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### Permalink

<https://escholarship.org/uc/item/8q85s676>

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### Publication Date

2017-01-01

### DOI

10.1016/j.contraception.2017.08.003

Peer reviewed

**1Measuring health utility in varying pregnancy contexts among a diverse cohort of pregnant  
2women**

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10

11Funding: Dr. Lundsberg and Dr. Gariepy were supported by grants received by Dr. Gariepy  
12(NIH CTSA ULI TR000142 and the Albert McKern Scholar Awards for Perinatal Research).

13

14Conflicts of Interest: None

15

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20Abstract word count: 234

21Manuscript word count: 3,284

22

## 23 ABSTRACT

24

25 Objective: To contribute to decision analysis by estimating utility, defined as an individual's  
26 valuation of specific health states, for different pregnancy contexts.

27

28 Study design: Cross-sectional analysis of data from pregnant women recruited at pregnancy  
29 testing clinics during June 2014-June 2015. Utility was measured using the visual analog scale  
30 (VAS), PROMIS GSF-derived utility, standard gamble (SG), and time-trade-off (TTO)  
31 approaches. Six dimensions of pregnancy context were assessed including: intention, desirability,  
32 planning, timing, wantedness, and happiness. Multivariable regression modeling was used to  
33 examine the associations between pregnancy context and utility while controlling for women's  
34 sociodemographic and health characteristics.

35

36 Results: Among 123 participants with diverse characteristics, aged  $27 \pm 6$  years, with mean  
37 gestation of  $7.5 \pm 3$  weeks, few reported optimal pregnancy contexts. Mean utility of the  
38 pregnancy state varied across contexts, whether measured with VAS (0.28-0.91), PROMIS GSF-  
39 derived utility (0.66-0.75), SG (0.985-1.00) or TTO (0.9990-0.99999). The VAS-derived mean  
40 utility score for unintended pregnancy was 0.68 (95% CI 0.59, 0.77). Multivariable regression  
41 analysis demonstrated significant disutility of unintended pregnancy, as well as all other  
42 unfavorable pregnancy contexts, when measured by VAS. In contrast, PROMIS GSF-derived  
43 utility only detected a significant reduction in utility among ambivalent compared to wanted  
44 pregnancy, while SG and TTO did not show meaningful differences in utility across pregnancy  
45 contexts.

46Conclusions: Unintended pregnancy is associated with significant **patient-reported** disutility, as  
47is pregnancy occurring in other unfavorable contexts. VAS-based measurements provide the  
48most nuanced measures of the utility for pregnancy in varying contexts.

49Implications: Decision analyses, including assessments of the cost-effectiveness of pregnancy  
50related interventions, should incorporate measures of the utility of pregnancy in various contexts.

51

52Keywords: London Measure of Unplanned Pregnancy, unintended pregnancy, utility, visual  
53analog scale

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## 58INTRODUCTION

59        Approximately half (45%) of all U.S. pregnancies are unintended [1], resulting in an  
60estimated \$4.5 billion in annual direct medical costs [2] and \$21 billion in 2010 Federal and state  
61public expenditures [3]. **With increased focus on reducing unintended pregnancy [4], cost-**  
62**effectiveness analyses are** a useful tool to inform decisions regarding efforts to reduce  
63unintended pregnancies **and improve reproductive health outcomes** by evaluating expected  
64economic and quality of life impact of various interventions [5]. **Yet cost effectiveness research**  
65**related to reproduction, including assessment of utility related to pregnancy, is currently**  
66**understudied [5, 6]. Further, reliable and valid utility measure estimates are necessary for cost-**  
67**effectiveness analyses regarding unintended pregnancy. To date,** the quality of these studies has  
68been limited by lack of objective measures that reflect differences in health utility by pregnancy  
69context.

