Sociodemographic and prenatal predictors of preterm birth, low birth weight and caesarean sectionand the impact on child feeding practices, perinatal and early years health

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Doctor of Philosophy (PhD) by Exisiting Published Work

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Author's declaration

I, **Ahmed A. Hassan**declare that, this thesis is in the form of a series of papers. I have included as part of the thesis a written statement from each co-author, endorsed in writing by the Faculty Assistant Dean, attesting to my contribution to any jointly authored papers.

This thesis is within the word limits.

Total words count: 20,919

Dedication

This work is dedicated to the soul of my father (Ali)

Acknowledgements

I would like to thank my supervisors: Dr. Floor Christie and Prof. Jonathan Ling; all committee members;liaison librarian (Elaine Andrew); the co-authors; all participants who participated in the studies; my family: my Mother (Elnakheel), my wife (Atfa), my sons (Ali, Yousif and Abd Alaziz), my brothers, my sisters, and my friends.

List of the included 9published papers

This work is based on nine published papers. These papers were conducted at different settings in Sudan,namely Khartoum and Kassala,and in the United Arab Emirates (Abu Dhabi).The nine papers will be referred to in the text as paper1 - 9.

Paper 1:Hassan AA, Abubaker MS, Radi EA, Adam I. Education, prenatal care, and poorperinataloutcome in Khartoum, Sudan. International Journal of Gynaecology&Obstetrics. 2009;105(1):66-67.

Paper 2: Elmugabil A, Rayis DA, **Hassan AA,** Ali AA, Adam I. Epidemiology of cesarean delivery in Kassala, Eastern Sudan: a community-based study 2014-2015. Sudan Journal ofMedical Sciences. 2016;11:49–54.

Paper 3: Hassan AA, Taha Z, Ahmed MAA, Ali AAA, Adam I. Causes and risk factors of under-five children hospitalization in Eastern Sudan: a community-based study. Open Access Macedonian Journal of Medical Sciences. 2020;8(E):451-457.

Paper 4: Hassan AA,Taha Z, Ahmed MAA, Ali AAA, Adam I. Assessment of initiation of breastfeeding practice in Kassala, Eastern Sudan: a community-based study.International Breastfeeding Journal. 2018;13. doi:10.1186/s13006-018-0177-6.

Paper 5: Hassan AA, Taha Z, Abdulla MA, Ali AA, Adam I. Assessment of bottle-feeding practices in Kassala, Eastern Sudan: a community-based study. Open Access MacedonianJournal of Medical Sciences. 2019;7(4):651-656. doi: 10.3889/oamjms.2019.132.

Paper 6: Taha Z, **Hassan AA**, Wikkeling-Scott L, Papandreou D. Prevalence and associated factors of caesarean section and its impact on early initiation of breastfeeding in Abu Dhabi, United Arab Emirates. Nutrients. 2019;11:2723. doi: 10.3390/nu11112723.

Paper 7: Taha Z**, Hassan AA**, Wikkeling-scott L, Papandreou D. Factors associated with delayed initiation and cessation of breastfeeding among working mothers in Abu Dhabi, theUnited Arab Emirates. International Journal of Womens Health. 2021;13:539–548.

Paper 8: Taha Z, **Hassan AA**, Wikkeling-Scott L, Papandreou D. Risk factors associated with initiation of breastfeeding among mothers with low birth weight babies: a cross-sectional multi-center study in Abu Dhabi, United Arab Emirates. Open Access Macedonian Journal of Medical Sciences. 2020;8(B):38-44.

Paper 9: Taha Z, **Hassan AA**, Wikkeling-Scott L, Papandreou D. Factors associated with preterm birth and low birth weight in Abu Dhabi, United Arab Emirates. International Journal of Environmental Research and Public Health. 2020;17, 1382.

Summary of the included 9 published papers

Serial of paper	Type of study	Location	Sample size (mother-child pairs)	Dependent variable	Significant independent variable (*P*-value ≤ 0.05)	Number of citation up to October 2021
Paper 1	Cohort	Khartoum, Sudan	2076	Low Birth Weight (LBW)	First child order, lack of prenatal care, and small maternal arm circumference	43
				Perinatal mortality	Low maternal education, lack of prenatal care,and LBW neonates	
Paper 2	Community-based cross-sectional	Kassala, Sudan	303	Caesarean Section (CS)	Old maternal age, first child order, and maternal illness	4
Paper 3	Community-based cross-sectional	Kassala, Sudan	297	Child hospitalisation	High birth order, low paternal education, and bottle feeding	0
Paper 4	Community-based cross-sectional	Kassala, Sudan	250	Early initiation of Breastfeeding (BF)	Male child, and mothers with medical disorders	18
Paper 5	Community-based cross-sectional	Kassala, Sudan	242	Bottle feeding practice	Urban residence, not receiving BF education, and child hospitalisation	5
Paper 6	Multicentre cross-sectional	Abu Dhabi, the United Arab Emirates (UAE)	1624	CS	Old maternal age, nationality, and obesity	7
Paper 7	Multicentre cross-sectional	Abu Dhabi, the UAE	1610	Delay initiation of BF	Old maternal age, nationality, CS, not rooming-in, and mothers with LBW children	1
				Early cessation of BF	Nationality, and mother with high income rating	
Paper 8	Multicentre cross-sectional	Abu Dhabi, the UAE	134	Delay initiation of BF among mothers with LBW children	CS	1
Paper 9	Multicentre cross-sectional	Abu Dhabi, the UAE	1610	Preterm birth	Arab mothers, low maternal education, CS,and LBW	19
				LBW	Female child, CS, first child order, and preterm birth	

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Abstract

According to the World Health Organisation (WHO), certain adverse pregnancy outcomes such as preterm birth, low birth weight (LBW) and caesarean section (CS) present major public health problems due to their adverse effects on maternal and child health, (i.e. poor child feeding practices, increasing perinatal mortality, child morbidity and mortality).

The aim of the current work is to assess the impact of sociodemographic factors, prenatal factors and adverse pregnancy outcomes on child feeding practices and child health.The current work createdanintegrated maternal and child healththeoretical framework aiming to improve maternal and child health. The newly-created framework isbased ona thorough understanding of the existing knowledge and gaps about the main current work aim through critically reviewing the literature, including the author'sprior publications (9 papers), as well as existing relevant frameworks. The significance of the newly-created framework arises from the author's prior work, creating new meaning by combining and discussing the findings from the author's published work with existing literature and comparing the findings between the studied settings (Sudan and the United Arab Emirates (UAE)), transforming the existing related frameworks forward, and addressing the socialdeterminants of health (SDH)that can help decision makers to prioritise actions for improving maternal and child health as well as the generalizability of the findings through the application of the newly-created framework in different settings.

The newly-created theoretical framework identifies particular sociodemographic factors, (i.e. nationality, residence, parental education, socioeconomic status (SES), maternal age, obesity

and child gender); particular prenatal factors, (i.e. prenatal care, maternal illness, birth order, and breastfeeding education) as the main predictors of adverse pregnancy outcomes, child feeding practices, perinatal and child health.

In conclusion, the current work addresses all these predictors and outcomesas well as their implications on public health and future research. Also, the current work provides recommendations for decision makers and researchers. Therefore, the current work significantly contributes to the knowledge by creatingan integrated maternal and child healththeoretical framework.Taking the wider scope of generalizability of the created framework into account, application of the current work findings will lead to improvements in maternal and child health in the studied settings and beyond settings.

Chapter 1

Introduction

According to the World Health Organisation (WHO), certain adverse pregnancy outcomes such as preterm birth, low birth weight (LBW) and caesarean section (CS)present major public health problems(1–3). Based on the WHO'srecent annual estimation, the numbers of preterm, LBW and CS are rising globally (4–6). The WHO defined preterm birth as the birth of a baby of <37 weeks' gestation(7) and LBW as birth of a baby of <2500 grams (8). Babies born with these public health problems are more vulnerable to poor feeding practices,morbidity and mortality (9–14)**.**For example, delayed initiation of breastfeedingis associated with neonatal morbidity and mortality(15,16).

The WHOreported that every year an estimated 15 million babies are born preterm and this global trend is rising (7). Of the estimated 14.84 million preterm births in 2014, the majority (81.1%) occurred in Asia and Sub-Saharan Africa(4). In Sudan, 170,600 babies are born preterm every year(17). Preterm birth complications are considered the leading cause of death among children under-five years of age, and in 2015, preterm births were responsible for approximately 1 million deaths globally (18). In Sudan, preterm complications result in 13.6% of deaths among children under-five years (17). In Sudan, the preterm birth rates ranged from 3.8% to 4.7% (19,20). In the United Arab Emirates (UAE), preterm birth rate was 6.3%(21) and it was similar to the rate reported in Saudi Arabia (6.5%) (4)butlower than Oman rate (9.7%)(22).In Arabian Gulf countries, including the UAE, due to allocation of budgets and investment in health systems a remarkable reduction in neonatal mortality, infant mortality and

under-five mortalityhasbeenachieved(23). Therefore, unlike Sudan, in the UAE due to more developed neonatal care, the available preterm birth data are about the management of specific preterm birth complications such as retinopathy of prematurity(24).The UAE rate of preterm birth (6.3%)(21), is lower than that of high income countries (HICs) such as the United Kingdom (UK)(7.8%) and the United State of America (USA) (10.2%) (25).

In addition to preterm birth, another major public health problem is LBW which may result from preterm birth, intrauterine growth restriction (IUGR) or both(5). The WHO has estimated that more than 20 million LBW babies are born annually and over 96% of those babies are borninlow income countries (LICs) (8,9).

In Sudan, the rate of LBW was 12.5%(26), and it was 9.4% in the UAE(21). In Iran the neighbouring country of UAE, it was (9.4%)(27), similar to the UAE's rate (21). However, the Sudan rate was higher than many countries including the UAE(9.4%), Iran (9.4%), and Ethiopia (10.4%)(21,26–28). On the other hand, both Sudan and the UAE rates of LBW are higher thanthe UK rate (6.8%)(29)and the USA rate (8.3%)(25).

These LBW babies are more vulnerable to several health problems such as delayed initiation of breastfeeding, growth retardation, infectious diseases and developmental delays, and death during infancy and childhood(9,11). Furthermore, several long-term negative outcomes were reported associated with both preterm birth and LBW such as low educationachievement, low employment rate and an increased rate of receipt of social benefits in adulthood (30). In Sudan and the UAE, both preterm birth and LBW babies were associatedwith neonatal morbidity and mortality(13,26,31). In the current work, perinatal mortality was defined as death occurring

between 28 weeks of gestation (in uterus or outside) and 7 days post-partum(26) and neonatal mortality as death occurring within the first 28 days of baby's life(14). The cut-off 28 weeks gestational was based on the WHO's definition for international comparison(32).The current work focuses on both maternal and child health, especially early years healthand the maximum child age included in the nine papers was five years, (Paper 3)(33).

Although the WHO considers that a CS rate of 10 to 15% is an optimal range, considering the necessity of the procedure of CS as a life-saving intervention for both the mother and foetuswhen used for medically indicated reasons(34), overuse of CS has been reported in many countries, including Sudan (17.8%) and the UAE (30.2%) (35,36). Although, high rates of CS were reported in HICs, for example, the UK (26.2%) (37)and the USA (31.7%)(25), maternal and perinatal death were high following CS in low and middle income countries(LMICs),especially in Sub-Saharan Africa(38). Unfortunately, the WHO estimates every year 29.7 million deliveries occurred via CSglobally(6). Like any surgery, CS is associated with risk to the mother, the child, and future pregnancies (34). For example, CS is associated with suboptimal consequences related to both the mother and her infant's health (39,40). Among those consequences reported includehaemorrhage, endometritis, urinary tract infection, infant respiratory complication, infant hypoglycaemia, and delayed initiation of breastfeeding (10,40,41).

United Nations Children's Fund (UNICEF)(42) considers the first 1000 days of a child's life (9 months of pregnancy plus the first 2 years of life) as a crucial period. In support ofthat, the WHO reported in 2015, 4.5 million (75%) of all under-five deaths occurred within the firstyear of life and the highest rate was in the African Region (55/1000 live births). This is over fivetimes

higherthan the European Region (10/1000 live births)(43). Monge,in 2017, Hanieh, et al.,in 2015and Patel, et al.,in 2015reportedpoor breastfeeding practices such as delayinitiation of breastfeeding, non-exclusive breastfeeding (EBF) and bottle feeding were the main predictors of child morbidity(44–46). The main causes of under-five morbidity reported in previous studies, including Sudan, were gastroenteritis and respiratory tract infection (RTI)(33,45,47).

In Sudan, a study conducted by Abdelgadir, et al.,in 1995 documentedchild's health during the first five years of life is largely set by events occurring during prenatal, intranatal and post neonatal periods (48). Aiming to save children's lives, the WHO encourages all mothers to initiate early breastfeeding (within 1 hour of birth), exclusively breastfeeding up to six months, avoid bottle feeding and continue breastfeeding for two years or more(49,50).The rate of early initiation of breastfeeding was 68.7% in Sudan (51) and 62.5% in the UAE (36). In both Sudan and the UAE, the rate of early initiation of breastfeeding is rated as 'good' according to the WHO indicators, (i.e. between 50% and 89%)(52). In the UK, although the National Health Service (NHS) reported that for the period 2013-2014 mentioned 74% of the babies initiated breastfeeding, the report did not specify the time of breastfeeding initiation,(i.e. within 1 hour of birth or more)(53). In the USA, the rate of early initiation of breastfeeding was 65% in 2013 (54).

Early initiation of breastfeeding promotes EBF by enhancing bonding, increasing the likelihood of breastfeeding success and generally extending breastfeeding duration (49,52). Both early initiation of breastfeeding and EBF are key predictors of infant survival(55,56).

These important public health problems (preterm birth, LBW and CS) are interrelated(22,28,57–60). Such interrelation was also found among the studied countries (Sudan and the UAE) (13,21).Therefore, logic follows that, studying all these public health problems together and not merely separatelycould propose interventions aiming to mitigate their negative impacts combined. For example, an intervention aims at tackling one of these public health issues, such aspreterm birth,may influence another of these public health issues, (e.g.LBW). Previous studies documented a strong association between adverse pregnancy outcomes and sociodemographic factors (12,61–63). Furthermore, many studiesascertained a significant association between sociodemographic factors and prenatal factors (62,64–68). For example, in Sudan, low coverage of prenatal care was associated with sociodemographic factors such as low parentaleducation and teenage pregnancy (67,68).Adverse pregnancy outcomes, breastfeeding practices, perinatal mortality and early years health are influenced by the social determinants of health (SDH) (69–71). The WHO defines SDH as the conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life(72). These forces and systems include but are not limited to economic policies and systems, development agendas, policies, political systems, cultural and societal norms and values(72). In the USA, the relationship between SDH, including individual socioeconomic factors, and community factors such as crime, poverty, housing conditions, racial disparities, and adverse perinatal outcomes such as preterm birth, perinatal mortality and early years mortality were reported (69). To ensure better health outcomes, SDH including socioeconomic factors, health related behaviors, and the physical environment need to be well addressed as they contribute to people's health outcomes by 80%-90% compared to medical

care 10%-20% (73).In the UAE, medical and non-medical determinants of health were identified by healthcare providers and policy makers as key elements in developing culturally appropriate maternal and child health strategies(74).

The current work investigated the published data from2009 up to dateregarding maternal and child health in Sudan, namely Khartoum and Kassala, and in the UAE (Abu Dhabi)(11,21,26,33,35,36,75–77).The included ninepublished papers upon which this current work is based are numbered as follows: Paper 1 (26), Paper 2 (35), Paper 3(33), Paper 4 (75), Paper 5 (76), Paper 6 (36), Paper 7 (77), Paper 8(11) and Paper 9 (21).These papers contributed to the improvements of maternal and child health, especially in Kassala. Kassala is characterised by food insecurity (78),unstable security (79), and children's morbidity and mortality in such situations especially the under-fives are found to be high and damaging (80–85).For example, in Sudan, a recent nutritional assessment of under-five children showed the heavy burden of malnutrition on the health, wellbeing, and sustainable development of populations(86).In Sudan, 3.3 million children are acutely malnourished, with 522,000 children suffering from severe acute malnutrition and about 2.2 million children requiring treatment for moderate acute malnutrition(86).In Sudan, the burden of disease isaffected by many factors such as poverty, politics, armed conflict, and mismanagement of resources(87). It is worth mentioning, for many years Sudan has beensuffering from the consequences of conflict, and the separation of Sudan into North and South Sudan in 2011 was not the end of conflict(79). Currently, Sudan is passing through political and societal changeand it has been managed by transitional government since 2019(87).

The included nine papers have been published in peer-reviewed journals. The current work combines these included papers into one thesis by creating a theoretical framework. By focusing attention on the identified sociodemographic, prenatal factors and adverse pregnancy outcomes and the extent to whichthese outcomes and factors impact child feeding practice and maternal and early years health, major improvements inmaternal and child health could be achieved, especially in countries with low resources such as Sudan and transforming ones such as the UAE.

Chapter 2

Literature Review

2.1 Introduction

The main purpose of this literature review is to find out answers for the following four questions:

1. What has already been reported regardingpredictor of and interrelation betweenpreterm birth, LBW, CS, feeding practices, perinatal and early years morbidity and mortality?
2. What has already been reported regarding the impacts of preterm birth, LBW and CS on child feeding practices, perinatal and early years morbidity and mortality?
3. What has already been reported regarding the impacts ofchild feeding practices on perinatal and early years morbidity and mortality?
4. What can be done furtherto improve child feeding practices and maternal and child health, according to the existing literature?

2.2 Search strategy

A comprehensive electronic search for the following databases; Medline, Cumulated Index to Nursing and Allied Health Literature (CINAHL) and Human Research Premium Collectionwas carried out. The searching was carried under three concepts in combination with Boolean operators (AND, OR, NOT) as follows:

Concept 1: Preterm birth OR low birth weight OR caesarean section OR cesarean section OR caesarean delivery OR cesarean delivery.

Concept 2: Infant feeding, child feeding practice OR breast feeding OR breastfeeding.

Concept 3: Perinatal mortality OR infant mortality OR infant death OR child morbidity OR child mortality OR child death.

The searched Boolean keywords were: (preterm birth OR low birth weight OR caesarean section OR cesarean section OR caesarean delivery OR cesarean delivery) AND (infant feeding, child feeding practice OR breast feeding OR breastfeeding) AND (perinatal mortality OR infant mortality OR infant death OR child morbidity OR child mortality OR child death).

2.3 Inclusion and exclusion criteria

The following inclusion and exclusion criteria were set to conduct the literature review.

2.3.1 Inclusion criteria

The following inclusion criteria were applied in data searching:

- Only English language data.
- Only studies with available abstracts and full texts.
- Any study type, (i.e. quantitative, qualitative, cross-sectional studies, case–control studies, cohort, reviews and systematic reviews).
- All studies were searched up to 14thAugust 2021.
- Any study conducted at any location, (i.e. global).

- Any study relevant to the purpose of the above-mentioned literature review, (i.e. for anystudy to be included, the study at least should report predictors of preterm birth, and/or LBW and/or CS, and/or feeding practices, and/orperinatal and/orearly years morbidity and/or mortality, and/or report impacts of preterm birth, and/or LBW and/or CS on child feeding practices, perinatal and early years morbidity and mortality).

2.3.2 Exclusion criteria

Any study not fulfilling the above-mentioned inclusion criteria was excluded from the literature review,(i.e. not in English language, lack of availability of abstract and full text, not reporting predictors of preterm birth, LBW, CS, feeding practices, perinatal and early years morbidity and mortality, and not reporting impacts of preterm birth, LBW and CS on child feeding practices, perinatal and early years morbidity and mortality).

2.4 Data extraction

Initially, titles and abstracts were screened, and then full texts were reviewed for any relevant study that fulfilled the inclusion criteria. Finally, from the relevant reviewed studies, the appropriate information (e.g. study'stype, location, and key findings) was extracted accordingly and included in the literature review(see Appendix 1 for details).

Based on inclusion and exclusion criteria from the initial identified studies (n=1385) in the end42studies were included in the literature review (Figure 1).The 42 included studies were published from 1999 to 2021.

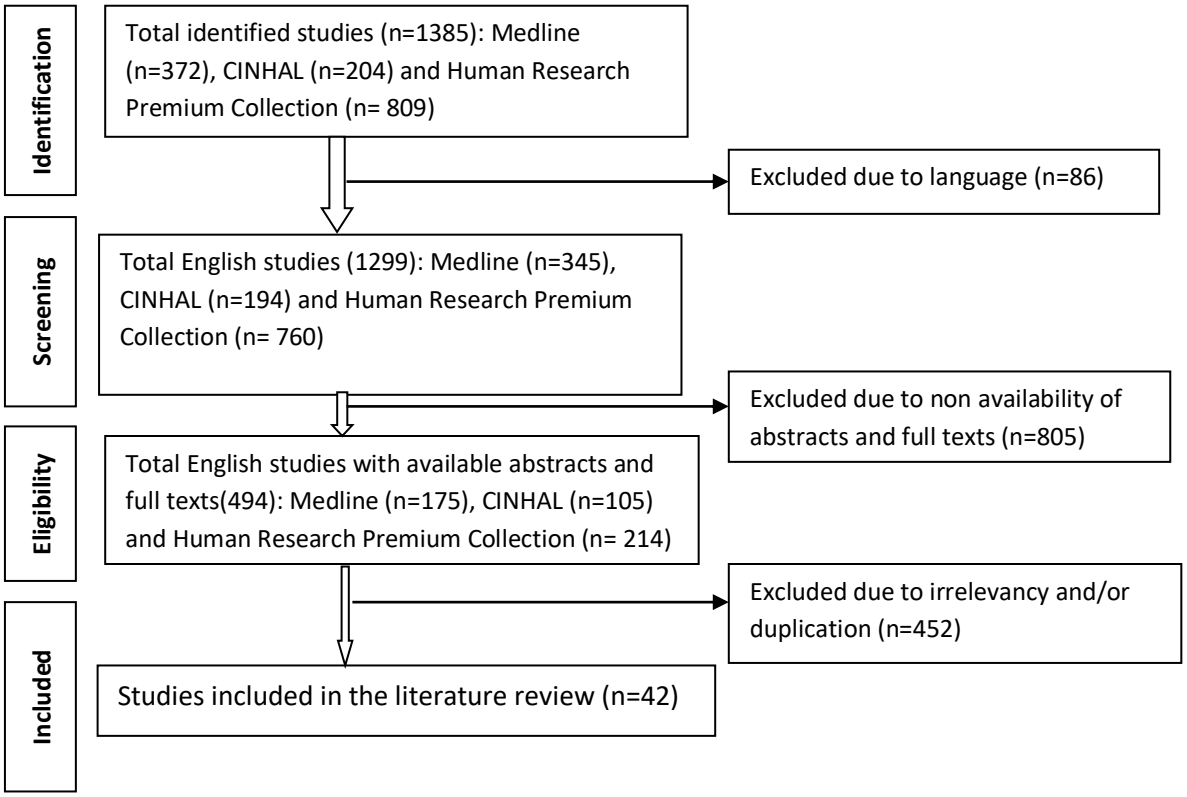

Figure 1: The key steps taken in the identifications of the studies included in the literature review

2.5 Adverse pregnancy outcomes: preterm birth and low birth weight

A population-based cross-sectional study which explored the2008 demographic and health survey of Nigeria, including 28,647 children of under-five years, revealed that the main predictors of under-five mortality were early maternal marriage (<15 years), under utilisation of healthcare services, short duration of breastfeeding (<18 months), non-using of family planning, big family size, polygamy, high birth order, LBW, rural residence, and poor sanitation (88). In India, Saroj, et al.,(89) reported that under-five mortality associated with socioeconomic,

demographic factors such as education, women's age, and religion, and proximate and biological factors such as total number of children ever born, birth in the last 5 years, number of living children, currently breastfeeding, smokers, desire for more children, delivery by CS, prenatal care visits, and birth order.

Another population-based cross-sectional study in Portugal that studied 1,285 under-five children in 2011reported that birth weight, nutritional status, and maternal education and weight gain during the first year of life were key protective factors against undernutrition during infancy and childhood (90).In Australia, a population-based retrospective cohort study conducted from2007to 2012 among 488,603 under-five children, reported childhood infection associated with CS, labour induction, birth at <39 weeks and formula feeding(91).

A community study conducted by Muhe, et al.,(92) among 1,304 childrenin Ethiopia documented nutritional and healthcare factorsmake a significant impact on under-five morbidity.Another prospective cohort study in Ethiopia conducted from April to July 2014, among 1,152 neonates documented that, neonatal mortality associated with LBW, not initiating EBF, neonatal complications, maternal complications and lack of access to healthcare services (93). Similar to Ethiopia's findings(93), amatched case–control study conducted in 2013, in Indonesia revealed that, neonatal mortality associated with neonatal complications during birth, maternal complications during pregnancy and after delivery, maternal lack of knowledge of danger signs for neonates, and home delivery (94). In Ghana, a population-based study conducted from 2003 to 2008 among 6,900 women indicated both individual and community characteristics showed a marked impact on neonatal survival (95).

According to a recent systematic review carried out in 2017 studied risk factors for mortality among infants hospitalised for sepsis or serious infections in LMICs, both preterm birth and LBW were the common reported factors associated with neonatal mortality; malnutrition, lack of breastfeeding and low oxygen saturation were the most common reported factors associated with infant mortality (96).

A cohort study was conducted between June 2007 and September 2009among 32,126 live births in Bangladesh; of them 22.3% were preterm babies and 46.4% of all neonatal deaths occurred among preterm babies(97). Preterm babies who were first child order, from low socioeconomic status(SES) families and of mothers suffering prenatal complications were at higher risk of mortality compared to term babies (97).

A population-based birth cohort study included 447 late preterm (34 to 36 weeks' gestation) in Brazil, in 2004 indicated the main factors associated with late preterm birth were young maternal age (<20 years), inadequate prenatal care, and hypertension; compared with term births, late preterm births associated with maternal depression at birth, perinatal morbidity, and delay initiation of breastfeeding and neonatal and infant mortality (98). Although preterm births are at higher risk of morbidity and mortality compared to term births (97), very preterm births (<33 weeks' gestation) are at higher risk of morbidity and mortality compared to late preterm births, as this was reported by a cohort study in Western Australia among 538 very preterm birthsfrom1990 to 1991(99). In addition to the studies which investigated association between sociodemographic and prenatal factors, another study in Canada called (All Our Babies

Study) is aimed to predict women at risk of preterm birth through examining gene expression profiles and the environment among 2000 women(100).

In Oman theneighbouring country of UAE, a case-control study was conducted among 190 cases underweight children and 190 controls non-underweight children age 6-35-months, showed a child born with LBW was strongly associated with persistent underweight, maternal height, low maternal education, morbidity, formula feeding and poor sanitation (101).

A qualitativestudyin two rural settings of Bangladesh included 32 in-depth interviews ofpregnant women(11), recently delivered women (12), husbands (4), and mothers-in-law (5), two focus group discussions among 16 husbands and key-informant interviews with 4 community health workers explored that most of participants did not consider birth weight a priority for assessing a newborn's health status, lack of awareness of birth weight and fear of CS (102). The mostperceivedcauses of LBW by the participantswere maternal poor nutrition, inadequate diet during pregnancy, anaemia, illnesses during pregnancy, short stature, twin births, and influence of supernatural spirit (102).

A study analysed data from World Bank and Food and Agriculture Organisation (FAO) databasescollected of under-five mortality from 2000 to 2016 of 37 Sub-Saharan African countries, concluded that child nutritional status, LBW, EBF, health resources and environmental hygiene play a key role in child mortality in Sub-Saharan Africa (103). A secondary data analysis from rural Haryana, North India assessed association between birth weight and mortality, hospitalisation and breastfeeding practices, from the total included infants 44,984, 10,658 (23.7%) were LBW (104). Those LBW infants were more prone to

hospitalisation and mortality compared with normal birth weight ones, especially in the neonatal period (LBW babies had four times more prone to mortality), in the post neonatal period (LBW babies had two times more prone to mortality), the likelihood of hospitalisation in the neonatal period and post neonatal period was 1.86 times and 1.13 times, respectively (104). In addition, LBW babies were associated with delay initiation and early cessation of breastfeeding (104).

In Ethiopia the neighbouring country of Sudan, a study investigated the survival status and predictors of mortality among 216 LBW neonates admitted in neonatal intensive care unit (NICU)at public hospitals, the study reported high rate of mortality (83/1000 live births), especially among maternal history of diabetes mellitus, human immunodeficiency virus (HIV), not practicing kangaroo mother care and non-EBF(105).

Another study in Ethiopia showed that under-five mortality rate was 72/1000 live births and the key factors determining child mortality were breastfeeding, parental education, family planning, preceding birth interval, presence of diarrhoea, LBW and age of the mother at first birth (106). Among LBW infants, extremely low birth weight (ELBW) (birth weight ≤ 1000 grams) were more prone to mortality and morbidity such as necrotizing enterocolitis (107).

In Iran the neighbouring country of the UAE, a community-based nested case-control study in rural areas of Shahroud, among under-five children (65 cases and 130 controls) reported under-five mortality was significantly associated with short period of breastfeeding, less frequent healthcare visits and LBW (108). A study in Somaliland analysed hospital records of 164 neonates showed 16% preterm birth, 31% LBW and 27% delivered via CS (109). The study

attributed the high neonatal mortality rate to preterm birth and LBW (109). Furthermore, the discharged neonates faced many health problems such as non-EBF, low rate of vaccination and more prone to gastroenteritis and RTI(109). A community-based cohort study conducted among 497 infants in India showed the interrelation between preterm birth and LBW, and infant morbidity associated with male gender and non-EBF(110).

Although in the literature review there were no studies included from Sudan and the UAE focused on adverse pregnancy outcomes, the included studies covered the neighbouring countries of Sudan, (i.e. Ethiopia) (92,105,106) and the UAE, (i.e. Oman and Iran)(101,108).In addition, the reviewed studies were conducted in both LMICs (96,103,106) and HICs as well (90,91). The included studies are of adequate sample size and including demographic surveys as well (88,91,92,97). Such adequate sample sizes will give more reliability to the results.

It is clear from the reviewed studies, access to healthcare services including prenatal care is a big challenge, especially in LMICs (88,89,93,94). Although the reviewed studies addressed the marked impact of preterm birth and LBW on neonatal, infant and under-five morbidity and mortality by using different studies types, (i.e. cross-sectional, case-control, cohort, reviews), there is lack of using framework to integrate the findings of the reviewed studies. One of the studies is a qualitative study, especially it included different study participants, (i.e. pregnant women, recently delivered women, husbands, and mothers-in-law, and community health workers (102). Including of both quantitative and qualitative studies can give in-depth understanding of the problem under study, (i.e. adverse pregnancy outcomes).

2.6 Adverse pregnancy outcomes: caesarean section

The literature shows a rapid rise of CS, such rising of CS will be associated with negative impact on maternal and child health(111–114). According to the WHO's global survey of randomly selected 131 African health facilities regarding maternal and perinatal healthamong 83,439 births, high CS rates were influenced by many factors such as previous CS, preeclampsia, induced labour, pregnancy complications, and higher health facility classification scores, (i.e. the higher the classification scores, the higher the CS rate)(115).

In Pakistan, a study assessed the impact of mode of delivery among 2,500 women from 2008 to 2009 on breastfeeding practice, revealed that women delivered via CS faced breastfeeding problems compared to vaginal delivery, and there isincreasing trend of bottle feeding with the increases in the rates of CS (116). In addition to bottle feeding practice, another breastfeeding problem associated with CS is delay initiation of breastfeeding as this was reported in many countries such as South Sudan(117), the Democratic Republic of Congo (118), Bangladesh (111) and Vietnam (119). In contrast, a study conducted in Yucatec Maya, Mexico among 88 children under-five years did not find a direct link between CS,child breastfeeding practices and child morbidity (120), and the lack of association can be explained by the small sample size.

