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Full Length Research Paper

The Cumulative Effect of Induction of Labour on Maternal and Infant Morbidity in Northern Jordan

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Abstract

In 1985, the World Health Organization (WHO) stated that no country should have an induction rate higher than 10%. Inappropriate use of technology in childbirth has become an issue of international concern with reports of its negative impact on maternal and infant physical and psychological wellbeing. The aim of this paper is to describe the outcome data from a prospective cohort study and how these were used to test a model of the association between birth technology for inducing birth and maternal and infant morbidity, taking into account labour type, obstetric risk, method of monitoring, oxytocin, number of ultrasound scans and type of analgesia. Data from a prospective cohort study of a convenience sample of 200 primigravida women who gave birth at Bade'a Hospital in Northern Jordan was used for this statistical analysis. The data was obtained from a self-assessment questionnaire that was used to collect data on maternal and infant outcomes during the antenatal, intra-natal and postnatal period. Data extraction was confirmed by examining the case notes. A multivariate analysis using Structural Equation Modelling with goodness of fit assessed using chi-square. Ethical approval to conduct the study was given by the University of Ulster Research Ethics Committee and the Human Subject's Committee at the Jordan University of Science and Technology. The data analyses demonstrated that Induction of labour (IOL) was associated with use of oxytocin, electronic fetal monitoring and analgesia. A number of chains of association was found: induced labour was associated with fetal distress (p<0.005); electronic fetal monitoring predicts fetal distress and operative deliveries (p<0.005); operative deliveries had an effect on lower Apgar scores at 1 minute (p<0.005); Apgar scores at 1 minute have a direct effect on fetal distress, lower Apgar scores at 5 minutes and need for resuscitations (P<0.005). Oxytocin for induction predicted perineal trauma (p<0.005), perianal trauma has a direct effect on postpartum haemorrhage (p<0.005). Postpartum haemorrhage had a direct effect on lower haemoglobin level six weeks following birth (P<0.005), birth weight had a direct effect on Apgar score at 5 minutes (p=0.005). Socio-demographic variables were not related to induction of birth. The cumulative and knock on effect of the indiscriminate use of induction technology has the potential to increase maternal and infant morbidity leading to poorer outcomes for mother and baby. A clear policy needs to be implemented so that IOL is used in situations where the risks to mother or baby of continuing with the pregnancy outweigh the risks of artificially bringing the pregnancy to an end.

Keywords: Induction of Labour, Infant morbidity, maternal morbidity, Jordan, Middle East, birth technology, prospective study.

Background

In 1985, the World Health Organization (WHO) Consensus Conference on the Appropriate Use of Technology made 21 recommendations about the use of technology in childbirth. The conference was called because of an increase in the routine use of birth technology and concluded that the international induction rate for post term should be no more than 10% (World Health Organization Regional Office for Europe, 1985). This was based on the evidence available on the incidence of post term reported at 4%-6% (Crowley, 1989). Furthermore, the use of electronic fetal monitoring was to be governed by evidence that women were at ‘high risk’. In 1998 the WHO produced 10 principles of intranatal care including the ‘appropriate use of technology based on evidence’ and the demedicalisation of childbirth (World Health Organization, 1998). The primary goal of the WHO recommendations for Induction of Labour (IOL) is to improve quality of care and outcomes for pregnant women undergoing the procedure in under-resourced settings (World Health Organization, 2011). Current guidelines suggest that it should be used in situations where the risks to mother or baby of continuing pregnancy outweigh the risks of artificially bringing the pregnancy to an end (National Institute for Health and Clinical Excellence, 2008). In spite of these recommendations induction is extensively used all over the world. Around 50% of labour inductions are performed in the absence of recognised medical complications (Grivell et al., 2011; Stock et al., 2012). Pregnancy outcome data from the United States indicates that 26% of women underwent induction of labour in 2006; slightly higher than the rate in Australia (25.3%) and in UK, where the rate is over 20% (Cooper and Warland, 2011; Cheyne et al., 2012). According to the recent WHO global survey in Asia on maternal perinatal health 2007-2008 in medium-to-large health-care facilities, it is estimated that approximately 10% of all deliveries involve induction of labour IOL, ranging widely: from 1.4% in Niger to 35.5% in Sri Lanka(World Health Organization, 2011). In 2004 the induction of labour rates for Sweden, France and Mala were 10.8%, 19.8% and 37.9% respectively (Euro- Peristat Project, 2008), and the rate of induction in Scotland was 22.4% (Information Services division, ISD Scotland, 2010). Likewise the rate of caesarean section has increased worldwide: notably 46.2% in China, and 27.3% in Asia—in both developed and developing nations (Lumbiganon et al., 2010), and 24%for the UK and 32.8% for the USA (Hamilton et al., 2011) and in Jordan the rate of caesarean section is 28% (Hatamleh et al., 2008).

A technological cycle of birth has been described as part of routine midwifery practice involving antenatal monitoring, induction of labour, oxytocin infusion, continuous electronic fetal monitoring, increased likelihood of episiotomy, giving birth in the lithotomy position, and the use of epidural and other forms of systemic analgesia (Sinclair, 1999 and Sinclair, 2004).

The literature identifies a number of possible risks for mothers and babies from IOL, such as an increase in the incidence of both instrumental deliveries and caesarean sections, haemorrhage, anaemia, more perineal trauma, greater requirement for analgesia, low gestation age, low birth weight neonatal admission to neonatal intensive care unit, lower Apgar score (Joseph et al., 2007; Grivell et al., 2011; Rossen et al., 2011; Burgos et al , 2012 and Stock et al., 2012)

. Induction by using amniotomy is associated with an increased rate of caesarean section for fetal distress, and lower Apgar score (Joseph et al., 2007; Grivell et al., 2011, Rossen et al., 2011, Burgos et al , 2012 and Stock et al., 2012). Induction by sweeping of membranes has been associated with bleeding, irregular contractions and discomfort during vaginal examination (Boulvain et al., 2010). Induction by using oxytocin is associated with increased use of pain relief and continuous fetal heart monitoring (Alfirevic et al, 2009). Continuous electronic fetal monitoring is associated with increased risk of operative delivery and caesarean section for fetal distress (Alfirevic et al., 2008 and Devane et al., 2012).

Alfirevic and colleagues carried out a systematic review to compare continuous CTG monitoring with intermittent auscultation (listening), using the results of 12 published randomised controlled trials (Alfirevic et al., 2008) and found that there was no difference in the number of babies who died during or shortly after labour (about 1 in 300). Fits (neonatal seizures) in babies were rare (about 1 in 500 births), but they occurred significantly less often when continuous CTG was used to monitor fetal heart rate (Alfirevic et al., 2008). There was no difference in the incidence of cerebral palsy, although other possible long-term effects have not been fully assessed. Continuous monitoring was associated with a significant increase in caesarean section and instrumental vaginal births. Both procedures are known to carry the risks associated with a surgical procedure although the specific adverse outcomes were not assessed in the included studies. The challenge to EFM is that since the use of EFM began in 1970s the rate of cerebral palsy has not decreased and the rate of cerebral palsy remains 2-3/100 000 live births (Parkes et al., 2001).