70        “Utility” is one way of evaluating health-related quality of life (HRQoL) for specific  
71health states [7]. Existing research on the utility of pregnancy is limited by using utility  
72estimates derived from hypothetical health scenarios among non-pregnant participants [8, 9]. As  
73perspectives on hypothetical health states differ from individuals’ actual experiences [10],  
74research is needed to better characterize the utility of pregnancy in unfavorable pregnancy  
75contexts using more relevant study populations. Furthermore, recent literature has called for  
76awareness of the limitations of considering only whether a pregnancy was intended or planned  
77when evaluating the effects of the pregnancy on a woman’s life and health [11, 12].  
78Multidimensional pregnancy perspectives may be relevant to women’s perceived utility of  
79pregnancy as well.

80 To fill this gap, our study aimed to evaluate health utility of pregnancy occurring in a  
81variety of “contexts” measured as intention, wantedness, planning, timing, desirability, and  
82happiness [13] among a cohort of pregnant women. *Specifically, we aimed to calculate utility*  
83*estimates for varied contexts of pregnancy that can be used in future cost-effectiveness analyses.*  
84We also compared utilities elicited using the visual analog scale (VAS) approach [9, 14], which  
85has demonstrated validity in previous studies examining valuation of pregnancy outcomes [15,  
8616], with those derived from other approaches, including standard gamble [7, 17], time-trade-off  
87[18], and the Patient Reported Outcome Measurement Information System (PROMIS) Global  
88Short Form (GSF)-derived utility [19].

89

## 90METHODS

### 91*Study setting and design*

92 Data for this analysis came from a sample of women presenting for pregnancy testing  
93services at two clinical sites in New Haven, CT, during the period of June 2014 to June 2015.  
94*While the original study included women recruited at various clinical settings including abortion*  
95*care sites, the current analysis is restricted to women with a recent pregnancy diagnosis from*  
96*pregnancy testing sites only in order to best assess the relationship between pregnancy context*  
97*and utility.* Women were eligible if they had a positive pregnancy test on the day of recruitment,  
98were English or Spanish speaking, had completed <24 weeks of gestation, were 15-44 years of  
99age, and completed study enrollment within 1 week of their clinical pregnancy test. Participants  
100could complete the study in English or Spanish. Overall, research staff approached 225 women

101with a positive pregnancy test regarding study participation. Of those, 123 women were eligible  
102and completed the enrollment questionnaire.

103 The enrollment questionnaire was self-administered, and ascertained each participant's  
104sociodemographic characteristics, medical history, reproductive history, HRQoL, and  
105assessments of the utility of their current pregnancy. The study protocol was reviewed and  
106approved by the Yale University Human Research Protection Program. Written consent was  
107obtained from study participants prior to enrollment.

#### 108*Measures of pregnancy context*

109 As previously described [13], there are six measures of pregnancy context (Appendix A),  
110and assessment of utility scores associated with these pregnancy contexts can enable a more  
111comprehensive understanding of patients' perceptions about their pregnancy-related health state.  
112These context measures included 3 "pre-pregnancy perspectives," including intention,  
113wantedness, and planning, and 3 "post-conception perspectives," including timing, desirability,  
114and happiness. Each of the pregnancy context measures was evaluated as a 3-level categorical  
115variable reflecting a (1) favorable, (2) ambivalent/neutral, or (3) unfavorable pregnancy context.  
116For example, pregnancy intention was categorized as: "intended", "intentions changing", or  
117"unintended." Pregnancy intention, wantedness, and timing were measured using elements from  
118the London Measures of Unplanned Pregnancy (LMUP) construct [20].

#### 119*Measures of Utility*

120 Utility is a metric quantifying the "relative value placed on a specific health status or an  
121improvement in health status" [21]. Utility values range from 0 to 1, with 0 representing death  
122and 1 representing perfect health state [22], while disutility is defined as the corresponding

123decrease or measured decrement in overall utility. We measured utility using four different  
124approaches detailed below.

#### 125Visual Analog Scale

126 Visual analog scale (VAS) measures utility of health states [9, 14] by asking participants  
127to indicate how they felt after learning they were pregnant by placing a mark on a 10-cm line that  
128ranged from 0 (“As if I was dying”) to 10 (“In perfect health”)[9]. Values from the 10-cm scale  
129were then calibrated to a 0-1.0 scale.