Many indicators showed the strengths of the above-mentioned reviewed studies such as (1) the large samples size in most of the studies, apart from study conducted in Mexico by Veile, et al, (120), (2) stating of the rapid rising of CS (111–114), and (3) covering of the most reported impact of CS on early years feeding practices, namely delay initiation of breastfeeding and

bottle feeding (111,117–119). Despite of all these strengths there is lack of integrating of CS with other adverse pregnancy outcomes such as preterm birth and LBW.

2.7 Child feeding practices

In many countries including Sudan, suboptimal breastfeeding practices, (e.g. delay initiation of breastfeeding and non-EBF, bottle feeding practice, and early cessation of breastfeeding) were reported by Abdel-Rahman, et al.,(10)in Sudan, Mukunya, et al.,(121) in Uganda,Onah, et al.,(112) in Nigeria,Hazir, et al.,(122) in Pakistan, Khanal, et al.,(114) in Nepal, Raihana, et al.,(123) in Bangladesh, Woldeamanuel, (124) and Taye, et al., (125) in Ethiopia. For example, in Sudan, a cross-sectional analysis conducted by Abdel-Rahman, et al.,(10)from the 2014 Multiple Indicator Cluster Survey (MICS) among 5,622 mothers reported optimal early feeding varied across regions of Sudan;CS was negatively associated with optimal early feeding practice; mothers with high education, those who desired their pregnancy at the time, those who were assisted by a professional healthcare personnel at birth, and those who gave birth to female infants had higher odds of optimal early feeding practices.Such suboptimal breastfeeding practices show a marked impact on neonatal survival(95,108,123).

A systematic review reported early initiation of breastfeeding is a simple intervention that has the potential to significantly improve neonatal outcomes (126). A study conducted in South Sudan the neighbouring country of Sudan assessed the prevalence and determinants of delay initiation of breastfeeding in Juba Teaching Hospital, which showed that 52% of 806 mothers included in the study delayed initiation of breastfeeding and the main factors associated with delay initiation of breastfeeding were CS, discarding of colostrum, unmarried mothers,

exposure to infant formula advertising and no house ownership(117). In Nigeria, a cross-sectional analytical study in 2012 among 400 mother-infant pairs documented a low rate of EBF (33.5%) and non-EBF associated with low maternal education, high SES, CS, and delay initiation of breastfeeding (112).

A recent hospital-based prospective cohort study conducted from December 2017 to May 2018 among 513 neonates admitted to the NICU of Debre Markos, Ethiopia, reported 109 (21.3%) of the admitted neonates died during the follow-up time; mother's employment status, not attending prenatal care, not initiating EBF were the main predictors of neonatal mortality (127).

A study in the Democratic Republic of Congo showed factors associated with delay initiation of breastfeeding among 396 mother-child pairs were unmarried mothers, CS, no counselling on early initiation of breastfeeding and counselling by a non health professional (118). In rural Ghana a study reported improving early infant feeding practices is an effective, feasible, low-cost intervention that could reduce early infant mortality of LBW infants in LICs, especially in Sub-Saharan Africa where many LBW infants are born at home (128).

In Pakistan, a cross-sectional study used data of 3,103 children under-two years of the Pakistan Demographic and Health Survey from 2006 to 2007, reported delay initiation of breastfeeding associated with employed mothers, and CS; bottle feeding practice associated with mothers with ≥ 4 prenatal visits and belonged to high SES(122).

In both Sudan and South Sudan, CS was the common factors associated with suboptimal breastfeeding, namely delay initiation of breastfeeding (10,117). Unlike Sudan, in the Democratic Republic of Congo and South Sudan, unmarried mothers were more likely to delay

the initiation of breastfeeding (117,118). Therefore, marital status should not be ignored when collecting data as such women need special care and support from healthcare professionals and the community. Despite the negative impact of suboptimal breastfeeding practices on neonatal survival, Kayode, et al., 2014, Chaman, et al., 2012, Raihana, et al., 2019, and Alebel, et al., 2020 focused on the morbidity impact rather than mortality one (95,108,123,127). Linking of suboptimal breastfeeding practices with both child morbidity and mortality is of paramount importance in estimating both the proximal (morbidity) and distal (mortality) impact of suboptimal breastfeeding practices. Strengths of the reviewed studies regarding child feeding practices including Abdel-Rahman, et al., in Sudan is the highlighting of the key role of healthcare professional regarding optimal breastfeeding through appropriate breastfeeding counselling (10,118). In addition, the studies highlighted the association between suboptimal breastfeeding practices, namely non-EBF and bottle feeding and high SES (112,122). Studying the structural factors such as SES that lead to suboptimal breastfeeding practices is crucial in targeting mothers and families with appropriate breastfeeding counselling strategy.

2.8 Strengths and limitations of the literature review

Conducting a literature review is an essential step in discovering the gaps in knowledge and paving the pathway to take further actions aiming to improve maternal and child health. This literature review is helpful to formulate the author's current work's aims and objectives. The current published studies which were included in this literature review contributed to improve maternal and child health by tackling the searched variables, (i.e. preterm birth, LBW, CS, feeding practices, perinatal and early years morbidity and mortality). However, the potential

benefits of these studies are not reached yet. This can be attributed to many limitations, of them:

- Some of the included studies assessed only the impact of CS on child health(111,116–119), but not considering other adverse pregnancy outcomes such as preterm birth and LBW.
- Although there is interrelation between the searched variables, (e.g. preterm birth, LBW and CS) (109), there is lack of in-depth studying of these variables together in the literature review.In addition, maternal and child health is a complex issue, therefore, a comprehensive answer is expected, (i.e. not to focus only one variable).
- From the 42 literature review included studies, there is no framework that combines all the searched concepts together aiming to integrate maternal and child health.

2.9 What can be done further to improve maternal and child health?

Maximising the benefits of existing studies by analysing them together and assessing the collective impact of the searched variables on maternal and child health will take the debate of maternal and child health issues forward and improve maternal and child health. Not showing up of the author's nine papers (upon which this work is based) when combining the concepts with Boolean operator AND, (i.e. only showed up in individual concept searching)can justify the rationale beyond combiningthe findings of these nine papers together to improvematernal and child health in the studied settings and beyond. Therefore, this literature review is used as a foundation to create a framework that combines the findings of maternal and child health related studies and this is the main aim of the current work.

Chapter 3

Theoretical framework

3.1 Introduction

This chapter explores the existing theoretical and conceptual frameworks relevant to the current work. Furthermore, it justifies the need to integrate maternal and child health and to move the existing knowledge forward.

3.2 Theoretical framework

As theoretical framework comes from two key words, 'theory' and 'framework', it is logical to understand both these words. The word 'theory' is a common word used in research,developed for many reasons, to explain, predict, understand phenomena under research, challenge and advance existing knowledge (129). Yamauchi, et al.,(130) recommended using theory at early stages of research and throughout the research process. Theory can help researchers by many ways such asinforming collection, analysis, and interpretation of findings, and moving existing knowledge forward (130).Theories play a key role in healthcare practice, promotion, and research(131,132). Regarding framework, developing of a framework is an added value to overall research processes, from developing of research question or hypothesis, through the analysis to the presentation of research findings (133). Frameworks are developed for many purposes: (1) to connect the work to the existing body of knowledge, (2) to fill identified gaps inexisting knowledge, (3) to guide the study

processes, (i.e. developing the study's aims, and questions), and (4) to understand the problem under study(134).

3.2 The importance of developing theoretical framework

Both theoretical and conceptual frameworks help researchers in many ways, such as better understanding of theories and concepts upon which their research is built on(135).

Although boththeoretical and conceptual frameworks are commonly used frameworks by researchers to achieve logical findings and conclusions, there are some differences(132,136,137). For example, Imenda, (136) reported that a deductive approach and an inductive approach lead to the development of a theoretical and a conceptual frameworks, respectively.Whilea theoretical framework uses an existingtheory, conceptual frameworks do not necessarily use an existing theory (132). As the current work is built on established theories,a theoretical framework is adopted.

Theoretical framework playsan important role in conducting studies as it provides a clear structure and vision for a study(138) as well as it addresses the research problem under study(133).

In conclusion, to create an appropriate theoretical framework that gives a comprehensive understanding of maternal and child health, first of all,the existing frameworks that are relevant to the current work need to be studied thoroughly, as done below.

3.3 The most relevant frameworks

The important frameworks relevant to the current work areAndersen's Behavioural Model1968(139), Hector, et al.,'s framework of factors affecting breastfeeding practices (140), UNICEF's framework of malnutrition and death (141), Mosley and Chen's framework of child survival in LICs(142), Oliveira, et al.,'s framework for factors associated with preterm birth (66), and Vettore, et al.,'s framework for factors associated with LBW and preterm LBW (62). These have been modified and extended in the newly-created framework whichcontainsmultiple factors:sociodemographic factors, prenatal factors, preterm birth, LBW, CS, child feeding practices, perinatal, and early years morbidity and mortality. More details are given below about the already existing six frameworks from where the newlyframework is created.

3.3.1 **Andersen's Behavioural Model 1968** (139)

Andersen's Behavioural Model was first developed in 1968 (Figure 2). The main goal of Andersen's Behavioural Modelis to explore access to medical carebased on both individual and family characteristics. Andersen's model identifies three main components that determine the usage of healthcare services. These three components are:(1) predisposing factors, (2) enabling factors, and (3) need factors.The initial version of Andersen's Behavioural Modelwas reviewed by many researchers (139,143). For example, Kehrer,(143) reported, each of the three components consist of subcomponents containing a series of variables which are responsible of use of healthcare services as follows:

- The predisposing component includes family composition, social structure, and health beliefs.

- The enabling component includes family resources and community resources.
- The need which is the most immediate cause of healthcare service use, includes family self-reports of illness and response of family reaction to illness or potential illness.

In addition, the model indicates for healthcare services to be used both community and individual resources such as financial need to be present and organised. Andersen's Behavioural Model has been used extensively by many researchers to investigate the use of healthcare services(144–146). For example,in Sudan, the Model was used by El Shiekh and Kwaak to explore the factors influencing the utilisation of maternal healthcare services by nomadic communities(145).Also, the modelwas used by Jadoon, et al., toreveal certain factors such as maternal age, education, birth order, residence and set of beliefs as key predisposing factors responsible for the varying trend in CS rate in the WHO Eastern Mediterranean Region including Sudan and the UAE during 2000–2017 (146). Likewise, one of the objectives of the current work is to explore the possible factors associated with utilisation of prenatal care and CS (overuse or underuse);therefore, Andersen's Behavioural Model is relevant to the current work.

Figure 2: Andersen's Behavioural Model 1968(139)

3.3.2 Hector, et al.,'sframework2005 of factors affecting breastfeeding practices (140)

In Australia, a framework of young children's feeding practices was developed by Hector, et al.,(140)(Figure 3). Hector, et al.,'sframework(140)investigates the factors influencing breastfeeding practices such as early cessation of breastfeeding and non-EBF for the first six months after birth. Hector, et al.,'s framework indicates breastfeeding practices areinfluencedby three levels of factors as follows:

- Individual level factors relate directly to the mother, infant and the mother-infant dyad which can directly influence the initiation and duration of breastfeeding, and are frequently correlated with sociodemographic variables.
- Group level factors relate to the environments that enable or disable mothers to breastfeed including hospitaland healthcare services, home environment, workenvironment,community environment and public policy.
- Society level factors which includecultural norms, role of women and men in society and food system.

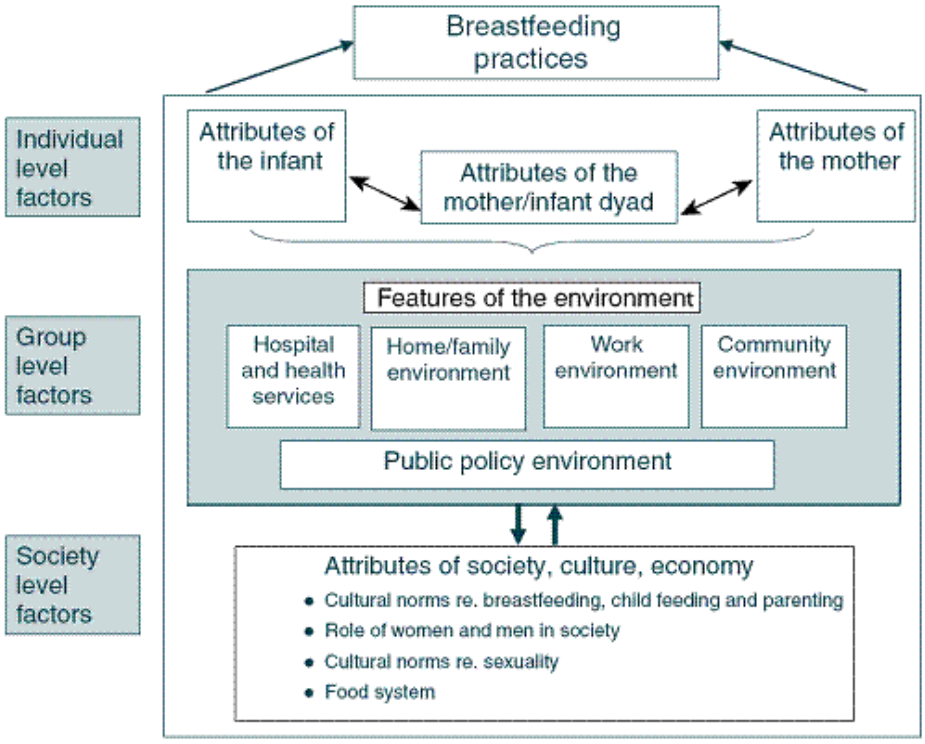

Figure 3:Hector, et al.,'sframework 2005 of factors affecting breastfeeding practices (140)

Hector, et al.,'s framework was used by Blaney, et al.,(147)to highlight the potential determinants of feeding practices among Indonesian children. Hector, et al.,'sframework(140) by studying the interrelationship between breastfeeding practices among different level factors is useful in generating hypotheses about factors affecting breastfeeding and suitable types of interventions that might be used to address them.Likewise, one of the aims of the current work is to assess the impact of sociodemographic, prenatal factors andadverse pregnancy outcomes on child feeding practices. This makes Hector, et al.,'sframework(140)suitable for the current work. However, the current work is more advanced as it assesses the impact of child feeding practices onchild health as well. Therefore, child feeding practices are used as intermediate

outcomes as they are influenced by some factors and at the same time, they influence child health (the final outcomes).

Although Hector, et al.,'s framework (140) studied breastfeeding practices in a systematic approach, the complete picture will not be obtained without taking into account the negative impact of poor breastfeeding practices on child morbidity and mortality. This is one of Hector, et al.,'sframework (140) limitations. Not only this, but also the lack of involving adverse pregnancy outcomes in the framework.

3.3.3 UNICEF's framework 1990 of malnutrition and death (141)

The original UNICEF's conceptual framework of malnutrition and death was developed in 1990 (Figure 4), since that time, the framework was revised and extended by researchers, (i.e. new variables are added to the framework)(148,149). For example, according to a recent commentary on UNICEF's framework, the final outcome (whether the child survives and thrives) depends on proximal components such as safe and nutritious food, responsive care, healthcare learning opportunities and safety and security, enabling environments such as families, communities services and policies and distal factors such as politics, and ideology(148).

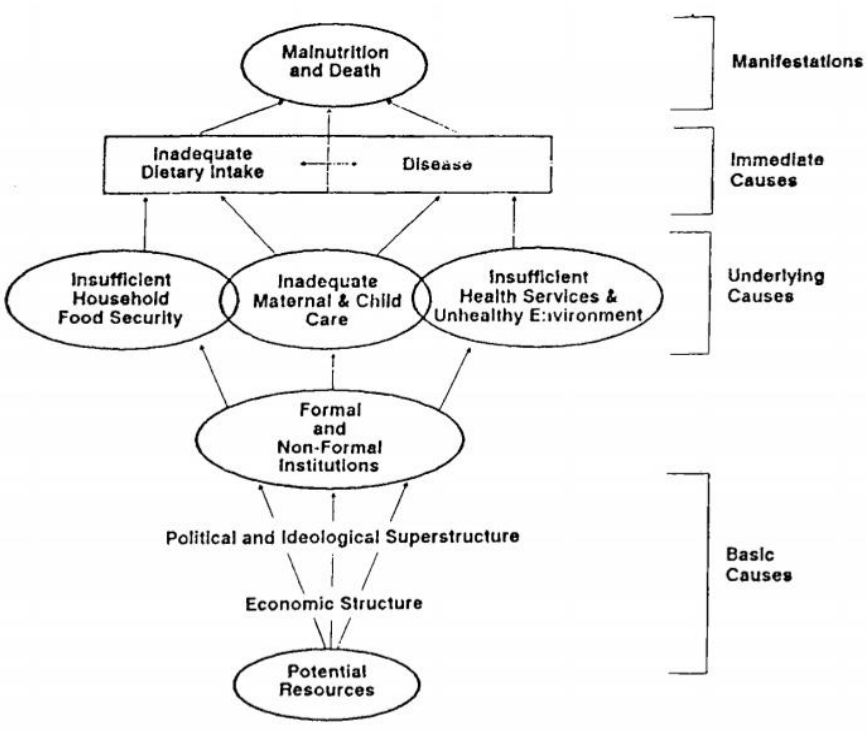

Figure 4:UNICEF's framework 1990 of malnutrition and death (141)

In Kenya, Matanda, et al.,(150) examined the multivariate relationships between sociodemographic factors and feeding practices, by adapting UNICEF's framework for nutrition and extended by Engle, et al.,(149), among sociodemographic factors,residence was the most common predictors of early initiation of breastfeeding across all collected data, in addition to CS. Although Matanda, et al.,(150)analysed data of 6,375 dyads of mothers aged between 15 and 49 years and their children aged under-two years, Matanda, et al.,'s studycontains some limitations such as data missing of the number of prenatalcare visits and type of birth attendant during delivery in one of its surveys and it used old data of Demographic and Health Survey data collected in 1998, 2003 and 2008–2009.

3.3.4 Mosley and Chen's framework 1984 of child survival in developing countries (142)

Similar to UNICEF's framework (141)**,** Mosley and Chen'sframework aims to improve child survival inLICsthrough identifying the distal and the proximate determinants (Figure 5).These determinants influencechild health,(i.e.morbidity and mortality). Likewise, in the current work child morbidity and mortality is used as the dependent variable, and distal and proximal determinants as the independent variables. In Mosley and Chen's framework, distal determinants influence child health directly or indirectly through the proximal determinants. These determinants include various variables. Distal determinants such as socioeconomic variables, which are grouped into three categories: (1) individual related to father and mother, (2) household related to family income, and (3) community level related to ecological setting, economy, and health system. Proximal determinants are grouped into five categories:(1) maternal factors, (e.g. age and birth order), (2) environmental contaminants, (e.g. air, water and food), (3) nutrient deficiency, (e.g. calories, protein and micronutrients), (4) injury, (e.g. accidental), and (5) personal illness control, (e.g. prevention and treatment measurements). Similar toMosley and Chen'sframework, the current work focuses on both child morbidity and mortality.

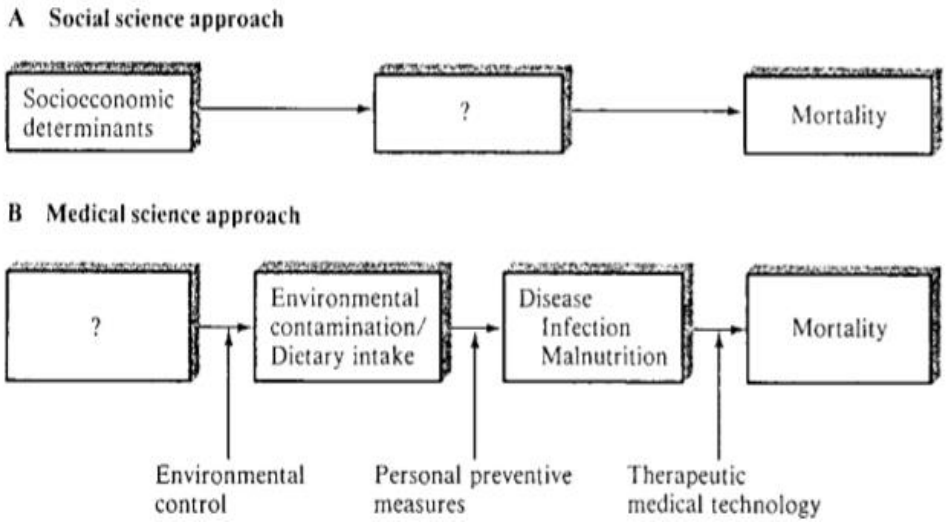

Figure 5: Mosley and Chen's framework 1984 of child survival in developing countries (142)

The key advantage of Mosley and Chen'sframework is the grouping of distal and proximal determinants and linking those determinants with child survival. Mosley and Chen'sframework was used by Bashir, et al., (14) to investigate factors associated with neonatal mortality in Sudan. Bashir, et al., illustrated in their conceptual framework the common factors influencing neonatal mortality were old maternal age(>35 years), low SES, male child, CS and delivery complications (14).

3.3.5 Oliveira, et al.,'s framework 2019 for factors associated with preterm birth (66)

In Brazil, a population-based case-control study proposed a theoretical framework by using hospital birth data to investigatethe direct and indirect influence of sociodemographic and prenatal factors on preterm birth outcomeamong 296 cases and 329 controls from June 2006 to March 2007(66) (Figure 6). Oliveira, et al.,'stheoretical framework revealed several factors influencing preterm birth such as socioeconomic, psychosocial, pregnancy complication,

reproductive history, work and physical activity(66). Furthermore, Oliveira, et al.,'s framework emphasised the key role of inadequacy of prenatal care on preterm birth(66). Although predictors similarities were noted in the literature among preterm birth and LBW(62,151), Oliveira, et al.,'s framework mainly focused on preterm birth(66).

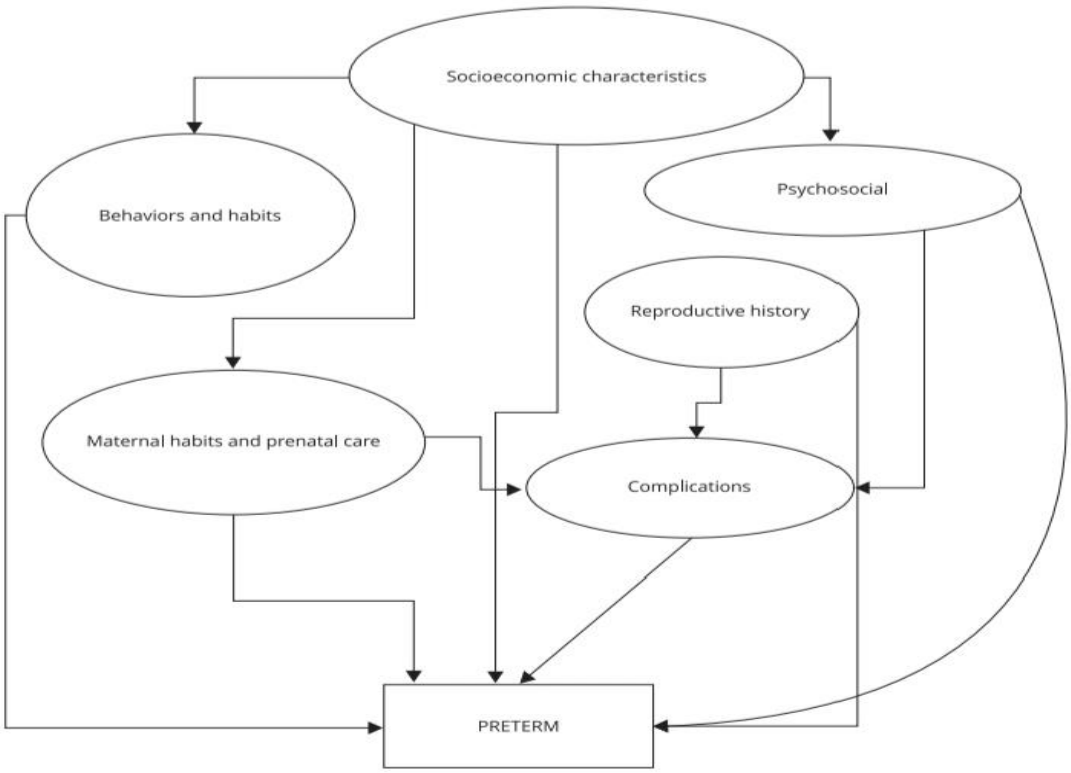

Figure6:Oliveira, et al.,'s framework 2019 for factors associated with preterm birth(66)

3.3.6 Vettore, et al.,'s framework 2010 for factors associated with low birth weight and preterm low birth weight(62)

In Brazil, another theoretical framework was developed by Vettore, et al., to assess the relationship between housing conditions and LBW and preterm LBW by using hospital-based case-control studyamong two groups of cases, LBW (n=96) and preterm LBW infants (n=68), compared with normal weight term controls (n=393) in 2003-2005(62) (Figure 7). In addition, Vettore, et al.,'s framework investigated many factors including sociodemographic, prenatal care and psychosocial factors(62). Vettore, et al.,'s framework concluded that poor housing conditions, inadequate prenatal care and previous history of preterm birth were associated with both LBW and preterm LBW (62). AlthoughVettore, et al.,'s framework covered two adverse pregnancy outcomes,(i.e. LBW and preterm LBW) which put it in advance compared to Oliveira, et al.,'s framework (66), however, both(Oliveira, et al.,'sframework andVettore, et al.,'s framework) did not cover other adverse pregnancy outcomes such as CS (146,152).

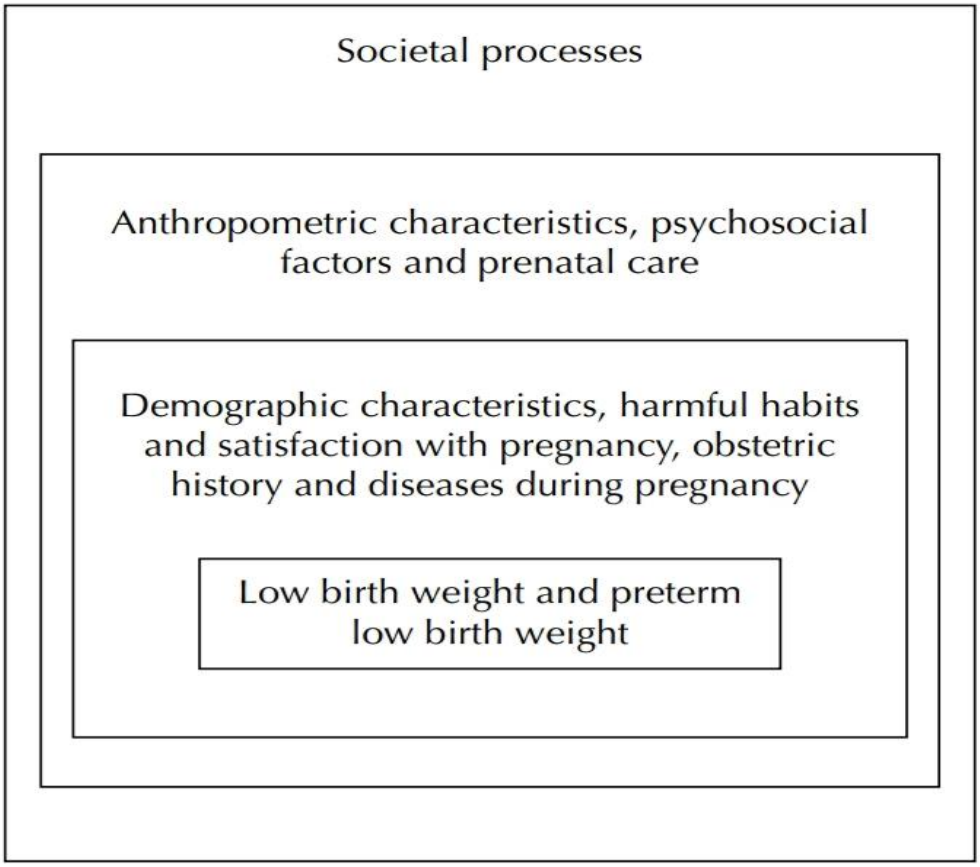

Figure 7:Vettore, et al.,'s framework 2010 for factors associated with low birth weight and preterm low birth weight(62)

3.4 Rationale for creating integrated framework

These above-mentioned six frameworks (Andersen's Behavioural Model 1968 (139), Hector, et al.,'s framework(140), UNICEF's framework (141), Mosley and Chen's framework (142), Oliveira, et al.,'s framework (66), and Vettore, et al.,'s framework (62)) are most relevant to the current work aim and objectives.The strength of all theseframeworks from where the current framework is created(62,66,139–142) is their multi-factorial nature, including structural factors, however, these frameworks are not without limitations, especially when comparing them with

the scope of the current work as the relevant frameworks focused on a particular subset of adverse pregnancy outcomes, child feeding practices, as well as neonatal and early years health.For example, Hector, et al., studied breastfeeding(140), Oliveira, et al., studied only preterm birth (66),and Vettore, et al., studied preterm LBW and LBW (62).Therefore, creation of atheoretical frameworkwitha holistic approach is of paramount importance to achieve a complete picture of the issues related to perinatal and early years health such as sociodemographic, structural factors, prenatal factors, adverse pregnancy outcomes and poor feeding practices. In addition, to maximise the benefits of the included nine papers from both studied countries (Sudan and the UAE), and the current work will move the debate regarding maternal and child health forward. As none of the six relevant frameworks covered all aspects of the current work with such in-depth, all six frameworks are combined together to create a new theoretical framework. The purpose of the proposed theoretical framework of the current work is: (1) to fill the identified gap in the literature, and (2) to explorethe complexity of maternal and child health factors through knowing the interrelation between the above searched variables and their impact on maternal and child health.

In conclusion, after a thorough review of the existing literature, integration of maternal and child health is crucial in achieving nation's sustainability; to achieve so, creation of a new theoretical framework is needed (see the Results chapter below).

Chapter 4

Methods

4.1 Introduction

This chapter highlights the following: the thesis's aim and objectives, the methods used for the included nine papers (11,21,26,33,35,36,75–77) upon which this thesis is built, and the methods used for the newly-created theoretical framework and the ethical considerations.

4.2 Thesis aim and objectives

The created framework is used as guidance to achieve the main aim of this thesis: exploring the relationships between sociodemographic and prenatal factors and adverse pregnancy outcomes and their significance in predicting child feeding practices and child health through combining the findings of the included ninepublished papers and their integration with the existing literature. Therefore, the current thesis has five objectives:

Objective 1: To assess to what extent sociodemographic and prenatal factors determine adverse pregnancy outcomes, namely preterm birth, LBW and CS.

Objective 2: To assess the impact of sociodemographic and prenatal factors on child feeding practices, perinatal and early years health.

Objective 3: To assess the impact of these adverse pregnancy outcomes on child feeding practices, perinatal and early years health.

Objective 4: To assess the impact of child feeding practices on early years health.

Objective 5: To propose suitable recommendations that will lead to improvements in maternal and child health, especially at the studied settings by combining all the studies' findings.

4.3 Methods used for the included 9 papers

This subsection highlights the main methods used for the included nine papers, studies' settings, samples and data collection (more information about the nine papers is mentioned above). Furthermore, the full texts of the published work are available below (Appendix 2).