Caughey and colleagues (2009) carried out a systematic review to compare the benefits and harms of elective induction of labor and expectant management of pregnancy, using 11 randomized, controlled trials and 25 observational studies. They found that women at or beyond 41completed weeks of gestation who were managed expectantly had a higher risk for cesarean delivery (OR, 1.21 [CI, 1.01 to 1.46]), but this difference was not statistically significant in women at less than 41 completed weeks of gestation (OR, 1.73 [CI, 0.67 to 4.5]). Furthermore, women were more likely to have meconium-stained amniotic fluid than those who were electively induced (OR, 2.04 [CI, 1.34 to 3.09]). They concluded that evidence from RCTs indicated that elective induction of labor at 41weeks of gestation and beyond is associated with a decreased risk for cesarean delivery and meconium-stained amniotic fluid. A recent systematic review carried out by Gülmezoglu et al., (2012), using 22 trials involving over 9000 women who were induced between 37 weeks and 42 weeks' gestation reported that there were fewer baby deaths when a labour induction policy was implemented regardless of the timing (1) 37 to 39 weeks, (2) 39 to 40 weeks, (3) < 41 weeks, (4) 41 weeks, and (5) > 41 weeks. Perinatal deaths were rare with either of these policies and significantly fewer babies developed meconium aspiration syndrome and fewer caesarean sections were required in the induction group compared with the expectant management group.

However, the findings of both recent systematic reviews cannot be generalized to the current practice since there were no recent RCTs of elective induction of labor at less than 41 weeks of gestation and the two studies conducted at less than 41 weeks of gestation were of poor quality and some were quite old trials and the quality was variable.

Induction in the Middle East

The focus of attention for this paper is Jordan, a country of nearly six million people with a median age of 23 years, a crude birth rate of 27 per 1000 population, a total fertility rate of 3.8, a perinatal mortality rate of 22 per 1000 total births, a neonatal mortality rate of 15 per 1000 live births and an infant mortality rate of 23 per 1000 live births (Jordan Population and Family Health Survey, 2009 and Central Intelligence Agency, 2011). It is estimated that the majority of infant deaths occur in the neonatal period, with the major causes being respiratory distress syndrome, sepsis, and asphyxia. There is no available data on the rate of infant morbidity (Ministry of health, 2011).A report from the Jordanian Higher Population Council indicates that , 99% of women receive some antenatal care; 99.5% were attended by a healthcare professional during labour and delivery and 97% gave birth in hospital (Hatamleh et al., 2008).

A study carried out in Jordan to assess the maternal mortality rate showed that between 1997 and 2008 there was a significant reduction in maternal deaths from 41 in 1997 to 19.4 per 100.000. The report identified the leading causes of maternal deaths in Jordan to be haemorrhage, followed by pulmonary embolism, and septicaemia (Amarin et al., 2009). A recent national study carried out to determine the overall incidence of maternal morbidity rate showed that about 61% of women suffered from one or more health problems during pregnancy, labor, and postpartum. The highest rate of morbidity was during pregnancy (41.3%), followed by labor and delivery (34.5%), and during postpartum (18.7%). Morbidities ranged from mild conditions to severe life threatening complications (higher Population Council, 2007-2008). The estimated rate of induction in Jordan is between 15%-20% but there are no reliable statistics to support this and obstetricians having no official guidelines or policies on induction. Observers agree that the Jordanian government's programs addressing obstetric emergencies have contributed to a significant reduction in maternal deaths. However, some evidence suggests that Jordan runs the risk of over-medicalizing maternal health care; a rapid increase in the use of technology to start, augment, accelerate, regulate and monitor the process of birth has led to the adoption of inadequate, unnecessary and sometimes interventions associated with increased risk (World Health Organization, 2004). This risk is illustrated by the rapid increase in caesarean section deliveries from 16 percent of all deliveries in 2002 to 27.7 percent of all deliveries in 2007 (Hatamleh et al., 2008 and Khresheh et al., 2007). The available literature show that Jordanian birth practices are interventionist and different from WHO guidelines and evidence-based recommendations (World Health Organization, 2004 and Caughey et al., 2009).

Aim of the study

The main aim of the original study was to provide baseline information about birth technology for birth induction in a major maternity hospital in Northern Jordan, to provide evidence from statistical analyses on the impact of induction on maternal and infant outcomes in a Middle-Eastern context.

Subsequently to test a model of the association between birth technology for inducing birth and maternal and infant morbidity, while taking into account relations between labour type, obstetric risk, method of monitoring, oxytocin, number of ultrasound scan and type of analgesia.

METHODS

A prospective cohort study was used to explore the impact of birth technology (induction of labour in particular) on the lives of women and babies in Jordan using a convenience sample of 200 primigravida women and to test a model of the association between birth technology for inducing birth and maternal and infant morbidity, while taking into account relations between labour type, obstetric risk, method of monitoring, oxytocin, number of ultrasound scan and type of analgesia.

The project was advertised on posters placed in the antenatal clinic at Bade'a hospital in Northern Jordan. The posters contained the study title, process, aims, benefits and inclusion criteria.Women who met the inclusion criteria, primiparous and aged between 17-38 years, were approached then women who were willing to participate in the study were recruited. The recruitment began of women who agree to take part by the researcher, after explaining the study process, aims and benefits. Convenience sampling was employed and women booking at the hospital for the first time between February to August were entered to the study with their informed consent.

In an attempt to recruit sufficient numbers of women, a convenience sample of 530 primigravida women was entered into the study over a twelve-month period. Analysis was undertaken on the complete data for 200 women, as 62.2% (n=330) of the initial sample dropped out during the second stage of data collection (follow-up six-weeks). The final response rate was 37.3% (n=200).

A data abstraction form was used to collate data from women themselves within three days of birth, and repeated again at six weeks postnatal. Data extraction was confirmed by examining the case notes. Data related to labour and delivery process, such as name of given drugs during labour and delivery, Apgar scores at 1 minute and at 5 minutes were extracted from the medical records.

Instrument and measures

Following extensive literature review, a self-designed instrument was developed to collect data about the impact of birth technology for birth by induction on maternal and infant outcomes during antenatal, intranatal, and postnatal period. It focused on demographic and social data, antenatal histories of women, maternal and infant birth outcomes, as well as memories of their perceptions of childbirth, mainly their feelings and thoughts about the technology used during childbirth.

The questionnaire was designed with consideration of the culture and language of women being studied, as well as their educational level. Translation and back translation was carried out, where the majority of women are native Arabic. The instrument was examined for bias, clarity, sequences and face validity. It also was subjected to extensive pre-testing by conducting three pilot studies to determine the validity.

Hypothesised model

Following literature review and based on published evidence, a hypothesised model was developed that included all the important variables within the labour process. The relationship between these variables was used to examine the etiological processes through which labour type is related to maternal and infant morbidity.

