warwick.ac.uk/lib-publications

Mode of delivery and long term health-related quality of life outcomes: A prospective population-based study

Short title:

Mode of delivery and long term health-related quality of life

Authors:

Stavros Petrou, BSc MPhil PhD,[1] Sung Wook Kim, BSc MSc,[1] Penny McParland, MB BS, PhD, FRCOG,[2] Elaine M Boyle, MBChB MD MSc PhD[3]

Affiliations:

[1] University of Warwick, Coventry, UK; [2] University Hospitals, Leicester NHS Trust; [3] University of Leicester, Leicester UK

Address correspondence to:

Professor Stavros Petrou, Division of Health Sciences, Warwick Medical School, Gibbet Hill Road, University of Warwick, Coventry CV4 7AL, UK.

Email: s.petrou@warwick.ac.uk

Telephone: +44(0) 2476 151124.

Word count: 3,658

Abstract

Background: Relatively little is known about the effects of mode of delivery on long-term health-related quality of life outcomes. Furthermore, no previous study has expressed these outcomes in preference-based (utility) metrics.

Methods: The study population comprised 2161 mothers recruited from a prospective population-based study in the East Midlands of England encompassing live births and stillbirths between 32^{+0}-36^{+6} weeks' gestation and a sample of term-born controls. Perinatal data were extracted from the mothers' maternity records. Health-related quality of life outcomes were assessed at 12 months postpartum using the EuroQol Five Dimensions (EQ-5D) measure with responses to the EQ-5D descriptive system converted into health utility scores. Descriptive statistics and multivariable analyses were used to estimate the relationship between mode of delivery and health-related quality of life outcomes.

Results: The overall health-related quality of life profile of the women in the study cohort mirrored that of the English adult population as revealed by national health surveys. A significantly higher proportion of women delivering by caesarean section reported some, moderate, severe or extreme pain or discomfort at 12 months postpartum than women undergoing spontaneous vaginal delivery. Multivariable analyses using the Ordinary Least Squares estimator revealed that, after controlling for maternal sociodemographic characteristics, caesarean section without maternal or fetal compromise was associated with a significant EQ-5D utility decrement in comparison to spontaneous vaginal delivery amongst all women (-0.026; $p = 0.038$) and amongst mothers of term-born infants (-0.062; $p < 0.001$). Amongst mothers of term-born infants, this result was replicated in models that controlled for all maternal and infant characteristics (utility decrement of -0.061; $p < 0.001$). The results were confirmed by sensitivity analyses that varied the categorisation of the main exposure variable (mode of delivery) and the econometric strategy.

Conclusions: Amongst mothers of term-born infants, caesarean section without maternal or fetal compromise is associated with poorer long-term health-related quality of life in comparison to spontaneous vaginal delivery. Further longitudinal studies are needed to understand the magnitude, trajectory and underpinning mechanisms of health-related quality of life outcomes following different modes of delivery.

Introduction

The rate of caesarean deliveries has increased markedly across the industrialised world in recent decades (1), highlighting the need to understand their potential adverse sequelae. Previous empirical studies have demonstrated that women delivering by caesarean section, either elective or emergency, are at increased risk of hysterectomy, blood transfusion, admission to intensive care and postpartum infection compared with women undergoing vaginal delivery (2). Over the longer term, there is some evidence to suggest a higher risk of exhaustion, lack of sleep and bowel problems following caesarean section in comparison to spontaneous vaginal delivery (3). Furthermore, evidence from economic analyses suggests that delivery by caesarean section (either elective or emergency) is more costly than vaginal delivery (either spontaneous or instrumented) in low risk or unselected populations (4).

In contrast to our understanding of the effects of different modes of delivery on clinical and cost outcomes, relatively little is known about the effects on the health-related quality of life of women following delivery. It is increasingly recognised that narrow biomedical-based outcomes fail to capture the effects of health care on aspects of health-related quality of life that may be of concern to the recipient, for example, their ability to function, their social activities and their psychological well-being (5). Moreover, health-related quality of life measurement has become an integral component of the health technology assessment process in many industrialised nations (6-9). All but one longitudinal study that has assessed the health-related quality of life of women following different modes of delivery limited the time horizons of their analyses to the first few months' postpartum (10-20). In low risk study populations, several studies have shown that, over the first few months' postpartum, women delivering vaginally have significantly better scores on physical (10, 11, 13, 15-17), mental (13, 16, 17), social (16) and pain (15) dimensions of health-related quality of life measures, as well as greater energy levels (15) and vitality (13), in comparison to

women delivering by caesarean section. Assessments of early postnatal health-related quality of life conducted in specific clinical contexts reveal a mixed pattern of results. Prick and colleagues assessed women's health-related quality of life following obstetric complications using data from three randomised controlled trials. The authors found that the physical component score of the Short Form (36) Health Survey (SF-36) was 5-6 points lower (indicating worse functioning), on average, following elective and emergency caesarean section than following vaginal delivery (20). Hutton and colleagues, meanwhile, found no differences at three months postpartum in the health-related quality of life of women randomised to give birth by planned caesarean section or by planned vaginal birth in the multinational Twin Birth Study (18).