4.3.1 Studies settings

The current work is based on the previous nine published papers (quantitative studies)(11,21,26,33,35,36,75–77) which were conducted in the last ten years in different settings in Sudan, namely Khartoum and Kassala,and in the UAE (Abu Dhabi) (Figure 8). These studies were conducted in collaboration with colleagues from both countries. Sudan (North Sudan) consists of 18 states, with a population of 40 million people, of whom 8 million live in Khartoum State and Khartoum is the capital of Sudan (153).

Kassala is the capital of Kassala State. Kassala is 550 Kilometres from Khartoum on the Ethiopian-Eritrean border. Kassala has an estimated population of 453,159 inhabitants (154).

Abu Dhabi is the capital of the UAE and it represents 87% of the geographical landmass of the all seven emirates of the UAE (155). Abu Dhabi is the largest emirate among the seven emirates (155). According to the recent statistics of the World Bank,about 10 million peoplelivein the UAE(156). Some differences exist between the two studied countries of them: (1) unlike Sudan,

rural population represents a minority in 2020 13% compared to Sudan 65%(157), (2) free access to prenatal care services as health insurance is mandatory in the UAE(158), (3) in Sudan the majority of prenatal care services are delivered freely by the government, however the quality and coverage of the provided services is questionable, especially in remote and armed conflict areas(159), and (4) overall, according to the World Bank, Sudan is classified as LIC compared to the UAE as HIC(160).

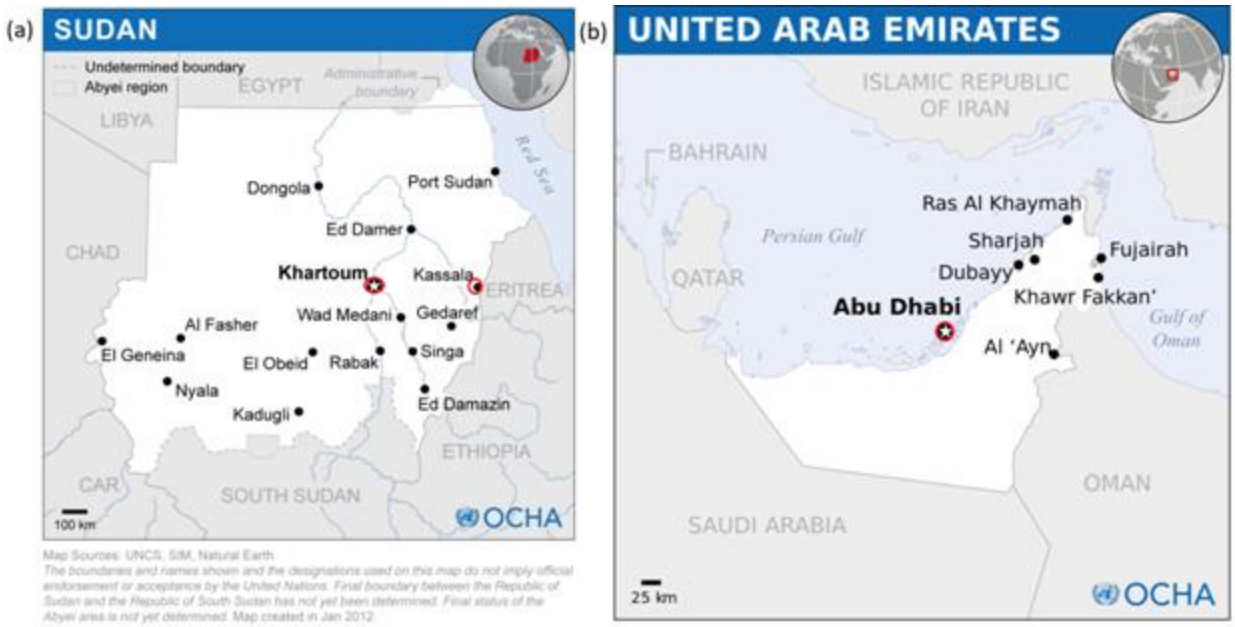

Figure 8 .Two maps of the studies' locations marked by red cycle, Sudan (Khartoum and Kassala) and the United Arab Emirates (Abu Dhabi). (Source: Adapted from OCHA: https://reliefweb.int/location-maps)

4.3.2 Description of samples

In each study of the included nine papers a representative sample was chosento give appropriate results.The sample of Khartoum's study Paper 1 (26)(n=2076) included women with a singleton pregnancy who attended thelabour ward of Khartoum hospital, Sudan, between February and April 2008.

A series of community-based studies included mothers with children under-five years in Kassal, eastern Sudan; the studies were conducted between December 2014 and September 2017;the sample sizes for Paper 2 (35), Paper 3 (33), Paper 4 (75), Paper 5 (76) were (n=303), (n=297), (n=250), and (n=242), respectively.

The sample of the UAE'sproject (n=1822) included both Emirati and non-Emirati mothers with children under-two years attending the seven healthcare centres located in different geographical areas in Abu Dhabi, the UAE, from March to September 2017.

4.3.3 Data collection

In each study a protocol was developed by the investigators to guide the study as well as a questionnaire to collect the data. To ensure data reliability many actions were taken by the investigators: (1) training of the data collectors (research assistants) about the study and how to administer the questionnaire, (2)validation of the questionnaire by conducting a pilot study and all necessary corrections were done before collecting the data,(3) setting of inclusion and exclusion criteriafor each study/paper based on its aims and objectives, and (4) using same definition of terms in all nine papers, for example preterm birth (<37 weeks' gestation) andLBW (<2500 grams).

The data of each paper were presented in text, tables and figures where appropriate.

4.3.4 Data analysis

In all nine papers Statistical Package for the Social Science(SPSS) was used and both descriptive statistics, (e.g. mean and percentages) and inferential statistics,(e.g. logistic regression

analyses) were used to analyse the data. For all included nine papers, Adjusted Odds Ratio (AOR), and 95% Confidence Interval (CI) were calculated; variable with a *P*-value ≤ 0.05was considered as significant.

4.4 Methods used to create the theoretical framework

Working in medical research since 2004(more than 15 years) has giventhe author the opportunity to look back into theprevious published work,especially those related to maternal and child health. The idea of creating the framework came after the author reviewedall his published work. The author has publishedmore thantwenty-five publications including papers and book chapters(see Appendix 3 for details), from thesetwenty-five publications, nine papers areclosely related. Therefore, a framework is needed to guide the author to explore and to maximise the benefits of the selected ninepublished papers. The following are the key steps taken by the author which led to build the newly-created framework:

- A thorough review of all selected nine papers.
- The selection of papers is based on the integration of papers.
- Key variables are identified such as preterm birth, LBW, CS, breastfeeding practices and child health.
- The initial questions came to the author's mind, of them, what factors influence these variables, (e.g. sociodemographic influencers) and to what extent do these variables determine child health,(i.e. live or death)?
- Reviewing the related literature including the commonly used frameworks in public health to find answers for the above-raised questions.

- Grouping the related variables into dependent and independent variables. The dependent variable (child health), (i.e. morbidity and mortality) which in this thesis is referred to as final outcomes.The independent variables such as adverse pregnancy outcomes, sociodemographic and prenatal variables.However, breastfeeding practices variable act as intermediate outcomes, (i.e. both dependent and independent variable) as it has impact on the final outcomes and at the same times influence by others independent variables as well.
- The impact of the independent variable on the dependent variable, (i.e. the outcome) is estimated by the magnitude of AOR, for example, Paper 1 (26) showed a LBW neonate is more than seven times more prone to perinatal mortality (AOR 7.2, 95% CI 3.8, 13.5).
- The initial drafting of the framework was based on the relevant existing frameworks, (i.e. relevant to the current work aim and objectives). The relevant frameworks were well studied,(i.e. their strengths, weaknessesand validations by other researchers).
- More refining of the framework was carried out through in-depth understanding of the included nine papers, literature, aims and objectives, until the main aim and objectives of the current work were achieved.

4.5 Ethical considerations

As the current work combines existing data, no ethical approval was needed and any authored work used was acknowledged properly in the text and the referencing. For all the included nine papers, all ethical issues were considered, forexample, in each paper, ethical approval and informed consents were obtained from the ethical committees and the participants,

respectively. In addition, all measures such as excluding personal identifiers during the data collection were taken to ensure privacy and confidentiality of the participants.

Chapter 5

Results

5.1 Introduction

Thisresults chapter focuses on the findings of the included ninepapers and combiningthese findings into anewly-created theoretical framework.

5.2 Summary of the included 9 papers findings

The included nine papers upon which this current work is built were conducted at different settings in Sudan (Khartoum and Kassala) and in the UAE (Abu Dhabi). These ninepapers focused on maternal, perinatal and early years health.

5.2.1 The study conducted in Khartoum, Sudan (Paper 1)

- Paper 1 (26)was published under title: Education, prenatal care, and poorperinataloutcome in Khartoum, Sudan.

Paper 1 (26): Identified and quantifiedthe predictorsfor LBW neonates and perinatal mortality in Khartoum, and assessed the role of sociodemographic factors among 2,076 singleton deliveries. Of them, 260 (12.5%) were LBW neonates and 46 were stillbirths (24 were fresh and 22 were macerated) and 20 early neonatal deaths. The stillbirth rate was 35.5/1000 births; the early neonatal death rate was 15.4/1000 births, giving a perinatal mortality rate of 51/1000 births. The main predictors for LBW werefirst child order (AOR 1.4, 95% CI 1.1, 2.1), lack of prenatal care (AOR 2.2, 95% CI 1.4, 3.4) and small maternal arm circumference (AOR 1.4, 95% CI 1.1, 2.0). The main factors associated with perinatal mortality were low maternal education

(below secondary) (AOR 1.9, 95% CI 1.0, 3.8), lack of prenatal care (AOR 1.7, 95% CI 1.1, 2.5) and LBW neonates (AOR 7.2, 95% CI 3.8, 13.5).

5.2.2 The studies conducted in Kassala, Sudan (Paper 2, Paper 3, Paper 4 and Paper 5)

Four series community-based cross-sectional studies were conducted in Kassala, Eastern Sudan from 2014 to 2017 to understand feeding practices and associated factors among under-five children. From these four studies, one paper was published per each study, (i.e. 4 papers)as follows:

- Paper 2 (35) was published under title: Epidemiology of cesarean delivery in Kassala, Eastern Sudan: a community-based study 2014-2015.

Paper 2 (35):Investigated the epidemiology of CS among 303 women. The main predictors of CS were old maternal age(AOR1.1, 95%CI 1.01, 1.34),first child order(AOR 6.4, 95% CI 1.3, 31.8) and women with medical disease (AOR 2.9, 95% CI 1.16, 7.6).

- Paper 3 (33) was published under title: Causes and risk factors of under-five children hospitalization in Eastern Sudan: a community-based study.

Paper 3(33): Estimated the prevalence and investigated the possible causes and predictors for under-five children's hospitalisation over the last 6 months among 297 mother-child pairs. More than one-third of the children 34.7% (103/297) were hospitalised over the last 6 months. The most common mentioned causes for the last hospitalisation were gastroenteritis 28.1% (29/103), RTI 19.4% (20/103), and malaria 9.7% (10/103). The main factors associated with under-five children hospitalisation were high birth order (AOR 1.25, 95% CI 1.06, 1.47), low

paternal education (AOR 2.89, 95% CI 1.32, 6.30) and bottle feeding (AOR 2.26, 95% CI 1.30, 3.80).

- Paper 4(75) was published under title: Assessment of initiation of breastfeeding practice in Kassala, Eastern Sudan: a community-based study.

Paper 4(75): Investigated the prevalence and factors associated with the timely (early) initiation of breastfeeding among 250 mothers with children of under-two years, of them, 218 (87.2%) initiated breastfeeding earlier. The main factors associated with delayedinitiation of breastfeeding include having a male baby (AOR 3.90, 95% CI 1.33, 11.47) and mothers with medical disorders (AOR 5.07, 95% CI 1.22, 21.16).

- Paper 5 (76) was published under title: Assessment of bottle feeding practices in Kassala, Eastern Sudan: a community-based study.

Paper 5(76): Assessed the usage and factors associated with bottle feeding practices during the first six months of life among 242 mothers with children aged between 6 and 24 months. From the total, 96(39.7%) used bottle feeding for their children in the first six months of life. The main factors associated with bottle feeding were urban residence (AOR 1.96, 95% CI1.06, 3.63), not receiving breastfeeding education (AOR 1.92, 95% CI 1.07, 3.45) and child hospitalisation (AOR 1.83, 95% CI 1.02, 3.28)

5.2.3 Project conducted in Abu Dhabi, the UAE (Paper 6, Paper 7, Paper 8 and Paper 9)

Besides the studies conducted in Sudan (Khartoum and Kassala), the thesis included work conducted in Abu Dhabi as well. A multicentre cross-sectional study that aimed to evaluate

infants' and young children's feeding practices among 1822 mothers of children under-two years in Abu Dhabi. Four papers (Paper 6, Paper 7, Paper 8 and Paper 9)have been published from this project as follows:

- Paper 6 (36) was published under title: Prevalence and associated factors of caesarean section and its impact on early initiation of breastfeeding in Abu Dhabi, United Arab Emirates.

Paper 6(36): Described the prevalence of CS and evaluated its impact on breastfeeding initiation. Among the 1,624 participants, about one-third (30.2%) delivered via CS, of which 71.1% were planned, while 28.9% were emergency CS. More than half of all mothers (62.5%) early initiated breastfeeding. The main factors associated with CS were old maternal age (AOR 1.04, 95% CI 1.02, 1.07), non-Arab nationality (AOR 1.36, 95% CI 1.08, 1.71) and maternal obesity (AOR 1.79, 95% CI1.15, 2.79). However, advanced gestational age was negatively associated with CS (AOR 0.80, 95% CI 0.75, 0.86), (i.e. preterm babies were more likely to be delivered viaCS). CS is associated with lower early initiation rates of breastfeeding. The early initiation rates of breastfeeding were 804 (79.2%), 162 (16.0%), and 49 (4.8%) among vaginal delivery, planned CS and emergency CS, respectively. Regarding the mode of delivery, a child delivered viavaginaldelivery was almost threetimes more likely to initiate early breastfeeding (AOR 2.78, 95% CI2.17, 3.56). CS in general and emergency CS in particular, was the main predictor for the delayed initiation of breastfeeding.

- Paper 7(77) was published under title: Factors associated with delayed initiation and cessation of breastfeeding among working mothers in Abu Dhabi, the United Arab Emirates.

Paper 7 (77): Investigated the prevalence and factors associated with delayed initiation and cessation of breastfeeding among working mothers with children under-two years, in Abu Dhabi. Among the 1,610 mother-child pairs with completed data, 606 were working mothers giving an employment rate of 37.6%. Of the 606 mothers, 217(35.8%) delayed initiation of breastfeeding and 359(59.2%) ceased breastfeeding. Factors associated with delayed breastfeeding initiation among working mothers were old maternal age (AOR 1.04, 95% CI1.01, 1.08), non-Arab nationality (AOR 2.24, 95 % CI1.53, 3.27), CS (AOR 2.70, 95 % CI1.84, 3.96), not rooming-in(AOR 3.85, 95 % CI1.56, 9.51) and mothers with LBW children (AOR 2.47, 95% CI 1.23, 4.94). The main factors associated with cessation of breastfeeding were non-Arab nationality (AOR 1.59, 95 % CI1.09, 2.31) and mothers withhigh income rating (AOR 2.79, 95% CI1.36, 5.75).

- Paper 8 (11) was published under title: Risk factors associated with initiation of breastfeeding among mothers with low birth weight babies: a cross-sectional multi-center study in Abu Dhabi, United Arab Emirates.

Paper 8(11): Investigated the prevalence and factors associated with initiation of breastfeeding among mothers with LBW children of under-two years. Of 134 mothers of LBW children included in the study, 40(29.9%) early initiated breastfeeding within the first hour. Sixty-four (47.8%) delivered vaginally, and 70(52.2%) via CS. The only significant factorassociated with delayed initiation of breastfeeding among the LBW children was CS (AOR2.33, 95% CI1.07, 5.07).

- Paper 9 (21) was published under title: Factors associated with preterm birth and low birth weight in Abu Dhabi, United Arab Emirates.

Paper 9(21): Investigated the prevalence and factors associated with preterm birth and LBW among 1,610 mother-child pairs. Preterm birth rate was 102 (6.3%) and LBW rate was 151 (9.4%). Factors associated positively with preterm birth were Arab mothers (AOR 2.02, 95% CI1.19, 3.43), low maternal education (AOR 4.38, 95%CI1.95, 9.81), CS (AOR 2.35, 95% CI 1.48, 3.73) and LBW (AOR 17.62, 95% CI 11.05, 28.10). LBW was associated with female child (AOR 2.08, 95% CI 1.41, 3.08), CS (AOR 2.29, 95% CI 1.57, 3.35), first child order (AOR 1.98, 95% CI 1.35, 2.89) and preterm birth (AOR 17.64, 95%CI 11.03, 28.21).

5.3 Combining of the included 9 papers' findings to build the theoretical framework

The findings of the included ninepapers represent the core workupon which the current theoretical framework is built. The theoretical framework is composed of three main levels and each level is intended to achieve one objective or more than one objectiveas mentioned below.

5.3.1 Level 1 of the created framework

Level 1 assesses the impact of sociodemographic and prenatal factors on perinatal and early years health. This level is built on the results ofincluded ninepapers, (i.e. Paper 1(26), Paper 2 (35), Paper 3 (33), Paper 4 (75),Paper 5 (76), Paper 6 (36), Paper 7 (77), Paper 8 (11),and Paper 9(21)). Furthermore, Level 1 is subcategorised into three sublevels. Level 1 with its subcategories provides a solid basis for answering objectives 1 and 2 as follows (Figure 9):

- level 1a assesses the impact of sociodemographic and prenatal factors on adverse pregnancy outcomes, namely preterm birth, LBW and CS. This level is based on Paper 1 (26) which showed first child order (AOR 1.4, 95% CI 1.1, 2.1), lack of prenatal care (AOR 2.2, 95% CI 1.4, 3.4), and small maternal arm circumference (AOR 1.4, 95% CI 1.1, 2.0) were the main predictors for LBW; Paper 2 (35) which revealed old maternal age(AOR 1.1, 95% CI 1.01, 1.34), first child order (AOR 6.4, 95% CI, 1.3, 31.8) and women with medical disorders (AOR 2.9, 95% CI, 1.16, 7.60)were the main predictors of CS; Paper 6 (36)which identified old maternal age(AOR 1.04, 95%CI1.02, 1.07), non-Arab nationality, (AOR 1.36, 95%CI 1.08, 1.71)and maternal obesity(AOR 1.79, 95%CI 1.15, 2.79) were the main factors associated with CS; Paper 9 (21) showed mothers from Arab nationality (AOR 2.02, 95%CI1.19, 3.43) and mother with low education (AOR 4.38, 95%CI1.95, 9.81) were associated withpreterm birth, while motherhavinga female child(AOR2.08, 95%CI 1.41, 3.08) and first child order (AOR 1.98, 95%CI 1.35, 2.89) were at more prone to LBW.
- level 1b assesses the impact of sociodemographic and prenatal factors on child feeding practices (intermediate outcomes). This level is based on Paper 4(75)which found the main factors associated with the delay of breastfeeding initiation were having a male baby (AOR 3.90, 95% CI 1.33, 11.47) and mothers with medical disorders (AOR 5.07, 95% CI 1.22, 21.16); Paper 5 (76) which revealed urban residence (AOR 1.96, 95% CI1.06, 3.63), not receiving breastfeeding education (AOR 1.92, 95% CI 1.07, 3.45) were associated with

bottle feedingduring the first six months of life; Paper 7 (77) which found old maternal age (AOR 1.04, 95%CI 1.01, 1.08) and non-Arab nationality (AOR 2.24, 95%CI1.53, 3.27) were the main factors associated with delayed breastfeeding initiation among working mothers and the main factors associated with cessation of breastfeeding were non-Arab nationality (AOR 1.59, 95% CI1.09, 2.31) and mother with high income rating (AOR 2.79, 95% CI 1.36, 5.75).

- Level 1c assesses the impact of sociodemographic and prenatal factors,(i.e. the direct impact) on perinatal and early years health (final outcomes).This level is based on the results of Paper 1 (26) which indicated mother with low education was almost two times more prone to perinatal mortality (AOR 1.9, 95% CI 1.0, 3.8)as well as mother with lack of prenatal care (AOR 1.7, 95% CI 1.1, 2.5); Paper 3 (33) which showed high birth order (AOR 1.25, 95% CI 1.06, 1.47)and low paternal education (AOR 2.89, 95% CI 1.32, 6.30) were associated with under-five children hospitalisation.

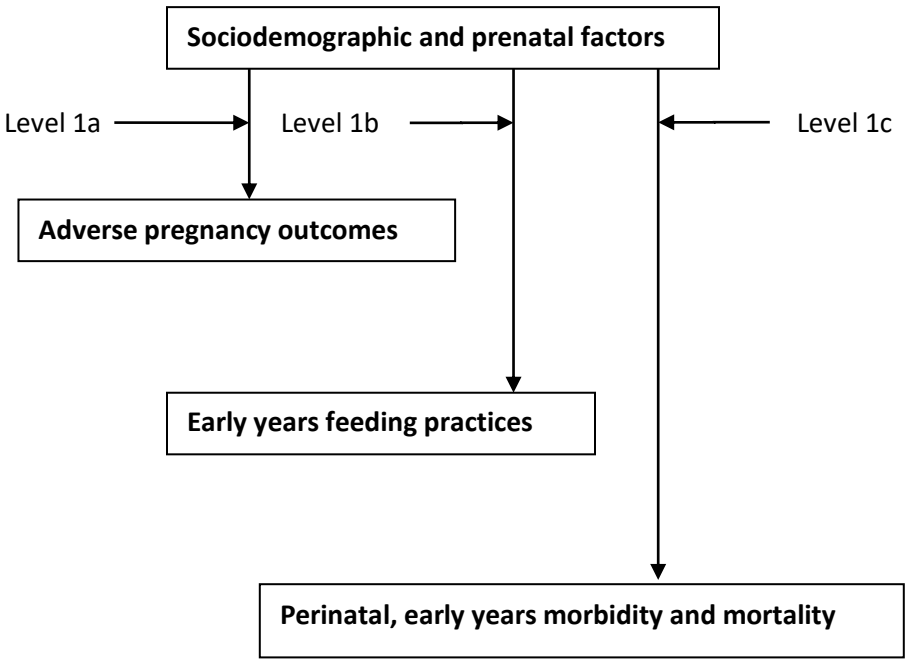

Figure 9:Level 1 of the theoretical framework, illustrates the impact of sociodemographic and prenatal factors on adverse pregnancy outcomes (level 1a), on early years feeding practices (level 1b) and on perinatal, early years morbidity and mortality (level 1c)

5.3.2 Level 2of the created framework

Level 2 assesses the impact of adverse pregnancy outcomes on perinataland early years health. This level provides a solid basis for answering objective 3. This level is mainly built on the results of Paper 1 (26), Paper 6(36), Paper 7 (77),and Paper 8(11). Moreover,level 2 is subcategorised into two sublevels as follows (Figure 10):

- Level 2aassesses the impact of adverse pregnancy outcomes on child feeding practices and it is based on the results of Paper 6 (36) which showed in contrast to CS, mothers who delivered via vaginal delivery were almost three times more likely related to an early initiation of breastfeeding(AOR 2.78, 95% CI 2.17, 3.56);Paper 7(77)showedworking motherswith LBW children were more than two times morelikely to delay initiation of breastfeeding (AOR 2.47, 95%CI 1.23,

4.94) and Paper8 (11)showed when a mother delivered via CS she was more than two times more likely to delay initiation of breastfeeding (AOR2.33, 95%CI1.07, 5.07).

- Level 2b assesses the impact of adverse pregnancy outcomes,(i.e. the direct impact) on perinatal, and early years health and it is based on Paper 1(26), which showed LBW neonate was more than seven times more likely to die in the perinatal period (AOR 7.2, 95% CI 3.8, 13.5).

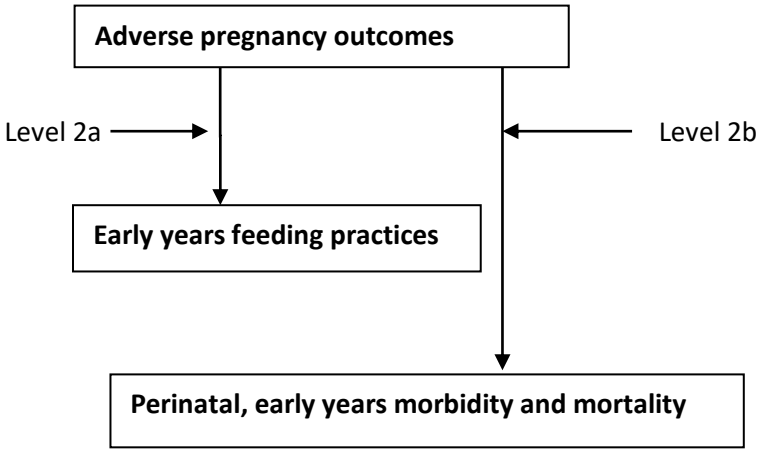

Figure 10:Level 2 of the theoretical framework, illustrates the impact of adverse pregnancy outcomes onearly years feeding practices (level 2a) and on perinatal, and early years health (level 2b)

5.3.3 Level 3 of the created framework

Level 3 assesses the impact of child feeding practices on early years health (Figure 11). This level provides a solid basis for answering objective 4.This level is mainly built on Paper 3(33)which indicated a child who used bottle feedingwasmore than two times more likelyto be hospitalised (AOR 2.26, 95% CI 1.30, 3.80).

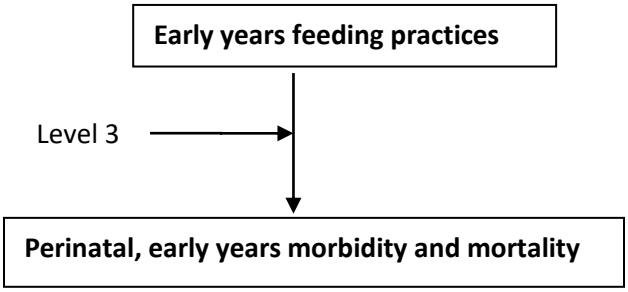

Figure 11:Level 3 of the theoretical framework, illustrates the impact of early years feeding practices on perinatal, early years morbidity and mortality

5.4 The integrated theoretical framework

The integrated theoretical framework is composed from the combination of all above-mentioned three levels (Figure 12).In addition, the results showed an interrelation within the same level such as adverse pregnancy outcomes and it is clear in Paper 9 (21), preterm birth associated with LBW, preterm birth associated with CS and LBW associated with CS.Objective 5, (i.e. the proposed recommendations) is based on the overall findings of the current work.

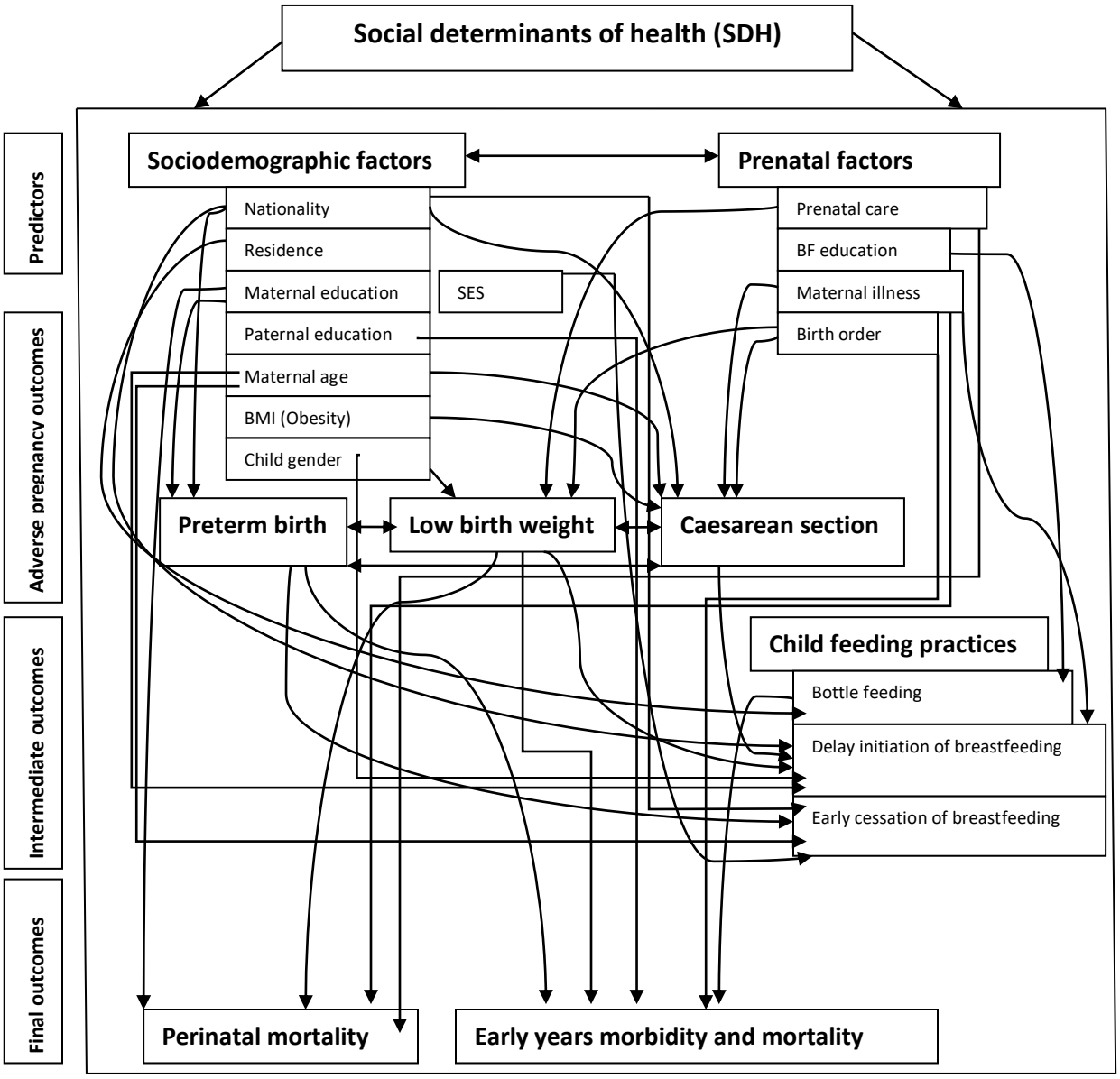

Figure 12: Theintegrated maternal and child health framework (the newly-created framework integrates maternal and child health by using the findings of the included 9 papers.

Note 1: The framework was adapted from references(62,66,139–142)**.**

Note 2: Abbreviations,BMI: body mass index,BF: breastfeeding, SES: socioeconomic status

Chapter 6

Discussion

6.1 The significance original contribution to Knowledge of the current work

To the best of the author'sknowledge, and after a thorough review of the literature, there is no previous work that focuses on the whole scope of the current work and with such in-depth. The previous work focused on a particular subset of adverse pregnancy outcomes, child feeding practices, as well as neonatal and early years health(14,62,66,139–142,146).The current work significantly contributed to the knowledge by creating a theoretical framework.The significance of the newly-created framework arises from its findings, achieving the current work's main aim and objectives, transforming the existing related theories forward as well as the application of the newly-created framework in different settings. Such a framework is a suitable tool to predict child feeding practices, perinatal and early years health. Predicting maternal and child health and putting appropriate preventive measures accordingly is an essential key step in achieving the sustainable development goals (SDGs), especially those related to child health (SDG3 target 2), (i.e. reducing child mortality), (18,161,162). In addition to the created framework, certain recommendations are proposed below (see Chapter 7for details).