The hypothesised model of impact of birth technology on maternal and infant morbidity included six independent variables: 1) number of ultrasound scan, 2) obstetric risk, 3) type of labour: induced, not induced (induced means the presence of any of the three measures: (Artificial Rupture of Membranes (ARMU), oxytocin infusion, prostaglandins) and not induced means the absence of all measures mentioned above), 4) analgesia (Pethidine 100mg I.M), 5) oxytocin infusion, and 6) method of monitoring. The model tested the relationship between number of ultrasound scan, obstetric risk, type of labour, analgesia, oxytocin infusion, method of monitoring and infant outcomes, such as gestation age, birth weight, Apgar score at one minute, Apgar score at five minutes, fetal distress during labour, infant need for resuscitation, admission to NICU, and length of stay at NICU, and maternal outcomes such as type of delivery, perineal trauma, postpartum haemorrhage, postnatal infection, haemoglobin level six weeks after giving birth and the sum score on the Edinburgh Postnatal Depression Scale (Figure 1).

Analysis

Correlational analyses were conducted to examine whether or not socio-demographic variables, obstetric risk, method of monitoring, type of labour, analgesia, oxytocin and number of ultrasound scan during

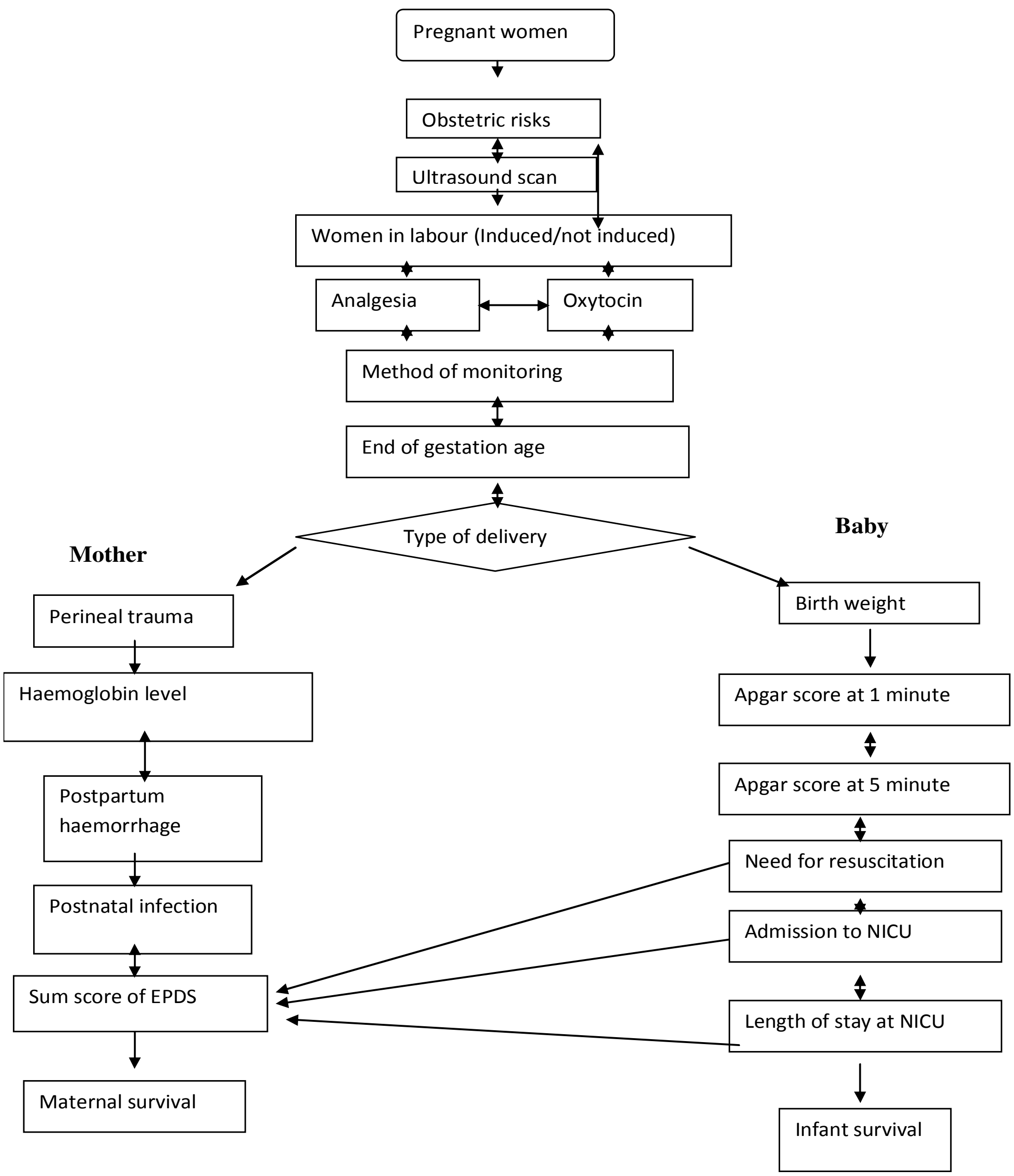

Figure1. Flow chart showing process of birth, delivery type and major outcomes for mother and baby.

pregnancy were significantly (0.05 level) associated with each other and with the maternal and infant morbidity.

Bivariate analysis on the bivariate correlations demonstrated that it was evident that socio-demographic variables were not associated with type of labour, oxytocin infusion, method of monitoring, number of ultrasound scan, analgesia, or obstetric risk. However, there was an association between socio-demographic variables and birth outcomes such as postnatal infection, haemoglobin level six weeks after giving birth, sum score on EPDS and infant admission to NICU.

Correlations between the observed, exogenous variables and the observed endogenous variables in the model

There were statistically significant (0.05 level) correlations between the measured variables for maternal and infant outcomes. For example, type of labour was