Only one longitudinal study, to our knowledge, has assessed the health-related quality of life of women following different modes of delivery beyond the first few months' postpartum. Carlander and colleagues assessed the health-related quality of life of 372 women recruited from one clinical centre in Sweden five years after the birth of their first child (21). The authors found that women having a vaginal birth, an instrumental vaginal birth or women who underwent caesarean section on maternal request were more likely to report better perceived health-related quality of life as measured by the Swedish Health-Related Quality of Life Survey (SWED-QUAL) than women who had undergone an emergency caesarean section or caesarean section due to medical indication. The authors' analyses were constrained by an absence of data on underlying illnesses and conditions, and indeed further pregnancy experiences, as well as a focus on a relatively affluent cohort. Of particular note is that the SWED-QUAL is not a preference-based measure, i.e. it does not capture individuals' preferences (or *utility*) for the health state experienced. For economists and other social scientists, preference-based measures of health outcome move beyond the narrow biomedical model for evaluative research, and importantly generate outputs that satisfy the requirements of decision-making bodies concerned with cost-effectiveness comparisons (6-9). The objective of this study

was to describe long-term preference-based health-related quality of life outcomes associated with different modes of delivery within the context of a large prospective, population-based study.

Methods

Study population

The study population encompassed all mothers within The Late And Moderately preterm Birth Study (LAMBS), a prospective, population-based study of all live births and stillbirths between 32^{+0}-36^{+6} weeks' gestation whose families were normally resident in a pre-defined region of Leicestershire and Nottinghamshire, UK, between September 2009 and December 2010. LAMBS included a comparison group of babies born at $\geq 37^{+0}$ weeks' gestation that was selected by random sampling of dates and times of births in the same geographical area during the previous year. Births occurred in four perinatal centres, one low-risk midwifery-led unit and at home or outside hospital. Six research midwives worked collaboratively across participating centres, obtaining signed consent from mothers in hospital following delivery. When early discharge made this impossible, a home visit was arranged to discuss the study and obtain consent. LAMBS was approved by the Derbyshire Multicentre Research Ethics Committee, UK. Further details about LAMBS, including its sampling and recruitment procedures, are available elsewhere (22).

Mode of delivery and other perinatal data

Data relating to mothers' general medical history, past obstetric history, antenatal care, labour and delivery were extracted from the mothers' maternity records. Mode of delivery was categorized as spontaneous vaginal, instrumental vaginal, or caesarean section. Further, caesarean sections were

sub-categorized in two alternative ways. First, for the purposes of the primary analysis, caesarean sections were sub-categorized using a modified version of the classification proposed by Lucas and colleagues (23) now recommended by the Royal College of Obstetricians and Gynaecologists (RCOG) in the UK (24) as a valid measure of urgency of caesarean section, with four distinct categories: (1) maternal or fetal compromise with immediate threat to life of woman or fetus; (2) maternal or fetal compromise with no immediate threat to life of woman or fetus; (3) no maternal or fetal compromise but requirement of early delivery; or (4) no maternal or fetal compromise with delivery at a time to suit the woman and maternity services. Second, for the purposes of a sensitivity analysis, caesarean sections were sub-categorized as either performed during labour or not in labour (4).

Gestational age was assessed using ultrasound scan in the first trimester, last menstrual period or ultrasound scan later in pregnancy, or clinical assessment at birth. In addition to collecting information from medical records, research midwives interviewed each consenting mother using a semi-structured questionnaire shortly after delivery to obtain information about her sociodemographic and socioeconomic characteristics, and pre-pregnancy and antenatal health. Each infant's medical records were consulted to extract data about the infant's characteristics and clinical course until hospital discharge.

Health-related quality of life

Postnatal health-related quality of life was assessed at 12 months postpartum using the EuroQol Five Dimensions (EQ-5D) measure (25). The EQ-5D is a generic, multi-attribute, preference based measure preferred by decision-making bodies such as the National Institute for Health and Care Excellence (NICE) in England and Wales for cost-effectiveness comparative purposes (9). Its psychometric performance has previously been demonstrated in the maternity context (26). The