Which makes this current work distinguished is the generalizability of the findings throught the application of the created framework. Such wide scope of generalizability will provide a good foundation for further interventions targeting maternal and child health based on a thorough studying of the local context. The created framework successfully integrated findings from both LIC (i.e. Sudan) and HIC (i.e. the UAE), however, the approach of intervention will depend on local assessment. For example, interventional programmes to improve prenatal care coverage

in Sudan and to reduce the high CS rate in the UAE will improve maternal and child health.Therefore, by using this framework and applying the proposed recommendations, the main goal of the current work, to improve maternal and child health in the studied settings and other settingscan be achieved. The key findings of the current work are the identification of sociodemographic and prenatal predictors of preterm birth, LBW and CS and the assessment ofthe impact of these predictors and public health problems on child feeding practices, perinatal and early years health.

6.2 Impacts of sociodemographic and prenatal factors on perinatal and early years health

This work identifies that particular sociodemographic, prenatal factors and adverse pregnancy outcomes had a direct and indirect negative impact on child feeding practices, namely delay initiation of breastfeeding, bottle feeding and early cessation of breastfeeding. A plethora of studies conducted in many countries including Sudan documented the association between sociodemographic, prenatal factors, adverse pregnancy outcomes, child feeding practices and poor perinatal and child health (12,14,61–63,66,140,146,152,163)**.** Among the studied factors,sociodemographic factors are the more powerful factors than adverse pregnancy outcomes and breastfeeding practices, because sociodemographic factors impact child health through three levels, indirect(1) on adverse pregnancy outcomes, and (2) on breastfeeding practices and direct (3) on child morbidity and mortality.In line with this result, Hood, et al.,highlighted the social and economic determinants of health compared to medical care, their study revealed socioeconomic factors contribute to the health outcomes by 47% compared to health behaviours (34%), medical care (16%), and the physical environment (3%)

(73).Additionally, the literature from many countries, including Sudan,revealed the strong association between sociodemographic factors,(e.g. low parental education and teenage pregnancy)and prenatal factors,(e.g. inadequate prenatal care)(62,64–68). Most of the identified factors were reported as key SDHinfluencing maternal and child health(163–166). In Italy, old maternal age and employment status were the main determinants of breastfeeding initiation (163).In Iran, the relationship between SDH and pregnancy outcomes was studied, andthe main social determinants of adverse pregnancy outcomes (preterm birth, LBW and CS) were maternal education and body mass index (BMI)(167). Worldwide among SDH that have a significant determinant on adolescent (aged 10-24 years) health are structural factors such as national wealth, income inequality, and access to education (168). For example, in Sudan, infant mortality is influenced by SDH such as residence (rural-urban), gender (boys-girls), educational level, income and territorial disparity between the 18 states(164).The following highlights the impact of the identified sociodemographic factors such as parental education, SES, maternal age,nationality, residence, obesity, child gender,maternal health and maternal nutritional statusas well as prenatal factors such as prenatal care, maternal illness andchild birth order.

6.2.1 Impacts of parental education

Paternal education is higher than maternal education in both studied countries (Sudan and the UAE)(33,36). Even among mothers, mothers in the UAE were more educated (96.0%) compared to Sudanese ones (43.8%) (33,36). Likewise, the maternal employment rate was higher in the UAE (37.6%) (77)compared to Sudan (11.8%) (33).Interestingly, in Kassala,achild of low paternaleducation was three times more prone to hospitalisation (33), and in

Khartoumamother with low education was two times more likely to have perinatal death (26). It is clear, there are variations regarding the impact of parent's education on perinatal and early years health. These variations could be explained by the quality of the provided education to each parent (169) and the effectiveness of education on empowering women to take decision regarding their own health such as prenatal care and family planning (170,171).Such variations ofimpact of parental education on child mortality was shown ina comprehensive global systematic review and meta-analysis, (i.e.increasing of both parental education is associated with under-five mortality reduction, and maternal education is stronger than paternal education in reducing under-five mortality)(172).In contrast to education in both studied countries and the literature, parentaloccupation was not associated with child feeding practices and child healthin both studied countries, nevertheless, it was only associated in the univariate logistic regression analysis, (i.e. crude odds ratio)(35,75). Even when the association existed between child health and parent's occupation (173,174), the impact of paternal occupation on child health is more than maternal one (174). For example, in China, while maternal unemployment has a positive impact on child health, (i.e. less child hospitalisation), paternal unemployment has the opposite impact(173). Although, education is strongly associated with health and wellbeing, through itinfluences life expectancy, morbidity, health behaviours, employment, and income, it is one of the neglected SDH(70).

It can be concluded that parental education is a key factor of achieving the SDG3 target 2; however, more research is required to explore the mechanisms by which education influences child health. According to UNICEF's education report 2018, the main barriers to schooling in Sudan are poverty, geographical disparities, gender inequities, disability, armed conflict, and

displacement (175).UNICEF's report concluded that Sudan remained far from achieving SDG 4 (quality education)(175). In addition, a recent study in 2021 conducted by Daoud, (176) among 40 illiterate girls from villages in three states, namely Khartoum, Kassala, and North Kordofan reported poverty was the most mentioned cause of drop out from basic school. In addition to the old challenges of education that faced LICs, the unanticipated global COVID-19 pandemic is putting education at risk through forced global shutdown of many activities, including educational activities(177,178).

6.2.2 Impactsof maternal health and nutritional status

While undernutrition, (e.g. small maternal upper arm circumference<23 centimetres) is a public health problem in Sudan (26), overnutrition, (e.g. overweight and obesity) is the case in the Gulf countries including the UAE (36,179). Nevertheless, micronutrients and anaemia with their complications such as perinatal deaths are major public health problems in both studied countries, particularly in Sudan (180–185). Although all these types, (i.e. undernutrition, overnutrition and micronutrition) are malnutrition problems their approaches are different, especially when coexisting in the same community, (i.e. undernutrition and overnutrition)(186). In Khartoum,Paper 1 reported small maternal upper arm circumference was the main predictor of LBW (26). In addition, 12.5% of thepregnant women (1801) in Khartoum were undernutrition, especially among women with few prenatal care visits (≤2 visits)(187).It is worth mentioning that, more attention should be paid not only to number of prenatal care visits but to the quality of prenatal care visit.

In Sudan, malaria is a major public health problem (184,188), especially among vulnerable groups such as children and women, regardless of age and birth order (189). In Africa including Sudan, many authors have reported a close relationship between malaria and adverse pregnancy outcomes such as preterm birth (190), LBW (188) and stillbirth (191). In addition, maternal anaemia is linked to both peripheral and placental malaria (184,188,189). Recently, in Sudan, anaemia was associated with an increased risk of CS (182). Simple measures such as access to prenatal care, adherence to nutrition, (e.g. iron supplementation) and malaria preventive measures, (e.g. anti-malarial chemoprophylaxis and bed nets) can prevent malaria and its life-threatening complications such as anaemia and improve maternal and child health (184,192).In Kassala, the greater the severity of anaemia during pregnancy, the greater risk of preterm birth, LBW and stillbirth was reported (193). The complexity of the association between malaria, anaemia, preterm, LBW and CS is understudied (182,184,188,189). This may raise the need for further research to explain the variations of preterm birth rates. Therefore, malaria and anaemia could be taken into consideration in future studies.

6.2.3 Impacts of prenatal care

Adequate prenatal care is an important strategy for improving maternal and child health outcomes (62,66,71).In line with other studies, the framework emphasises the importance of prenatal care for child health (62,66).In Sudan,lack of prenatal care associated with significant maternal and perinatal morbidity and mortality such as LBW and small maternal upper arm circumference (26,187). Regarding prenatal care services, Sudan is characterised by both low prenatal care coverage and low quality of prenatal care (26,67) compared to free access to

prenatal care in the UAE (158,194), however, in the UAE, low educated mothers were less likely to start early prenatal care (194). Consistent with Sudan, a mother with no or few prenatal care visits was more likely to deliver a LBW child in different settings (195,196).In the USA, among the identified SDH, low education and young maternal age played key roles in late or no prenatal care utilisation among pregnant women (71).

In Sudan, lack of prenatal care has a negative impact on perinatal outcomes (26,197). For example, in Khartoum, a mother with no prenatal care was two times more prone to have LBW and perinatal death (26). In addition, mothers with no prenatal care and with LBW were at almost two times and seven times more prone tohave perinatal death, respectively (26). In Kassala, the likelihood of perinatal death was more than three times among non-prenatalcare users (197). Lack of prenatal care was stated by many researchers as the main factor of neonatal death (198,199). In support of the current results, LBW and preterm birth were the main causes of neonatal and infant morbidity and mortality (13,200). Thus, to reduce perinatal and infant deaths, all efforts should be directed to encourage women to attend prenatal care visits (26,197,201) and to investigate the main barriers of access to maternal healthcare services , especially among disadvantagedcommunities such as nomad womenand teenage pregnancy girls (145,202,203). In the nomadic community in Sudan, the main identified barriers of access to maternal healthcare services are the mobile lifestyle of nomads, their low level of education and knowledge, gender norms, beliefs, values and attitudes, and their geographical locations(145).

In Sudan, the main identified barriers of prenatal care were cost, distance, dissatisfaction with previously used services and low level of education (145,203). Prenatal care visit is a good time to check maternal health status (e.g. nutritional), to provide breastfeeding education, to discuss with the mother in advance all the possibilities of adverse pregnancy outcomes and how to overcome them. For example, a systematic review and meta-analysis study conducted in 2018 by McFadden and others concluded both prenatal and postnatal breastfeeding counselling is an effective public health intervention to initiate and continue breastfeeding(204).

It is worth emphasising that,in Sudan, provision of access to healthcare services is an important SDH. Fortunately, simple interventions such as promoting prenatal care and improving maternal nutrition can improve child survival through reducing the high rates of preterm births and LBW. Not to mention, every effort that can reduce the unnecessary CS and preterm birth will definitely improve child survival (21). In contrast to Sudan, in the UAE healthcare coverage including maternity benefit is mandatory for both Emirati and non-Emirati families (158). However, the quality of prenatal care needs to be improved in the UAE (194).

By analysing these factors in-depth, the key factorthat healthcare decision-makersneed to focus on is the prenatal care as the other factors, (e.g. using a mosquito net, nutritional supplementations and breastfeeding education) can be received during prenatal care visits. The low coverage of prenatal care in Sudan can be improved through focusing on providing healthcare services for all mothers, especially those with high birth order and husbands' with low education(68). Improving educationof motherscan improve the quality of prenatal care in the UAE too (194), and potentially reduce the preterm birth rate as a consequence (21).

6.3 Predictors and impacts of preterm birth, low birth weightand caesarean section

6.3.1 Predictors and impacts of preterm birth and low birth weight

In Sudan, abnormal BMI, dental problems and maternal illness and short inter pregnancy intervals were the common reported factors of preterm birth (19,20). Low maternal education, LBW and Arab mothers were associated with preterm birth in the UAE(21). Recently, a study indicated that low educated mothers were less likely to start early prenatal care in the UAE (194). Another study in Belgium documented a significance association between the content and timing of prenatal care and the risk of delivering preterm birth (205). CS was the common predictor of preterm birth in both studied countries (19–21).

Fortunately, most of the factors associated with preterm birth can be modified; therefore, preterm births can be reduced by implementing community programmes regarding maternal education, dental hygiene and adequate prenatal care.

LBW associated with perinatal morbidity and mortality (13,26) and delayed initiation of breastfeeding (11) in Sudan and the UAE, respectively. In addition, in Abu Dhabi, a LBW infant was at thirty times greater risk of being admitted into theNICUcompared to a normal birth weight infant(31). The main factors associated with perinatal deaths in Sudan were home delivery, birth order ≥3, lack of prenatal care, not using a mosquito net and not taking prenatal iron supplementation (26,197,206). In addition, lack of prenatal care and low maternal education were associated with high maternal mortality in Kassala (183). In Sudan, the most common reported cause of neonatal and infant morbidity and mortality was septicaemia, especially among preterm birth and LBW infants (13,207).

6.3.2 Predictors and impacts of caesarean section

Besides the countries included in this work, studies from other countries have documented an overuse of CS (57,208,209). The overuse of CS has been associated with adverse pregnancy outcomes, (e.g. preterm birth and LBW)(57,208,209), delayed initiation of breastfeeding (117,210–213), maternal mortality, stillbirths, neonatal mortalityand infant mortality(14,208).

Although the rates of CS were above the WHO recommended rates (10% to 15%) (34) in both studied countries, it was nearly double in the UAE (30.2%) (36)compared to Sudan (17.8%) (35). The high rate of CS in the UAE could be attributed to many reasons: (1) lack of knowledge among the majority of pregnant women (78.4%)about risks associated with CS as it was reported by a recent study (214), which can lead to unnecessary CS, (i.e. CS on maternal request), (2) increase in the prevalence of obesity(36,215), and (3) increase in the proportion of older women(36). In many regions, including the Eastern Mediterranean Region, the high CS rate was attributed to multiple factors such as social, economic, cultural, individual and healthcare facilities factors (146,216).

In the current work,old maternal age was the common predictor of CSin both studied countries(35,36). This result is consistent with existing literaturethat showing strong association between old maternal ageand CS indifferent countries including the UAE (217–220).However, in Sub-Saharan Africa, young maternal agewas a strong predictor for other adverse pregnancy outcomes such as preterm birth and LBW(221). This could be attributed to the lowmaternal healthcare service utilisation in the majority of Sub-Saharan African countries including Sudan(202).This could be attributed to limited access to prenatal care and education among

teenage mothers (67,202,222). In Kassala, the rate of teenage pregnancy was 15.2%(67).However, teenage pregnancy is not commonly recordedin the UAE. The last recorded rate of teenage pregnancy in the UAE was 8% in 1995(223). A low rate of teenage pregnancyinthe UAE is expectedin comparison to Sudan, for many reasons, of them, the high mean of maternal age in the UAE (30 years) (36) compared to Sudan's mean (27 years)(35), (i.e. the possibility of teenage pregnancy is higher with low maternal age mean compared to high maternal age mean), the high maternal education level in the UAE (96.0%) compared to Sudan (43.8%)(33,36)as access to education (222), prenatal care (202) as well as high pregnancy health literacyamong teenagers (224) are preventive factors for teenage pregnancy, the UAE is a high income country andlow rate of teenage pregnancy is expected(225). However, teenage pregnancy is a complex issue as it is influenced by many sociocultural factors(67,226).

It can be concluded thatextreme maternal ages,(i.e.<20 years and >35 years) havenegative impacts on poor pregnancy outcomes(227) and this can be linked to SDH such as low access to healthcare services, especially in Sub-Saharan Africa (202).

While first child order and maternal illness,(e.g. diabetes with pregnancy and hypertension with pregnancy) were identified as predictors of CS in Sudan (35), non-Arab mothers and obesity were identified in the UAE as predictors of CS(36). In line with the current results in Qatar, obesity and non-Arab mothers' nationality were the main factors associated with pregnancy complications such as diabetes with pregnancy, hypertension with pregnancy and adverse pregnancy outcomes,(e.g. preterm birth and CS)(179). In Sudan,mothers with illness during pregnancy such as diabetes, hypertension and malaria were associated with poor pregnancy

outcomes such as CS (35), preterm birth (19), still birth (191), and delayed initiation of breastfeeding (75). The risk related tofirst child order in Sudan could be due to the association between younger age and first child order, unlike in the UAE with older age,(i.e. the mean of maternal age in Sudan (35)was less compared tothe UAE (36)). Obesity was reported by many researchers as the main predictor of CS including both studied countries (36,179,228–230).Obesity influences CS in many ways and this was reported by Rogers, et al.,(230).

In contrast to other studies (231,232), in both settings maternal education was associated with CS only in univariate logistic regression analysis(35,36). The literature is contradictory regarding the impact of high maternal education on CS, positive impact (231), (i.e. educated mother is less likely to bedelivered by CS), negative impact (232) and no impact (229) similar to the current work (35,36).

The literature has documented that CS has both short-term and long-term impacts on the health of women and children (233). CS is the most reported predictor to poor breastfeeding practices (10,36,234). Reducing high CS rates should be a global health issue. The high rates of CS in both studied countries necessitate a call for action.

In the studied settings some modifiable factors for CS such as medical disorders and obesity were identified(35,36). Addressing these factors and prioritising action to reduce the high CS rates will ultimately improve the survival of infants and children (235). Modifying such factors will also improve breastfeeding practices(236,237). Breastfeeding is a significant protective factor against obesity (238) and chronic medical disorders such as diabetes in later life (239).Interesting, a recent study in Sudan, reported breastfeeding of previous child might

reduce the likelihood of hypertension during pregnancy(240).Therefore, breastfeeding is acting in the frontline against obesity, diabetes and hypertension during pregnancy.

Although CS impacts negatively on early initiation of breastfeeding in both the UAE (11) and Sudan(10), CS was only associated in the univariate logistic regression analysisin Kassala (35). Another study with a larger sample size could reveal such an association in Kassala.

6.4 Predictors and impacts of breastfeeding practices

Despite the WHO adoption of the International Code of Marketing of breast-milk substitutes, still poor adherence exists(241)(242). Such poor adherence was documented in the WHO's report of February 2022 which exposes the aggressive marketing practices used by the formula milk industry, and highlights impacts on families' decisions about how to feed their babies and young children (243). In addition, the report explores some opportunities for action that governments, health professionals and their associations, civil society and individuals can and should take such as (1) recognise the scale and urgency of theproblem, (2) develop, activate, and enforcelegislation, and regulation, (3) protect the integrity of science and medicine, (4) safeguard children's health on digital platforms, (5) invest in mothers and families, divest fromformula milk companies, and (6) expand coalitions to drive action (243).

Higher prevalence of formula feeding was reported in various studies, for example in Sudan 40% (76), Yemen 55% (244), and in Iraq 64% (245). Such high rates of formula feeding could be attributed to the degree of security instability in these countries, (i.e. donation of infant formula and other mother's milk substitutes at the time of the previous humanitarian/refugee crisis) (76)(244)(245). According to Gribble, 2013, in emergency situations breastfeeding should be encouraged, (i.e. psychosocial support) as much as possible and formula feeding should be

avoided to save children's lives(246). Therefore, in any situations breastfeeding should be the best choice for babies.

In Kassala, male child, and child of a mother with illness during pregnancy were four and five times more likelyto delay initiation of breastfeeding, respectively (75). The association between male child and delay initiation of breastfeeding was reported in the recent Sudan MICS as well (10). Such an association needs to be studied thoroughly including sociocultural factors and to explore if there is any sort of gender biased breastfeeding, (i.e. gender inequality in breastfeeding). It is worth mentioning that, according to the WHO, gender is a strong SDH(72).

On the other hand, poor breastfeeding practices are associated with poor infant and early years health (33,247,248). In Kassala, poor breastfeeding practices such as bottle feeding was among factors associated with child morbidity (33,76) and bottle fed children were more than two times more prone to hospitalisation(76). Urban residence and lack of breastfeeding education during pregnancy were associated with bottle feeding (76) and these factors might have an indirect association with child hospitalisation. In support of this assumption, Ray, et al.,(249) found infants living in rural areas were less utilising hospital and stay less at hospital compared to urban ones. Although the four included papers from the UAE did not include child morbidity data, poor breastfeeding practices such as delay initiation of breastfeeding and bottle feeding were associated withchild morbidity including RTI, gastroenteritis, and malaria(15,248).

Although delayed initiation of breastfeeding increases the likelihood of neonatal morbidity and mortality in many settings (15,16), it was not in Kassala. This could be due to lack of including mortality data, (e.g. child with delayed initiation of breastfeeding may result in death) in Kassala

(75). In Abu Dhabi, CS (36) and LBW (11) were associated with delayed initiation of breastfeeding and among working mothers were old maternal age, non-Arab nationality, CS, not rooming-in and LBW(77).

In summary, early initiation of preventive measures for maternal and child health such as good maternal health, safe pregnancy and delivery, and optimal breastfeeding will save children's lives. To achieve this, the current work addresses certain sociodemographic, prenatal, adverse pregnancy outcomes and child feeding practices aiming to improve perinatal and child health. Furthermore, the current work provides some recommendations to reduce the high rates of preterm birth, LBW and CS; promotion of prenatal care and promoting breastfeeding among all mothers,especially to vulnerable mothers.

6.5 Implications forpublic health

A plethora of studies in many countries including Sudan and the UAE have reported that sociodemographic, prenatal predictors, public health problems such as preterm birth, LBW, CS and poor feeding practices such as bottle feeding and delayed initiation of breastfeeding are important causes of child morbidity and mortality (9,18,208,250).These issues represent major public health problems and put a heavy burden on human health, economy and the nation as a whole (1–3).These public health problems are interrelated (22,28,57–60), hence, their impact on child morbidity and mortality can be direct or indirect. Aiming to improve birth outcomes and child health, the WHO has issued recommendations and guidelines regarding preterm birth (7), LBW (8), CS (2) and breastfeeding practices (251). Such recommendations and guidelines are of paramount importance when linked to the local context based on the surveillances'

findings so as to prioritise interventions. A thorough understanding of the whole context is needed to prioritise interventions. This is the core aim of this work,(i.e. exploring the magnitude of the predictors, adverse pregnancy outcomes, assessing the impacts and proposing suitable recommendations including interventions to improve maternal and child health within the studied settings and beyond). This work was a wonderful opportunity to look back to whatI have already done regarding maternal and child health. Such considerationis needed to understand the context as a holistic approach, critique the existing situations, identifying the gaps, paving the path to future research.Furthermore, this work indicates the importance of the need for more collaboration of all involved parties and even across countries. Such collaboration is needed, particularly during difficult times of global emergencies such as COVID-19 and its direct and indirect negative impact on maternal and child health (252).

The benefits of the included nine published papers (11,21,26,33,35,36,75–77) were not confined to the studied settings as many of these papers have beencited by other scholars. The frequent citations of thesepapers may indicate the gaps they filled. For example, although, Paper 9 (21)regarding preterm birth and LBW in Abu Dhabi was published in February 2020, it has beencited nineteen times. In addition, the author received verbal positive feedback from healthcare staff that the original papers of this work helps them to improve their practices such as updating their guidelines, conducting campaigns regarding safe pregnancy awareness and breastfeeding promotion.Taking the wider scope of generalizability of the current work findings into account, by transforming this work into actions, especially by applying this newly-created framework, maternal and child health in the studied settings and beyond settings will be improved.

In conclusion, this work can be a good foundation for future research targeting maternal and child health in the studied settings and similar contexts.

6.6 Implications for future research

This work revealed valuable information regarding the identification of certain sociodemographic and prenatal, adverse pregnancy outcomes and child feeding practices and their final impact on perinatal and early years health. This information can be used by healthcare decision-makers to improve pregnancy outcomes and child health. As the papers upon which this work is built were all carried out in the last ten years, it is meaningful to combine these in one thesis. Such combining will widen the scope and increase the impact of the already published work. This work evaluated the previous papers, by detecting the strengths and weaknesses of the previous published nine papers, and integrating their findings within the existing literature and by doing that, the path for future research will be clear.

Due to the dynamic nature ofhealth predictors and transformation within and between countries further research is needed to understand these public health issues in-depth. Future research needs to take into consideration the limitations highlighted in these papers, in addition to the newly detected limitations in this current work.

Although the current work explores the existing situation and shows the complexity of maternal and child health in the studied settings; it raisesnew questions that need to be answered byfuture research. This indicates the non-linearity of maternal and child health issues, for example, investing in child health will improve SES such as education and vice versa (253).

As the present work explores the impact of sociodemographic, prenatal, preterm birth, LBW and CS on child feeding practices, perinatal and early years health,furtherwork to reverse the impact is desirable,(i.e. to estimate the impact and benefits of breastfeeding practices on preterm birth, LBW survival, and to come up with suitable interventions and suggestions to improve breastfeeding among, preterm, LBW and CS babies). As the health of a child starts not only from pregnancy but even before pregnancy (42) any investment in this period is cost effective and should be encouraged.

Another example justifying the significant social and economic benefits of investing in women's and children's health, (i.e. by increasing health expenditure, high health and socioeconomic return is estimated when using simulation modelling) was demonstrated by Stenberg, et al.,(254). Such work highlights the needs and the cost-effectiveness of investing in the health of girls, women and children as a key in achieving SDGs (253).

Further research is needed for many reasons, such as overcoming the previous work limitationsas mentioned below, answering the newly created questions from the current discussion and validating the newly-created framework, (i.e. Hassan's framework for integrating maternal and child health 2021). The future research should focus on the discrimination between parent's education and occupation within and between countries; the mechanism of influence of parent's education and occupation on child feeding practices, perinatal, infant and child health; sociocultural factors behind some child feeding practices such as child gender discrimination regarding delay initiation of breastfeeding; in future research more attention should be paid to data linking so as to have a full picture of the situation, (i.e. integrating child

morbidity data with mortality data and community-based data with hospital-based ones). Also, the current work highlights the importance of understanding the SDH, their impact on health outcomes, and the need to provide comprehensive healthcare for all, especially fordisadvantagedcommunities.

6.7 Limitations of the current work

The current work has some limitations that need to be mentioned. The limitations are related to the original included nine papers, which are summarised below with some suggestions to overcome them:

- Few data were missing, any data collector should know the value of the completed data and early checking of data is desirable.
- Some studies were hospital-based and others were community based, collecting data from both hospitaland community at same time can give an accurate estimation and better description for these public health issues, in addition to longitudinal projects that could follow women even before pregnancy until child age five years or more.
- All theincluded nine papers arequantitative studies, a mixed methods study that combines both quantitative and qualitative data collection will be of paramount importance to providemore in-depth findings about maternal and child health.
- Lack of in-depth tackling of some factors of SDH such as policies, laws, and environmental factors and their impact on child health in the original nine papers. For

example, the influence of environmental factors on child mortality will be prominent in the future(255).

Future research that takes all these limitations into account will improve the newly-created theoretical framework.

6.8 The dissemination plan for the current work

To maximise the benefits of the current work, especially encouraging use of the created theoretical framework, the author will communicate the findings of this work to wider communities through publishing the thesis, delivering of presentations at conferences, and sharing the information with the health authorities in both studied countries as well as with colleagues. Furthermore, the author invites researchers from the studied countries and across the globe to use the created framework under the title of 'Hassan's framework for integrating maternal and child health 2021', and the authorencourages potential users of Hassan's framework to send feedback and comments aiming to improve the framework. In addition, the author will try to update this framework based on the findings of his future research. For example, the author future research will focus on studying and integrating more SDHin the framework.

Chapter 7

Recommendations and Conclusions

7.1 Recommendations

This work showsmaternal and child health needs to be improved in the studied settings, therefore, urgent action should be taken by all involved parties, such as decision-making authorities, healthcare staff, family members, employers and societyas a whole. Based on the created theoretical framework,the analysisof the content and the triangulation of the collected information from reviewing the literature and the included nine papers regarding maternal and child health in both Sudan and the UAE, the current work addresses the following recommendations including implementation of policies and initiatives that will lead to improvements in maternal and child health:

- The reported papersprovided valuable baseline information to develop appropriate strategies to reduce the high rates of preterm birth, LBW and CS through estimating their magnitude, addressing the associated sociodemographic and prenatal factors and their impact on child feeding practices, perinatal and early years health.The future strategies need to focus on the above identified factors so as to address social determinants of maternal and child health in the studied settings and beyond settings.

- Addressing the SDH as well as health promotion activities, especially those related to women's healthcare such as age of marriage, female education,gender inequality, prenatal care and women nutrition, to prepare women,their families and healthcare

providers for safe pregnancy and with good outcomes. Addressingthe SDH can be through many ways: raising awareness about SDH, developing and updating policies and laws related to human health and wellbeing. Addressing the SDH is essential to improvematernal and child health, especially in countries suffering from armed conflict and its adverse effects on child health and development, (e.g. lack of access to basic needs, malnutrition,high maternal and neonatal mortality rates, social and psychological problems), and Sudan is not an exception(87,256,257).

- Parental education status has a significant impact on maternal and child health, for example, in Sudan; a father'seducation status was more powerful than a mother's education status on seeking prenatal care services. Therefore,provision of education for all children regardless of their gender with more attention to education's quality and output. In addition, further research is needed to explore the variations of parental education on maternal and child health including access to prenatal care services.

- Appropriate strategy is needed to improve access to healthcare services, especially for disadvantagedcommunities, for example, provision of free prenatal care services for all mothers with more emphasis on mothers with low education and residing in difficult access areas such as nomads. More attention should be paid not only to the coverage of healthcare services but to the quality of the provided services as well.

- Implement policies such as safe pregnancy and breastfeeding promotion, auditing and reporting of preterm birth, LBW and CS.

- Initiatives to raise awareness of unnecessary CS, appropriate breastfeeding practices, among women, men, healthcare staff and the public through education, training,launching of campaigns, (i.e. posters, brochures and media sessions) and discussing cultural breastfeeding related issues such as acceptance of breastfeeding in public.

- Promotion of breastfeeding practices among all mothers through early initiation of breastfeeding within the first hour, EBF up to 6 months, appropriate introduction of complementary feeding and continuebreastfeeding for two years or more. This can be achieved through supporting, promoting, and educating allmothers and fathers regarding good breastfeeding practices and discourage bottle feeding. Furthermore, women who face breastfeeding difficulties need to be identified as early as possible and challenges and barriers properly addressed. Such support can be from the healthcare staff, family, employers and the community as a whole.

- The WHO International Code of Marketing of breast-milk substitutes should be adopted, and enforced by all countries through developing of policies, law and raising awareness.

- More attention should be paid to mothers with medical illness such as diabetes, hypertension, and malaria. This can be achieved through early detection and close prenatal care follow up as well as looking for SDH related to these medical illnesses.

- Creating of partnerships with other countries to share knowledge and practices aiming to improve maternal and child health. For example, Sudan can extend such partnership with the UAE,throughtheUAE funding of maternal and child health programmes such as

increasing prenatal care coverage, decreasing teenage pregnancy and improving women education in Sudan. This work can be a good start for a fruitful partnership.

In addition, the above-proposed recommendations can be implemented to improve the current situation of maternal and child health. The proposed recommendations including policies and initiatives can be applied at the studied countries and can be duplicated in others countries and even across the globe.

7.2 Conclusions

The current work addresses the main determinants of preterm birth, LBW and CS and their impact on child feeding practices, perinatal and early years health**.** Adverse pregnancy outcomes such as preterm birth, LBW and CS present major public health problems due to their adverse effects on maternal and child health, (i.e. poor child feeding practices, increasing perinatal mortality, child morbidity and mortality), especially in LICs. To improve maternal, child health, a theoretical framework is created.The significance of the newly-created framework arises from the author's prior work, creating new meaning by combining and discussing the findings from the author's published work with the existing literature and comparing the findings between the two studied countries (Sudan and the UAE), transforming the existing related frameworks forward, and addressing SDH that can help decision makers prioritise actions for improving maternal and child health as well as the applicationof the newly-created framework in different settings. Therefore, the current work significantly contributes to the knowledge by creating a theoretical framework and helpshealthcare professionals to take decisions based on a holistic approach.

The newly-created theoretical framework identified certain sociodemographic factors such as nationality, residence, parental education, SES, maternal age, obesity and child gender; certain prenatal factors such as prenatal care, maternal illness, birth order and breastfeeding education as the main predictors of adverse pregnancy outcomes, child feeding practices, perinatal, and early years health. The current work addresses all these predictors and outcomes; highlights the implications on public health and future research and provides some recommendations.The findings of this current work, especially the created framework and the proposed recommendations can be used by decision makers and researchers to prioritise their interventions.In addition toapplication of the current work findings with such generalizability scope will lead to improvements in maternal and child health in the studied settings and beyond settings. Improving maternal and child health is key for any nation's sustainability as both mother and child represent the core of the SDGs. The created framework is a suitable tool to predict child feeding practices, perinatal and early years health. Predicting maternal and child health and putting appropriate preventive measures accordingly is an essential key step in achieving SDGs. This can be achieved through empowering women by education, employment, and free access to healthcare services.