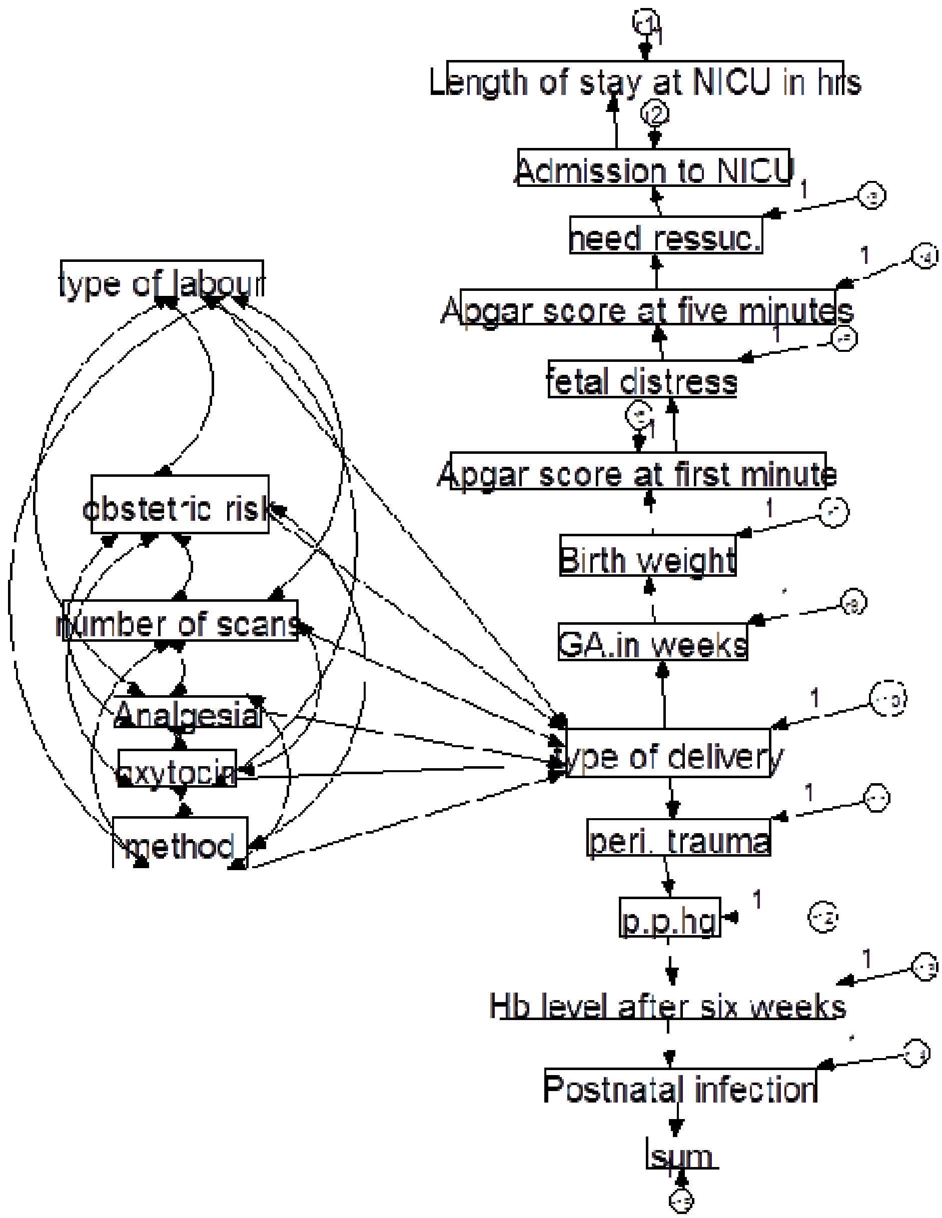

Figure 2. Some of the six influences type of delivery has direct influences on outcomes and some Outcomes influence other outcomes (arrow show direction of significant effect). Paths between latent variables and measured variables represent factor loading.

associated with postpartum haemorrhage, length of stay at NICU, admission to NICU, Apgar score at 1 minute, birth weight, perineal trauma, fetal distress, type of delivery, analgesia, oxytocin, method of monitoring, gestation age, and obstetric risk. Analgesia was associated with admission to NICU, Apgar score at 1 minute, perineal trauma, type of delivery, fetal distress, oxytocin, and type of labour.

Oxytocin was associated with length of stay at NICU, admission to NICU, need for resuscitation, Apgar score at 5 minutes, Apgar score at 1 minute, birth weight, infant, perineal trauma, type of delivery, fetal distress, analgesia, method of monitoring, type of labour, and gestation age.

Method of monitoring was associated with fetal distress, oxytocin, type of labour, need for resuscitation, and sum score on EPDS. The number of ultrasound scans was associated with gestation age and obstetric risk was associated with birth weight, type of labour, and gestation age.

Structural Model

Structural Equation Modelling (SEM) using the AMOS software (Analysis of moment structures) was conducted in two stages. In the first stage of analysis the impact of birth technology for induction of birth was allowed to effect maternal and infant morbidity and the relationships between labour type, obstetric risk, number of ultrasound scan, analgesia, method of monitoring and oxytocin infusion to maternal and infant. This is the first stage of explaining how the variables affect each other. On the left are six major influences on type of delivery. Two tracks show the outcomes for the baby (top right) and for the mother (bottom right) (Figure 2).

Ethical approval

Approval to conduct the study was given by the University of Ulster Research Ethics Committee and the Human Subject's Committee at the Jordan University of Science and Technology. In order to obtain access to all governmental hospitals, a letter was sent to the Ministry of Health and permission was granted to collect the data.

RESULTS

Participants' characteristics

A total of 200 women completed the data entries at all three points in time, antenatally, just after birth and within six weeks postnatally. They were between 17-37 years of age (mean=24, SD=4.5) with most lived in the city (n=129, 64.5%). The majority of women (64%) had attended school of 12years, less than half (n=71, 35.5%) had obtained graduate education, and one woman was illiterate. Most women were not in paid employment (72.5%). However, a small number 55 (27.5%) were working. The majority of women n=180 (90%) were on a family income of <£360 per month, with a small proportion earning £361-£560 and £561-£960. A small percentage of respondents smoked (n=23, 11.5%); nine of these stopped smoking during pregnancy.

The gestational age at delivery ranged between 30 and 42 weeks and the majority of women delivered at term, but 28/200 (14%) gave birth before 37 completed weeks of gestation. This group included four twin pregnancies, so the total number of babies born to these 200 women was 204. Five infants died at birth, all of them were twins, three of them were the first twin and two were the second twin. The cause of death was respiratory distress syndrome as a result of prematurity. Birth weights ranged from 1.5Kg to 4.5 Kg with a mean of 3.1Kg (SD=0.55).

Induction was the "norm" with 161/200 (80.5%) being induced and 39 had spontaneous labour or planned CS. The majority of women (65%, n=129) had their labour induced at a gestational age of between 38 and 39 weeks, with only 12 women (6%) experiencing spontaneous labour. Those who had spontaneous labour went into labour at home and presented themselves to hospital staff in early labour. A range of technological interventions was recorded: 144 (72%) women had an artificial rupture of membranes, 145 (72.5%) had their labour augmented with oxytocin, 178 (89%) had continuous EFM and 132 (66%) had an episiotomy.

Results of structural equation modelling for the hypothesised model

The exogenous variables in the model were allowed to be associated. In most case these associations were statistically significant. The non-significant correlations were between ultrasound scan and all covariance's, between obstetric risk and all the covariance's except type of labour and between method of monitoring and analgesia.

Type of labour with gestation age and fetal distress

The model indicates that induced labour predicted a higher gestation age and the presence of fetal distress during labour (Table 1). The standardised total effect of induced labour on gestation age was 0.439, and on fetal distress it was 0.30. Induced labour had a direct effect on type of delivery but this was not significant (Standardised =-0.124). It also had an indirect effect on (a) higher birth weight through higher gestational age (b) lower Apgar score at 1 minute, through the presence of fetal distress (c) an increase in the need for resuscitation through lower Apgar score at 5 minutes (d) an increase in the need for admission to NICU, (e) an increase in the length of stay at NICU through need for resuscitation.