EQ-5D consists of two principal measurement components. The first is a descriptive system, which defines health-related quality of life on the day of completion in terms of five dimensions: 'mobility', 'self-care', 'usual activities', 'pain/discomfort' and 'anxiety/depression'. Responses in each dimension have commonly been divided into three ordinal levels coded: (1) no problems; (2) some or moderate problems; and (3) severe or extreme problems; a five level version is now being disseminated (27). A total of 243 (3^5) health states are generated by the EQ-5D (3 level version) descriptive system. For the purposes of this study, the York A1 (Dolan) tariff was applied to each set of responses (28). The York A1 tariff set had been derived from a survey of the UK general population ($n = 3337$), which was commissioned by UK funders to elicit relative valuations attached by the general public to different health states (defined by the EQ-5D descriptive system). Health state valuations for a subset of 45 EQ-5D health states were derived using the time trade-off valuation method, with the remainder of the 243 EQ-5D health states subsequently valued through the estimation of a multivariate model (28). Resulting values, described as utility scores (28), range from -0.59 to 1.0, with 0 representing death and 1.0 representing full health; several health states in the York A1 tariff set have utility scores below 0, indicating that the population surveyed considered those health states worse than death. The second measurement component of the EQ-5D consists of a 20 cm vertical visual analogue scale (VAS) ranging from 100 (best imaginable health state) to 0 (worst imaginable health state), which provides an indication of the respondent's own assessment of their health status on the day of completion. The VAS values do not act as data inputs into health economics evaluations, and were excluded from our analyses.

The postal questionnaires containing the EQ-5D were mailed to women within one week of the date on which their child reached 12 months of age and a second copy of the questionnaire was mailed 2-3 weeks later if a completed questionnaire had not been returned. Women who did not respond to either postal questionnaire were contacted by telephone, e-mail or text message to confirm that they had received the questionnaire and to offer the option to complete it as a

telephone interview. Up to three attempts were made to contact each woman by telephone, e-mail or text message.

Statistical analysis

Differences in baseline maternal and infant characteristics between the women who completed the 12 month postpartum questionnaire and those who did not were tested using the Pearson chi-squared (1^2) test. For the purposes of our empirical investigation, analyses of health-related quality of life outcomes were performed on data for all responding mothers regardless of the gestational age at birth of their infants, as well as subgroups of mothers (delivering either late or moderately preterm (LMPT), or term) according to the gestational age at birth of their infants. In addition, comparisons of health-related quality of life outcomes between women experiencing different modes of delivery necessitated dichotomization of the caesarean sections. In the primary analyses, this was on the basis of the RCOG classification of urgency (maternal or fetal compromise (categories 1 and 2) versus no maternal or fetal compromise (categories 3 and 4)) (24).

For each of the five dimensions of the EQ-5D, we compared the proportion of women with sub-optimal levels of function (defined as some, moderate, severe or extreme problems) between mode of delivery comparators using the Pearson chi-squared (1^2) test. Differences in the EQ-5D utility scores between the comparison groups were tested using two-sample *t*-tests for unequal variance. In addition, we performed multivariable analyses using the Ordinary Least Squares (OLS) estimator to explore the effects of mode of delivery on the EQ-5D utility score (dependent variable). Two sets of multivariable analyses were performed. The first incorporated covariates commonly considered in utility studies, including maternal age, ethnicity, education status, marital civil status, socioeconomic status, and home ownership status (28). The second additionally incorporated an assessment of the pre-pregnancy EQ-5D utility score collected during the maternal interview shortly

after delivery, place of delivery, and a set of potential infant predictors of maternal health-related quality of life, namely multiplicity, gender, small for gestational age status, presence or not of a congenital anomaly, and birth order (20, 29).

Two sets of sensitivity analyses were performed. First, we re-estimated all health-related quality of life outcomes using the alternative dichotomization of caesarean sections, namely performed during labour or not in labour. Second, our multivariable models were re-run using two-part regression models as an alternative to the OLS estimator (30). The two-part models accounted for the non-normal distribution of EQ-5D utility scores and had two stages: (i) a logistic regression, in which the dependent variable indicated perfect health (yes, no); followed by (ii) a generalized linear model with a gamma distribution for the utility data relating to women with less than perfect health. All analyses were performed using STATA software (StataCorp. 2013. *Stata Statistical Software: Release 13. College Station, TX: StataCorp LP).

Results

A total of 2161 mothers of 2404 live births or still births were recruited into the LAMBS study (22). The characteristics of the 1374 (63.6%) responders and 787 (36.4%) non-responders to the 12 month postpartum health-related quality of life questionnaire are summarized in Table 1. The two groups were similar in terms of distribution of mode of delivery, but non-responders were significantly more likely to had previously reported indicators of socioeconomic disadvantage (e.g. having no or low educational qualifications; looking after the family, never worked or long-term unemployed; living in rented accommodation) or had delivered preterm.

For all mothers and for mothers of LMPT infants, there were no significant differences in proportions of suboptimal levels of function across all EQ-5D dimensions between the comparison groups (Table 2). However, in mothers of term-born infants, women delivering by caesarean section

reported a significantly higher proportion of suboptimal level of function in the pain/discomfort attribute compared to women undergoing spontaneous vaginal delivery (21.9% versus 14.3%; $p = 0.02$). This result was replicated when women delivering by caesarean section without maternal or fetal compromise were compared to women undergoing spontaneous vaginal delivery (23.4% versus 14.3%; $p = 0.02$).