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Appendix 1

Data extraction and strengths and limitations of the literature review included studies

Study, location	Type of study	Sample	Study's concept	Study's key findings
Kayode, et al.,(88), Nigeria	Population-based cross-sectional study explored the 2008 demographic and health survey	28,647 children of under-five years	- Under-five mortality	Under-five mortality associated with early maternal marriage (<15 years), under utilisation of healthcare services, short duration of breastfeeding (BF) (<18 months), non-using of family planning, big family size, polygamy high birth order, low birth weight (LBW), rural residence, and poor sanitation
Valente, et al., (90), Portugal	Population-based cross-sectional study conducted between January and May 2011	1,285 under-five children	- Nutritional status of under-five children	birth weight, nutritional status, and maternal education and weight gain during the first year of life were key protective factors against undernutrition during infancy and childhood
Liang, et al., (96), data from low and middle income countries (LMICs)	Systematic review carried out in 2017	45 articles included in the analysis	- Infants under one year of age	- Both preterm birth and LBW were associated with neonatal mortality - Malnutrition, lack of BF and low oxygen saturation were associated with infant mortality

Shah, et al.,(97), Bangladesh	Cohort study conducted between June 2007 and September 2009	32,126 live births	- Preterm	- 22.3% were preterm babies - 46.4% of all neonatal deaths occurred among preterm babies - Preterm babies associated with first child order, low socioeconomic status (SES) and maternal complications during pregnancy - Preterm babies were at higher risk of deaths compared to term babies
Santos, et al., (98), Brazil	Population-based birth cohort study in 2004	447 late preterm births	- Preterm	- Late preterm birth associated with young maternal age, lack of prenatal care, and hypertension - compared with term births, late preterm births associated with maternal depression at birth, perinatal morbidity, and delay initiation of BF and neonatal and infant mortality
Elder, et al.,(99), Australia	Cohort analysed hospital readmissions to one year in infants delivered with very preterm during 1990 and 1991	538 very preterm births	- Preterm	- Readmission of very preterm babies associated with aboriginal race, male baby and chronic lung disease - BF was protective of readmission - Very preterm births are at higher risk of morbidity and mortality compared to late preterm births
Gracie, et al., (100), Canada	Study protocol	2,000 women	- Preterm	To predict women at risk of preterm birth through examining gene expression profiles and the environment

Alasfoor, et al., (101), Oman	Case-control study conducted in 2002	190 cases underweight children and 190 controls non-underweight children age 6-35-months	- LBW	Child born with LBW was strongly associated with persistent underweight, maternal height, low maternal education, morbidity, usage of milk formula and poor sanitation
Nisha, et al.,(102), Bangladesh	Qualitative study in two rural settings	32 in-depth interviews of pregnant women (11), recently delivered women (12), husbands (4), and mothers-in-law (5), two focus group discussions among 16 husbands and key-informant interviews with 4 community health workers	- LBW	- Most of participants did not consider birth weight a priority for assessing a newborn's health status - Lack of awareness of birth weight and fear of caesarean section (CS) - The most perceived causes of LBW were maternal poor nutrition, inadequate diet during pregnancy, anaemia, illnesses during pregnancy, short stature, twin births, and influence of supernatural spirit
Ricci, et al., (103), Sub-Saharan African countries	Structural equation modelling approach was applied to the databases collected from 2000 to 2016	Analysis of the World Bank and FAO databases of under-five mortality in sub-Saharan African countries (37)	- Under-five mortality	Child nutritional status, LBW, exclusive breastfeeding (EBF), health resources and environmental hygiene play a key role in child mortality
Upadhyay, et al., (104), India	Secondary data analysis of primary intervention trial aimed to evaluate the effect of vitamin A supplementation on mortality in the first 6 months of life	44,984 infants	- LBW - BF - infants morbidity - infants mortality	- 10,658 (23.7%) were LBW - LBW infants were at risk of hospitalisation and mortality compared with normal birth weight ones, especially in the neonatal period - LBW babies were at increased risk of delay initiation and early cessation of BF

Dessu, et al., (105), Ethiopia	Prospective cohort study conducted during March 2018 to February 2019	216 LBW neonates admitted in neonatal intensive care unit (NICU)	- LBW	High rate of mortality (83/1000 live births), especially among maternal history of diabetes mellitus, HIV, not practicing kangaroo mother care and non-EBF
Tesfaye, et al., (106), Ethiopia	Decision tree analysis for Ethiopian demographic and health survey data (EDHS) data of 2011	11,654 records of EDHS	- Under-five mortality	Child mortality associated with BF, parental education, family planning, preceding birth interval, presence of diarrhoea, LBW and age of the mother at first birth
Colaizy, et al., (107), USA	Analysis of secondary data collected between October 1999 and August 2001 by using models	848 extreme LBW infants	- LBW - BF	- ELBW were more at risk of mortality and morbidity such as necrotizing enterocolitis (NEC) - optimised feeding (≥98% maternal milk) associated with reduced risk of NEC among ELBW infants
Chaman, et al., (108), Iran	Community-based nested case-control study conducted among children born from June 1999 to March 2009 (10,912 children)	65 cases and 130 controls	- Under-five children	Under-five mortality associated with short BF period, less frequent healthcare visits and LBW
Lundeby, et al., (109), Somaliland	Observational study based on hospital records from 164 neonates admitted to the neonatal unit from June to October 2013	164 neonates	- Neonatal morbidity and mortality	- Neonatal mortality associated with preterm birth and LBW - The discharged neonates faced many health problems such as non-EBF, low rate of vaccination and more prone to gastroenteritis and respiratory distress
Karim, et al.,(111), Bangladesh	Secondary data analysis of Bangladesh Demographic and Health Survey, 2014	3,162 delivered mothers	- BF	Delay initiation of BF associated with CS and not receiving postnatal care

Veile, et al., (120), Mexico	Study used a longitudinal child health dataset	88 children aged up to 60 months	- CS - BF - childhood infectious morbidity	No a direct link between CS, child BF practices and child morbidity
Shah, et al.,(115), randomly selected 131 African health facilities	The WHO's global survey in 7 African countries between September 2004 and March 2005	83,439 births	- CS	CS rates influenced by many factors such as previous CS, preeclampsia, induced labour, pregnancy complications, and higher health facility classification scores
Saeed, et al., (116), Pakistan	Hospital-based cross-sectional study conducted during 2008 to 2009	2,500 women	- Mode of delivery - BF	Women delivered via CS faced BF problems compared to vaginal delivery, and there is increasing trend of bottle feeding with the increases in the rates of CS
Bruno, et al., (117), South Sudan	Cross-sectional study conducted from October 2016 to January 2017	806 mothers	- BF	52% delayed initiation of BF Delay initiation of BF associated with CS, discarding of colostrum, unmarried mothers, exposure to infant formula advertisement and no house ownership
Kambale, et al., (118), The Democratic Republic of Congo	Cross-sectional study conducted between July and October 2016	396 mothers	- BF	Delay initiation of BF associated with unmarried mothers, CS, no counselling on early initiation of BF and counselling by a non health professional
Nguyen, et al., (119), Vietnam	Cross-sectional questionnaire survey in February 2017	286 mothers	- BF	- 90.6% initiated BF earlier - Less intention to breastfeed exclusively was higher among mothers of preterm babies and low education compared to term babies and educated mothers, respectively - Delay initiation of BF associated with CS

Debes, et al., (126), Global data	Systematic review for data bases from 1963 to 2011.	18 included studies	- BF	Early BF initiation is a simple intervention that has the potential to significantly improve neonatal outcomes
Alebel, et al., (127), Ethiopia	Hospital-based prospective cohort study conducted between December 2017 and May 2018	513 neonates admitted to the NICU	- Neonatal mortality	- 21.3% died during the follow-up time - Predictors of neonatal mortality were being unemployed mother, not attending prenatal care, and not initiating EBF
Edmond, et al., (128), Ghana	Analysis of secondary data from a cluster randomised trial based in rural Ghana of the impact of weekly vitamin A supplementation to women of childbearing age on maternal and infant mortality	3,411 infants	- BF - LBW - neonatal mortality	- 8.7% were LBW - Improving early infant feeding practices is an effective, feasible, low-cost intervention that could reduce early infant mortality of LBW infants in low income countries (LICs)
Muhe, et al., (92), Ethiopia	A one-year community study	1,304 children	- Under-five morbidity	Nutritional and healthcare factors make a significant impact on under-five morbidity

Kayode, et al., (95), Ghana	a population-based study conducted from 2003 to 2008	6,900 women	- Neonatal mortality	- Both individual and community characteristics show a marked impact on neonatal survival - Infants of multiple-gestation, neonates with inadequate birth spacing and LBW had a lower chance of surviving the neonatal period - Similarly, high birth order infants and non-breastfed infants were more likely to die during neonatal life, whereas adequate utilisation of prenatal, delivery and postnatal health services, reduced the likelihood of neonatal mortality - Dwelling in a neighbourhood with high socioeconomic deprivation was associated with increased neonatal mortality
Onah, et al.,(112), Nigeria	Cross-sectional analytical study in 2012	400 mother-infant pairs	- Infant feeding	- Low rate of EBF (33.5%) - Non-EBF associated with low maternal education, high SES, CS, and delay initiation of BF
Ezeh et al.,(113), 13 Economic Community of West African States (ECOWAS)	Population-based cross-sectional surveys	76,934 children under-two years	- BF	Delay initiation of BF associated with mothers who perceived their babies to be small at birth, CS, not-attending prenatal care, delivered by non-health professionals, male children and mothers from poor households
Raihana, et al.,(123), Bangladesh	Community-based study conducted from 2013 to 2015	30,646 newborns.	- BF	Children who delayed and who never initiated BF were at risk of morbidity

Abdullah, et al.,(94), Indonesia	Matched case–control study conducted in 2013	154 cases and 308 matched controls (surviving neonates)	- Neonatal mortality	Neonatal mortality associated with neonatal complications during birth, maternal complications during pregnancy and after delivery, maternal lack of knowledge of danger signs for neonates, and home delivery
Mengesha, et al.,(93), Ethiopia	Prospective cohort study conducted from April to July 2014	1,152 neonates	- Neonatal mortality	- high neonatal mortality rate 62.5/1000 live births - Neonatal mortality associated with LBW, not initiating EBF, neonatal complications, maternal complications and lack of access to healthcare services
Hazir, et al.,(122), Pakistan	Cross-sectional study used data of the Pakistan Demographic and Health Survey 2006–2007	3,103 children under-two years	- BF	- Delay initiation of BF associated with employed mothers, and CS - Bottle feeding practice associated with mothers had ≥ 4 prenatal clinic visits and belonged to high SES
Bentley, et al.,(91), Australia	Population-based retrospective cohort study conducted 2007–2012	488,603 children	- Under-five morbidity	Childhood infection associated with CS, labour induction, birth at <39 weeks and formula feeding
Taye et al., (125), Ethiopia	Community-based cross-sectional study conducted from April to May 2020.	494 mothers with infants 0–6 months of age	- Infant feeding	Formula feeding practice associated with high maternal education, CS, delayed initiation of BF, pre-lacteal feeding practice

Saroj, et al.,(89), India	Secondary data analysis by using models	National Family Health Survey (published in 2016)	- Under-five mortality	Under-five mortality associated with socioeconomic, demographic such as educational level, women's age, and religion, and proximate and biological factors such as women's age in years, total number of children ever born, birth in the last 5 years, number of living children, currently BF, smokers, desire for more children, delivery by CS, prenatal care visits, and birth order
Kattula, et al.,(110), India	Community-based cohort study	497 infants	- LBW - Infant morbidity	- LBW associated with maternal anaemia during pregnancy, < 4 prenatal visits and preterm birth - Infants morbidity associated with male gender and non-EBF
Khanal, et al., (114) Nepal	Community- based prospective cohort study	735 mother-infant pairs	- BF	- Delay initiation of BF associated with mothers who were assisted by traditional attendants during childbirth, CS, from ethnically disadvantaged families and LBW - Early initiation of BF associated with mothers from the poorest families and did not introduce prelacteal feeds to their infants

Abdel-Rahman, et al., (10) Sudan	Cross-sectional analysis from multiple Indicator cluster surveyconducted in 2014	5,622 mothers	- BF	- Optimal early feeding varied across regions of Sudan - CS was negatively associated with optimal early feeding practice - Mothers with secondary education, those who desired their pregnancy at the time, those who were assisted by a professional healthcare personnel at birth, and those who gave birth to female infants had higher odds of use optimal early feeding practice
Mukunya, et al.,(121), Uganda	Comparative cross-sectional study in 2016	930 children under-two years	- BF	- Delayed initiation of BF associated with low maternal education, CS, discarding initial breast milk, home delivery and mother being responsible for initiating BF as compared to a health worker
Woldeamanuel, (124), Ethiopia	Study extracted data from the Ethiopian Demographic and Health Survey (EDHS) 2016	5,122 children	- BF	- Delay initiation of BF associated with rural residence, female child, home delivery, CS, LBW and large family size - non- EBF associated with Living in Affar, Somali, and Harari, low maternal education, home delivery, no prenatal care follow up, and no postnatal check-up - cessation of BF associated with younger maternal age, Muslims, home delivery, and maternal employment

Appendix 2

The full texts of the included 9 published papers

Paper 1

Under title:

Education, prenatal care, and poor perinatal outcome in Khartoum, Sudan

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Education, prenatal care, and poor perinatal outcome in Khartoum, Sudan

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Perinatal outcome is an important indicator of obstetric care and health status. Reducing the incidence of low birth weight neonates by at least one third between 2000 and 2010 is one of the major goals of the United Nations resolution "A World Fit for Children" [1] and is an important contribution toward Millennium Development Goal (MDG) 4 which is to reduce child mortality by two thirds by 2015 [1]. Local surveillance and basic epidemiology can more accurately assess perinatal outcome and identify areas to which interventions should be targeted. The aims of the present study were to identify and quantify the risk factors for low birth weight neonates and perinatal mortality in Sudan, and to assess the role of sociodemographic factors.

The study was conducted between February and April 2008 in the labor ward of Khartoum hospital, Sudan. After informed consent had been obtained, women with a singleton neonate were approached to participate in the study. A structured questionnaire was administered to each woman to gather information on sociodemographic markers such as education, age, parity, and prenatal care attendance. Maternal mid-upper right arm circumference, weight, height, and body mass index (BMI, calculated as weight in kilograms divided by height in meters squared) were obtained.

Neonates were weighed immediately and followed-up on day 7 post partum (at hospital or at home). Placenta and cord were examined for malaria using Giemsa stained thick blood films. Maternal hemoglobin level was determined.

Statistical analysis was performed using SPSS (SPSS, Chicago. IL, USA). Means and percentages were calculated. Univariate analyses were performed initially and variables with significant results ($P<0.05$) were analyzed by multivariate analyses. Low birth weight and perinatal mortality were categorized as dependent variables, while maternal sociodemographic characteristics were categorized as independent variables. $P<0.05$ was considered significant.

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Low birth weight was defined as weight less than 2500 g. Perinatal mortality was defined as death occurring between 28 weeks of gestation (in utero or outside) and 7 days post partum. Stillbirths were defined as delivery of a neonate after 28 weeks with no signs of life, and were categorized as fresh (normal in appearance with intact skin) or macerated (when the skin was not intact), which implies that death occurred more than 24 hours before delivery.

A total of 2076 women with a singleton pregnancy and complete data available were eligible for participation. The mean age and parity of the women were 27.4 ± 8.5 years and 1.9 ± 2.2, respectively; 789 (38.0%) of the women were primiparous. There were 976 (47.0%) women who had less than secondary education (less than 8 years). A total of 354 (17.0%) women had not attended a prenatal care clinic during the index pregnancy. Mean BMI and arm circumference were 26.9 ± 7.6 and 26.2 ± 4.7 cm, respectively. Mean hemoglobin level was 10.6 ± 1.3 g/dL.

Eight women were identified with peripheral, placental, and cord *Plasmodium falciparum* malaria, and another 3 women had positive placental blood films for malaria.

Of the 2076 singleton deliveries, 260 (12.5%) were low birth weight neonates, for a rate of 125 per 1000 births. Mean birth weight was 3040.6 ± 573.3 g. At follow-up 7 days post partum, data were available for 1293 deliveries. Of these, there were 46 stillbirths (24 were fresh and 22 were macerated) and 20 early neonatal deaths. The stillbirth rate was 35.5 per 1000 births, the early neonatal death rate was 15.4 per 1000 births, giving a perinatal mortality rate was 51 per 1000 births.

Primiparous status (OR 1.4, 95% CI, 1.1–2.1; $P=0.007$), lack of prenatal care (OR 2.2, 95% CI, 1.4–3.4; $P=0.001$), and small maternal arm circumference (OR 1.4, 95% CI, 1.1–2.0; $P=0.009$) were the predictors for low birth weight in univariate and multivariate analyses. Height and level of education were only significantly associated with low birth weight in the univariate analysis (Table 1). Low level of education (OR 1.9, 95% CI, 1.0–3.8; $P=0.04$), lack of prenatal care (OR 1.7, 95% CI, 1.1–2.5; $P=0.005$), and low birth weight neonates (OR 7.2, 95% CI, 3.8–13.5; $P<0.001$) were

Table 1
Factors associated with low birth weight and perinatal mortality in Khartoum hospital, Sudan using univariate analyses

Variable	Low birth weight			Perinatal mortality		
	OR	95% CI	*P* value	OR	95% CI	*P* value
Maternal age	0.9	0.9–1.0	0.06	0.9	0.9–1.0	0.4
Primiparous status	1.4	1.1–1.9	0.005	1.0	0.9–1.1	0.1
Education less than secondary	1.5	1.2–2.0	0.01	2.3	1.3–4.0	0.003
Occupation	0.8	0.6–1.1	0.2	0.7	0.7–1.2	0.2
Lack of prenatal care	2.3	1.5–3.4	<0.001	2.4	1.7–3.4	<0.001
Maternal weight	0.9	0.9–1.0	0.1	1.0	0.9–1.1	0.6
Maternal height	0.9	0.9–0.9	0.01	0.9	0.9–1.0	0.4
Maternal BMI	0.9	1.0–1.0	0.7	1.0	1.0–1.0	0.7
Maternal MUAC<25	0.9	0.9–0.9	<0.001	0.9	0.9–1.0	0.06
Gender	1.0	0.9–1.1	0.6	0.9	0.8–1.2	0.5
Maternal hemoglobin level	0.9	0.8–1.0	0.5	0.7	0.6–1.0	0.07
Low birth weight				6.2	3.6–10.7	<0.001

Abbreviation: MUAC, maternal upper arm circumference.

significantly associated with perinatal mortality in univariate and multivariate analyses (Table 1).

Rate and predictors (primiparous status and maternal height) for low birth weight were comparable with previous reports from eastern and central eastern Sudan and neighboring Ethiopia [2–5]. In the present study the total perinatal mortality rate was 51 per 1000 births; most of these deaths were stillbirths and might have been labor-related deaths. In high-resource countries, intrapartum stillbirths comprise less than 10% of all stillbirths, while in low-resource countries higher proportions of stillbirths are thought to occur in the intrapartum period. In the present study, women who had not attended prenatal care had a 2-times higher risk of low birth weight and perinatal death. This is similar to previous observations in other African countries [6].

Future efforts should emphasize improving the education, nutrition, and attendance of women at prenatal care clinics, to prepare them and their families for the delivery, and to prevent and prepare for complications.

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Paper 2

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Epidemiology of cesarean delivery in Kassala, Eastern Sudan: a community-based study 2014 - 2015

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Original Article

Epidemiology of Cesarean Delivery in Kassala, Eastern Sudan: A community-based study 2014- 2015

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ABSTRACT

Background: Cesarean delivery is a main obstetrical operation and its rate should be optimized where the World Health Organization regards that a cesarean delivery rate of 5-15% is an optimal range, putting in consideration the necessity of the procedure as a life-saving intervention for both the mother and fetus.

Objectives: To investigate the epidemiology of cesarean delivery in Kassala, Eastern Sudan from December 2014 to March 2015.

Materials and Methods: A stratified, multistage, household survey was carried–out. Questionnaires were applied to gather mode of delivery and its determinants.

Results: Out of 303 women, 87 (28.7%), 100 (33%), 116 (38.3) were primiparous, secondiparous and multiparous, respectively, Mothers' age ranged from 13 to 48 with mean (SD) 27.79 (5.94) years. In logistic regression, elder women (OR=1.1, 95 CI= 1.01-1.34, p = 0.005), primparae (OR= 6.4, 95% CI = 1.3-31.8, p = 0.001) and women who had medical disease (OR= 2.9, 95% CI= 1.16-7.6, p= 0.023) were at higher risk to deliver by caesarean delivery.

Conclusion: The rate of cesarean delivery in Kassala in the current study is17.8% and the elder women, primiapare and women with medical disorders were at a higher risk to deliver by caesarean delivery.

Keywords: Cesarean, Kassala, pregnancy, Sudan.

Cesarean delivery is a major obstetrical operation and its rate should be optimized where the World Health Organization considers that a cesarean delivery rate of 5–15% is an optimal range, regarding the necessity of the procedure as a life-saving intervention for both the mother and fetus[1]. While a low rate of cesarean delivery indicates an unmet need for this operation, high rates suggest improper selection of the procedure itself and it has to be reduced. High cesarean delivery rates has been reported in advanced countries, such as the United States of America and Canada, in contrast to the low rates observed in low-resource setting e.g. sub-Saharan Africa where the cesarean delivery rates are not more than 3% of all deliveries in some settings[2,3]. Therefore, research on the epidemiology (rate, indications, risk determinants, and maternal and perinatal complications of cesarean delivery is important for health planners as well as for caregivers and practicing clinicians. There are much data on caesarean delivery for most of the countries in Africa[4-6], few published data are accessible on the epidemiology of cesarean delivery in Sudan[7]. Moreover the vast majority of the studies on caesarean delivery in Africa were hospital ones which might not reflect the true picture at the community level. Hence there is a need for community-based research that assesses caesarean delivery and yield data

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needed to adjust or readjust the practice in the particular settings. Therefore, this was a community –based study conducted at Kassala in Estern Sudan, to investigate the epidemiology of cesarean delivery and to add to our previous reports on caesarean delivery as well as reproductive health in this setting[7-10].

MATERIALS AND METHODS:

A stratified, multistage, household survey was conducted in Kassala, eastern Sudan from December 2014 to March 2015. Kassala is the capital of Kassala State. Kassala is 550 kg from Khartoum on Ethiopian-Eritrean border with 260000 inhabitants. In Kassala, there are 28 health centres and three hospitals providing health services Kassala state area is 42,282 Kilometres Square located in the eastern part of Sudan. The focused house (each one of ten houses out of 6 blocks in the stratum) was visited and the aim was to find women who deliver during the last six months. The second house (on the right) was chosen if the focused one contains no woman to be interviewed. Five medical officers were trained by the investigator to collect the data and how to administer the questionnaires. The data were collected through direct application of the questionnaires at community level. The recruited sample size during the study period was 303 mothers who gave birth in the last six months in Kassala. After acceptance to participate and fulfilling the inclusion criteria which included: accept to participate in the study, delivered within the last six months and available at the time of data collection. The study excluded any mother, who did not fulfill the above mentioned inclusion criteria. First, aninformed consent was obtained from study participants in their own language, then explaining the purpose of the study, and the right to refuse. The participants also were assured about the confidentiality of the data. Then after acceptance to participate in the study, a written consent was signed by the participant. The questionnaire was used to gather the background information (age, parity, education, place of living, husband education and occupation etc), medical disease e.g. diabetes, hypertension, mode of the delivery (vaginal or cesarean).

Statistical analysis:

Data were entered in SPSS and double checked before analysis. The results were illustrated in tables and text by calculating the means and standard deviation (SD) for continuous variables, and frequencies and percentages for categorical variables to describe the participants' responses. Continuous and categorize data were compared between the women with cesarean and vaginal delivery using t-test and X^2 test, respectively. Logistic regression was conducted with cesarean delivery was the dependent variable and the other variables were the independent variable (age, parity, education, residence, and the newborn gender) Odds ratio, 95% CI were calculated and p value < 0.05 was considered significant.

Ethical considerations:

The ethical approval was obtained from Ministry of Health, Kassala State, Sudan.

RESULTS:

The socio-demographic characteristics of the participants

Three hundred and three women had complete data and analyzed in the results. Mothers` age ranged from 13 to 48 with mean (SD) 27.79 (5.94) years. Out of these 303 women, 87 (28.7%), 100 (33%), 116 (38.3) were primiparous, secondiparous and multiparous, respectively. The illiteracy among the total 303 women and their couples was 127 (41.9%) and 98 (32.3), respectively. About 41% of these women lived in rural areas. Male gender was dominating among the newborns (164, 54.1%). About one in tenth 29 (9.6) suffered from chronic problems during

pregnancy, e.g. diabetes mellitus 2 (0.7%), hypertension 7 (2.3%), and others 7 (6.6%). Regarding paternal occupation, about similar numbers of the parents were employed by the government 83 (27.4%) and the rest of the parents 84 (27.7%) were freelancers, and the rest of 303 worked as private employees 61 (20.1%), farmers 46 (15.2%), labour 13 (4.3%) and others 16 (5.3%).

Fifty four out of the 303 delivery were caesarean delivery and the rest by vaginal delivery giving the rate of 17.8%.

The mean (SD) of the age was significantly higher in women who delivered by cesarean [29.2(5.4) vs. 27.3 (6.0) years, 0.036]. Compared to vaginal deliveries, a significantly higher number of women who delivered by cesarean were primipare, educated, resided in a rural area and were employed, Table 1.

In logistic regression, elder women OR=1.1, 95 CI=1.01-1.34, P = 0.005, primparae (OR= 6.4, 95% CI =1.3-31.8, P = 0.001) and women who had medical disease (OR= 2.9, 95% CI= 1.16-7.6, P= 0.023) were at higher risk to deliver by caesarean delivery, Table 2.

Table 1: Demographic characteristic of cesarean delivery maternal responses in Kassala, eastern Sudan, 2014- 2015

Characteristic	Cesarean delivery (n=54)	Vaginal delivery (n=249)	P
Parity			
Primiparae	24 (44.4)	63(25.3)	
Parous (2-5)	27(50.0)	170(68.3)	0.018
Grandparity (> 5)	3(5.6)	16(6.4)	
Maternal education < secondary level	26(48.1)	160(64.3)	0.021
Maternal occupation housewives	36(66.7)	199(79.9)	0.029
Paternal education< secondary level	22(40.7)	134(53.8)	0.560
Paternal occupation (Governmental employee)	26(48.1)	118(47.4)	0.519
Residence			
Rural	16(29.6)	108(43.5)	
Urban	38(70.4)	140(56.5)	0.040
Infant sex			
Male	25(46.3)	139(55.8)	0.131
Female	139	45.9	
Maternal medical history			
Diabetes	2	0.7	
Hypertension	7	2.3	
Others	20	6.6	0.051
No	9(16.7)	20 (8.0)	

DISCUSSION:

The main findings of the current study were the rate of cesarean delivery and the elder women, primiparae and women with medical disorders were at a higher risk to deliver by cesarean**.** We have recently shown that only 8% of deliveries were cesarean deliveries in Sudan using the data of the national survey[11]. Interestingly the rate of cesarean delivery was 20% in Sudan, which was based on national hospital-based surveys that were conducted in 1993[12]. We have recently observed that the rate of cesarean delivery

was 43.2% in a tertiary hospital in Khartoum, Sudan[7]. A much lower rate of cesarean delivery was reported in in neighboring Ethiopia where Fesseha *et al*.[5] observed that while the national population-based cesarean delivery rate was 0.6%, with regional rates varying from 0.2% to 9%. likewise, most of the African continent countries have a low rate of cesarean delivery (e.g. the rate of cesarean delivery was 4.5% in the Congo[6] and it was between 0.1% and 1% in Kenya, Rwanda, Southern Sudan, and Uganda[13].

In the current study elder women, primipare and women with medical disease were at higher risk to have cesarean delivery, similarly, a group of African researchers claimed the same finding[14], and this could be attributed to the fact that increased maternal age is linked to complicated pregnancy such as preeclampsia as we have shown in a previous research[15], moreover, chronic diseases like diabetes mellitus and hypertension are more likelier than younger ages. This is in contrast to our recent findings in the hospital based study where neither age nor parity was associated with cesarean delivery[7]. It is worth to be mentioned that in the later study obese women were at a higher risk to have cesarean delivery. We did not investigate the body mass index in the current study because women have already delivered and it would be difficult to recall their weight and height during the index pregnancy.

Table 2: Predictors for cesarean delivery using logistic regression analysis

Characteristic	OR	95% CI	P
Age	1.1	1.01-1.34	0.005
Parity			
Primiparae	6.4	1.3-31.8	0.001
Parous (2-5)	Ref	Ref	Ref
Grandparity (> 5)	1.6	0.40-6.911	0.481
Maternal education < secondary level	0.8	0.30-2.4	0.794
Maternal occupation housewives	0.6	0.29-1.4	0.300
Paternal education< secondary level	1.1	0.40-3.1	0.828
Paternal governmental employee	0.8	0.42-1.6	0.615
Residence	1.3	0.62-2.8	0.469
Infant sex	1.3	0.73-2.6	0.314
Maternal medical history	2.9	1.16-7.6	0.023

Some factors e.g. education, women`s job and residence showed an association with cesarean delivery in univariate analyses. It seems that these were confounders and disappeared during logistic regression. The plausible explanation for this is that educated women were most likely to be employed and were older. Thus age was the only factorthat persisted among these in logistic regression.

The limitations of this study were; its sample size was rather small, it failed to differentiate between elective and emergency cesarean and indications of caesareans were not investigated.

CONCLUSION:

The rate of cesarean delivery in Kassala in the current study is17.8% and the elder women, primiapare and women with medical disorders were at a higher risk to deliver by caesarean delivery.

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Paper 3

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Causes and risk factors of under-five children hospitalization in Eastern Sudan: a community-based study

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Causes and Risk Factors of Hospitalization among Under-five Children in Kassala, Eastern Sudan

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Abstract

BACKGROUND: According to the World Health Organization estimation, African Region deaths of all under-five deaths in 2015 were over 5 times higher in comparison to the European Region.

AIM: The study aimed to estimate the prevalence, investigate the possible causes and risk factors associated with under-five children's hospitalization in Kassala, Eastern Sudan.

METHODS: A community-based cross-sectional study was conducted from December 2015 to March 2016. The data were collected by interviewing mothers.

RESULTS: A total of 297 mother-child pairs participated in the study. The mean (SD) of maternal age and children's age was 27.6 (5.9) years and 16 (11.3) months, respectively. One hundred and three children were hospitalized over the past 6 months. The most common mentioned causes for the last hospitalization were gastroenteritis 28.1% (29/103), respiratory tract infections 19.4% (20/103), malaria 9.7% (10/103), and trauma 3.8% (3/103). In multivariable analysis, a high birth order (adjusted odds ratio [AOR] 1.25, 95% Confidence Interval [CI] (1.06, 1.47), low paternal education (AOR 2.89, 95% 1.32, 6.30), and bottle feeding (AOR 2.26, 95% CI 1.30, 3.80) were associated with under-five children's hospitalization.

CONCLUSIONS: More than one-third of the children were hospitalized in Eastern Sudan. Urgent action is required to address children's health issues (i.e., the above-mentioned causes and associated factors).

