	24	No benefits experienced/not sure it is worth this amount	2
Based WTP value on family research into price of unit	6	Received benefits/but cannot afford it	2
If money no object would pay more/an amount that would not cause hardship to family	4	Undecided about whether there is a benefit but still useful to install	1
Considered running and service costs	2	Amount considered paying before trial	1
All I am prepared to pay	1	If helped eczema be priceless	1
Already decided to buy one at the end of the trial	1	Not popular with the rest of the family	1
Child's problems not so bad	1	Not had long enough to experience it	1
		Need to compare bills over same period	1
		The amount I am willing to pay to see if there is any benefit	1

^a participants could give more than one reason.



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Table 3: Ex-ante WTP by intervention group

	Intervention	Usual care
Mean, SD (Median, min:max) WTP	508.56, 344.89 (500, 0:2000)	504.72, 428.94 (450, 0:3000)
Wilcoxon-rank Sum test	$z = -1.040$	$p=0.2982$

Table 4: Ex-ante WTP by whether the water softener was actually purchased

	Purchased	Not purchased
Mean, SD (Median, min:max) WTP	552.47, 391.36 (500, 0:2000)	454.10, 377.95 (400, 0:3000)
Wilcoxon-rank Sum test	$z = -2.979$	$P < 0.01$

Table 5: Ex-ante WTP by combined gross annual income groups

Combined gross annual income	<£30,000	£30,000-£<£50,000	>£50,000
Mean, SD (Median, min:max) WTP*	426.51, 385.76 (400 ,15:3000)	477.94, 267.70 (500,0:1500)	673.75, 482.28 (500 ,0:2000)
Number (%) purchasing water softner	49 (44.55)	63 (61.17)	54 (66.67)

* Kruskal-Wallis, chi-squared with ties = 21.483 , $p < 0.001$;

Table 6: Ex-ante WTP by WTP/purchase categories

	Purchased and WTP	Purchased but not WTP	Did not purchase but WTP	Did not purchase and not WTP
Number (%)	106 (31.55)	73 (21.73)	69 (20.54)	88 (26.19)
Mean, SD (Median, min:max) WTP~	760.38, 374.21 (575, 450:2000) #	246.39, 123.28 (250, 0:400)*	727.54, 414.05 (500, 450:3000) #	234.71, 110.74 (200, 0:400)*
<£30,000	20 (18.18)	29 (26.36)	24 (21.82)	37 (33.64)
£30,000-£<£50,000	36 (34.95)	27 (26.21)	23 (22.33)	17 (16.50)
>£50,000	42 (51.85)	12 (14.81)	12 (14.81)	15 (18.52)
~Kruskal-Wallis, chi-squared with ties = 252.956, $p < 0.001$				
# Wilcoxon-rank Sum test $z = -0.993$ $p = 0.32$, * $z = -0.726$ $p = 0.47$				

Table 7: Ex-ante WTP by difficulty answering WTP

	Easy	Difficult
Mean, SD (Median, min:max) WTP	716.28, 486.79 (500, 0:1500)	472.24, 358.39 (450, 0:3000)
Wilcoxon-rank Sum test	$z = -3.053$	$P < 0.01$



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Table 8: Multiple linear regression predictive equation for ex-ante WTP values in UK£