Descriptive statistics for the utility scores for the alternative comparison groups are presented in Table 3. Notably, among mothers of term-born infants, women delivering by caesarean section without maternal or fetal compromise had a significantly lower EQ-5D utility score than women undergoing spontaneous vaginal delivery (0.882 versus 0.936; ($p = 0.017$).

The OLS multivariable analyses revealed that even after controlling for maternal sociodemographic characteristics, caesarean section without maternal or fetal compromise was associated with a significant reduction in EQ-5D utility score in comparison to spontaneous vaginal delivery amongst all women (-0.026; $p = 0.038$) and amongst mothers of term-born infants (-0.062; $p < 0.001$) (Table 4). Furthermore, amongst mothers of term-born infants, caesarean section without maternal or fetal compromise continued to be associated with a significant reduction in EQ-5D utility score in comparison to spontaneous vaginal delivery in the models adjusted for all maternal and infant characteristics (-0.061; $p < 0.001$).

The first sensitivity analysis that re-estimated all health-related quality of life outcomes using the alternative dichotomization of caesarean sections (performed during labour or not in labour) revealed that, in comparison to spontaneous vaginal delivery, undergoing a caesarean section not in labour was associated with a significant reduction in EQ-5D utility score of 0.028 ($p = 0.023$) in all women and 0.052 ($p = 0.002$) in mothers of term-born infants (data available upon request). The multivariable analyses revealed that caesarean section not in labour was associated with a significant reduction in EQ-5D utility score in comparison to spontaneous vaginal delivery amongst all women (-0.028; $p = 0.015$) and amongst mothers of term-born infants (-0.063; $p < 0.001$) (models adjusted for maternal

sociodemographic characteristics). Furthermore, amongst mothers of term-born infants, caesarean section not in labour continued to be associated with a significant reduction in EQ-5D utility score in comparison to spontaneous vaginal delivery in the models adjusted for all maternal and infant characteristics (-0.058; $p = 0.001$). The second sensitivity analysis that reran the multivariable models using a two-part estimator revealed that, following adjustment for all maternal and infant characteristics, caesarean section without maternal or fetal compromise was associated with a significant reduction in EQ-5D utility score in comparison to spontaneous vaginal delivery amongst all women (-0.067; $p = 0.043$) and amongst mothers of term-born infants (-0.136; $p = 0.006$) (Table 5).

Discussion

The data reported in this article augment previous estimates of health-related quality of life outcomes associated with different modes of delivery that have been generated by other researchers (10-21). Its unique contribution is its focus on long-term health-related quality of life outcomes that have been estimated using a preference-based measure on the basis of a prospective, population-based cohort. The study revealed that the overall health-related quality of life profile of the women in the study cohort was broadly in keeping with that of the English adult population as revealed by national health surveys (31). However, mode of delivery was associated with differences in health-related quality of life outcomes at 12 months postpartum.

The study revealed that a significantly higher proportion of women delivering by caesarean section report some, moderate, severe or extreme pain or discomfort at 12 months postpartum than women undergoing spontaneous vaginal delivery. One previous study reported that women delivering by caesarean section have significantly worse scores on the pain dimension of the Nottingham Health Profile at 1-2 weeks postpartum than women delivering vaginally (15). Although several other

studies have reported poorer physical components scores on the SF-36 in women delivering by caesarean section, they do not disentangle the pain scores within the physical component scores (10, 11, 13, 17). Moreover, these studies differ in their representativeness of all women that deliver and their length of follow-up.

The study is, to our knowledge, unique in its estimation of health utilities associated with different modes of delivery. Our principal finding is the 0.054 reduction in utility score associated with caesarean section without maternal or fetal compromise, in comparison to spontaneous vaginal delivery, which was observed in mothers of term-born infants. This exceeds the 0.030 minimally important difference in utility score postulated in the literature as clinically important, i.e. the smallest difference in score on the health utility scale which is perceived as beneficial and which could mandate a change in an individual's health care (32, 33). Moreover, this result held following multivariable analyses that controlled for all maternal and infant characteristics (utility decrement of 0.061), as well as sensitivity analyses that varied our categorization of the mode of delivery variable and the approach to multivariable analysis. This suggests that our results are likely to be of interest and relevance to both clinical and policy decision-makers. In addition, the standard errors surrounding estimates of reduction in utility score generated by the multivariable models can be used to estimate the probable bounds of effect of caesarean section without maternal or fetal compromise on the EQ-5D utility score.

The negative impact of delivery by caesarean section on long-term health-related quality of life may be mediated through operative complications, elevated risks of maternal morbidity, and adverse outcomes in subsequent pregnancies (2). In the LAMBS study, we did not track the clinical and social experiences of women through the first year postpartum. Consequently, we are unable to disentangle the biological and psychosocial pathways through which the association between caesarean section and impaired health-related quality of life might be generated. Of particular note is the significant association between caesarean section performed with a low degree of urgency

(i.e. without signs of maternal or fetal compromise or, alternatively, not in labour) in mothers of term-born infants and reduction in utility score. It is plausible that this group of women are viewed as being at lower risk of adverse sequelae than those delivering at term by caesarean section with a high degree of urgency, or mothers of LMPT infants, and subsequently receive less sustained support. Future research studies aimed at specifying the underpinning mechanisms for this association are clearly needed.