There were significant paths between oxytocin infusion and type of delivery, and perineal trauma as hypothesised (Table 1.) The standardised total effect of oxytocin on type of delivery was -0.297, and on perineal trauma was 0.116. There were indirect effects of oxytocin on (a) gestation age (standardised = -0.058) (b) birth

Table 1 The un-standardised regression coefficients estimate after introducing all the effects.

			Esti.	S.E.	C.R.	P	Stand.
Type of delivery	<---	Type of labour	-.15	.12	-1.25	.206	-.12
Type of delivery	<---	Method of monitoring	.15	.05	2.06	.040	.15
Type of delivery	<---	Obstetric risk	-.05	.05	-.81	.418	-.05
Type of delivery	<---	Analgesia	-.4	.10	-4.28	***	-.29
Type of delivery	<---	Oxytocin	-.32	.010	-3.25	.001	-.210
Gestation age	<---	Type of delivery	.82	.30	2.70	.007	.110
Gestation age	<---	Type of labour	2.3	.37	6.41	***	.46
Birth weight	<---	Gestation age	.16	.05	10.24	***	.59
Apgar score at 1 minute	<---	Type of delivery	-.8	.16	-4.89	***	-.32
Apgar score at 1 minute	<---	Birth weight	.41	.14	2.82	.005	.18
Fetal distress	<---	Apgar score at 1 minute	-.04	.02	-2.16	.031	-.13
Perineal trauma	<---	Type of delivery	-.81	.03	-28.45	***	-.86
Fetal distress	<---	Method of monitoring	.43	.08	5.22	***	.32
Fetal distress	<---	Type of labour	.43	.07	6.08	***	.41
Perineal trauma	<---	Oxytocin	.12	.03	3.8	***	.12
Fetal distress	<---	Gestation age	-.05	.01	-3.5	***	-.22
Apgar score at 5 minutes	<---	Fetal distress	.010	.11	.89	.373	.04
Postpartum haemorrhage	<---	Perineal trauma	.16	.05	3.4	***	.23
Apgar score at 5 minutes	<---	Apgar score at 1 minute	.64	.04	16.7	***	.74
Apgar score at 5 minutes	<---	Birth weight	.33	.08	3.9	***	.17
Need for resuscitations	<---	Apgar score at 5 minutes	.010	.04	.28	.779	.02
Haemoglobin level six weeks after giving birth	<---	Postpartum haemorrhage	-.81	.24	-3.36	***	-.23
Need for resuscitations	<---	Apgar score at 1 minute	-.31	.03	-9.55	***	-.74
Haemoglobin level six weeks after giving birth	<---	Type of delivery	-.45	.163	-2.76	.006	-.110

***** p value is significant (p<0.05)**

weight (standardised = -0.034) (c) fetal distress (standardised = 0.001) (d) Apgar score at 1 minute (standardised = 0.089) (e) Apgar score at 5 minutes (standardised = 0.060) (f) the need for resuscitation (standardised = -0.064) (g) admission to NICU (standardised = -0.142) (h) the length of stay at NICU (standardised = -0.012) (i) postpartum haemorrhage (standardised = 0.087) (j) haemoglobin level six weeks after giving birth (standardised =0.037) (k) sum score of EPDS (standardised = -0.001) and (l) postnatal infection (standardised = -0.001).

Oxytocin with type of delivery and perineal trauma

The model indicates that oxytocin infusion predicts vaginal delivery and perineal trauma directly and that it predicts lower gestation age and birth weight, higher Apgar score at 1 minute, higher Apgar score at 5 minutes, lower length of stay at neonatal intensive care unit, and a decrease in admissions to the NICU through an increase in vaginal delivery. Oxytocin also predicts higher haemoglobin level six weeks after giving birth, lower sum score of EPDS, an increase in perineal trauma through vaginal delivery, and postpartum haemorrhage, through the presence of perineal trauma, as hypothesised. All findings are in keeping with the hypothesis except the effects of oxytocin on type of delivery. It was hypothesised that induced labour is associated with operative delivery. However, the model indicates that oxytocin predicts vaginal delivery and not operative delivery.

Obstetric risk and type of delivery

There was a direct effect of obstetric risk on type of delivery (standardised =-0.047), but it was not significant (Table 1). The standardised total effect of obstetric risk during pregnancy on gestation age was -.195, and on fetal distress during labour was 0.162. There was a direct effect of obstetric risk on the type of delivery but a non-significant effect (standardised direct effect =-0.049) on birth weight. Obstetric risk was found to have an indirect effect on (a) gestation age (standardised =-0.009), (b) birth weight (standardised =-0.005), (c) Apgar score at 1 minute (standardised = 0.014) (d) Apgar score at 5 minutes (standardised =-0.010) (e) infant's need for resuscitation (standardised =-0.010) (f) admission to NICU (standardised =-0.023) (g) the length of stay at NICU (standardised= -0.002) (h) perineal trauma (standardised = 0.041) (i) postpartum haemorrhage (standardised = 0.009) (j) haemoglobin level six weeks after giving birth (standardised = 0.007) and (k) sum score of EPDS (standardised = -0.002).

The model indicates that the presence of obstetric risks did not predict any birth outcomes directly. However, it predicted indirectly: (a) lower birth weight (b) lower Apgar score at 1 minute and at 5 minutes (c) an increased need for resuscitation (d) admission to NICU (e) an increased length of stay at NICU. All findings are in keeping with the hypothesis that there would be an association between obstetric risk and type of labour. It was hypothesised that the presence of obstetric risk would be related to induced labour and a higher chance for maternal and infant morbidity.

Analgesia and type of delivery

There was a statistically significant path between analgesia and type of delivery (Table 1). The standardised total effect was -0.294. Analgesia had an indirect effect on (a) gestation age (standardised = -0.058) (b) birth weight (standardised = -0.034) (c) fetal distress (standardised = -.001) (d) Apgar score at 1 minute (standardised = 0.088) (e) Apgar score at 5 minutes (standardised =0.060) (f) the need for resuscitations (standardised = -0.064) (g) admission to NICU (standardised = -0.141) (h) the length of stay at NICU (standardised =-0.012) (i) perineal trauma (standardised =0.255), (j) postpartum haemorrhage (standardised =0 .059) (k) haemoglobin level six weeks after giving birth (standardised =0.043) (l) postnatal infection (standardised = -0.001) (m) the sum score of EPDS (p=-0.012).

The model also indicates that the presence of analgesia predicts (a) vaginal deliveries (b) lower gestation age (c) lower birth weight (d) higher Apgar score at one minute (e) higher Apgar score at 5 minutes (f) a decrease in the need for resuscitations (g) decreased admission to NICU (h) a decreased length of stay at NICU (i) higher haemoglobin level six weeks after giving birth (j) lower sum score of EPDS and (k) higher chance of perineal trauma through vaginal delivery. All findings are keeping with the hypothesis that there was an association between analgesia and type of labour. It was also hypothesised that presence of analgesia would predict operative delivery. However, the model indicates that presence of analgesia was unrelated to operative delivery.