Introduction

According to the World Health Organization (WHO), in 2015, 4.5 million (75%) of all under-five deaths occurred within the 1st year of life and the highest risk was in the WHO African Region (55/1000 live births). This is over 5 times higher in comparison to the European Region (10/1000 live births) [1].

Based on the results of the previous studies on under-five children's hospitalization, the predictors of admission were non-exclusive breastfeeding; delay of initiation of breastfeeding; bottle-feeding; unemployed mothers; having two or more children; and complementary feeds given by a person other than the mother; prolonged rupture of membrane; place of delivery; intrapartum fever; and APGAR score <7 at 5th min [2], [3], [4], [5], [6], [7], [8], [9]. Likewise, exclusive breastfeeding and avoidance of bottle feeding have been documented as key predictors of child survival [9], [10], [11], [12]. Besides, child hospitalization has a heavy burden on the economy [4], [13]. The main causes of admission reported by the previous studies including Sudan were respiratory tract infections and gastroenteritis [2], [4], [5], [6], [7], [8].

Unfortunately, in Sudan, infants and young children are the most vulnerable ones among the population [2]. Child hospitalization rates, as well as causes and risk factors, have been studied in many countries [4], [5], [6], [14], [15], [16], [17]. However, little data exist in Sudan, especially in the most vulnerable and remote areas.

Kassala, located in Eastern Sudan, was selected to study children's hospitalization for several reasons. First, most of the available data in Sudan regarding child hospitalization were hospital-based studies [9], [18], [19]. Furthermore, the target area of Kassala State is categorized to be among the most vulnerable states where high rates of acute and chronic malnutrition have been reported, especially among children [20]. Most of the previous studies on children's hospitalization were carried out in the capital state of Khartoum and the nearby areas [18], [19] which is a relatively stable region. In contrast, Kassala is

characterized by refugees' settlement mainly from the neighboring country Eritrea from early eighth of the last century [21], [22]. It has had an influx of refugees from that time until now (i.e., according to the last report, influxes of refugees from Eritrea continue on average at a rate of approximately 2000 per month). This has increased Kassala's population and has put stress on the already limited resources [22], [23], [24]. The previous reports for both food [23] and security [25], as well as the recent report for food [26], have shown that Kassala is more vulnerable to humanitarian crises. In the context of food insecurity and unstable security, child morbidly and mortality, especially the under-fives, is found to be high and damaging [27], [28], [29], [30], [31], [32]. Both food insecurity and unstable security are linked to each other [33] as unstable security limits the provision of food production and distribution as well as health-care provision such as child vaccination [29], [34]. Besides, the availability of data before the crisis is of paramount importance to build on when a crisis occurs.

Conducting such a study at a community-level in an area characterized by both food insecurity and unstable security is, therefore, of great importance toward identifying the magnitude of the problem and will ultimately provide the basis for a future community-based intervention. Sudan is one of those developing countries where the rationale use of resources should always be strategic. Furthermore, such kind of research is needed to understand the gap and to prioritize the interventions for child life saving which this study aimed to achieve.

The study aimed to estimate the prevalence of under-five children's admission to health-care facilities and to investigate the possible causes and risk factors over the past 6 months in Kassala, Eastern Sudan by collecting community-level data.

Methods

A two-stage random (using a computer-generated number) cluster study was conducted in Kassala, Eastern Sudan from December 2015 to March 2016. Kassala is the capital of Kassala State. Kassala is 550 km from Khartoum on Ethiopian-Eritrean borders. Kassala has an estimated population of 453,159 inhabitants [35]. In stage one, simple random sampling of the localities was performed to randomly identify the household. In stage two, random sampling of the households was done to identify subjects (under-five children).

The houses were mapped to select a representative sample. The main tool used to collect data, in this study, was a structured pre-tested questionnaire. The questionnaire was tested among 15 participants (i.e., not considered in the final data) and the necessary corrections were done accordingly. Five female medical officers were trained by the investigators to collect the data. The following inclusion criteria were set before conducting the study: Willingness to participate in the study, having under-five children (in case the mother had two children under-5 years and less, and the interview took place based on the youngest child), and availability at the time of data collection. The study excluded any mother, who did not fulfill the above-mentioned inclusion criteria.

A child was considered to be hospitalized when a child was admitted to a health-care facility complaining from any sickness and spent at least 24 h or more [36], [37]. A child admitted for <24 h was included in the study but considered as not having been admitted. For example, a child who came for routine immunization was not considered as child hospitalization and was included in the study as non-hospitalized.

The target participant was approached and before collecting any data, the following information was delivered by the interviewer to the participant, that is, the study purpose was explained, the right to refuse at any time, and the confidentiality of the obtained information. After participant acceptance and success in fulfilling the study inclusion criteria, a questionnaire was applied to collect relevant information from mothers through a face-to-face interview. The questionnaire was developed based on the previous studies [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19]. It included demographics (e.g., education, age, and occupation), mode of delivery (vaginal delivery, and cesarean delivery), infant's information (e.g., age, gender, and history of hospitalization over the past 6 months), and the main cause for hospitalization. For children who were hospitalized more than once, the cause of hospitalization was based on the last hospitalization.

A sample size of 309 participants was calculated using the assumption of the prevalence of (27.8%) which was reported in the previous community survey among children below the age of 5 years in Sudan [38]. This sample was selected to give 80% power with a precision of 5%.

Statistical analysis

The questionnaire was coded, for example, the main outcome variable (child hospitalization) was coded as (0) and (1) for not hospitalized and hospitalized, respectively.

Data were entered into the computer using Statistical Package for the Social Sciences version 20.0 for Windows, International Business Machines Corporation (IBM Corp, New York, United States), and double-checked before analyses. The results were illustrated in tables and text by calculating the means and SD for continuous variables, and frequencies and percentages for categorical variables to describe the participants' responses. t-test and Chi-square were applied for the

continuous and the categorical variable, respectively. Univariate analysis was applied with child hospitalization (hospitalized/not hospitalized) as the dependent variable and the other variables (age, parity, education, residence, mode of delivery, the new-born gender, etc.) as the independent variable. Moreover, variables with $p < 0.2$ were entered in multivariable analysis to control confounding variables. This cutoff $p < 0.2$ was chosen because being significant (i.e., the variable) in univariate analysis but not significant in logistic regression and vice versa is not uncommon, as it has been explained in the literature [39], [40]. Odds ratio (OR), adjusted OR (AOR), and 95% confidence interval (CI) were calculated. Variable with $p < 0.05$ was considered as significant.

Results

From the total (309) enrolled mother-child pairs, 297 (96.1%) had complete data. The mean (SD) of maternal age and children's age was 27.6 (5.9) years and 16 (11.3) months, respectively. Of these 297 participants, 122 (41.1%) were a rural, 269 (88.6%) were housewives, and 197 (66.3%) had education less than the secondary level. Twenty-eight (9.4%) of the mothers had medical disorders (diabetes, hypertension, and others). Less than half 137 (46.1%) of the children were females. More than half 161 (54.2%) of the children were institutional deliveries with a cesarean rate of 18.2%. One hundred and fifteen (38.7%) children were bottle-fed in the first 6 months.

Over the past 6 months, more than one-third of the children 34.7% (103/297) was hospitalized and spent 24 h or more at the hospital at least 1 time over the past 6 months.

The most commonly mentioned causes of hospitalization over the past 6 months based on the last hospitalization were gastroenteritis 28.1% (29/103), respiratory tract infections 19.4% (20/103), malaria 9.7% (10/103), and trauma 3.8% (3/103).

Residence and maternal education were found to be significant in univariate analysis only (Table 1).

In multivariable analysis (Table 2), a high birth order (AOR 1.25, 95% CI 1.06, 1.47), low paternal education (AOR 2.89, 95% 1.32, 6.30), and bottle feeding (AOR 2.26, 95% CI 1.30, 3.80) were associated with hospitalization of the under-five children.

Discussion

The main finding of the current study was that more than one-third (34.7%) of the studied children were hospitalized over the past 6 months. This prevalence was higher in comparison to the prevalence which was reported in Nigeria (9.7%) [14], in the United Arab Emirates (UAE) (10%) [15] and Ethiopia (21.5%) [16]. The difference could be due to the study methodologies as this is a community based one.

The commonly reported causes of admissions over the past 6 months were respiratory tract infections, gastroenteritis, and malaria. This is consistent with the previous reports in Sudan where the most common clinical presentations for under-five children were gastroenteritis, malaria, urinary tract infections, giardiasis, and tuberculosis [18], [41]. Likewise, the previous studies conducted in food insecurity areas showed that respiratory infection and gastroenteritis were the common causes of under-five children's hospitalization [17], [27], [32], [42].

Table 1: Socio-demographic characteristic of the under-five children's hospitalization in Kassala, Eastern Sudan (n=297)

Variable	Total (n=297) Child hospitalization (hospitalized n=103), (non-hospitalized n=194)			
	Mean (SD)	Mean (SD)	Mean (SD)	p-value
Maternal age, years	27.6 (5.9)	27.1 (6.3)	27.8 (5.7)	0.366
Child age, months	16.0 (11.4)	17.6 (11.9)	15.2 (11.1)	0.086
Birth order	2.5 (1.6)	2.9 (1.9)	2.3 (1.4)	0.006
	n (%)	n (%)	n (%)	
Child gender				
Male	160 (53.9)	55 (53.4)	105 (54.1)	0.905
Female	137 (46.1)	48 (46.6)	89 (45.9)	
Residence				
Rural	122 (41.1)	51 (49.5)	71 (36.6)	0.039
Urban	175 (58.9)	52 (50.5)	123 (63.4)	
Mode of delivery				
Cesarean	54 (18.2)	16 (15.5)	38 (19.6)	0.389
Vaginal	243 (81.8)	87 (84.5)	156 (80.4)	
Place of delivery				
Institutional	161 (54.2)	52 (50.5)	109 (56.2)	0.348
Home	136 (45.8)	51 (49.5)	85 (43.8)	
Bottle-feeding in the first 6 months				
Yes	115 (38.7)	52 (50.5)	63 (32.5)	0.002
No	182 (61.3)	51 (48.1)	131 (67.5)	
Maternal education				
<Secondary level	197 (66.3)	82 (79.6)	115 (59.3)	<0.001
≥Secondary level	100 (33.7)	21 (20.4)	79 (40.7)	
Paternal education				
<Secondary level	167 (56.2)	75 (72.8)	92 (47.4)	<0.001
≥Secondary level	130 (43.8)	28 (27.2)	102 (52.6)	
Maternal medical history				
Yes	28 (9.4)	12 (11.7)	16 (8.2)	0.339
No	269 (90.6)	91 (88.3)	178 (91.8)	
Maternal occupation				
Housewife	262 (88.2)	96 (93.2)	166 (85.6)	0.052
Employed	35 (11.8)	7 (6.8)	28 (14.4)	

Table 2: Multivariable logistic regression analyses of factors associated with the under-five children's hospitalization in Kassala, Eastern Sudan

Variables	Crude OR (95% CI)	AOR (95% CI)	p-value
Child age	1.02 (0.99, 1.04)	1.02 (0.996, 1.043)	0.101
High child order	1.23 (1.06, 1.43)	1.25 (1.06, 1.47)	0.011
Residence			
Rural	1.67 (1.03, 2.71)	1.10 (0.62, 1.95)	0.738
Urban (reference)			
Bottle feeding			
Yes	2.12 (1.30,3.46)	2.26 (1.3, 3.8)	0.002
No (reference)			
Maternal education			
<Secondary level	2.68 (1.54, 4.69)	1.21 (0.50, 2.89)	0.677
≥Secondary level (reference)			
Paternal education			
<Secondary level	2.97 (1.77, 4.98)	2.89 (1.32, 6.30)	0.009
≥Secondary level (reference)			
Maternal occupation			
Housewife	2.31 (0.97, 5.50)	1.13 (0.40, 3.17)	0.820
Employed (reference)			

CI: Confidence interval, AOR: Adjusted odds ratio, OR: Odds ratio.

The current study showed a high rate of bottle feeding (38.7%) and children who were bottle-fed were

at 2.26 higher risk of hospitalization. In Khartoum, among bottle-fed infants, 100 and ten bacterial species including *Escherichia coli* were isolated from contents [43]. Many studies documented that poor breastfeeding practices (e.g., using bottle feeding) were the main key risk factor for children's hospitalization mainly due to respiratory tract infection and gastroenteritis[2], [4], [5], [6], [7], [8], [9]. Breastfeeding, particularly when exclusive and prolonged, protects against severe morbidities such as diarrhea and respiratory infections [4]. Various studies documented that bottle-feeding is associated with child morbidity (e.g., diarrhea, respiratory infection, and allergies) and mortality [9], [10], [43], [44], [45], [46]. For example, in Sudan, bottle-fed children were at high risk of malnutrition and hospitalization due to infectious causes as 83.3% of hospitalized children used bottle feeding [9].

The result of the current study showed that high birth order was a risk factor for child survival. In line with the current results, high birth order was reported by many studies in different countries including Sudan as a key risk factor for poor children's health due to morbidity and mortality [9], [47], [48], [49], [50]. This could be explained by the fact that high parity and extensive periods of breastfeeding presumably result in deletion of the reserved maternal nutrition such as anemia [51], and this could lead to a low birth outcome with its catastrophic effects [52]. In addition, in Sudan, Ibrahim, and Nabag found that the majority of the under-five malnourished children had increased birth order (i.e., their birth order was second and above). They attributed the effects of higher birth order on child health to access to less food and reduced time received per child [9].

The study showed that paternal education level (≥ Secondary level) was higher in comparison to maternal education 43.8% and 33.7%, respectively. Such variations between paternal and maternal education in Sudan have been reported previously [9]. This variation of education levels was also reflected in the employment rate as only 12% of the mothers were employed. This may raise the issue of gender inequality in both education and employment. In Africa, education gender-based inequality is not only confined to the years and level of education but also in the provided quality of the education itself, that is, poor quality for girls at schools [53].

Unlike maternal education, high level of paternal education was found to be a protective factor of child hospitalization. In line with the current results, other studies reported that maternal education does not influence the incidence of child morbidity and mortality [53], [54]. Interestingly, Sudan Household Health Survey 2000 revealed a positive correlation between maternal education and incidence of diarrheal diseases, that is, high maternal education level associated with a high rate of diarrheal diseases [41]. In contrast, the previous studies in different regions of Sudan including the study area revealed that maternal education was associated with poor perinatal and maternal outcomes [55], [56]. This contradiction could be due to the complex relationship between parental education and child health and the necessity of the presence of others preconditioning factors (e.g., equity, and women empowerment), for education to be more effective in improving knowledge, the income, and child survival [50], [53], [57].

For example, regardless of maternal education, a child of an educated father was more likely to be vaccinated against measles [58]. The influence of paternal education on child hospitalization could be explained by the small family size (i.e., less birth order) as the evidence provided by the literature is that educated parents desire smaller families than those with less education [59], [60]. By having fewer children more time and care can be given to each child. Besides, parents with higher education level may have more chances of employment, as well as better socioeconomic status, better food security status, accessibility to health insurance, and more knowledgeable about child health [58], [59], [61], [62]. Thus, we can conclude that factors such as low paternal education and high child order are correlated. Therefore, in Sudan, the impacts of parent education on infants and young child health need to be explored through more research.

In this study, residence in rural or urban areas was not significantly associated with child hospitalization. In contrast to another study [63], residence showed associated with children's hospitalization only in the univariate analysis. A recent study in Bangladesh revealed that disparity between urban and rural residency regarding child health has decreased over time [50].

The study has given valuable information regarding child hospitalization. However, the study had some limitations such as recall bias and the causes of child hospitalization were only based on the mother's memory (i.e., not on hospital records). In addition, the comorbidities among the reported causes are not uncommon [42], [64], [65], [66] and even among children who were hospitalized for more than 1 time over the past 6 months different causes were observed between the first and second hypostatization; and the children's weights were not measured as they have been done in the previous studies [2], [4], [5], [6], [7], [8]. Furthermore, the study investigated only living children that were hospitalized and it failed to trace children who were hospitalized and died.

Conclusions

More than one-third of the children were hospitalized in Eastern Sudan. The most common

mentioned causes of hospitalization were gastroenteritis, respiratory tract infections, malaria, and trauma. A high birth order, paternal education, and bottle feeding were associated with hospitalization of the under-five children. Urgent action is required to address children's health issues as the situation is fragile and unpredictable and the consequences will be more severe, if the situation worsens in the future.

Authors' Contributions

AAH, ZT, and IA designed the study and participated in the manuscript drafting. MAA, ZT, and AAA collected the data. AAH, AAA, and IA conducted the statistical analyses. All authors read and approved the final manuscript

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Assessment of initiation of breastfeeding practice in Kassala, Eastern Sudan: a community-based study

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Abstract

Background: The World Health Organization (WHO) encourages early initiation of breastfeeding within the first hour after birth with the objective of saving children's lives. There are few published research papers about factors associated with the initiation of breastfeeding in Sudan.
The aim of this study was to investigate the prevalence of and factors associated with the timely initiation of breastfeeding among mothers with children two years and under in Kassala, Eastern Sudan.

Methods: A community-based cross-sectional study was conducted from December 2016 to March 2017. Mothers were interviewed using a structured questionnaire.

Results: A total of 250 mother-child pairs participated in the study. The mean (standard deviation) of maternal age and children's age was 27.1 (5.68) years and 11.9 (6.9) months, respectively.
Of the 250 mothers, 218 (87.2%) initiated breastfeeding within the first hour. In multivariable logistic regression analysis, factors associated with the delay of breastfeeding initiation were having a male baby (Adjusted Odds Ratio [AOR] 3.90, 95% Confidence Interval [CI]1.33, 11.47), and mothers with medical disorders (AOR 5.07, 95% CI 1.22, 21.16).

Conclusion: There was a high prevalence of early initiation of breastfeeding. An association with delayed initiation of breastfeeding was found amongst mothers who had medical disorders and those who had a male infant. Wherever possible, early initiation of breastfeeding should be promoted for all infants, regardless of gender.

Keywords: Timely initiation of breastfeeding, Early initiation of breastfeeding, Maternal medical disorders, Sudan

Background

According to the United Nations Children's' Fund (UNICEF) [1], the first 1000 days of a child's life (9 months of pregnancy plus the first 2 years of life) is considered to be a crucial period. In countries with fewer resources such as Sudan, children two years and under are the most vulnerable in terms of morbidity and mortality [2, 3]. These children are vulnerable to malnutrition, gastroenteritis and respiratory tract infections [2–6]. A study published in 2015 documented high rates of malnutrition among children in Khartoum who were either not breastfed or were weaned early [6]. The children of Kassala are categorized as among the most vulnerable in Sudan where high rates of acute and chronic malnutrition were reported, especially among children [7]. The main reported causes of childhood hospitalisation in previous studies which include Sudan were respiratory tract infections and gastroenteritis [2, 8–12]. Predictors of hospital admission were identified as non-exclusive breastfeeding, delayed initiation of breastfeeding, maternal unemployment, having two or more children, complementary feeds given by a person other than the mother, prolonged rupture of membranes, home delivery, intrapartum fever, and Apgar score < 7 at 5 min [2, 8–13]. Likewise, early initiation of breastfeeding and exclusive breastfeeding are documented as key predictors of infant survival [14, 15].

Aiming to save children's lives, the World Health Organization (WHO) developed a set of recommendations, including: Skin-to-skin' at or as soon as possible after the birth, and unrestricted access to the breast thereafter to enhance the initiation of breastfeeding and the establishment

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of an adequate milk supply [16]. The WHO rated initiation of breastfeeding based on the percentage of babies breastfed within one hour of birth as follows: (0–29%), (30–49%), (50–89%), (90–100%) to poor, fair, good and very good, respectively [17]. Varying rates of initiation of breastfeeding were 17.7 and 98.4% [18–22].

Early initiation of breastfeeding promotes exclusive breastfeeding by enhancing bonding, increasing the likelihood of breastfeeding success, and generally extending breastfeeding duration [16, 17, 23].

Poor breastfeeding practices such as delayed initiation, low rates of exclusivity, and early weaning have been documented in previous studies undertaken in different regions of Sudan including Kassala [5, 24–26]. In addition to more recent reports these practices have been noted previously. A 1993 publication identified one urban and rural community study including the eastern region of Sudan where 27.1% of mothers weaned their infants before 12 months [27].

Although many studies in Sudan identify delayed breastfeeding initiation [19, 28], none report the factors associated with initiation of breastfeeding. Moreover, most of the available data about breastfeeding in Sudan is hospital-based [4, 27, 28] Investigating initiation of breastfeeding at community-level would help identify the factors which lead to early weaning and delayed breastfeeding initiation. Community based research is more efficient in yielding data needed for future community-based interventions.

The aim of this study is to investigate the prevalence of breastfeeding initiation and associated factors among mothers of infants aged two and under in Kassala, Eastern Sudan.

Methods

A two-stage random cluster study was conducted in Kassala, Eastern Sudan between December 2016 and March 2017. Stage one, simple random sampling of the localities was performed to randomly identify households. Similarly, stage two, random sampling of the household was used to identify participants (children aged two years or less). Kassala has an estimated population of 453,159 inhabitants of which 55% live in urban areas, with 33,604 and 52,853 households in urban and rural areas, respectively [29]. Houses were mapped to select a representative sample. The main tool used to collect data in this study was a structured questionnaire. Three female medical officers were trained by the investigators to collect the data. Before data collection the questionnaire was tested among 10 mothers (not included in the final sample) and the necessary corrections were done. The following inclusion criteria were set before conducting the study: willingness to participate, having a child of two years or younger (where there were two children aged two or younger, the interview was based on the youngest child), and availability at the time of data collection.

The time for the initiation of breastfeeding was measured by asking the mother about the time at which her current child was put to the breast after delivery (within one hour or more than one hour of delivery) [16, 19]. Initiation of breastfeeding with one hour or more than one hour was considered as early and delayed initiation respectively. The questionnaire was coded with the outcome variable (initiation of breastfeeding) as (0) and (1) for early and delayed initiation of breastfeeding, respectively.

Eligible participants were approached and the purpose of the study explained. Participants signed the study consent form after assurance was provided regarding the confidentiality of any information gained and the right to withdraw at any time clarified. After the participant's acceptance and fulfilment of the study inclusion criteria, a face-to-face interview was conducted using a structured questionnaire.

The questionnaire included demographic information (maternal age, education, occupation), place of delivery (home, institutional) mode of delivery (vaginal delivery, caesarean delivery), and medical disorders such as diabetes in pregnancy, hypertension in pregnancy and asthma, delivery details; infant information (e.g. age in months, gender, child order, history of hospitalization, and the main reason for hospitalization.

Breastfeeding information about the index child was collected (e.g. initiation of breastfeeding, breastfeeding difficulty, etc.).

The calculated sample size was 250 participants using an assumption of 79.6% prevalence of early initiation of breastfeeding [30]. This sample was selected to give 80% power with a precision of 5%.

Statistical analysis

After the data were collected, the questionnaires were checked and all participants ($n = 250$) found to have complete data. Data were entered into the computer using Statistical Package for the Social Science (SPSS0 version 20.0 for Windows) and double checked before analysis. The results were illustrated in tables and text calculating the means and standard deviation (SD) for continuous variables, frequencies and percentages for categorical variables to describe participant response. T-test and Chi-square test were applied to analyse continuous and categorical data, respectively. Variables with P-value of < 0.2 in univariate analysis were entered in multivariable logistic analysis with delayed initiation of breastfeeding as the dependent variable and the other variables such as age, birth order, education, residence, maternal medical disorders, mode of delivery, child gender, etc. as the independent variables. Odds Ratio (OR) and

95% Confidence Intervals (CI) were calculated. *P*-value < 0.05 was considered as significant.

Results

A total of 250 mother-child pairs participated in the study. The mean (SD) of maternal and infant age was 27.1 (5.68) years and 11.9 (6.9) months, respectively. Maternal age ranged from 13 to 40 years and 40 (16%) of the women were ≤ 20 years. Twenty seven percent of participants were primiparous.

Of the 250 participants, 218 (87.2%) initiated breastfeeding within the first hour of delivery. Of 218 mothers who initiated breastfeeding within 1 h, 165 (66%) did so immediately and the remainder 53 (21.2%) within 1 h.

Only 11.2% (28/250) of the mothers were employed (government employed ($n = 26$), private ($n = 1$), own business ($n = 1$)). Almost all ($n = 27$) mentioned that there was no lactation room in their work place and 6/28 (21.4%) of the employed mothers complained about the lack of cooperation of their employers regarding breastfeeding issues (providing flexible work hours). One-fifth of the participants, 55 (22%), faced breastfeeding problems such as nipple problems, and mastitis.

Of the 250 participants, 103 (41.2%) were rural residents, 193 (77.2%) were housewives and 171 (68.4%) had received less than secondary level education. Twenty–three (9.2%) of the mothers had medical disorders (diabetes in pregnancy ($n = 2$), hypertension in pregnancy including pre-eclampsia ($n = 5$) and other ($n = 16$). Less than half 114 (45.6%) of the children were females. Over three-quarters of the children, 207 (82.8%) were delivered vaginally and the remainder 43 (17.2%) by caesarean section. Ninety four percent of infants born vaginally initiated breastfeeding within the first hour of delivery compared to 77% of infants born by caesarean section ($p = 0.024$).

One-hundred and forty six (58.4%) of the mothers had received breastfeeding education provided by healthcare personnel during pregnancy and/or after the delivery.

About one-third, (88/250) 35.2%, of the children were hospitalized at least once in the last 6 months and spent 24 h or more at the hospital. The most common reasons for hospitalization were respiratory tract infections, gastroenteritis, and malaria. Ninety three percent of infants hospitalized had initiated breastfeeding within the first hour of delivery, compared to 84% who weren't hospitalized ($p = 0.052$).

The child age, number of children less than five years, residence, mode of delivery, having received breastfeeding education, and paternal education level and occupation were found to be associated with initiation of breastfeeding in bivariate analysis only (Table 1).

In multivariable logistic regression analysis (Table 2), factors associated with the delay of breastfeeding initiation were male baby (Adjusted Odds Ratio [AOR] 3.90, 95% CI 1.33, 11.47), and maternal medical disorders (AOR 5.07, 95% CI 1.22, 21.16).

Discussion

The main finding of the current study was the rate of early initiation of breastfeeding (87.2%) within one hour of delivery. This rate was higher compared with the national rate (68.7%) in Sudan [19], Eastern Sudan (45.8–76.6%) [28, 31]. This rate (87.2%) is recognized by the WHO as "good" (between 50 and 89%) [17], but is low compared with 92.8% in Khartoum [4] and 90.6% in Kassala, in eastern Sudan [26]. Variations in breastfeeding rates even within the same country have been reported before in Ethiopia [32], where the highest rate was reported in Addis Ababa, (71.5%), and the lowest, (41.7%). in the Somali regional state. Low rates of early initiation of breastfeeding have been reported in other African countries, 34.7–78.3% in Nigeria [20, 21] and 51.8% in Uganda [22].

The current study showed that male infants were 3.9 times more likely to experience delayed breastfeeding initiation. This is in line with a previous study in Uganda [33]. The data regarding any relationship between infant gender and early initiation of breastfeeding are contradictory, previous studies in Turkey and India report that boys were fed earlier than girls [34, 35]. This could be explained by the difference in cultures, for example, in Sudan, it was observed after delivery of a male baby, the family members would give him more care in comparison to a female baby by handling the male baby first and then pass him to the mother for breastfeeding and this may cause delaying of initiation of breastfeeding among male babies. Moreover, male infants are at higher risk of preterm birth and morbidity, respectively [36, 37] and these factors are associated with delayed initiation of breastfeeding [38–40]. Although, the gestational age at birth was not mentioned, in one hospital in Sudan, high rates of preterm births were reported in 2010 and about one fifth of the total preterm births identified as medically indicated (iatrogenic) [41]. This could be explained by maternal medical disorders such as preeclampsia and premature infants requiring hospitalization, both circumstances which may lead to delayed initiation of breastfeeding.

The study found that mothers with medical disorders and their infants were more likely to experience delayed initiation of breastfeeding. Inconsistent with the current results, delayed initiation of breastfeeding was observed among mothers with medical disorders such as diabetes and hypertension [18, 42]. In an African context, among maternal medical disorders, maternal human immunodeficiency virus (HIV) was found as a key barrier to early initiation of breastfeeding [43–45]. In Mauritius, despite

Table 1 Characteristics of participants in Kassala, Eastern Sudan

Variables		Total		Initiation of breastfeeding Early ($n = 218$) Delayed ($n = 32$)					
		Mean (SD)		Mean (SD)		Mean (SD)		Odds Ratio (95% Confidence Interval)	*P*-value
Maternal age, years		27.1 (5.7)		26.9(5.65)		28.3 (5.8)		1.04(0.97, 1.11)	0.186
Child age, months		11.9 (6.9)		12.2 (6.8)		9.2 (6.86)		0.93(0.88, 0.99)	0.019
Birth order		2.4(1.5)		2.4(1.5)		2.0(1.46)		0.81(0.60, 1.09)	0.179
Number of children < 5 years		1.7(0.7)		1.7(0.73)		1.4(0.66)		0.45(0.24, 0.85)	0.012
Number of breastfeeding per day		7.4(3.4)		7.5(3.58)		6.2(1.68)		0.87(0.76, 0.99)	0.442
		N	%	N	%	N	%	OR (95% CI)	*P*-value
Child gender	Male	136	54.4	111	81.6	25	18.4	0.29 (0.12, 0.70)	0.004
	Female	114	45.6	107	93.9	7	6.1		
Residence	Rural	103	41.2	95	92.2	8	7.8	2.29 (0.98, 5.33)	0.054
	Urban	147	58.8	123	83.7	24	16.3		
Living with extended family	Yes	126	50.4	109	86.5	17	13.5	0.88 (0.42, 1.85)	0.741
	No	124	49.6	109	87.9	15	12.1		
Mode of delivery	Vaginal	207	82.8	185	89.4	22	10.6	2.54 (1.10,5.86)	0.024
	Caesarean	43	17.2	33	76.7	10	23.3		
Place of delivery	Institutional	136	54.4	114	83.8	22	16.2	0.49 (0.22, 1.10)	0.081
	Home	114	45.6	104	91.2	10	8.8		
Received education on breastfeeding by healthcare personnel	Yes	146	58.4	120	82.2	26	17.8	0.29 (0.11, 0.73)	0.006
	No	104	41.6	98	94.2	6	5.8		
Faced breastfeeding difficulties	Yes	55	22	50	90.9	5	9.1	1.44 (0.52, 3.96)	0.472
	No	195	78	168	86.2	27	13.8		
Maternal education	<Secondary level	171	68.4	149	87.1	22	12.9	0.98 (0.44, 2.18)	0.964
	≥Secondary level	79	31.6	69	87.3	10	12.7		
Paternal education	<Secondary level	145	58.0	133	91.7	12	8.3	2.60 (1.21, 5.60)	0.012
	≥Secondary level	105	42.0	85	81.0	20	19.0		
Maternal medical disorders	Yes	23	9.2	16	69.6	7	30.4	0.28 (0.10, 0.75)	0.008
	No	227	90.8	202	89.0	25	11.0		
Maternal occupation	Housewives	193	77.2	165	85.5	28	14.5	0.44 (0.14, 1.32)	0.137
	Employed	57	22.8	53	93.0	4	7.0		
Paternal occupation	Employed	124	49.6	116	93.6	8	6.5	3.41 (1.46, 7.92)	0.003
	Non-employed	126	50.4	102	81.0	24	19.0		
Child hospitalization	Yes	88	35.2	82	93.2	6	6.8	2.45 (0.96, 6.22)	0.052
	No	162	64.8	136	84.0	26	16.0		

the fact that 60.6% of mothers initiate breastfeeding, low rate of exclusive breastfeeding in the first six months were documented (17.9%) [46]. Several studies identify the positive influence of breastfeeding education for successful breastfeeding [47–49].