Explanatory variable	Full model*			Parsimonious model#		
	β	95% Confidence interval for β	P value	β	95% confidence interval for β	P value
Intercept	780.10	(260.66, 1299.53)	0.003	757.15	(616.874, 897.432)	<0.001
Child age: Under 3years	-57.51	(-174.79, 59.78)	0.335			
3-under 7 years	-48.19	(-156.51, 60.14)	0.382			
Child gender	-30.22	(-123.06,62.61)	0.522			
Child baseline SASSAD	-0.69	(-4.19, 2.81)	0.700			
Child Positive filaggrin status	92.15	(-6.16, 190.45)	0.066			
Number of nights at home	4.69	(0.35, 9.04)	0.034			
Number of medications at baseline	7.15	(-16.25, 30.54)	0.548			
Household income (per annum): <£30,000	-173.72	(-291.61,-55.84)	0.004	-215.61	(-326.681,-104.543)	<0.001
£30,000 to £50,000	-155.10	(-274.01,-36.19)	0.011	-194.45	(-306.851,-82.039)	0.001
Intervention group	-32.84	(-123.52, 57.84)	0.476			
Water hardness at baseline	-0.58	(-1.45, 0.29)	0.189			
Number of residents at home	-36.99	(-89.26, 15.28)	0.165			
Reason: This is a reasonable or fair amount for me to pay	-103.56	(-200.01, -7.11)	0.035			
Reason: This is just a guess	-20.47	(-122.85, 81.91)	0.694			
Reason: This amount reflects the benefits I think my child with eczema might get from the water softener	126.74	(31.85, 221.62)	0.009	134.86	(46.280,223.430)	0.003
Reason: This amount reflects the wider benefits of installing a water softener in my home	20.49	(-86.64, 127.63)	0.707			
Reason: This is how much I think a water softener would cost	86.92	(-19.37, 193.20)	0.109			
Reason: This is how much I can afford to pay	-102.91	(-202.55, -3.28)	0.043			
Reason: Other reasons	-99.292	(-239.65,41.07)	0.165			
Difficulty of WTP question	-26.354	(-44.47, -8.24)	0.005	-25.70	(-42.899,-8.509)	0.004

N=278, *Adjusted R² =0.142, F-value = 3.29 p<0.001; # Adjusted R² =0.111, F-value = 9.65, p<0.001



Table 9: Ex-post WTP by intervention group

	Intervention (n=43)	Usual care (n=53)
Mean, SD (Median, min:max) ex ante WTP	481.28, 48.43 (400, 15:1500)*	438.52, 50.10 (375, 0:1500)#
Wilcoxon-rank Sum test	z = -1.336	p=0.1815
Mean, SD (Median, min:max) ex post WTP	417.44, 291.32 (350, 0:1500)*	341.48, 272.47 (300, 0:1500)#
Wilcoxon-rank Sum test	z = -1.593	p=0.1111

*Wilcoxon signed-rank test z = 1.865 p= 0.0117; # Wilcoxon signed-rank test z = 2.522 p= 0.0622.

Table 10: Ex-post WTP by whether the water softener was actually purchased

	Purchased (n=46)	Not purchased (n=51)
Mean, SD (Median, min:max) ex-ante WTP	572.39, 57.22 (500, 0:1500)	353.82, 37.20 (300, 0:1500)
Wilcoxon-rank Sum test	z = -3.545	p<0.001
Mean, SD (Median, min:max) ex-post WTP	472.93, 317.87 (400, 50:1500)	286.96, 212.32 (250, 0:1000)
Wilcoxon-rank Sum test	z = -3.442	P<0.001

Table 11: Ex-post WTP by combined gross annual income groups

Combined gross annual income	<£30,000	£30,000-£<50,000	>£50,000
Mean, SD (Median, min:max) WTP*	323.83, 213.36 (300 ,0:1000)	408.68, 261.03 (375, 0:1000)	424.4, 388.01 (350 ,60:1500)
Number (%) purchasing water softner	13 (43.3)	16 (47.1)	15 (60.0)

* Kruskal-Wallis, chi-squared with ties = 1.527, p= 0.4659;

Table 12: Ex-post WTP by WTP/purchase categories

	Purchased and WTP	Purchased but not WTP	Did not purchase but WTP	Did not purchase and not WTP
Number (%)	27 (27.84)	19 (19.59)	13 (13.40)	38 (39.18)
Mean, SD (Median, min:max) WTP~	579.63, 352.26 (500, 100:1500)#	321.32, 178.96 (300, 50:800)*	461.54, 204.28 (450, 200:800)#	227.24, 181.69 (200, 0:1000)*
<£30,000	3 (10.00)	10 (33.33)	2 (6.67)	15 (50.00)
£30,000-<£50,000	11 (32.35)	5 (14.71)	8 (23.53)	10 (29.41)
>£50,000	11 (44.00)	4 (16.00)	2 (8.00)	8 (32.00)