Method of monitoring with type of delivery and fetal distress during labour

There were significant paths (p= 0.05) between the method of monitoring, type of delivery and fetal distress (Table 1) as hypothesised. The standardised total effect of method of monitoring on type of delivery was 0.127. There was an indirect effects on (a) gestation age (standardised =0 .025) (b) birth weight (standardised = -0.015) (c) fetal distress (standardised = -0.001) (d) Apgar score at 1 minute (standardised = -0.038) (e) Apgar score at 5 minutes (standardised = -0.013) (f) the need for resuscitation (standardised = 0.028) (g) admission to NICU (standardised =0 .061) (h) length of stay at NICU (standardised =0 .000) (i) perineal trauma (standardised = -0.110) (j) postpartum haemorrhage (standardised = -0.025) (k) haemoglobin level six weeks after giving birth (standardised = -0.018) (l) postnatal infection (standardised = 0.000) and (m) sum score on EPDS (standardised =0.005).

The model indicates that electronic fetal monitoring predicted operative delivery and presence of fetal distress during labour directly. Further, fetal monitoring also predicted (a) higher birth weight through higher length of gestation age (b) lower Apgar score at 5 minutes (c) an increase in the need for resuscitation (d) infant's admission to NICU and (e) an increased length of stay at NICU through presence of fetal distress, (f) lower haemoglobin level six weeks after giving birth, (g) risk for postpartum haemorrhage, (h) postnatal infection and on (i) higher sum score on EPDS through operative delivery as hypothesised.

Type of delivery with Apgar scores at one minute and perineal trauma

There was a significant path between type of delivery Apgar score at 1 minute, and perineal trauma $p<0.001$ as hypothesised (Table 1). The standardised total effect of type of delivery on (a) Apgar score at 1 minute was -0.300 (standardised), (b) perineal trauma (standardised=-0.865), there was a direct effect of type of delivery on gestation age (standardised= 0.196), haemoglobin level six weeks after giving birth (standardised=-0.193), admission to neonatal intensive care unit (standardised =

- 0.333), but not significant. There were indirect effects of type of delivery on (a) birth weight (standardised = 0.115), (b) fetal distress (standardised = -0.005), (c) Apgar score at 5 minutes (standardised = -0.202), (d) the need for resuscitations (standardised = 0.216), (e) the length of stay at NICU (standardised = 0.041), (f) postpartum haemorrhage (standardised = -0.201), (g) haemoglobin level six weeks after giving birth (standardised= 0.047), (h) postnatal infection (standardised = 0.002), and (i) sum score of EPDS (standardised =0 .041).

The model indicates that operative delivery predicts lower Apgar score at 1 minute, and increases the need for admission to the NICU and lower chance for perineal trauma. It indicates that operative delivery indirectly predicts higher birth weight, presence of fetal distress, lower Apgar score at 5 minutes, increases the need for resuscitations, increases the length of stay at NICU, lower haemoglobin level six weeks after giving birth, higher chance for postnatal infection, and higher sum score of EPDS as hypothesised.

Gestation age with birth weight and fetal distress during labour

There were significant paths between gestation age, fetal distress, and birth weight p<0.001 (Table 1). The standardised total effect of gestation age on birth weight was 0.587 (standardised), on fetal distress during labour was -0.234 (standardised), and on the length of stay at NICU was (standardised=-0.411). There was an indirect effect of gestation age on Apgar score at 1 minute .109 (standardised), Apgar score at 5 minutes 0.173 (standardised), on the need for resuscitation -0.076 (standardised), and admission to NICU -0.051 (standardised). The model indicates that higher gestation age predicts higher birth weight, lower chance of fetal distress during labour and lower length of stay at neonatal intensive care unit. It also predicts higher Apgar score at 1 minute, higher Apgar score at 5 minutes, decreases the need for resuscitation and admission to NICU as hypothesised.

Perineal trauma and postpartum haemorrhage

There were significant paths between perineal trauma and postpartum haemorrhage p<0.001 as hypothesised (Table 1), the standardised total effect was 0.233 (standardised). There was an indirect effect of perineal trauma on haemoglobin level six weeks after giving birth (standardised = -0.055), postnatal infection (standardised = 0.001), and on the sum score on EPDS (standardised = 0.051).

The model indicates that perineal trauma predicts presence of postpartum haemorrhage directly, and predicts lower haemoglobin level six weeks after giving birth and higher sum score on EPDS indirectly through postpartum haemorrhage as hypothesised.

Birth weight and Apgar score at five minutes

There was a significant path between birth weight and Apgar score at 5 minutes p<0.001 as hypothesised (Table 1), the standardised total effect was 0.309. There was a direct effect of birth weight on Apgar score at 1 minute, the standardised direct effect was not statistically significant (standardised = 0.185), and an indirect effect of birth weight on (a) fetal distress during labour (standardised = -0.024) (b) the need for resuscitation (standardised= -0.130) (c) admission to NICU (standardised= -0.087), (d) the length of stay at NICU (standardised = -0.122).

The model indicates that lower birth weight predicts lower Apgar score at 5 minutes directly and indirectly predicts presence of fetal distress; increases need for resuscitation, increase admission to NICU, increase the length of stay at NICU through lower Apgar score at 1 minute as hypothesised.

Apgar score at one minute with fetal distress and Apgar score at five minutes

There were significant paths between Apgar score at 1 minute, fetal distress during labour, Apgar score at 5 minutes, and need for resuscitation P<0.001 as hypothesised (Table 1). The standardised total effect of Apgar score at 1 minute on (a) Apgar score at 5 minutes was 0.734 (standardised), (b) the need for resuscitations -0.720 (standardised), (c) fetal distress -0.128 (standardised). There was an indirect effect of Apgar score at 1 minute on admission to NICU (standardised = -0.483), on the length of stay at NICU (standardised = -0.308).

The model indicates that lower Apgar score at 1 minute predicts presence of fetal distress, lower Apgar score at 5 minutes, and increases the need for resuscitations; it also predicts admission at NICU, and length of stay at NICU indirectly through lower Apgar score at 5 minutes as hypothesised.

Apgar score at five minutes and length of stay at neonatal intensive care unit

The standardised total effect of Apgar score at 5 minutes on the length of stay at NICU was -0.375, there was direct effects of Apgar score at 5 minutes on the need for resuscitation but not significant (standardised = 0.022) and indirect effect on admission to NICU (standardised = 0.014). The model indicates that higher Apgar score at 5 minutes predicts decreased length of stay at NICU and it also predicts decrease admission to NICU indirectly as hypothesised.

Infants' need for resuscitations and admission to neonatal intensive care unit

There was a direct effect of need for resuscitation on admission to NICU was 0.670 (standardised), and indirect effect on the length of stay at NICU -0.045 (standardised).

The model indicates that babies who need resuscitation predict their admission to NICU directly and this indirectly predicts an increased length of stay at NICU, through admission to NICU, as hypothesised.