The strengths of this study lie in the fact that it was based on a large geographically-determined prospective population cohort, included validated research instruments and a comprehensive econometric strategy. Moreover, the fact that our study cohort was heterogeneous can be seen as a strength, as it allowed us to disentangle effects in women with differing delivery experiences across birth settings. Nevertheless, the study does have caveats, which should be borne in mind by readers. First, because the study was based in the East Midlands of England, it may not be representative of settings in other industrialised nations with different clinical practices and organisational structures for perinatal care. Second, some of the subgroups of women in our study, for example mothers of LMPT infants undergoing instrumental vaginal delivery (n=75), were based on relatively small samples. Nevertheless, our overall study population (n=2161) is to our knowledge the largest population in this body of literature. Third, although the EQ-5D is the most widely used preference-based health-related quality-of-life measure, its tariff set has been derived from a survey of UK adults rather than the study participants. Nevertheless, our approach is consistent with that recommended by decision-making bodies, such as NICE in England and Wales, which highlight the importance of valuing health outcomes using population-based preferences of the type we have used for the broader comparative purposes of economic evaluation (9). Fourth, our assessments of long-term health-related quality of life were only made at one time point, namely at 12 months postpartum. Further research is clearly needed to track the trajectory in health-related quality of life outcomes associated with different modes of delivery through the postnatal period and over the longer term.

How might the results of our study be used? If confirmed by future research, the data generated by our study provide a basis for targeting postnatal services towards women likely to experience unfavourable health-related quality of life outcomes following delivery. In addition, the health utility data reported in this study can act as a significant new resource that can inform quality-adjusted life year (QALY) estimation within the maternity context (34). The use of health utility catalogues to inform QALY estimation and cost-effectiveness estimates for preventive and treatment interventions is now relatively common in other areas of health care (5). However, this approach remains relatively uncommon in the maternity context. It is hoped therefore that our data will act as inputs into modelling-based economic evaluations that rely on secondary data sources.

In conclusion, the results of this study reveal that, amongst mothers of term-born infants, caesarean section without maternal or fetal compromise is associated with poorer long-term health-related quality of life in comparison to spontaneous vaginal delivery. Further longitudinal studies are needed to understand the magnitude, trajectory and underpinning mechanisms of health-related quality of life outcomes following different modes of delivery.

Acknowledgements

References

1. Niino Y. The increasing cesarean rate globally and what we can do about it. *Biosci Trends* 2011;5(4):139-150.

2. Villar J, Carroli G, Zavaleta N, Donner A, Wojdyla D, Faundes A, et al. Maternal and neonatal individual risks and benefits associated with caesarean delivery: multicentre prospective study. *BMJ* 2007;335(7628):1025.

3. Thompson JF, Roberts CL, Currie M, Ellwood DA. Prevalence and persistence of health problems after childbirth: associations with parity and method of birth. *Birth* 2002;29(2):8394.

4. Petrou S, Khan K. An overview of the health economic implications of elective caesarean section. *Appl Health Econ Health Policy* 2013;11(6):561-576.

5. Brazier J, Ratcliffe J, Salomon J, Tsuchiya A. Measuring and valuing health benefits for economic evaluation. Oxford, UK: Oxford University Press; 2007.

6. Canadian Agency for Drugs and Technologies in Health (CADTH). Guidelines for the Economic Evaluation of Health Technologies: Ottawa, Canada: CADTH; 2006.

7. Scottish Medicines Consortium (SMC). Guidance to Manufacturers for Completion of New Product Assessment Form (NPAF). Glasgow, UK: SMC; 2007.

8. Pharmaceutical Benefits Advisory Committee (PBAC). Guidelines for preparing submissions to the Pharmaceutical Benefits Advisory Committee (version 4.3). Canberra, Australia: PBAC; 2008.

9. National Institute for Health and Care Excellence (NICE). Guide to the methods of technology appraisal 2013. London, UK: NICE; 2013.

10.   Jansen AJ, Duvekot JJ, Hop WC, Essink-Bot ML, Beckers EA, Karsdorp VH, et al. New insights into fatigue and health-related quality of life after delivery. *Acta Obstet Gynecol Scand* 2007;86(5):579-584.

10.   Jansen AJ, Essink-Bot ML, Duvekot JJ, van Rhenen DJ. Psychometric evaluation of health-related quality of life measures in women after different types of delivery. *J Psychosom Res* 2007;63(3):275-281.

11.   Safarinejad MR, Kolahi AA, Hosseini L. The effect of the mode of delivery on the quality of life, sexual function, and sexual satisfaction in primiparous women and their husbands. *J Sex Med* 2009;6(6):1645-1667.