~Kruskal-Wallis, chi-squared with ties = 31.700, p<0.001

Wilcoxon-rank Sum test z= -5.805 p<0.001, * z= -5.070 p<0.001

Table 13: Ex-post WTP by difficulty answering WTP

	Easy	Difficult
Mean, SD (Median, min:max) WTP	524.29, 468.00 (475,50:1500)	350, 232.33 (300, 0:1000)
Wilcoxon-rank Sum test	z = -1.026	P=0.305



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Table 14: Purchase decision by hypothetical baseline ex-ante willingness to pay
(a) for the full sample (b) for the subsample

	Purchased water softener	Did not purchase water softener	Total		Purchased water softener	Did not purchase water softener	Total
WTP> purchase price	106 (59.2%)	69 (43.9%)	175 (52.1%)	WTP> purchase price	27 (27.84%)	13 (13.40%)	40 (41.2%)
WTP< purchase price	73 (40.8%)	88 (56.1)	161 (47.9%)	WTP< purchase price	19 (19.59%)	38 (39.18%)	57 (58.8%)
Total	179 (53.3%)	157 (46.7%)	336 (100%)	Total	46 (47.4%)	51 (52.6%)	97 (100%)
	Sensitivity 59.2%	Specificity 56.1%			Sensitivity 58.70%	Specificity 74.51%	

Table 15: Purchase decision by hypothetical ex-ante willingness to pay for the sub sample
(a) Those in the intervention arm (b) those in the usual care arm

	Purchased water softener	Did not purchase water softener	Total		Purchased water softener	Did not purchase water softener	Total
WTP> purchase price	14 (30.23%)	5 (9.30%)	19 (44.2%)	WTP> purchase price	13 (20.62%)	8 (11.34%)	21 (38.8%)
WTP< purchase price	6 (16.28%)	18 (44.19%)	24 (55.8%)	WTP< purchase price	13 (26.80 %)	20 (41.24%)	33 (61.1%)
Total	20 (46.5%)	23 (53.5%)	43 (100%)	Total	26 (48.1%)	28 (51.9%)	54 (100%)
	Sensitivity 70.0%	Specificity 78.3%			Sensitivity 50.0%	Specificity 71.4%	

Table 16: Purchase decision by hypothetical 12 week willingness to pay for the sub sample
(a) Those in the intervention arm (b) those in the usual care arm

	Purchased water softener	Did not purchase water softener	Total		Purchased water softener	Did not purchase water softener	Total
WTP> purchase price	13 (30.23%)	4 (9.30%)	17 (39.5%)	WTP> purchase price	7 (20.62%)	7 (11.34%)	14 (25.9%)
WTP< purchase price	7 (16.28%)	19 (44.19%)	26 (60.5%)	WTP< purchase price	19 (26.80 %)	21 (41.24%)	40 (74.1%)
Total	20 (46.5%)	23 (53.5%)	43 (100%)	Total	26 (48.1%)	28 (51.9%)	54 (100%)
	Sensitivity 65.0%	Specificity 82.6%			Sensitivity 26.9%	Specificity 75.0%	



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Table 17: Binary logistic regression analysis to explain decision to purchase