Postpartum haemorrhage and haemoglobin level six weeks after giving birth. There was a significant path between postpartum haemorrhage and haemoglobin level six weeks after giving birth p=0 .001 (Table 1). The standardised total effect of postpartum haemorrhage on haemoglobin level six weeks after giving birth was -0.235 (standardised), and indirect effect of postpartum haemorrhage on the sum score of EPDS (standardised = 0.066) and on postnatal infection (standardised =0 .003). The model indicates that postpartum haemorrhage predicts lower haemoglobin level six weeks after giving birth directly and indirectly predicts higher score of EPDS and presence of postnatal infection as hypothesised.

Haemoglobin level six weeks after giving birth and sum scores of EPDS

There was total effect of haemoglobin level six weeks after giving birth on the sum score on EPDS was -0.281 (standardised), and there was a direct effect of haemoglobin level six weeks after giving birth on postnatal infection but it was not significant -0.014. The model indicates that higher haemoglobin level six weeks after giving birth predicts lower EPDS sum score directly and decreases the chance for postnatal infection as hypothesised.

Postnatal infection and sum scores of EPDS

There was direct effect of postnatal infection on the sum score on EPDS but it was not significant -0.239. The model indicates that postnatal infection predicts the presence of a higher score on the EPDS (postpartum depression), as hypothesised.

For the model, the squared multiple correlations were as follow: R^2 = 0.352, indicating that 35.2% of the variance in type of delivery was explained by these variables, R^2 for gestational age was (0.171), R^2 for Apgar score at one minute was (0.139), R^2 for birth weight was (0. 345). R^2 for postpartum haemorrhage was (0.054), R^2 for Apgar score at 5 minutes was (0.621), R^2 for infants' need for resuscitations was (0.517). R^2 for haemoglobin level six weeks after giving birth was (0.073), R^2 for sum score on EPDS was (0.136), R^2 for length of stay at neonatal intensive care unit was (0.336), R^2 for perineal trauma was (0.863), R^2 for admission to the neonatal intensive care unit was (0.680), and R^2 for fetal distress during labour was (0.372).

Associations between Socio-demographic variables and birth outcomes

There were statistically significant correlations (0.05 levels) between socio-demographic variables (age, total income, work status, education, and residency). There were also associations between socio-demographic measures and some birth outcomes such as postnatal infection, haemoglobin level six weeks after giving birth, sum score on EPDS and admission to NICU. For example, age was associated with education, work status, total income, and sum score on EPDS. Residency (city/village) was associated with postnatal infection (p= 0.022). Education associated with age, work status, haemoglobin level six weeks after giving birth, sum score on EPDS, and postnatal infection. Work status was associated with age, education, total income, and demission to NICU. Total income was associated with age, education, work status, and admission to NICU.

Structural Equation Model for socio demographic variables with birth variables

SEM was conducted in two stages. In the first stage of analysis, the impact of type of labour on maternal and infant morbidity, incorporating the relationships between labour type, age, total income, residency, work status and education to maternal and infant morbidity; the sum score on EPDS, postnatal infection, haemoglobin level six weeks after giving birth, admission to NICU was tested. The parameters in the model were estimated, and the fit of the model was tested and resulted in chi-square=70.5, DF=25, P=0.00, GFI=0.94, RMSEA= 0.096, 95% CI (0.070 - 0.122). These findings indicate that the model did not describe the data.

At the second stage, the model was trimmed on the

Table 2. The five effects that introduced to the model once at a time.

Effect	M.I	Chi-Square	DF	P	GFI	RMSEA	CI
Sum score on EPDS to postnatal infection	11	58	24	.00	.95	.084	.057-.112
Education to sum score on EPDS	7.7	48	23	.001	.96	.075	.045-.104
Residency to postnatal infection	6.4	42	22	.006	.96	.067	.035-.098
Education to haemoglobin level six weeks after giving birth	5.9	35	21	.025	.97	.059	.021-.092
Total income to admission to NICU	4.3	31	20	.057	.97.2	.052	.00-.087

Table 3. The un-standardised estimate for correlations coefficient after introducing all the effects once at a time.

			Estimate	S.E.	C.R.	P
Type of labour	<-->	Residency	.00	.01	.06	.954
Residency	<-->	Total income	.02	.02	1.3	.183
Total income	<-->	Work status	-.07	.02	-4.1	***
Work status	<-->	Education	-.70	.10	-6.1	***
Education	<-->	Age	4.94	.96	5.1	***
Type of labour	<-->	Total income	-.01	.01	-.88	.379
Type of labour	<-->	Work status	.001	.01	.11	.913
Type of labour	<-->	Education	-.05	.08	-.62	.533
Type of labour	<-->	Age	-.12	.13	-.92	.355
Work status	<-->	Age	-.75	.15	-4.9	***
Total income	<-->	Education	.43	.010	4.3	***
Total income	<-->	Age	.54	.16	3.4	***
Residency	<-->	Work status	-.03	.01	-1.8	.070
Residency	<-->	Education	.15	.09	1.5	.126
Residency	<-->	Age	.08	.15	.41	.618

***** p value is significant (p<0.05)**

Table 4. Un-standardised regression coefficients estimate after introducing the all the effect once at a time.

		Estimate	S.E.	C.R.	P
Sum score on EPDS	<--- Age	-.08	.09	-.864	.388
Sum score on EPDS	<--- Education	-.45	.15	-3.08	.002
Hb level 6 wks	<--- Sum score on EPDS	-.05	.01	-3.41	***
Hb level 6 wks	<--- Education	.07	.03	2.54	.011
Postnatal infection	<--- Hb level 6 wks	.02	.03	.814	.416
Postnatal infection	<--- Sum score on EPDS	.02	.00	3.81	***
Postnatal infection	<--- Residency	-.18	.07	-2.510	.009
Admission to NICU	<--- Postnatal infection	.010	.07	1.40	.161
Admission to NICU	<--- Type of labour	-.36	.08	-4.31	***
Admission to NICU	<--- Total income	.15	.07	2.17	.030

***** p value is significant (p<0.05)**

basis of results. The method of maximum likelihood was used to obtain parameter estimates. After a careful examination of the modification indices (threshold value to be 4), a series of theoretically meaningful changes were introduced to the model. After introducing each effect on the model, the model has been estimated. Five effects had been introduced to the model, these effects were from sum score on EPDS to postnatal infection, from education to sum score on EPDS, from residency to postnatal infection, from education to haemoglobin level six weeks after giving birth and from total income to admission to NICU. For details about Modification Indices value, Chi-square, P value and model fit indicators (Table 2).

At this stage no more modifications were needed to be done, so the model indicated a good fit between the model and the data; it was estimated and resulted in Chi-square=30.9, DF=20, P=0.057, GFI 0.972 and RMSEA =0.052, 95% CI (0.00-0.087). It showed that there were correlations between work status and total income, between education and work status, between age and education, between age and work status, between education and total income, between age and total income (Table 3). Non-significant correlations were between type of labour and all socio-demographic variables, and between residency and all measured variables in the model.