#### 130PROMIS Global Short Form derived utility

131 We administered the National Institutes of Health (NIH) Patient Reported Outcome  
132Measurement Information System (PROMIS) Global Short Form (GSF) [23, 24] to assess  
133HRQoL [13]. Participants’ responses to the GSF were converted to utility scores based on a  
134previously validated algorithm mapping GSF responses to the EuroQol (EQ-5D) utility score  
135[19].

#### 136Standard Gamble

137 The standard gamble [7] elicitation approach used questions previously employed to  
138assess utility of a hypothetical unintended pregnancy [9] (see Appendix B). The accepted risk of  
139death was then converted to a utility score as (1-accepted risk of death). SG is a well-established  
140method grounded in traditional economic theories to elicit individual’s preferences about a given  
141health state under specific conditions of uncertainty [22]. In this method, respondents are given  
142choices regarding willingness to accept a risk of death in order to avoid a specified health



143outcome; specific to this study, participants' willingness to accept a risk of death to avoid the  
144current pregnancy.

#### 145Time Trade-Off (TTO)

146       Utility assessed using TTO is based upon willingness to trade time at the end of life to  
147avoid a specific disease or health state [22]. In the TTO approach (see Appendix B), disutility  
148was calculated as the time that a woman reported being willing to give up to avoid being  
149pregnant divided by her life expectancy (life expectancy based on U.S. life tables [25]). Her  
150utility score is then calculated as (1-disutility). For women who selected the upper bound  
151category of time willing to give up (i.e.,  $\geq 3$  months), our primary analysis calculated their utility  
152score assumed 3 months as the maximum time they were willing to give up. We also performed a  
153sensitivity analysis by using 10 years as the maximum time willing to give up for women in this  
154upper bound category [9].

#### 155*Patient characteristics*

156       Measures of potential confounding factors in the association between pregnancy context  
157and utility included sociodemographic characteristics (i.e., age, race, ethnicity, level of  
158education, employment, and relationship status), reproductive history (i.e., parity, previous  
159miscarriage, and previous abortion), presence of chronic medical condition (e.g. asthma,  
160diabetes, thyroid problem), depression, anxiety, and substance use during the previous 3 months  
161(smoking and tobacco use, marijuana use and alcohol consumption). Gestational age was  
162measured based on reported last menstrual period at time of enrollment.

#### 163*Statistical analysis*

164 Descriptive statistics were estimated to summarize patient characteristics. Bivariate  
165 associations between pregnancy contexts and measures of utility were assessed using analysis of  
166 variance (ANOVA) or Kruskal Wallis tests for continuous measures depending on whether the  
167 utility score was normally distributed. We also estimated linear regression models for VAS and  
168 GSF-derived utility scores with and without adjusting for other covariates to examine the  
169 magnitude of difference in utility between different pregnancy contexts. Each pregnancy context  
170 was assessed in a separate model, using favorable pregnancy context as the referent group (e.g.  
171 intended pregnancy). Pregnancy context was forced into the model and patient characteristics  
172 that were significant at  $p < 0.20$  level in bivariate analysis were included as covariates in the  
173 regression model. Such regression analysis was not performed for SG and TTO-derived utility  
174 scores because there was very limited variation in the scores.

175 Twenty-eight women had missing observations for VAS measurement. We assessed their  
176 potential impact on interpretation of findings by comparing patient characteristics  
177 (sociodemographics, pregnancy context, and utility scores) between women who completed the  
178 VAS versus those with incomplete VAS information. Statistical analysis was performed using  
179 SAS 9.4 (SAS Institute, Cary, NC).

180

## 181 RESULTS

### 182 *Patient Characteristics and Pregnancy Context*

183 Among the 123 participants, mean age was 26.7( $\pm 6.3$ ) years and average gestational age  
184 at enrollment was 7.5( $\pm 3.0$ ) weeks (Table 1). Most participants were non-Hispanic Black  
185 (36.9%) or Hispanic (45.9%). Few (14.8%) were married or had at least some college education

186(36.0%). Most women were parous (72.9%), and previous miscarriage was reported by 38.8%  
187and previous abortion by 37.9%.