12.   Torkan B, Parsay S, Lamyian M, Kazemnejad A, Montazeri A. Postnatal quality of life in women after normal vaginal delivery and caesarean section. *BMC Pregnancy Childbirth* 2009;9:4.

13.   Fatusic Z, Hudic I, Sinanovic O, Kapidzic M, Hotic N, Music A. Short-term postnatal quality of life in women with previous Misgav Ladach caesarean section compared to Pfannenstiel-Dorffler caesarean section method. *J Matern Fetal Neonatal Med* 2011;24(9):1138-1142.

14.   Baghirzada L, Downey KN, Macarthur AJ. Assessment of quality of life indicators in the postpartum period. *Int J Obstet Anesth* 2013;22(3):209-216.

15.   Mousavi SA, Mortazavi F, Chaman R, Khosravi A. Quality of life after cesarean and vaginal delivery. *Oman Med J* 2013;28(4):245-251.

16.   Sadat Z, Taebi M, Saberi F, Kalarhoudi MA. The relationship between mode of delivery and postpartum physical and mental health related quality of life. *Iranian J Midwifery Res* 2013;18(6):499-504.

17.   Hutton EK, Hannah ME, Ross S, Joseph KS, Ohlsson A, Asztalos EV, et al. Maternal outcomes at 3 months after planned caesarean section versus planned vaginal birth for twin

pregnancies in the Twin Birth Study: a randomised controlled trial. *BJOG* 2015;122(12):1653-1662.

19.   Kavosi Z, Keshtkaran A, Setoodehzadeh F, Kasraeian M, Khammarnia M, Eslahi M. A Comparison of mothers' quality of life after normal Vaginal, cesarean, and water birth deliveries. *Int J Community Based Nurs Midwifery* 2015;3(3):198-204.

18.   Prick BW, Bijlenga D, Jansen AJ, Boers KE, Scherjon SA, Koopmans CM, et al. Determinants of health-related quality of life in the postpartum period after obstetric complications. *Eur J Obstet Gynecol Reprod Biol* 2015;185:88-95.

19.   Carlander AK, Andolf E, Edman G, Wiklund I. Health-related quality of life five years after birth of the first child. *Sex Reprod Healthc* 2015;6(2):101-107.

20.   Field D, Boyle E, Draper E, Evans A, Johnson S, Khan K, et al. Towards reducing variations in infant mortality and morbidity: a population-based approach. Programme Grants for Applied Research. Southampton, UK: NIHR; 2016.

21.   Lucas DN, Yentis SM, Kinsella SM, Holdcroft A, May AE, Wee M, et al. Urgency of caesarean section: a new classification. *J R Soc Med* 2000;93(7):346-350.

22.   National Institute for Health and Care Excellence (NICE). Caesarean section (update). CG132. London, UK: NICE, 2011.

23.   Brooks R. EuroQol: the current state of play. *Health Policy* 1996;37(1):53-72.

24.   Petrou S, Morrell J, Spiby H. Assessing the empirical validity of alternative multi-attribute utility measures in the maternity context. *Health Qual Life Outcomes* 2009;7:40.

25.   Devlin NJ, Krabbe PF. The development of new research methods for the valuation of EQ-5D-5L. *Eur J Health Econ* 2013;14 Suppl 1:S1-3.

26.   Dolan P, Gudex C, Kind P, Williams A. The time trade-off method: results from a general population study. *Health Econ* 1996;5(2):141-154.

29.   Van der Woude DA, Pijnenborg JM, de Vries J. Health status and quality of life in postpartum women: a systematic review of associated factors. *Eur J Obstet Gynecol Reprod* 2015;185:45-52.

1.   Miners A, Phillips A, Kreif N, Rodger A, Speakman A, Fisher M, et al. Health-related quality-of-life of people with HIV in the era of combination antiretroviral treatment: a cross-sectional comparison with the general population. *The Lancet HIV* 2014;1(1):e32-40.

2.   Feng Y, Devlin N, Herdman M. Assessing the health of the general population in England: how do the three- and five-level versions of EQ-5D compare? *Health Quality Life Outcomes* 2015;13:171.

3.   Drummond M. Introducing economic and quality of life measurements into clinical studies. *Ann Med* 2001;33(5):344-349.

4.   Marra CA, Woolcott JC, Kopec JA, Shojania K, Offer R, Brazier JE, et al. A comparison of generic, indirect utility measures (the HUI2, HUI3, SF-6D, and the EQ-5D) and disease-specific instruments (the RAQoL and the HAQ) in rheumatoid arthritis. *Soc Sci Med* 2005;60(7):1571-1582.

5.   Torrance GW, Feeny D. Utilities and quality-adjusted life years. *Int J Technol Assess Health Care* 1989;5(4):559-575.