In spite of a high rate (17.2%) of caesarean delivery in this study, an association between caesarean delivery and early initiation of breastfeeding was not identified. This may be because the sample size was not powered to show a difference. Previous studies have shown that caesarean delivery was a key barrier for early initiation of breastfeeding in different settings [18, 21, 22, 33, 43, 50–52]. When compared to planned caesarean delivery, emergency caesarean delivery was found to be associated with delayed initiation of breastfeeding [53]. Further categorizations of caesarean delivery (planned/ emergency) are vital to be taken into consideration in future research [53].

This study show no association between the delayed initiation of breastfeeding and child hospitalization. This might be explained by the poor outcomes for the hospitalised children (i.e. the deaths) which the current study failed to trace. A larger sample may have shown evidence

Table 2 Multivariable logistic regression analyses of factors associated with delay initiation of breastfeeding among mothers with child of two years and less in Kassala, Eastern Sudan

Variables		Adjusted Odds Ratio	95% Confidence Interval	*P*-value
Maternal age, years		1.07	0.97, 1.19	0.185
Child age, months		0.95	0.88, 1.02	0.122
Birth order		0.75	0.49, 1.15	0.181
Number of children < 5 years		0.61	0.29, 1.27	0.187
Child gender	Male	3.90	1.33, 11.47	0.013
	Female	Reference		
Residence	Rural	0.75	0.24, 2.28	0.606
	Urban	Reference		
Mode of delivery	Vaginal delivery	0.63	0.17, 2.30	0.483
	Caesarean delivery	Reference		
Place of delivery	Institutional	2.36	0.78, 7.19	0.130
	Home	Reference		
Received education on breastfeeding by healthcare personnel	Yes	1.42	0.41, 4.92	0.583
	No	Reference		
Paternal education	< Secondary level	0.48	0.16, 1.44	0.192
	≥ Secondary level	Reference		
Maternal medical disorders	With	5.07	1.22, 21.16	0.026
	Without	Reference		
Maternal occupation	Housewives	1.58	0.39, 6.44	0.527
	Employed	Reference		
Paternal occupation	Employed	0.34	0.11, 1.05	0.061
	Not employed	Reference		
Child hospitalization	Yes	1.47	0.45, 4.84	0.523
	No	Reference		

for such an association. For future research in this area larger sample size, more detail about the main reasons for hospitalization and inclusion of both mothers in the community in addition to those in hospital would be of value.

Although we have found that 59% of the mothers received breastfeeding education during the pregnancy course and/or after the delivery in logistic regression breastfeeding education was not found to be associated with breastfeeding initiation. Previous studies have shown that mothers who have received breastfeeding education were more likely to have initiate early breastfeeding [54, 55]. This could be explained by the fact that, even among the mothers who had received information about breastfeeding by healthcare personnel, more than half of them learned about breastfeeding from family members as well. Perhaps the influence of the family member on the mothers was more powerful than healthcare personnel. For example, in Myanmar, traditional beliefs that exclusive breastfeeding is not sufficient for babies and that solid foods and water were necessary are identified as barriers to the initiation of breastfeeding [56]. Moreover, in Sudan, even among healthcare workers, capacity-building regarding breastfeeding practices need to be improved [57]. To ensure the reliability of breastfeeding information, healthcare workers may require education about the provision of breastfeeding education. Involving family members in discussion about breastfeeding in a respectful and inclusive manner may help correct inaccurate information and help to share accurate information in a culturally appropriate manner.

In the current study, there was no association between maternal age, parental educational level or occupation and the initiation of breastfeeding. Previous studies have shown that parental education [54, 55, 58–60], occupation [59] and maternal age [58] were associated with initiation of breastfeeding. The variations of the associated factors among studies could be due to the influence of such factors on the family socioeconomic status. For example, paternal occupation could influence early initiation of breastfeeding through improving family income as high socioeconomic status was found to be associated with early initiation of breastfeeding [35, 61–64].

Although the sample size of the employed mothers among the study participants was small in comparison to studies in Ghana and Uganda [22, 65], this study highlighted two main issues, the low employment rate among the study participants and the lack of support for breastfeeding mothers who are employed. For example, some mothers faced breastfeeding problems related to work, these could be explained by several factors including poorly paid work, limited breastfeeding support in the workplace, excessive travel distance requiring long journeys between home and work and limited access to maternity leave. Further research with a larger sample size of the mothers of infants and young children would allow further exploration of the challenges experienced by women who wish to breastfeed and participate in the paid workforce.

Limitations

Study limitations included recall bias as mothers of children aged up to two years were asked for early infant feeding detail. Not tracing infant maturity status (term or preterm), gestational age, birthweight, reasons for and outcomes of infant hospitalization limited study analysis and outcomes - particularly as a recent systematic review and meta-analysis documented poor infant survival associated with delayed breastfeeding initiation [66].

Conclusion

The study concluded that the prevalence of early initiation of breastfeeding was 87.2% among mothers with children of two years or less in Kassala, Eastern Sudan. However, an association with delayed initiation of breastfeeding was found amongst mothers who had medical disorders and those who had a male infant. Wherever possible, early initiation of breastfeeding should be promoted for all infants' regardless of gender.

Abbreviations

AORs: Adjusted Odds Ratios; CI: confidence interval; SD: standard deviation; WHO: World Health Organization

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

AAH, ZT, and IA conceived and designed the study. MAA, AAA recruited the participants. AAH, ZT, MAA, AAA and IA analyzed the data and wrote the manuscript. All contributive authors of this original manuscript authorized the final version of the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The study received ethical approval from the Research Board at the Faculty of Medicine, University of Gadarif, Sudan. The reference number is 2015/11. Written informed consent was obtained from all the enrolled patients.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Publisher's Note

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Paper 5

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Assessment of Bottle-Feeding Practices in Kassala, Eastern Sudan: A Community-Based Study

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Abstract

BACKGROUND: The World Health Organization encourages exclusive breastfeeding up to six months and avoidance of bottle-feeding. There are few published research articles on the practice of bottle-feeding and associated factors in Sudan.

AIM: The study aimed to assess the usage and factors associated with bottle-feeding practices during the first six months of life among mothers with children aged between 6 and 24 months in Kassala, Eastern Sudan.

METHODS: A community-based cross-sectional study was conducted from July to September 2017. A structured questionnaire was used to collect relevant data from interviewed mothers.

RESULTS: A total of 242 mother-child pairs participated in the study. The mean (standard deviation) of maternal age and children's age was 27.13 (5.73) years and 12.2 (6.7) months, respectively. From the total, 96/242 (39.7%) used bottle-feeding for their children in the first six months of life. In multivariable analysis, urban residence (Adjusted Odds Ratio [AOR] 1.96, 95% Confidence Interval [CI] (1.06, 3.63), not receiving breastfeeding education (AOR 1.92, 95% CI 1.07, 3.45) and child hospitalization (AOR 1.83, 95% CI 1.02, 3.28) were significantly associated with bottle-feeding.

CONCLUSION: There was a high usage of bottle-feeding and it was found to be associated with child hospitalisation. To avoid bottle-feeding, urgent actions are required to support and educate mothers regarding breastfeeding with special attention to urban-residence ones.

Introduction

According to the United Nations Children's Fund (UNICEF) [1], the first 1000 days of a human being's life (nine months of pregnancy plus the first two years of life) are considered to be a crucial period. An inappropriately fed child is more vulnerable to malnutrition and its detrimental effects such as morbidity (diarrhoea and respiratory tract infections) and mortality [2], [3], [4].

Aiming to save children's lives, the World Health Organization (WHO) developed a set of recommendations, including exclusive breastfeeding up to six months and avoidance of bottle-feeding, safe complementary foods at six months and supporting mothers to practice this [5].

Various studies evidenced better cognitive development and intelligence quotients in breastfed infants compared to bottle-feed ones [6]. Previous studies have shown that bottle-feeding was a key factor for child morbidity and mortality in different settings [7], [8], [9]. For example, in the Philippines bottle-fed infants were found to be at high risk of hospitalisation due to infections [10].

The rate of bottle-feeding differs by country ranging from 15% in Nigeria [11] to 64% in Iraq [12]. Different reasons to practice bottle-feeding were mentioned by mothers such as mother's illness, breast-related health issues as well as perceived issues (i.e. perception of insufficiency of mother's milk) [13], [14]. Whatever the reason is for choosing

bottle-feeding, following the WHO recommendations, all mothers, even those who are HIV positive (the human immunodeficiency virus), can breastfeed their children [15]. In spite of the WHO adoption of the International Code of Marketing of breast-milk substitutes, still, poor adherence exists [16], [17], [18].

Breastfeeding education has been documented in many studies as an effective tool in promoting exclusive breastfeeding and avoidance of bottle-feeding in different settings [14], [19], [20]. Such breastfeeding education and support need to be directed to all mothers regardless of their residence and working status [21], [22]. Poor breastfeeding practices, such as low rates of exclusive breastfeeding, bottle-feeding and early weaning were documented in different regions of Sudan [23], [24], [25]. Early introduction of complementary feeding (i.e. before six months of age) was reported in Sudan [23], [26].

Our study aimed to examine bottle and breastfeeding practices amongst mothers in Kassala State, Eastern Sudan. Kassala State was selected to study breastfeeding patterns based on some factors. First is that most of the available data in Sudan about breastfeeding is derived from hospital-based studies [3], [26]. Also, the determinants of bottle-feeding are poorly understood, largely because this is an understudied area. Furthermore, the target area (Kassala State) is categorised as being amongst the most vulnerable regions with high rates of acute and chronic malnutrition, and most of the previous studies on breastfeeding were carried out in relatively more stable regions in the centre of Sudan [26], [27]. Kassala is more vulnerable to humanitarian crises as documented in many previous food and security reports [28], [29]. Also, the availability of data before the crisis is of paramount importance to build on them when a crisis occurred.

Therefore, the conduct of such a study at the community level, in an area characterised by both food insecurity and unstable security, is of great importance for the identification of the factors leading to bottle-feeding, which will ultimately provide the basis for future community-based interventions.

The study aimed to assess the usage and factors associated with bottle-feeding practices during the first six months of life among mothers with children aged between 6 to 24 months, at the community level in Kassala, Eastern Sudan.

Methods

A community-based cross-sectional study was conducted in Kassala, Eastern Sudan from July to September 2017. A two-stage random cluster study was used. Stage one, simple random sampling of the localities was performed to identify households randomly. Similarly, stage two involved random sampling of the household in identifying participants (any mother with a child aged between 6 to 24 months). Kassala has an estimated population of 453,159 inhabitants, of whom 55% live in urban areas, with 33,604 and 52,853 households in urban and rural areas, respectively [30]. Houses were mapped to select a representative sample. A structured questionnaire was used to collect relevant data from interviewed mothers. Two female medical officers were trained by the investigators to collect the data. The questionnaire was tested among 10 mothers (not included in the final sample), and the necessary corrections were completed before the field work. The inclusion criteria were as follows: willingness to participate in the study, having a child aged between 6 and 24 months (in case the mother had more than one child in this age group, she was interviewed about the youngest child) and availability at the time of data collection. The study excluded any mother who did not fulfil all of the inclusion mentioned above criteria.

The usage of bottle-feeding rate (%) was estimated based on the WHO definition for bottle-feeding: 'any liquid (including breast milk) or semi-solid food from a bottle with nipple/teat' [31]. In this study, the proportion of children aged between 6 and 24 months who were fed with a bottle during the first six months were considered as users of bottle-feeding, while others were excluded from this category. The first six months was specifically chosen because it is a period in which the infant should be exclusively breastfed [31].

A sample of 242 mother-child pairs was calculated based on the difference of the proportions of desired factors (education factor) which was assumed to be 61% vs 39% in the bottle user vs non-user. This sample has 80% power with a precision of 5% and assuming that 10% would not respond or have incomplete data.

Data were entered and analysed using the Statistical Package for Social Sciences (SPSS) version 20.0 for Windows (IBM Corp, New York, United States). The results were illustrated in tables and text by calculating the mean (M) and standard deviation (SD) for continuous variables, frequencies and percentages for categorical variables to describe the participants' responses. T-test and Chi-square test were used to analyse continuous and categorical data, respectively. Bivariate analysis was applied with bottle-feeding practice as the dependent variable (user/non-user of bottle-feeding) and the other variables (e.g. child gender, age, birth order, education, residence (rural/urban), mode of delivery (vaginal/caesarean birth), breastfeeding education (received/not received), child hospitalization (yes/no)) as the independent variables. Furthermore, variables with a P-value of < 0.25 were entered in multivariable analysis to control confounding variables [32], [33].

Odds Ratio [OR], Adjusted Odds Ratio [AOR] (Backward LR) and 95% Confidence Interval [CI] were calculated and a variable with a P-value < 0.05 was considered as statistically significant.

Results

A total of 242 mother-child pairs participated in the study (Table 1). The M and SD of mothers' age and children's age was 27.13 (5.73) years and 12.2 (6.7) months, respectively. Maternal age ranged from 13 to 45 years, and 20/242 (8.3%) were ≤ 18 years. Child's order ranged from 1 to 9 (2.40 ± 1.42), and 70/242 (28.9%) mothers were primiparous. From the total, 96/242 (39.7%) used bottle-feeding during the first six months of their child's life, 99/242 (40.9%) lived in a rural area, 186/242 (76.9%) were housewives, and 164/242 (67.8%) had education less than secondary level.

Table 1: Socio-demographic characteristics of the studied participants in Kassala, Eastern Sudan (N = 242)

Variables		Total	Bottle feeding practice users (N=96) Non-users (N=146)			
		Mean (SD)	Mean (SD)	Mean (SD)	Odds Ratio (95% Confidence Interval)	P-value
Maternal age, years		27.13 (5.73)	26.56 (5.63)	27.50(5.78)	0.97 (0.93, 1.02)	0.213
Birth order		2.40 (1.42)	2.41 (1.41)	2.40 (1.45)	1.01 (0.84, 1.20)	0.962
Number of children < 5 years		1.74 (0.73)	1.74 (0.73)	1.75 (0.73)	0.99 (0.69, 1.41)	0.942
Number of breastfeeding per day		7.31 (3.29)	7.59 (3.33)	7.12 (3.26)	1.04 (0.97, 1.13)	0.277
		N (%)	N (%)	N (%)	OR (95% CI)	P-value
Child gender	Male	131 (54.1)	51 (53.1)	80 (54.8)	1.07 (0.64, 1.79)	
	Female	111 (45.9)	45 (46.9)	66 (45.2)		0.799
Residence	Urban	143 (59.1)	61 (63.5)	82 (56.2)	1.36 (0.80, 2.31)	0.249
	Rural	99 (40.9)	35 (36.5)	64 (43.8)		
Living with extended family	Yes	125 (51.7)	51 (53.1)	74 (50.7)	0.91 (0.54, 1.52)	0.710
	No	117 (48.3)	45 (46.9)	72 (49.3)		
Mode of delivery	Caesarean delivery	42 (17.4)	20 (20.8)	22 (15.1)	1.48 (0.76, 2.90)	0.247
	Vaginal delivery	200 (82.6)	76 (79.2)	124 (84.9)		
Place of delivery	Institutional	132 (54.5)	52 (54.2)	80 (54.8)	1.03 (0.61, 1.72)	0.924
	Home	110 (45.5)	44 (45.8)	66 (45.2)		
Received breastfeeding education	No	99 (41.2)	49 (51.6)	50 (34.5)	2.02 (1.19, 3.43)	0.009
	Yes	141 (58.8)	46 (48.4)	95 (65.5)		
Faced breastfeeding difficulties	Yes	47 (19.8)	22 (23.9)	25 (17.2)	0.66 (0.35, 1.26)	0.291
	No	190 (80.2)	70 (76.1)	120 (82.8)		
Maternal education	< Secondary level	164 (67.8)	62 (64.6)	102 (69.9)	1.27 (0.74, 2.20)	0.390
	≥ Secondary level	78 (32.2)	34 (35.4)	44 (30.1)		
Paternal education	< Secondary level	138 (57.0)	56 (58.3)	82 (56.2)	0.92 (0.54, 1.54)	0.739
	≥ Secondary level	104 (43.0)	40 (41.7)	64 (43.8)		
Maternal medical disorders	Yes	20 (8.3)	8 (8.3)	12 (8.2)	0.99 (0.39, 2.51)	0.975
	No	222 (91.7)	88 (91.7)	134 (91.8)		
Maternal occupation	Housewives	186 (76.9)	71 (74.0)	115 (78.8)	1.31 (0.71, 2.39)	0.386
	Employed	56 (23.1)	25 (26.0)	31 (21.2)		
Paternal occupation	Governmental or private employed	121 (50.0)	51 (53.1)	70 (47.9)	0.81 (0.49, 1.36)	0.430
	Other than governmental or private employed	121 (50.0)	45 (46.9)	76 (52.1)		
Child hospitalization	Yes	79 33.3%	39 42.4%	40 27.6%	1.93 (1.11, 3.36)	0.018
	No	158 66.7%	53 57.6%	105 72.4%		
Weaned her child	Yes	54 (22.5)	20 (21.3)	34 (23.3)	1.12 (0.60, 2.10)	0.716
	No	186 (77.5)	74 (78.7)	112 (76.7)		

More than half of the mothers 132/242 (54.5%) of the children were institutional deliveries with a caesarean rate of 42/242 (17.4%), and 99/242 (41.2%) of the mothers did not receive breastfeeding education sessions.

Out of the 242 mothers, 54/242 (22.5%) had already weaned their children. The most common reasons mentioned by the mothers who had already weaned their children (N = 54), were pregnancy 11/54 (20.4%), appropriateness of the child's age for weaning 30/54 (55.5%), other reasons 13/54 (24.1%) such as child illness, mother illness, and return to work. Of those who did not wean yet (N = 188), 10/188 (5.4%) were planning to wean their children even before they reached the age of one year.

In multivariable analysis, urban residence (AOR 1.96, 95% CI 1.06, 3.63), not receiving breastfeeding education (AOR 1.92, 95% 1.07, 3.45) and child hospitalization (AOR 1.83, 95% CI 1.02, 3.28) were significantly associated with bottle-feeding during the first six months of the child's life (Table 2).

Table 2: Multivariable logistic regression analyses of factors associated with the use of bottle feeding among mothers with children aged between 6 to 24 months in Kassala, Eastern Sudan

Variables		Crude Odds Ratio (95% Confidence Interval (CI)	P-value	Adjusted Odds Ratio (95% CI)	P-value
Maternal age, years		0.96 (0.91, 1.01)	0.119	0.96 (0.91, 1.01)	0.111
Residence	Urban	2.03 (01.09, 3.79)	0.026	1.96 (1.06, 3.63)	0.032
	Rural (reference)				
Mode of delivery	Caesarean	1.80 (0.89, 3.64)	0.100	1.82 (0.90, 3.67)	0.095
	Vaginal (reference)				
Received breastfeeding education	No	1.83 (0.999, 3.33)	0.05	1.92 (1.07, 3.45)	0.029
	Yes (reference)				
Child hospitalization	Yes	1.84 (1.02, 3.29)	0.041	1.83 (1.02, 3.28)	0.042
	No (reference)				

Discussion

The usage of bottle-feeding in this study was 39.7% among all studied children. This is higher than the rates previously reported in central Sudan 20.5% [11], Nigeria 15% [19], Ethiopia 19.6% [26], Ghana 30.1% [34], and Namibia 35.7% [35]. Higher prevalence of bottle-feeding was reported in various studies, for example in Yemen 55% [36], and in Iraq 64% [12]. The high rates of bottle-feeding could be attributed to the degree of security instability in Eastern Sudan, or bottle-feeding experience gained in the past from donations (i.e. infant formula and other mother's milk substitutes) at the time of the previous humanitarian/refugee crisis in the area, and/or different methodologies as this is a community-based one. Therefore, in emergencies breastfeeding should be encouraged (i.e. psychosocial support) as much as possible and bottle-feeding should be avoided to save children's lives [37].

The current results showed that the risk of

bottle-feeding use amongst urban children was almost twice as much, compared to children in rural areas 1.96 (1.06, 3.63). In line with the current results, infants born to families residing in urban areas of Namibia [35], and Western Nepal [21], were at higher risk of bottle-feeding, 1.67 (1.26, 2.22) and 2.14 (1.37, 3.33), respectively. This could be attributed to the greater availability in urban areas of infant formulas at pharmacies as well as the promotion of these products by pharmaceutical companies through media, which is also abundant in urban areas. Therefore, the previous studies called for adoption and enforcement of the international code of marketing of breast-milk substitutes [17], [18]. Variations between rural and urban mothers regarding breastfeeding practices have been documented in many countries, including Sudan [38], [39]. Also, the work circumstances of mothers in urban areas are likely to motivate them to use bottle-feeding [22]. In particular, returning to work was documented as one of the weaning causes in the current study.

The results revealed that 99/242 (41.2%) of the mothers did not receive breastfeeding education sessions from healthcare personnel during pregnancy and/or after delivery, and these mothers had almost two times 1.92 (1.07, 3.45) the risk of bottle-feeding compared to mothers who received breastfeeding education. The prevalence of bottle-feeding among mothers who received and did not receive breastfeeding education were 46/141 (32%) and 49/99 (50%), respectively. This indicates that the prevalence of bottle-feeding practice is less likely to be among the breastfeed educated mothers by 18%. Previous studies have shown that breastfeeding education is effective in promoting exclusive breastfeeding and avoidance of bottle-feeding in different settings [14], [19]. Such education should be given to all mothers by healthcare workers to ensure reliability and most importantly, accuracy.

Furthermore, capacity-building regarding breastfeeding practices needs to be improved in Sudan, even among healthcare personnel [40]. Inadequate training of healthcare personnel was also reported in many other African countries including Ethiopia [41] and Nigeria [42]. Therefore, continuous breastfeeding education, ongoing support and encouragement from trusted family members or peers and healthcare personnel are essential for successful breastfeeding in future generations [43], [44].

In the present study, bottle-fed children were at higher risk of 1.83 (1.02, 3.28) of being hospitalised. Likewise, with the present results, previous studies [10], [26] documented the association between bottle-feeding and child morbidity. In Sudan, poor breastfeeding practice, including bottle-feeding has been associated with child morbidity and poor outcomes, i.e. deaths [2], [3], [4]. The risks of bottle-feeding for the children are as a result of contamination at any stage of food preparation, handling, storage and feeding [9], [24]. For example, among bottle-fed infants in Khartoum, 110 bacterial species including E. coli were isolated from bottle contents [45]. Even in certain circumstances where the bottle is used to deliver expressed mother's milk, there is still a risk from unsanitary methods of milk expression, with even worse consequences where fluid, other than expressed mother's milk, is delivered [9], [24]. Also, nipple confusion may happen when an infant has learned how to suck on the bottle and then struggles to adjust to sucking from the mother's breast [46]. Not only the contents of the bottle but also the material from which the bottle is made (e.g. plastic) can release toxic chemicals such as bisphenols, as it has been reported in recent studies including African countries (Cameroon and Nigeria) [47], [48]. Further research is required to overcome the limitations above and to investigate bottle content and composition (risk of exposure to bisphenols and other harmful substances).

The time at which bottle-feeding was introduced within the first six months and the reasons for bottle-feeding were reported to be addressed in the future intervention programs. Among the 96 mothers who introduced bottle-feeding in the first six months, it is clear that the first month 26/96 (27.1%), the fourth month 25/96 (26.1%), the fifth month 22/96 (22.9%), and other months 23/96 (23.9%) in descending order, were the most chosen times to introduce bottle-feeding, according to participant perception. Among the aforementioned 96 mothers, the most common reasons for bottle-feeding were insufficient breast milk 36/96 (37.5%), hot weather 20/96 (20.8%), maternal illness 14/96 (14.6%), work-related issues 12/96 (12.5%), child illness 9/96 (9.4%), and other reasons 5/96 (5.2%). The results of this study are in line with others in that the perception of insufficient mother's milk was reported by many authors as the main reason for bottle-feeding [13], [14]. Cultural reasons were also reported in the literature as mothers feel ashamed to breastfeed in front of strangers due to lack of privacy [14]. Identifying the reasons for bottle-feeding is of paramount importance for designing future breastfeeding education messages.

Unlike the current results, other factors such as maternal age [19], [26] mode of delivery [21], [49], parental education [11] and parents occupation [26] were reported to be significantly associated with bottle-feeding.

Our study tackled breastfeeding practices in an area which is characterised as a vulnerable area and provides valuable information which can be used to improve current breastfeeding practices. Our study has some limitations that need to be taken into consideration, including the possibility of recall bias. The study focused on one geographical area of Sudan (Kassala), so the results of this study cannot be generalised to the rest of the country. Moreover, the study failed to assess the feeding pattern of children

who were hospitalized and later died as the literature evidenced a strong correlation between bottle-feeding and child mortality.

In conclusion, the study showed high usage of bottle-feeding among mothers with children aged between 6 and 24 months in Kassala, Eastern Sudan. To avoid bottle-feeding and to improve child survival, urgent actions are required to support, promote, and educate all mothers regarding breastfeeding with special attention to those in urban residencies.

Ethics

The study was approved by the Research Board at the Faculty of Medicine, University of Gadarif, Sudan. Written informed consent was obtained from all the enrolled mothers.

Authors' contributions

AAH, ZT and IA designed the study and participated in the manuscript drafting. MAA, ZT and AAA collected the data. AAH, AAA and IA conducted the statistical analyses. All authors read and approved the final manuscript.

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Paper 6

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Prevalence and associated factors of caesarean section and its impact on early initiation of breastfeeding in Abu Dhabi, United Arab Emirates

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Article

Prevalence and Associated Factors of Caesarean Section and its Impact on Early Initiation of Breastfeeding in Abu Dhabi, United Arab Emirates

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Abstract: The World Health Organization (WHO) recommends the early initiation of breastfeeding. Research shows that factors such as mode of delivery may interfere with the early initiation of breastfeeding. However, data in the United Arab Emirates (UAE) on these findings is limited. Thus, the aim of this study was to describe the prevalence of caesarean sections (CSs) and evaluate their effect on breastfeeding initiation among mothers of children under the age of two years in Abu Dhabi. Data were collected in clinical and non-clinical settings across various geographical areas in Abu Dhabi during 2017 using consent and structured questionnaires for interviews with mothers. Data analysis included both descriptive and inferential statistics. Among the 1624 participants, one-third (30.2%) reportedly delivered by CS, of which 71.1% were planned, while 28.9% were emergency CS. More than half of all mothers (62.5%) initiated early breastfeeding. Multivariable logistic regression indicated factors that were associated positively with CS included advanced maternal age, nationality, and obesity. However, gestational age (GA) was negatively associated with CS. This study shows that the prevalence of CS is high in Abu Dhabi, UAE. CS is associated with lower early initiation rates of breastfeeding. The early initiation rates of breastfeeding were 804 (79.2%) 95% confidence interval (CI) (76.4, 82.0), 162 (16.0%) 95% CI (10.4, 21.6), and 49 (4.8%) 95% CI (1.2, 10.8) among vaginal delivery, planned CS, and emergency CS, respectively. Regarding the mode of delivery, vaginal were 2.78 (Adjusted Odd Ratio (AOR)): CI (95%), (2.17–3.56, $p < 0.001$) times more likely related to an early initiation of breastfeeding. CS in general, and emergency CS, was the main risk factor for the delayed initiation of breastfeeding. The study provides valuable information to develop appropriate strategies to reduce the CS rate in UAE. Maternal literacy on CS choices, the importance of breastfeeding for child health, and additional guidance for mothers and their families are necessary to achieve better breastfeeding outcomes.

Keywords: caesarean section; initiation of breastfeeding; maternal age; gestational age; United Arab Emirates

1. Introduction

The rate of caesarean section (CS) in the United Arab Emirates (UAE) has increased from 10% in 1995 [1] to 24% in 2014 [2]. The World Health Organization (WHO) [3] suggests a CS rate of 10%–15% of all live births, which is significantly lower than those reported in the UAE. Researchers suggest that the mode of delivery influences breastfeeding initiation and duration [4,5], and may influence subsequent breastfeeding and duration [6].

CS is well documented to be associated with suboptimal consequences related to both the mother and her infant's health [7,8]. Among those consequences reported, endometritis, hemorrhage, cystitis,

infant respiratory complications, and hypoglycemia [8,9] may have negative effects on breastfeeding. The effect of CS on the initiation of breastfeeding may be related to the adverse effects of anesthesia for both mothers and their newborns. Maternal distress, which often accompanies CS, may negatively affect the baby's feeding behaviors and breastfeeding outcomes.

An abundance of studies have shown that mothers who give birth via CS delivery may be less likely to breastfeed, and or more likely to delay breastfeeding initiation [10–12]. An early initiation of breastfeeding, i.e., within the first hour after delivery, has been recommended by the WHO as an important factor to extend breastfeeding duration [13–15]. An important practice recommended by the WHO, as part of the 10 steps of the Baby-Friendly Hospital Initiative (BFHI), is skin-to-skin contact [16]. To ensure this practice, the mother and her newborn infant must be conscious and fully awake. Therefore, babies born by CS may not benefit from skin-to-skin contact immediately after birth, and may be more susceptible to delayed breastfeeding [16]. Previous studies have found that delaying breastfeeding initiation that co-occurs with CS delivery is associated with factors such as mother–baby separation, impaired suckling skills, and insufficient milk production. This will ultimately impact the continuation of breastfeeding [10,17,18].

The health benefits of breastfeeding for mother and child have been well documented. Mothers who breastfeed their babies have a reduced incidence of type 2 diabetes mellitus, as well as breast and ovarian cancers [19]. Moreover, breastfed babies are less likely to develop childhood illnesses and obesity, and have higher levels of intelligence as an adult [20,21].

Following the WHO recommendations [14], the UAE has incorporated the Global Strategy for Infant and Young Child Feeding, and the Ministry of Health (MOH) has issued a national infant feeding policy [22]. This policy states that infants should be breast fed exclusively until six months of age and continue breastfeeding up to or beyond two years of age [22]. A previous study by Taha et al. revealed a breastfeeding initiation rate of 95.6% and early initiation of 62.5% [23]. However, only 7% of babies were still breastfeeding at six months of age, which prompted the authors to further investigate these findings.

Multiple studies from different countries on the effects of CS versus vaginal delivery on breastfeeding practices have shown contradicting results [24–27]. While some research has documented major barriers to breastfeeding after CS [28–30], other studies have indicated that CS had no effect on breastfeeding initiation [31,32] and duration [33]. Some studies reported that planned CS was associated with delayed breastfeeding [25,34] while others concluded the opposite [35].

Regardless of the discrepancies in previous results, CS will remain a significant and alarming concern, as it influences the initiation of breastfeeding. For a country such as the UAE, which follows the WHO recommendations of infants' and young children's feeding, but still encounters increased rates of CS deliveries, further investigation and more implementation is required to improve knowledge about predictive breastfeeding factors. Thus, the aim of this study was to describe the prevalence of CS and evaluate its effect on breastfeeding initiation among mothers of children under the age of two years in Abu Dhabi.