188 Fifty percent of participants reported that they did not intend to become pregnant, 25.2%  
189that they did not want a baby, 17.9% that pregnancy was unplanned, and 19.5% that the  
190pregnancy occurred at the wrong time (Table 2). However, most women reported that they were  
191happy about the pregnancy news (72.4%) and that the pregnancy was desired (60.1%).

192

### 193*Association of Pregnancy Context with Utility*

194 Overall, VAS scores among the sample ranged from 0.04-1.00 with average score of  
1950.79( $\pm$ 0.27). Mean VAS score varied substantially across different pregnancy context (Figure  
1961A, Table 3), with VAS-derived mean utility score for unintended pregnancy of 0.68 (95% CI  
1970.59, 0.77). Wide variation is observed for context measure of happiness with pregnancy news,  
198ranging from 0.28 among those unhappy, 0.67 for neither happy or unhappy, and 0.88 among  
199women happy with pregnancy news. Similar patterns are observed for other context measures,  
200with highest VAS scores among those reporting favorable pregnancy contexts, lower for  
201ambivalent categories and the lowest scores among those with unfavorable pregnancy contexts  
202(e.g. unwanted, unintended, unplanned pregnancy). For each of the six measures of pregnancy  
203context, the VAS score differed significantly across the favorable, ambivalent/neutral, and  
204unfavorable perception categories ( $p < 0.001$  for all).

205 Range of PROMIS GSF-derived utility scores was 0.46-0.88, averaging 0.71( $\pm$ 0.10) for  
206the sample. PROMIS GSF-derived utility scores demonstrated a similar pattern across pregnancy  
207context, but with somewhat less variation than VAS-derived scores. Mean utility scores

208demonstrated less variation in range across favorable, ambivalent, and unfavorable contexts,  
209particularly for pregnancy intention, ranging from 0.70-0.73. Additionally, lowest mean utility  
210scores for wantedness were observed among those who reported mixed feelings (0.68), while  
211utility among wanted and unwanted pregnancies was 0.74 and 0.71, respectively. GSF-derived  
212utility scores differed significantly across favorable, ambivalent/neutral, and unfavorable  
213perception categories for four pregnancy contexts (i.e., wantedness, timing, desirability, and  
214happiness).

215 In contrast, SG and TTO-based utility scores showed very limited variability across the  
216different pregnancy contexts and were clustered around 1.0, with overall scores ranging 0.90-1.0  
217for SG and 0.994-1.00 for TTO; mean values were 0.996( $\pm 0.017$ ) for SG and 0.9997( $\pm 0.001$ ) for  
218TTO, respectively. The mean SG-based utility varied slightly from 0.985 in unhappy pregnancy  
219to 1.00 in women who had changing intention or mixed wantedness about pregnancy, while the  
220mean TTO-based utility score varied subtly from 0.9990 in unhappy pregnancy to 0.99999 in  
221intended pregnancy. Although SG and TTO-based utility scores differed statistically across the  
222favorable, ambivalent/neutral, and unfavorable perception categories for three and six of the  
223measures of pregnancy context, respectively, the magnitude of the difference was minimal. Our  
224sensitivity analysis using an upper bound of 10 years for calculation of TTO-based utility score  
225showed no material difference in results.

226 Unadjusted and adjusted regression analyses for the association of pregnancy context  
227with VAS utility are presented in Figure 1B and Table 4. After adjusting for patient  
228characteristics, greater disutility was observed among those who did not intend to get pregnant,  
229did not want to have a baby, or were ambivalent or reported unplanned pregnancy (mean  
230adjusted difference ranging from -0.13 to -0.28,  $p < 0.03$  for these contexts), compared to women

231reporting their pregnancy was intended, they wanted to have a baby, or pregnancy was planned,  
232respectively. Likewise, women who indicated it was the wrong time to become pregnant, were  
233not sure or not desiring the pregnancy, or were unhappy about the pregnancy news, demonstrated  
234greater disutility measured by VAS compared to those reporting pregnancies that occurred at the  
235right time, were desired, or produced feelings of happiness with the pregnancy news (mean  
236adjusted difference ranging from -0.29 to -0.54,  $p < 0.01$  for these contexts).