Table 1: Sociodemographic and clinical characteristics of responders and non-responders to the 12 month postpartum EQ-5D questionnaire; LAMBS prospective population-based study, East Midlands of England, 2009-11†

Characteristic	Responders (N = 1374) n (%)	Non-responders (N = 787) n (%)
Maternal Characteristics		
Mode of delivery		
Spontaneous vaginal	761 (55.4)	442 (56.2)
Instrumental vaginal	209 (15.2)	108 (13.7)
Caesarean section:		
Maternal or fetal compromise, immediate threat to life	20 (1.5)	17 (2.2)
Maternal or fetal compromise, no immediate threat to life	175 (12.7)	91 (11.6)
No maternal or fetal compromise, requires early delivery	101 (7.4)	62 (7.9)
No maternal or fetal compromise, at a suitable time	107 (7.8)	65 (8.3)
Not known	1 (0.1)	2 (0.3)
Maternal age (years) * **		
<20	328 (23.9)	220 (28.0)
20-34	742 (54.0)	454 (57.7)
≥35	304 (22.1)	113 (14.4)
Maternal ethnicity* **		
White	1089 (79.3)	526 (66.8)
Non-white	279 (20.3)	258 (32.8)
Not known	6 (0.4)	3 (0.4)
Education status* **		
Higher degree or degree	505 (36.8)	142 (18.0)
Below degree	747 (54.4)	547 (69.5)
Not known	122 (8.9)	98 (12.5)
Marital civil status* **		
Single	147 (10.7)	178 (22.6)
Living as part of a couple	1224 (89.1)	608 (77.3)
Not known	3 (0.2)	1 (0.1)
Socio-economic status* **		
Managerial and professional occupation	480 (34.9)	123 (15.6)
Non-managerial and professional occupation	885 (64.4)	107 (83.7)
Not known	9 (0.7)	5 (0.6)
Home ownership* **		
Owner	812 (59.1)	213 (27.1)
Rented accommodation	562 (40.0)	571 (72.6)
Not known	0 (0)	3 (0.4)
Infant Characteristics		
Place of delivery		
Leicester	770 (56.0)	433 (55.0)
Nottingham	576 (41.9)	345 (43.8)
Home or other	28 (2.0)	9 (1.1)
Late or moderately preterm**	621 (45.2)	420 (53.4)
Twins or triplets	149 (10.8)	92 (11.7)
Male gender	722 (52.6)	425 (54.0)
Small for gestational age*	285 (20.7)	193 (24.5)
Congenital anomaly	15 (1.1)	12 (1.5)
First born* **	690 (50.2)	302 (38.4)

† Deliveries occurred between September 2009 and December 2010 with postnatal health-related quality of life assessed at 12 month postpartum.

$* p < 0.05$, $** p < 0.01$, $*** p < 0.001$.

Table 2: Sub-optimal levels of function within EQ-5D dimension at 12 months postpartum by mode of delivery; LAMBS prospective population-based study, East Midlands of England, 2009-11

	Spontaneous vaginal	Instrumental	Caesarean section:		*P* value†	*P* value††
			Maternal or fetal compromise	No maternal or fetal compromise		
	n (%)	n (%)	n (%)	n (%)		
All mothers (N=1373)						
Mobility	40 (5.3)	9 (4.3)	6 (3.1)	10 (4.8)	0.33	0.80
Self-care	11 (1.5)	1 (0.5)	1 (0.5)	2 (1.0)	0.30	0.59
Usual activities	44 (5.8)	11 (5.3)	7 (3.6)	15 (7.2)	0.82	0.45
Pain/discomfort	114 (15.0)	33 (15.8)	30 (15.4)	41 (19.7)	0.24	0.10
Anxiety/depression	121 (15.9)	27 (12.9)	32 (16.4)	35 (16.8)	0.75	0.75
Mothers of term infants (N=752)						
Mobility	21 (4.9)	4 (3.0)	1 (1.2)	7 (6.3)	0.68	0.56
Self-care	5 (1.2)	0 (0)	0 (0)	1 (0.9)	0.45	0.81
Usual activities	24 (5.6)	7 (5.2)	3 (3.7)	10 (9.0)	0.58	0.19
Pain/discomfort	61 (14.3)	22 (16.4)	16 (19.8)	26 (23.4)	0.02	0.02
Anxiety/depression	61 (14.3)	14 (10.5)	8 (9.9)	19 (17.1)	0.93	0.46
Mothers of late or moderately preterm infants (N=621)						
Mobility	19 (5.7)	5 (6.7)	5 (4.4)	3 (3.1)	0.33	0.31
Self-care	6 (1.8)	1 (1.3)	1 (0.9)	1 (1.0)	0.43	0.60
Usual activities	20 (6.0)	4 (5.3)	4 (3.5)	5 (5.2)	0.39	0.76
Pain/discomfort	53 (15.8)	11 (14.7)	14 (12.3)	15 (15.5)	0.51	0.93
Anxiety/depression	60 (17.9)	13 (17.3)	24 (21.1)	16 (16.5)	0.76	0.75

†: Compares spontaneous vaginal deliveries with all caesarean sections and calculated using χ^2 test;

††: Compares spontaneous vaginal deliveries with caesarean sections without maternal or fetal compromise and calculated using χ^2 test.