Explanatory variable	Full model*			Parsimonious model#		
	Odds ratio	95% Confidence interval for OR	P value	Odds ratio	95% confidence interval for OR	P value
Child age: Under 3years	1.207	(0.59, 2.47)	0.605			
3-under 7 years	1.185	(0.62, 2.27)	0.610			
Child gender	1.027	(0.58, 1.80)	0.927			
Child experienced a 20% reduction in SASSAD score (R=yes)	1.623	(0.93, 2.83)	0.089	1.631	(0.975, 2.731)	0.063
Child positive filaggrin status	0.656	(0.36, 1.19)	0.167			
Number of nights at home	0.987	(0.96, 1.02)	0.409			
Number of medications at baseline	1.243	(1.08, 1.43)	0.003	1.238	(1.087, 1.411)	0.001
Household income (per annum): <£30,000	0.345	(0.17, 0.72)	0.004	0.366	(0.194, 0.694)	0.002
£30,000 to £50,000	0.582	(0.27, 1.23)	0.156	0.611	(0.314, 1.187)	
Intervention group	1.040	(0.60, 1.80)	0.889			
Water hardness at baseline	1.007	(1.00, 1.01)	0.014	1.005	(1.000, 1.010)	0.031
Number of residents at home	1.026	(0.75, 1.40)	0.874			
Reason given: This is a reasonable or fair amount for me to pay	1.052	(0.53, 1.70)	0.865			
Reason given: This is just a guess	1.094	(0.50, 1.68)	0.772			
Reason given: This amount reflects the benefits I think my child with eczema might get from the water softener	0.610	(0.92, 2.93)	0.096	1.729	(1.043, 2.866)	0.034
Reason given: This amount reflects the wider benefits of installing a water softener in my home	1.022	(0.51, 1.88)	0.947			
Reason given: This is how much I think a water softener would cost	0.847	(0.61, 2.27)	0.619			
Reason given: This is how much I can afford to pay	0.912	(0.60, 2.00)	0.766			
Reason given: Other reasons	0.775	(0.53, 3.12)	0.572			
Willingness to pay prior to trial	1.000	(0.999, 1.00)	0.240			
Difficulty of WTP question	0.934	(0.83, 1.05)	0.234	0.910	(0.823, 1.007)	0.067

N=273, *Pseudo R² =0.116, Log likelihood = -164.29, LR chi2(21) = 43.07, p<0.01; # Pseudo R² =0.093, Log likelihood = -176.55, LR chi2(21) = 36.07, p<0.01.



Table 18: Comments from parents post trial as to why they purchase the water softener

Reason(s) for buying water softener given by parents who purchased the water softener unit	No.
Eczema improved on SWET (though hasn't disappeared) and believe water softener helps	43
Unsure at the time, but felt worth buying water softener in case it was beneficial in longer term	19
Eczema improved on SWET (though hasn't disappeared) and believe water softener helps + wider benefits of having a softener	15
Wider benefits not related to child's eczema	11
Eczema improved on SWET but have now found other factors more important than water softener e.g. avoiding certain foods; new skin-care regime; avoiding stress	9
Eczema improved on SWET (and now clear or nearly gone) and believe due to water softener	8
Eczema improved on SWET but now unsure if improvement due to water softener or child growing out of it	3
Eczema improved on SWET but has relapsed and now can't see any benefit	3
TOTAL	111

Comments from parents who did not buy the water softener	No.
Eczema did not improve on SWET, therefore did not wish to buy	23
Could not afford to buy the water softener but would have liked to	15
Eczema improved on SWET but not enough to warrant buying a water softener	7
Eczema improved on SWET and has continued clear without a water softener	3
Could not buy for practical/technical reasons/moving home	3
Needed a longer trial period to decide whether to buy or not	2
Eczema improved on SWET but did not believe this was due to water softener	1
TOTAL	54