237 Table 4 also reported unadjusted and adjusted regression analyses for the association of  
238pregnancy context with PROMIS GSF-derived utility score. After adjusting for patient  
239sociodemographic and health characteristics, PROMIS GSF-derived utility score only differed  
240significantly between women who had ambivalent feelings and those wanting to have a baby  
241(mean adjusted difference = -0.05,  $p = 0.01$ ). There was no significant difference in other  
242dimensions of pregnancy context.

243 Comparison of participants who had complete VAS data versus those with missing data  
244on VAS suggested no statistically significant differences in participant characteristics, pregnancy  
245context, and utility measures (all  $p$  values  $> 0.05$ ; data not shown in tables).

246

## 247DISCUSSION

248 Among women with a recent pregnancy diagnosis, pregnancies that **were reported to**  
249**have** occurred at the wrong time, were unintended, unwanted, not desired, unplanned, or met  
250with unhappiness, are associated with disutility as measured by the visual analog scale (VAS).  
251The value and range in variability of utility score for these pregnancy contexts differed by  
252measurement approach with the VAS-based approach demonstrating more discriminatory ability

253across pregnancy context than other measurement methods. This analysis provides utility  
254estimates for “unintended pregnancy”, as well as other pregnancy contexts, that can be used in  
255future cost-effectiveness analyses.

256 A previous study evaluating the utility of unintended pregnancy among 192 non-pregnant  
257women reported a VAS-based score of 0.49 [9]. In contrast, we found a higher VAS-based utility  
258score of 0.68 among women currently experiencing an unintended pregnancy. This is consistent  
259with previous literature suggesting higher utility/lower disutility among individuals experiencing  
260actual health states compared to hypothetical health states [10], highlighting the importance of  
261assessing utility in actual patient populations.

262 Our study improves upon and extends the literature in several important ways. First,  
263research examining utility regarding pregnancy among currently pregnant women has been  
264sparse [26, 27] and previous cost-effectiveness analyses have relied on published utility metrics  
265derived from non-pregnant samples [8, 9, 28, 29]. Earlier studies have often focused on  
266hypothetical scenarios of pregnancy [15, 16, 30], and therefore may not accurately reflect the  
267experiences of **pregnant women, including pregnant women’s experiences of** different pregnancy  
268**contexts**. In contrast, we assessed utility among currently pregnant women close to the time of  
269pregnancy diagnosis, and controlled for potential confounders in multivariable analysis. Further,  
270use of multidimensional context measures beyond traditional measures of planning and intention  
271are integral to improving our understanding of individual pregnancy perspectives and essential  
272for evaluating impact of various strategies for addressing women’s reproductive healthcare needs  
273[11, 12]. However, there has been a lack of data on utility with respect to different pregnancy  
274contexts in the literature. In this regard, our study extends analysis of multidimensional  
275pregnancy perspectives, including pregnancy timing, wantedness, desirability, and happiness

276with pregnancy. Additionally, we evaluated ambivalence as a separate category, which has been  
277largely overlooked in previous research, and demonstrated significant disutility within this  
278context category (e.g. mixed feelings about wanting to be pregnant). This highlights the  
279importance of more attention to this unique group in future research and clinical care.

280       Based on our findings, VAS captures the variability of utility across various pregnancy  
281contexts and may be the most appropriate metric for use in assessing health utility among  
282pregnant women. Previous research has demonstrated the validity of VAS in evaluating health  
283states related to pregnancy and birth outcomes, reporting high test-retest reliability among a  
284community-based sample [15] and within group validity among patient, layperson, and  
285professional participant groups [16]. Moreover, VAS measures adequately captured significant  
286differences within specific gynecological conditions including urinary incontinence measures  
287[31] and pelvic inflammatory disease health states [32]. In our analysis, we also found expected  
288differences in VAS-based utility across various pregnancy contexts and significant disutility for  
289ambivalent/unfavorable contexts. On the contrary, GSF-derived utility score only captured  
290variability in selected pregnancy contexts, and SG and TTO-derived utility measures varied  
291minimally across levels of pregnancy context. It is likely that these elicitation methods may not  
292be sensitive enough to detect differences in women’s perceptions about the various pregnancy  
293contexts. In addition, methods based on responses to risk of death (SG) or trading time at the end  
294of life (TTO) were designed to evaluate chronic or terminal disease health states and may not be  
295suitable for assessing utility of pregnancy-related health states which are generally not life-  
296threatening conditions.