Table 3: EQ-5D utility scores at 12 months postpartum by mode of delivery; LAMBS prospective population-based study, East Midlands of England, 2009-11

	N	Mean (SE)	Mean decrement from spontaneous vaginal delivery
All mothers (n=1374)			
Spontaneous vaginal	761	0.929 (0.006)	
Instrumental vaginal	209	0.943 (0.007)	0.014
Caesarean section: Maternal or fetal compromise	195	0.924 (0.012)	-0.005
Caesarean section: No maternal or fetal compromise	208	0.905 (0.014)	-0.024
Not known	1	0.796	
Mothers of term infants (n=753)			
Spontaneous vaginal	426	0.936 (0.007)	
Instrumental vaginal	134	0.948 (0.008)	0.012
Caesarean section: Maternal or fetal compromise	81	0.935 (0.016)	-0.001
Caesarean section: No maternal or fetal compromise	111	0.882 (0.022)	-0.054*
Not known	1	0.796	
Mothers of late or moderately preterm infants (n=621) Spontaneous vaginal	335	0.920 (0.010)	
Instrumental vaginal	75	0.933 (0.015)	0.013
Caesarean section: Maternal or fetal compromise	114	0.917 (0.017)	-0.003
Caesarean section: No maternal or fetal compromise	97	0.932 (0.016)	0.012

SE denotes standard error.

* $p < 0.05$.

Table 4: Multivariable analyses (Ordinary Least Squares Model) exploring effects of mode of delivery on EQ-5D utility scores at 12 months postpartum; LAMBS prospective population-based study, East Midlands of England, 2009-11

	Adjusted for maternal sociodemographic characteristics†	Adjusted for maternal and infant characteristics††
	Coefficient (SE)	Coefficient (SE)
All mothers		
Referent = Spontaneous vaginal		
Instrumental vaginal	0.005 (0.012)	0.004 (0.012)
Caesarean section: Maternal or fetal compromise	-0.008 (0.013)	-0.006 (0.013)
Caesarean section: No maternal or fetal compromise	-0.026 (0.012)*	-0.020 (0.012)
Mothers of term infants		
Referent = Spontaneous vaginal		
Instrumental vaginal	0.006 (0.015)	0.009 (0.016)
Caesarean section: Maternal or fetal compromise	-0.012 (0.018)	-0.008 (0.019)
Caesarean section: No maternal or fetal compromise	-0.062 (0.016)***	-0.061 (0.017)***
Mothers of late or moderately preterm infants		
Referent = Spontaneous vaginal		
Instrumental vaginal	0.002 (0.021)	0.006 (0.020)
Caesarean section: Maternal or fetal compromise	-0.006 (0.018)	0.002 (0.017)
Caesarean section: No maternal or fetal compromise	0.013 (0.019)	0.024 (0.018)

SE denotes standard error.

† Adjusted for maternal age, maternal ethnicity, educational status, marital civil status, socio-economic status and home ownership.

†† Additionally adjusted for pre-pregnancy EQ-5D utility score, place of delivery, multiplicity, gender of infant, small for gestational age status of infant, congenital anomaly status of infant and first born status of infant.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 5: Multivariable analyses (Two Part Model) exploring effects of mode of delivery on EQ-5D utility scores at 12 months postpartum; LAMBS prospective population-based study, East Midlands of England, 2009-11

	Adjusted for maternal sociodemographic characteristics†	Adjusted for maternal and infant characteristics††
	Coefficient (SE)	Coefficient (SE)
All mothers		
Referent = Spontaneous vaginal		
Instrumental vaginal	0.027 (0.018)	0.016 (0.021)
Caesarean section: Maternal or fetal compromise	-0.024 (0.028)	-0.031 (0.031)
Caesarean section: No maternal or fetal compromise	-0.046 (0.031)	-0.067 (0.033)*
Mothers of term infants		
Referent = Spontaneous vaginal		
Instrumental vaginal	0.026 (0.022)	0.012 (0.027)
Caesarean section: Maternal or fetal compromise	-0.059 (0.043)	-0.069 (0.048)
Caesarean section: No maternal or fetal compromise	-0.106 (0.045)*	-0.136 (0.050)**
Mothers of late or moderately preterm infants		
Referent = Spontaneous vaginal		
Instrumental vaginal	0.009 (0.034)	0.015 (0.043)
Caesarean section: Maternal or fetal compromise	0.006 (0.046)	0.021 (0.055)
Caesarean section: No maternal or fetal compromise	0.021 (0.044)	0.037 (0.042)

SE denotes standard error.
† Adjusted for maternal age, maternal ethnicity, educational status, marital civil status, socio-economic status and home ownership.
†† Additionally adjusted for pre-pregnancy EQ-5D utility score, place of delivery, multiplicity, gender of infant, small for gestational age status of infant, congenital anomaly status of infant and first born status of infant.
* $p < 0.05$, ** $p < 0.01$.