Socio-demographic variables with birth variables

There were significant paths between education and sum score on EPDS, and haemoglobin level six weeks after giving birth p<0.001 (Table 4). The standardised total effect of education on haemoglobin level six weeks after giving birth was (0.230). There were direct effects of education on sum score on EPDS, the standardised direct effect was -0.229. There were indirect effects of education on postnatal infection, the standardised indirect effect was -0.048, on admission to NICU (standardised indirect effect=-0.005). The model indicates that increased years of education predicts lower sum score on EPDS and higher haemoglobin level six weeks after giving birth. Women who had more years of education been less likely to have either postpartum depression or lower haemoglobin level six weeks after giving birth. There was direct effect of age on sum score on EPDS but it was not significant and the standardised indirect effect was -0.064.

Sum scores of EPDS with haemoglobin level six weeks after giving birth and postnatal infection

There were significant paths between sum score on EPDS, haemoglobin level six weeks after giving birth and postnatal infection p<0.001 (Table 4).The standardised total effect of the sum score on EPDS on postnatal infection was 0.254. The standardised direct effect of the sum score on haemoglobin level six weeks after giving birth was -0.236. There was an indirect effect of the sum score on EPDS on admission to NICU was 0.024 (standardised). The model indicates that women who had a higher sum score on EPDS (postpartum depression) predicted lower haemoglobin level six weeks after giving birth and presence of postnatal infection.

Haemoglobin level six weeks after giving birth and postnatal infection

There was a direct path between haemoglobin level six weeks after giving birth and postnatal infection but it was not significant and there was a direct path between residency and postnatal infection but it was not significant, between postnatal infection and admission to NICU (Table 4).

Type of labour and admission to NICU

There were significant paths between type of labour and admission to NICU p<0.001 (Table.4). The standardised direct effect was -0.288. The model indicated that induced labour predicts increase admission to NICU.

Total income and admission to neonatal intensive care unit

There were significant paths between total income and admission to NICU p=0.030 (Table 4). The standardised direct effect was .145. The model indicates that women who had a high total income predicted increased infants' admission to NICU. For the model, squared multiple correlations for socio-demographic variables and maternal and infant morbidity were as follow: R^2= 0.0 68, indicated that 6.8% of the variance in sum score on EPDS is explained by these variables, for haemoglobin level six weeks after giving birth R^2 = 0.108, for postnatal infection R^2 = 0.099, for admission to NICU R^2 =0. 117.

DISCUSSION

The discussion deals with the research aim in the light of the research findings and the major specific findings from the Structural Equation Modelling using the AMOS software (Analysis of moment structures) testing the technological cycle and the impacts of birth technology for induction on maternal and infant morbidity. The model indicated that induced labour was significantly associated with the use of continuous electronic fetal monitoring, oxytocin infusion and use of analgesics. It also indicated that oxytocin use was significantly correlated with the use of analgesia. Furthermore, oxytocin has a significant direct effect on perineal trauma (episiotomy with or without perineal trauma).

For the model, multiple squared correlations for type of delivery was 0.352 indicating that 35.2% of the variance in type of delivery is explained by continuous electronic fetal monitoring, oxytocin and analgesia use.

These findings support the work done by Devane and colleagues (Devane et al., 2012). It also indicated that 37.2% of variance in fetal distress during labour and 86.3% of variance in perineal trauma is explained by the variables in the model. These findings confirm Sinclair and Crozier's descriptions of the technological cycle of birth as part of routine midwifery practice involving antenatal monitoring, induction of labour, oxytocin infusion, continuous fetal monitoring, and increased likelihood of episiotomy, giving birth in the lithotomy position, and the use of epidural and another form of systematic analgesia (Sinclair, 2004). For the model, multiple squared correlations for gestational age was (0.171) explained by variables in the model. This can be explained in three ways. Firstly, the result may be due to the small number of women in spontaneous group (n=39) in comparison to 161 in induced group. Secondly, the high proportion of women in spontaneous group who had presented in early labour was 41% (16 out of 30) in comparison to women in induced group 6.8% (11 out of 161), and thirdly, because of low percentage and frequency of babies who had low gestation age and low birth weight in this sample in addition to the lack of power in this study. Nevertheless, the model indicated that induced labour predicted significantly presence of fetal distress during labour; fetal distress during labour was predicted by lower Apgar score at one minute. It also indicated that lower Apgar score at one minute predicted the lower Apgar score at five minute and need for resuscitation. Multiple squared correlations for Apgar score at one minute indicated that 13.9% of variance was explained by the variables in the model. Likewise, multiple squared correlations for Apgar score at five minutes indicated that 62.1% of variance was explained by the variables in the model. These findings support the work done by many researchers (Joseph et al., 2007; Grivell et al., 2011; Rossen et al., 2011; Burgos et al , 2012 and Stock et al., 2012).

Our findings contradicts with the recent systematic reviews done by Caughey and colleagues (2009) and Gülmezoglu et al., (2012), who concluded that evidence from RCTs indicated that fewer babies developed meconium aspiration syndrome and fewer caesarean sections, were required in the induction group compared with the expectant management group.

It is necessary to state clearly that there are fundamental differences in the study design that need to be considered carefully: their study looked very specifically at elective induction of labor and expectant management of pregnancy. In our study the comparison was between induced labour and labour without augmentation (physiological and spontaneous birth) and we clearly defined this as labour without any augmentation measures such as ARM, oxytocin and prostaglandins.

The power to induce labour where the risks to mother or baby of continuing pregnancy overweigh the risks of artificially bringing the pregnancy to an end must be kept in mind when reading the statistics presented in this paper. Induction is an invasive procedure with cumulative effects as demonstrated in this analysis and should not be used indiscriminately. IOL should be used judiciously based on best evidence and practice should be guided by evidence-informed policy that is individually relevant at clinical level. It is important to note that none of the women in this study died and we believe the significance of this needs to be explored further. We also believe this paper is an important foundation block for building the evidence profile to enable policy makers, researchers and clinicians to understand the cumulative impact of induction technology on maternal and infant morbidity.

CONCLUSION

This paper reports on a survey conducted in Jordan where there is no national data available on the induction rate.

Unlike earlier studies, this work has employed a full descriptive model which has included all the key variables and their time dependencies. This has elucidated the etiological processes and decision-making which occur before, during and after childbirth. It has helped to explain the variations in maternal and infant birth outcomes associated with induction of labour.

The findings contribute to the currently available literature regarding the impact of birth technology for induction of birth, and to the development of evidence based clinical practice guidelines. Further research needs to be undertaken testing the model with specific cases where IOL is a necessity.

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Authors' contributions

RH contributed in contributed in the study design, data acquisition, data analysis and interpretation of data and manuscript drafting. MS contributed to the study design, interpretation of data and manuscript revision. GK contributed in the study design, data analysis and manuscript revision. BB contributed in the interpretation of data and manuscript revision.

All authors agree for publication of this final version.

Competing interests the authors declare that they have no competing interests.

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