297       An important consideration is that utility measured during pregnancy reflects a short-  
298term, transient health state. While we demonstrate that unfavorable and ambivalent pregnancy

299 contexts are associated with significant disutility, further research is necessary to quantify  
300 potential changes in women's perception about pregnancy over time, i.e. whether their reported  
301 utility scores may differ as pregnancy progresses and after pregnancy ends (post-abortal or  
302 postpartum). Additionally, we demonstrate those with favorable pregnancy contexts have higher  
303 utility (e.g. mean VAS for all favorable contexts between 0.88-0.91). Understanding the duration  
304 of disutility associated with unfavorable pregnancy contexts will further inform future cost-  
305 effectiveness analyses. With over 6 million women experiencing pregnancy annually in the U.S.  
306 [33], these additional data will be particularly important to help enhance overall population  
307 health.

308       There are several limitations to the current study. Our cohort included women recruited  
309 from urban clinics and therefore may not be representative of the general population of pregnant  
310 women. However, the geographic area of our study recruitment is similar in demographic  
311 characteristics to the overall U.S. population [34] and study participants also demonstrated  
312 substantial diversity in sociodemographic characteristics, reproductive history, utility scores, and  
313 pregnancy context. Additionally, our sample size was relatively small; however, we observed  
314 statistically significant differences in utility scores across levels of pregnancy context, suggesting  
315 this is not a material concern. Future studies with a larger sample size could permit further  
316 informative analyses, such as sub-analyses to identify specific patient characteristics associated  
317 with lower or higher utility among women with the same pregnancy context. For SG and TTO,  
318 we were not able to perform multivariable analysis due to the limited variability in overall scores  
319 skewed towards 1.0. Additional research would be helpful to confirm whether such limited  
320 variation in utility exists amongst a population of pregnant women using these traditional  
321 elicitation methods. We also observed missing values for VAS among 28 participants in our



322analytic sample, which may be due in part to the self-administered format of the questionnaire  
323and the VAS element inadvertently skipped by respondents. Our sensitivity analysis  
324demonstrated no significant differences between those with VAS measures and those without.  
325Further, while VAS may be most appropriate for use among a pregnancy population with varied  
326pregnancy contexts, its strengths and limitations in measuring health utility has been debated.  
327Compared to choice-based elicitation methods such as SG and TTO, the VAS approach has been  
328criticized for being theoretically limited [35] as a single-scale construct that is not choice-based.  
329Yet others have argued it is theoretically grounded and does incorporate an element of choice  
330that is scaled-based using the VAS line, rather than a choice between two options [36]. Further  
331research validating our findings in other samples, including among women seeking abortion, will  
332provide additional insights regarding the most appropriate measurement of utility for different  
333pregnancy contexts.

334

### 335CONCLUSION

336Among a diverse cohort of women with a recent diagnosis of pregnancy, health utility varied by  
337pregnancy context. Unwanted, unintended, unplanned, not desired, poorly timed or unhappy  
338pregnancies were significantly associated with significant disutility. In addition, women with  
339ambivalent pregnancy contexts also reported considerable disutility. These data provided robust  
340utility scores for specific pregnancy contexts to inform future cost-effectiveness evaluations  
341related to pregnancy. Further research examining potential changes in pregnancy-related utility  
342metrics over time is warranted.

343

344 Acknowledgements: We would like to extend our sincere thanks to the providers and staff at  
345 participating clinical sites in New Haven, CT.

346

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