FIGURES

Figure 1: Trial study design

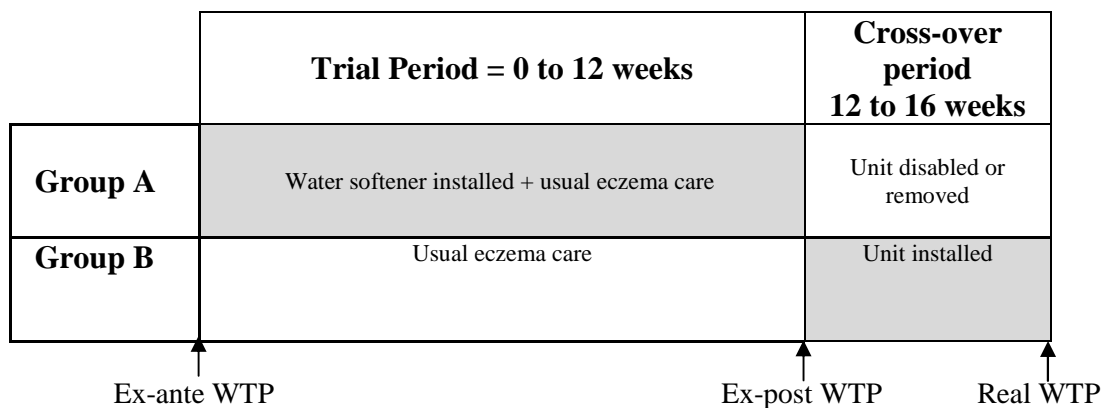




Figure 2: Willingness to pay for water softeners for children with eczema

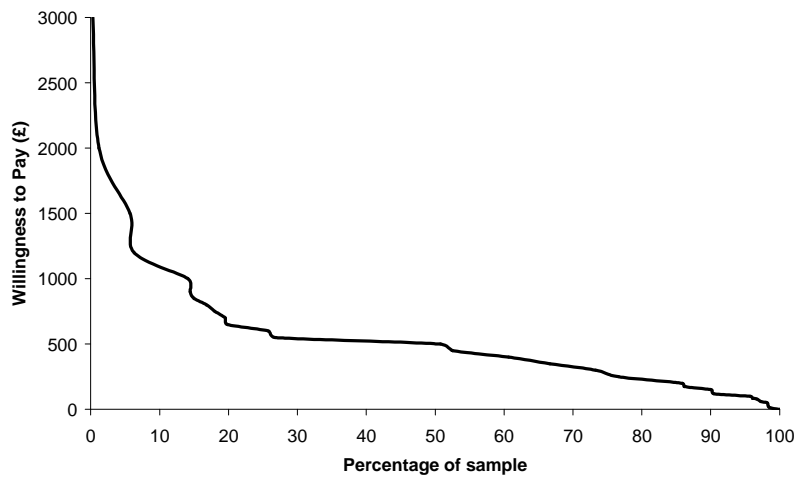


Figure 3: Ex-ante WTP distribution by whether the softener was purchased or not

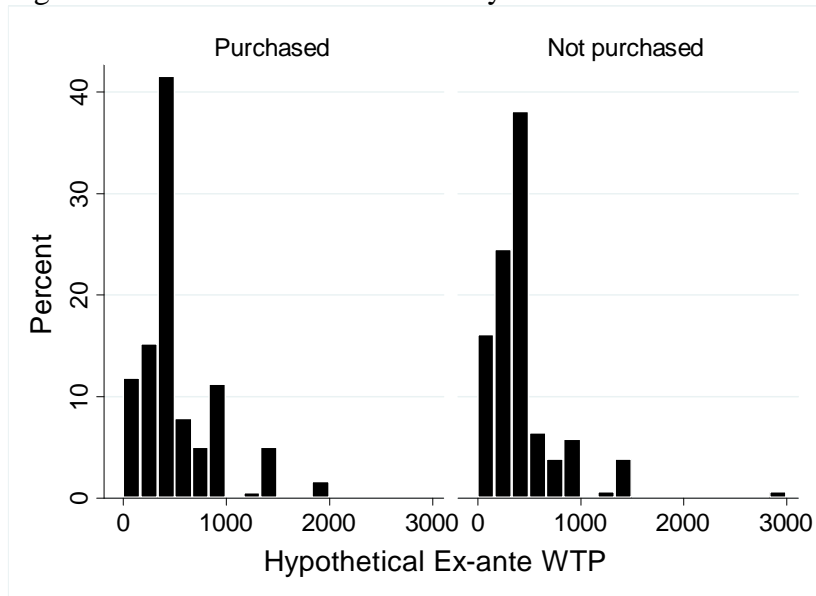


Figure 4: Demand curves for water softeners before and after participation in the trial