2. Materials and Methods

2.1. Participants and Data Collection

The sample for this study is based on secondary data from an original sample of clinical and non-clinical data obtained from mothers with at least one infant under the age of two years. Participants for the original study included UAE nationals and non-nationals in the Emirate of Abu Dhabi, which represents 87% of the geographical landmass of the UAE [36]. All data were collected between March and September 2017. The subjects were randomly selected from the community and seven out of a total of 11 maternal and child health centers serving children in Abu Dhabi Capital City (two rural, one suburban, four urban), which provided the possibility of data collection across various areas of Abu Dhabi. Among the 1578 mothers from the clinics who were invited to participate, 1555 mothers agreed

and were included in the study. Another 267 mothers from the community also agreed to participate in the study, resulting in a total sample size of 1822 mothers. The geographical distribution of the sample was 54%, 10.8%, and 35.2% of mothers recruited from rural areas, suburban areas, and urban areas respectively.

Mothers with young children attending the centers were approached by the trained bilingual (Arabic and English) female research assistants, who provided oral and written information about the study. Consenting mothers who met the inclusion criteria of having at least one child under two years of age were interviewed by the research assistants using a structured questionnaire.

2.2. Study Instrument

A pre-tested questionnaire included family demographics (e.g., education, age, nationality, occupation), child's information (e.g., birth weight and height, delivery mode), and infant feeding practices (e.g., initiation of breastfeeding, and rooming-in). Details of the methodology of the primary data have been previously described [23].

2.3. Study Inclusion and Exclusion Criteria

From the 1822 mother–child pairs, there were 1624 with complete data on all the variables of interest that were included in the analysis.

2.4. Statistical Analysis

Data analysis was conducted using Statistical Package for the Social Science (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.). Both descriptive and inferential statistics were used to analyze the data. T-tests and chi-square tests were applied to analyze continuous and categorical data, respectively. Variables with significant p-value (<0.05) in univariate analysis were entered in multivariable logistic analysis with mode of delivery (vaginal delivery was coded as 0 and CS was coded as 1) as the dependent variable. In addition, body mass index (BMI) was categorized to underweight, normal, overweight, and obese in order to establish which category was associated with CS. Other variables such as sociodemographic characteristic (e.g., age, parent education, occupation, child gender, etc.) were considered as the independent variables. Odds ratio (OR) and 95% confidence intervals (CIs) were calculated with a significance level of p-value < 0.05. Furthermore, multinomial logistic regression analysis was used to investigate the impact of each mode of delivery (vaginal delivery, planned and emergency CS) on the early initiation of breastfeeding.

2.5. Ethics

The original study from which this data was extracted was approved by the Research Ethics Committee at Zayed University UAE (ZU17_006_F). Additional clearance was obtained from the Abu Dhabi Health Services Company. Informed consent was obtained from all participants prior to any data collection. Several measures were taken to ensure privacy and confidentiality throughout the study period by excluding personal identifiers during data collection.

2.6. Definitions

Early initiation of breastfeeding: when the infant initiated breastfeeding within one hour after birth [37].

Delayed initiation of breastfeeding: when the infant initiated breastfeeding within more than one hour after birth.

Rooming-in: the child stays with mother in the same room during hospital stay.

Exclusive breastfeeding: the infant being fed only breast milk without any other oral intake, except medications and vitamins, for the first six months of life; it was calculated based on the last 24 h.

Breastfeeding support: the support and encouragement from family (mother, husband, other relatives, and other non-relatives) on breastfeeding

Breastfeeding advice and or discussion: any received information, positive or negative things about breastfeeding before or after delivery

Gestational age: a measure of the age of a pregnancy that is taken from the beginning of the woman's last menstrual period

Preterm birth: the birth of a baby at <37 weeks GA

Arab nationality: all Emirati mothers and other Arab ones

Non-Arab nationality: Asian mothers and other nationalities

Cesarean section: a surgical procedure in which incisions are made through a woman's abdomen and uterus to deliver her baby

3. Results

Secondary data analysis included 1624 samples from the original study, of which 491 (30.2%) participants reportedly delivered by CS, of which 349 (71.1%) delivered by planned CS, and 142 (28.9%) delivered by emergency CS (Figure 1).

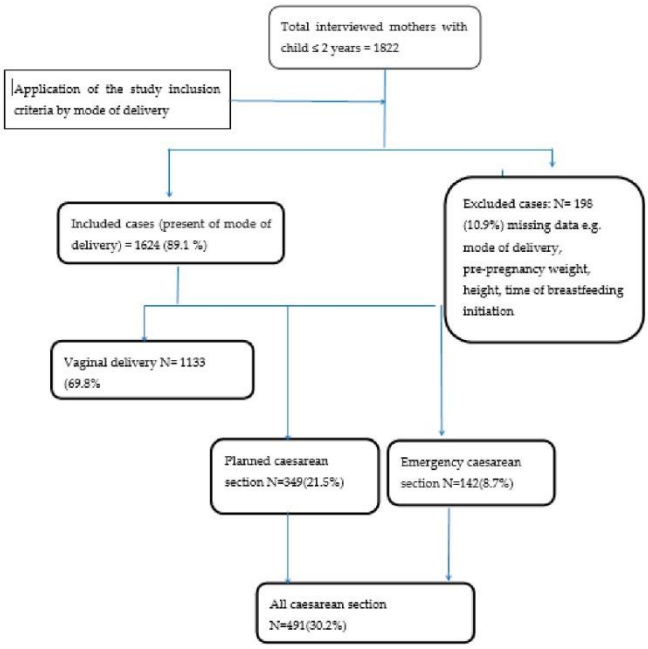

Figure 1. Study participants flow chart and main findings.

The mean and standard deviation (SD) of the mothers' age and children's age were 30.1 (5.2) years and 8.1 months (5.9), respectively. The mean (SD) gestational age at delivery was 39.1 (1.9) weeks, and 6.5% of infants were preterm (GA <37 weeks). More than half (62.5%) of the mothers initiated early breastfeeding. Bivariate analysis showed that child age, birth weight, pre-pregnancy BMI, maternal education, initiation of breastfeeding, and rooming-in were associated with the mode of delivery (Table 1). Exclusive breastfeeding among infants between 0–6 months was 46.5% (332/710).

Table 1. Bivariate analysis of factors associated with caesarean section among mothers with children two years old and younger in Abu Dhabi, United Arab Emirates (UAE).

Variables	Total (n = 1624)		Mode of Delivery: Vaginal (n = 1133)		CS (n = 491)		p-Value
	Mean (SD), range		Mean (SD)		Mean (SD)		
Maternal age, years	30.1(5.2)		29.9(5.3)		31.0(4.8)		<0.001
Child age, months (median 6, interquartile range 9)	8.1(5.9)		8.3(6.0)		7.6(5.7)		0.042
Gestational age, weeks	39.1(1.9)		39.4(1.7)		38.6(2.1)		<0.001
Birth weight, grams	3079(518)		3110(463)		3008(621)		<0.001
Mother pre-pregnancy BMI	23.9(3.8), (15.2, 64.9)		23.7(3.7)		24.3(4.2)		0.002
	N	%	N	%	N	%	
Child Gender							
Male	799	49.2	560	49.4	239	48.7	0.781
Female	825	50.8	573	50.6	252	51.3	
Nationality by category							
Arab	1056	65.0	757	66.7	299	60.9	0.049
Non-Arab	568	35.0	376	33.3	192	39.1	
Marital status							
Married	1602	98.6	1116	98.5	486	99.0	0.440
Unmarried	22	1.4	17	1.5	5	1.0	
Initiation of breastfeeding							
Delayed initiated	609	37.5	329	29.0	280	57.0	< 0.001
Early initiated	1015	62.5	804	71.0	211	43.0	
Rooming-in							
Yes	1562	96.2	1101	97.2	461	93.9	0.002
No	62	3.8	32	2.8	30	6.1	
Mother's education							
Secondary level	65	4.0	53	4.7	12	2.4	0.035
≥secondary level	1559	96.0	1080	95.3	479	97.6	
Father's education							
<Secondary level	31	1.9	23	2.0	8	1.6	0.588
≥secondary level	1593	98.1	1110	98.0	483	98.4	
Mother occupation							
Housewives	1008	62.1	695	61.3	313	63.7	0.533
Employed	616	37.9	438	38.7	178	36.3	
Child order							
1st order	1038	63.9	399	35.2	187	38.1	0.269
>1st order	1038	63.9	304	61.9	304	61.9	

Multivariable logistic regression analysis indicated that several factors were positively associated with caesarean section (CS). These included: advanced maternal age (Adjusted Odd Ratio (AOR) = 1.04, 95% confidence interval (CI) = 1.02, 1.07), nationality (non-Arab) (AOR = 1.30, 95% CI = 1.02, 1.65), and body mass index (BMI) status (obesity) (AOR = 1.79, 95% CI = 1.15, 2.79). Gestational age (GA); however, (AOR = 0.80, 95% CI = 0.75, 0.86) was found to be negatively associated with CS (Table 2).

Table 2. Multivariable logistic regression analyses of factors associated with caesarean section among mothers with children two years old and younger in Abu Dhabi, UAE.

Variable		Adjusted Odds Ratio	95% Confidence Interval	*p*-Value
Advanced maternal age, years		1.04	1.02, 1.07	< 0.001
Gestational age, weeks		0.80	0.75, 0.86	<0.001
Child's birth weight, grams		1.00	1.00, 1.00	0.283
Nationality	Non-Arab	1.36	1.08, 1.71	0.009
	Arab	Reference		
Maternal education	≥Secondary	1.88	0.94, 3.75	0.072
	<Secondary	Reference		
Mother pre-pregnancy BMI	Underweight (<18.5)	1.12	0.56, 2.26	0.746
	Normal (18.5–24.9)	Reference		
	Overweight (25–29.9)	1.10	0.85, 1.42	0.477
	Obese (≥30)	1.79	1.15, 2.79	0.010

From the total (1624), 1133 (69.8%), 349 (21.5%), and 142 (8.7%) delivered vaginally, by planned CS and by emergency CS, respectively. Among mothers who initiated breastfeeding early (1015), the rates of an early initiation of breastfeeding were 804 (79.2%) 95% CI (76.4, 82.0), 162 (16.0%) 95% CI (10.4, 21.6), and 49 (4.8%) 95% CI (1.2, 10.8) for vaginal deliveries, planned CS, and emergency CS, respectively.

By using logistic regression analysis, the different impacts of each mode of delivery (vaginal, planned CS, and emergency CS), and their impact on early initiation of breastfeeding, the study findings showed that vaginal delivery mothers were most likely to initiate early breastfeeding, followed by planned CS and emergency CS delivery (Table 3).

Table 3. Impact of mode of delivery (vaginal delivery, planned CS, and emergency CS) in comparison to each other on an early initiation of breastfeeding using logistic regression analysis.

Mode of Delivery	95% Confidence Interval (CI)	*p*-Value	AOR [1] (95% CI)	*p*-Value	AOR (95% CI)	*p*-Value
Vaginal delivery	4.5 (3.16, 6.61)	< 0.001	2.78 (2.17, 3.56)	< 0.001	Reference	
Planned CS	1.64 (1.09, 2.46)	0.017	Reference		0.36 (0.28, 046)	< 0.001
Emergency CS	Reference		0.61 (0.41, 0.91)	0.017	0.22 (0.15, 0.32)	< 0.001

[1] AOR: Adjusted for advance maternal age, gestational age, and mother's BMI.

4. Discussion

One of the main findings was the high rate of CS (30.2%). This rate is more than double in comparison to the WHO set upper limit of 15% [3], and three times that of rates previously reported in the UAE (10% in 1995%) [1]. These data support the WHO reports that the rate of CS is increasing [2]. The results from this study exceed those for other Arab nations such as Saudi Arabia where a low rate of CS was reported (13.7%) [38] and Sudan (17.8%) [39]. Researchers attributed the varying trend of CS rate among nations to multiple factors including affluence [40], urbanization [40], and increases in preterm births [41]. For example, Boatin et al. [42] reported a low CS rate in South Sudan of 0.6% in comparison to the Dominican Republic, which reported 58.9%. CS rates also vary between public and private hospitals [43,44], which may be attributed to access to care.

This study indicated that non-Arab mothers were 1.3 times more likely to deliver by CS compared to Arab mothers. In multinational countries such as the UAE, the interpretation of such differences requires additional research. It should be noted that maternal age among non-Arab mothers was higher than Arab mothers, which may have contributed to the increased rates of CS in this group.

Advanced GA was found to be a protective factor for CS, (AOR 0.80, 95% CI = 0.75, 0.86) i.e., full-term babies were less likely to have been delivered by CS in comparison to preterm babies, which

is a finding that is supported by previous research [41,45]. In addition, advanced maternal age was found to be associated with preterm birth [46–48]. Thus, we can conclude that factors such as advanced maternal age, preterm birth, and nationality are correlated.

In contrast to our results, previous studies have found birth weight [43,49] and maternal education [40,49] to be associated with mode of delivery. Differences in the scope and approach to data collection may limit the ability to adequately compare current results with previous studies and warrant additional research.

As with previous findings [50–52], the current study found an increased risk of CS in obese women. However, overweight was not associated with CS, and the findings of the current study were confined to the obese mothers. Regardless of the association between obesity and CS, it is well documented that maternal obesity is associated with a decreased intention and initiation of breastfeeding, a shortened duration of breastfeeding, a less adequate milk supply, and a delayed onset of lactogenesis II, and can thus be considered as a risk factor for adverse breastfeeding outcomes [53–55].

In addition to the CS prevalence and its associated factors, including the breastfeeding ones, the study also documented the impact of each mode of delivery on breastfeeding initiation. In line with others, the present results documented CS as a key risk factor for the delayed initiation of breastfeeding [24,28,56,57]. The researchers attributed the delay to many reasons, including pain [28], delayed lactogenesis [56], and feeding the newborn with formula [28,57].

The current study found that women who had a vaginal delivery 4.57 (3.16, 6.61) versus planned CS delivery 1.64 (1.09, 2.46) were four times more likely to initiate breastfeeding early. This finding is in line with several studies that documented vaginal delivery to be associated with an early initiation of breastfeeding [26,28–30]. This finding supports previous research that suggests rooming-in as a factor for the early initiation of breastfeeding, and CS decreases that opportunity.

However, controversy exists between planned CS and emergency CS. Some researchers propose that planned CS is associated with a delayed initiation of breastfeeding [34] while others report that emergency CS is associated with a delayed initiation of breastfeeding [35], similar to our findings. The delayed initiation of breastfeeding after emergency CS could be attributed to the stress accompanying the labor and delivery, which is associated with a delayed onset of lactation [35].

Our study is the first of this kind in the UAE, using clinical and non-clinical data to describe CS and the initiation of breastfeeding. Several limitations should be noted. First, maternal indications and/or fetal indications of CS such as fetal distress, the type of anesthesia (general or regional) used during CS, and maternal and child condition such as morbidity and history of hospitalization after delivery by CS were not reported. These issues can affect the mode of delivery and its effect on breastfeeding practices. Future studies are needed to better describe the factors associated with CS in UAE populations.

5. Conclusions

This study suggests that the prevalence of CS is high in Abu Dhabi, UAE and that CS is associated with advanced maternal age, GA, nationality, and obesity. CS, and emergency CS in particular, was the main risk factor for a delayed initiation of breastfeeding. The study provides valuable information to aid with the development of appropriate strategies to reduce the CS rate in the UAE. Maternal literacy on CS choices, the importance of breastfeeding for child health, and additional guidance so that mothers and their families can achieve better breastfeeding outcomes are recommended to ensure successful breastfeeding practices.

Author Contributions: Z.T. designed the study and recruited the participants. Z.T. and A.A.H. analyzed the data and wrote the manuscript. L.S. and D.P. contributed to the design of the study, data collection, and manuscript writing. All contributing authors of this original manuscript authorized the final version of the manuscript. All authors read and approved the final manuscript.

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Paper 7

Under title:

Factors associated with delayed initiation and cessation of breastfeeding among working mothers in Abu Dhabi, the United Arab Emirates

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ORIGINAL RESEARCH

Factors Associated with Delayed Initiation and Cessation of Breastfeeding Among Working Mothers in Abu Dhabi, the United Arab Emirates

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Introduction: Despite the enormous benefits of breastfeeding, working mothers face more challenges to meet the World Health Organization (WHO) recommendations regarding successful breastfeeding practices. Little research has been done to understand the breastfeeding practices among working mothers in the United Arab Emirates (UAE). Thus, the aim of this study was to investigate the prevalence and factors associated with delayed initiation and cessation of breastfeeding among working mothers with children under the age of two years in Abu Dhabi, the UAE.

Methods: A cross-sectional multicenter study was conducted from March to September 2017. The study included both Emirati and non-Emirati mothers of children below the age of two years. The data were collected from seven government health care centers in Abu Dhabi as well as from the community. Mothers with young children attending the centers during the study days were approached by trained research assistants, who provided oral and written information about the study.

Results: Among the 1610 mother–child pairs with complete data who were included in this study, 606 were working mothers giving an employment rate of 37.6%. The mean (standard deviation) of maternal age and children's age were 30.9 (5.1) years and 8.6 (6.1) months, respectively. Of the 606 mothers, 217 (35.8%) delayed initiation of breastfeeding, and 359 (59.2%) ceased breastfeeding. In multivariable logistic regression analysis, factors associated with delayed breastfeeding initiation among working mothers were older mother age (adjusted odds ratio [AOR] 1.04, 95% confidence interval [CI]1.01, 1.08), being of non-Arab nationality (AOR 2.24, 95% CI 1.53, 3.27), caesarean section (AOR 2.70, 95% CI 1.84, 3.96), non-rooming-in (AOR 3.85, 95% CI 1.56, 9.51) and mothers with low birth weight children (AOR 2.47, 95% CI 1.23, 4.94). The main factors associated with cessation of breastfeeding were being of non-Arab nationality (AOR 1.59, 95% CI 1.09, 2.31) and mother with high-income rating (AOR 2.79, 95% CI 1.36, 5.75).

Conclusion: The study highlighted the need for urgent actions to improve the working mothers' conditions in order to promote optimal breastfeeding practices, including both early initiation and continuation of breastfeeding among all mothers in the UAE regardless of employment status. Policies to improve EBF rates among professional working mothers should include maternity leave extension to enable mothers to continue breastfeeding.

Keywords: working mother, initiation of breastfeeding, cessation of breastfeeding, caesarean section, rooming-in, low birth weight, United Arab Emirates

Introduction

The World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) recommend early initiation of breastfeeding within one hour of birth,[1] exclusive breastfeeding (EBF) for the first six months of life,[2] and introduction of

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complementary foods at six months together with continued breastfeeding up to two years of age or beyond.[3]

The importance of early breastfeeding initiation has been well documented as one of the main steps for promoting exclusive breastfeeding for six months of life as well as the overall duration of breastfeeding.[4] Provision of breast milk to infants within one hour of birth is referred to as "early initiation of breastfeeding," and it ensures that the infant receives the colostrum, or "first milk", which is rich in protective factors.[5]

Exclusive breastfeeding up to six months is part of the optimal breastfeeding. The benefits of EBF for the first six months have been well documented in providing infants with optimal nutrition, growth, and development.[3]

Continuing breastfeeding for prolonged durations beyond six months also contributes to infants and young children's health and well-being as it has been found to be associated with several optimal infants and maternal health outcomes.[6] It was shown to provide a continuous essential source of energy and nutrients for children aged 6–23 months. Studies have shown that breastfeeding reduces the onset of childhood diseases and may protect infants and young children from diarrhea and respiratory infections, as well as malnutrition,[7] while the immunological component of breast milk provides infants with a strong immune system.[8]

The UAE health authorities have consistently made efforts to promote breastfeeding and encourage mothers to breastfeed their babies. Nationwide efforts have been initiated and implemented in hospitals, health centers, and the community.[9] At each level of these health care systems, several breastfeeding policies and guidelines have been developed to promote breastfeeding and increase the exclusive breastfeeding rate.

However, the recommendation of breastfeeding could be challenging for employed mothers.[10,11] Several studies in different parts of the world reported low rates of exclusive breastfeeding among working mothers.[12–14] Mother's return to work often negatively affects the consistency of breastfeeding practices. The rate of EBF is higher among mothers who are not employed compared to those employed.[15] Studies showed that maternity leave is positively associated with the duration of breastfeeding.[16,17]

Since early initiation of breastfeeding has been recommended to promote successful breastfeeding, it would be imperative to assess this important practice among working mothers. Another study found that women employed full time were less likely to initiate breastfeeding compared to mothers who were unemployed/students, after adjustment for confounding factors [adjusted rate ratio (aRR) = 0.92; 95% confidence interval (CI) 0.89, 0.96].[18] Moreover, evidence from an additional study found that among employed mothers, those who returned to work within four months postpartum were less likely to start breastfeeding compared to women who returned at 5 or 6 months [aRR = 0.95; 95% CI 0.92, 0.99].[18] Additionally, women who returned within the first six weeks were much less likely to start breastfeeding [aRR = 0.85; 95% CI 0.77, 0.94]. Additionally, data from a study in the United States that included 817 women aged 18 and older, using logistic regression, revealed that the odds of breastfeeding initiation were higher for women who held professional jobs, were primiparae, had a graduate degree, did not smoke prenatally, had no breastfeeding problems, and had family or friends who breastfed.[19] Finally, a study in Ethiopia revealed the requirement of women to return to paid employment was the main reason for the discontinuation of EBF.[20]

The UAE has been ranked one of the most-developed countries globally with sustainable growth in many fields, including economy, trade, investment and communications, infrastructure, and human and social development. Women play an important role in this progress. The female labor force participation rate in the UAE development has shown a remarkable increase from 1990 to 2019 with a rate of 28.09% and 52.39%, respectively.[21] Therefore, maternal employment rates in the UAE have increased rapidly in recent years, and little is known about how this influences women's breastfeeding initiation.

Regardless of the health providers' extensive efforts in the UAE to promote breastfeeding practices, the country is still experiencing a breastfeeding rate below the target recommended by the WHO, which is 50%.[22] Studies have identified several barriers to optimal breastfeeding practices in the UAE. They include insufficient milk production and breastfeeding problems eg, nipple problem, mother's age, education, delivery mode, and non-rooming.[23]

The aim of this study was to investigate the prevalence and factors associated with delayed initiation and cessation of breastfeeding among working mothers with children under the age of two years in Abu Dhabi, the UAE.

Materials and Methods

Participants and Data Collection

The current study data were extracted from a cross-sectional study, where 1822 mothers of children below the age of two years were recruited from the community and health care centers located in different geographical areas in Abu Dhabi from March to September 2017. The study sample included Emirati and non-Emirati families. Seven governmental clinics that render maternal and child health services were approved for data collection. Mothers with young children attending the centers during the study were approached by trained female research assistants, who provided oral and written information about the study. Mothers, who met the inclusion criteria of having at least one child under two years of age, were interviewed by the research assistants using a structured questionnaire. A detailed description of the study design and sampling has been published elsewhere.[24] The study was approved by the research ethics committee of Zayed University (ZU17_006_F) and complied with the Declaration of Helsinki Ethical Principles for Medical Research. Additional ethical clearance was also obtained from the Abu Dhabi Health Services Company.

Study Instrument

The study instrument was a questionnaire that has been validated by conducting a pilot study utilizing face validity before distributing the questions. Participants were divided into two categories, namely early initiation, and delayed initiation. To describe the results, these two groups were compared based on factors that include: family demographics (eg, parent education, age, nationality), child's information (eg, child gender, birth weight, delivery mode, childbirth order), and infant feeding practices (eg, initiation of breastfeeding, cessation of breastfeeding and received breastfeeding advice during pregnancy). The questionnaire was designed in English and Arabic, using a cross-translation strategy, where a local Arabic speaker translated the English document into Arabic. The same procedure was repeated where another local Arabic speaker translated the questionnaire back to English without accessing the original translation. The final version of the instrument was prepared considering the errors that have been recognized and identified through the translation. More information about the study methodology was described in the previous study.[24]

Study Inclusion and Exclusion Criteria

This study included only working mothers who have less than 24 months babies from the data collected. All working mothers (governmental or non-governmental) with children under two years of age, who have completed data regarding sociodemographic factors (eg, age, education), pregnancy and factors related to the mode of delivery, and breastfeeding practices (eg, breastfeeding initiation and cessation) were included in this study.

Statistical Analysis

Data were analyzed by using Statistical Package for the Social Science (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.). Both descriptive and inferential statistics were used to describe the results. *T*-test and Chi-square tests were applied to analyze continuous and categorical data, respectively. Variables with significant p-values (<0.05) in univariate analysis were further analyzed using multivariable logistic analysis with the breastfeeding initiation as a dependent variable, ie early initiation of breastfeeding was coded as (0) and delayed as (1). Another dependent variable (cessation of breastfeeding), not the cessation of breastfeeding, was coded (0) and cessation of breastfeeding (1). If one of the cells contained zero in the univariate, eg, exclusive breastfeeding, it was not included in the logistic regression. The independent variables included: sociodemographic variables, such as maternal age, nationality, parent education, pre-pregnancy body mass index (BMI); pregnancy variables such as gestational age at delivery and receiving of breastfeeding advice during pregnancy; delivery variables such as mode of delivery (vaginal/caesarean birth), child variables such as gender, birth weight, and birth order; breastfeeding variables such as receiving of breastfeeding advice during pregnancy, rooming-in. Odds Ratio (OR) and 95% Confidence Interval (CI) were calculated. P-value < 0.05 was considered to be significant.

Operational Definitions

Operational definitions are shown in Table 1.

Results

From the original sample (N=1822), a total of 1610 mother-child pairs who had completed data that are required for the analysis of the current study were identified. Among the 1610 participants, 606 were working mothers giving an employment rate of 37.6%.

Table 1 Operational Definitions

Variables	Operational Definitions
Maternal age	Maternal age in years at the time of interview
Maternal education	Maternal higher level of education categorized <Secondary level and ≥Secondary level
Father education	Maternal higher level of education categorized <Secondary level and ≥Secondary level
Nationality	Arab nationality: included all Emirati mothers and other Arab. Non-Arab nationality: included Asian mothers and other nationalities.
Marital status	Married and unmarried
Pre-pregnancy BMI	The weight in kilograms divided by the square of the height in metres (kg/m2) (1). Based on the index, it was subcategorized to normal between 18.50 and 24.99, and abnormal (underweight <18.5, overweight 25–29.9 and obese ≥30)
Income rating	The mother rating the family's overall financial well-being as excellent, very good, good, fair, and poor
Received breastfeeding advice during pregnancy	Any received information, positive or negative things, about breastfeeding before or after delivery.
Mode of delivery	Vaginal or caesarian
Child gender	Male or female
Child order	1st child order and ≥ 2
Rooming-in	Mother and infant being placed in the same room immediately after leaving the delivery suite, and, in the case of CS, when the mother was able to respond to her infant. Not rooming-in: babies who were not in the same room with mother since the delivery time, or those who required separation out of rooming-in in the middle of the course due to poor condition of babies or due to maternal condition.
Exclusive breastfeeding	The infant being fed only breast milk without any other oral intake, except medications and vitamins, for the first six months of life.
Cessation of breastfeeding	The mother was asked during the interview direct question if the index child "is breastfeeding", yes or no was indication for stopping exclusive breastfeeding for children below 6 months and continued breastfeeding for others.
Initiation of breastfeeding	Early initiation of breastfeeding: Provision of mother's breast milk to infants within one hour of birth. Delayed initiation of breastfeeding: when the infant initiated breastfeeding within more than one hour after birth.
Gestational age at delivery	The duration of pregnancy in weeks, any baby delivered before 37 weeks of pregnancy was considered as preterm and ≥37 weeks as full-term baby.
Childbirth weight at delivery	The baby weight in grams immediately after delivery, any baby delivered with weight <2500 grams was considered as LBW; and ≥2500 grams as normal weight.

Frequency analysis showed that among the 606 working mothers, there were 217 (35.8%) who reportedly had delayed initiation of breastfeeding within more than one hour after birth and 359 (59.2%) who had already stopped exclusive or any breastfeeding. All mothers who were exclusively breastfeeding their children at the interview time 83 (13.9%) maintained breastfeeding (Table 2).

In multivariable logistic regression analysis, factors associated with delayed initiation of breastfeeding among working mothers were older mother age (Adjusted Odds Ratio [AOR] 1.04, 95% CI 1.01, 1.08), being non-Arab nationality (AOR 2.24, 95% CI 1.53, 3.27), caesarean section (AOR 2.70, 95% CI 1.84, 3.96), non-rooming-in (AOR 3.85, 95% CI 1.56, 9.51) and mothers with low birth weight children (AOR 2.47, 95% CI 1.23, 4.94) (Table 3).

Table 2 Sociodemographic Characteristics of the Studied Participants in Abu Dhabi, the United Arab Emirates (N=606)

Variables		Total (N=606)	Initiation of Breastfeeding			Cessation of Breastfeeding		
			Early (n=389)	Delayed (n=217)	P-value	Yes (n=247)	No (n=359)	P-value
		Mean (SD)	Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)	
Maternal age, years		30.9 (5.1) N(%)	30.4(5.4) N(%)	31.8 (4.5) N(%)	0.001 P-value	30.9(5.5) N(%)	30.9(4.8) N(%)	0.993 P-value
Maternal education	<Secondary level ≥Secondary level	24(4.0) 582(96.0)	20(5.1) 369(94.9)	4(1.8) 213(98.2)	0.051	15(6.1) 232(93.9)	9(2.5) 350(97.5)	0.027
Paternal education	<Secondary level ≥Secondary level	16(2.6) 590(97.4)	14(3.6) 375(96.4)	2(0.9) 215(99.1)	0.063	11(4.5) 236(95.5)	5(1.4) 354(98.6)	0.021
Nationality	Arab Non-Arab	418(69.0) 188(31.0)	295(75.8) 94(24.2)	123(56.7) 94(43.3)	<0.001	187(75.7) 60(24.3)	231(64.3) 128(35.7)	0.003
Marital status	Married Unmarried	588(97.0) 18(3.0)	378(97.2) 11(2.8)	210(96.8) 7(3.2)	0.782	237(96.0) 10(4)	351(97.8) 8(2.2)	0.195
Pre-pregnancy BMI	Normal BMI Abnormal BMI	389(64.2) 217(35.8)	246(63.2) 143(36.8)	143(65.9) 74(34.1)	0.513	145()58.7 102(41.3)	244(68.0) 115(32.0)	0.019
Income rating	<good ≥good	34(5.6) 572(94.4)	24(6.2) 365(93.8)	10(4.6) 207(95.4)	0.423	21(8.5) 226(91.5)	13(3.6) 346(96.4)	0.010
Received breastfeeding advice during pregnancy	Yes No	537(88.6) 69(11.4)	339(87.1) 50(12.9)	198(91.2) 19(8.8)	0.128	217(87.9) 30(12.1)	320(89.1) 39(10.9)	0.625
Mode of delivery	Vaginal Caesarean	430(71.0) 176(29.0)	312(80.2) 77(19.8)	118(54.4) 99(45.6)	<0.001	178(72.1) 69(27.9)	252(70.2) 107(29.8)	0.618
Child gender	Male Female	297(49.0) 309(51.0)	187(48.1) 202(51.9)	110(50.7) 107(49.3)	0.536	130(52.6) 117(47.4)	167(46.5) 192(53.5)	0.139
Child order	1st child order ≥2	206(34.0) 400(66.0)	266(68.4) 123(31.6)	134(61.8) 83(38.2)	0.099	75(30.4) 172(69.6)	131(36.5) 228(63.5)	0.118
Rooming-in	Yes No	578(95.4) 28(4.6)	381(97.9) 8(2.1)	197(90.8) 20(9.2)	<0.001	233(94.3) 14(5.7)	345(96.1) 14(3.9)	0.308
Exclusive breastfeeding*	Yes No	83(13.9) 516(86.1)	49(12.8) 334(87.2)	34(15.7) 182(84.3)	0.315	0(0.0) 242(100)	83(23.2) 274(76.8)	<0.001
Cessation of breastfeeding	Yes No	247(40.8) 359(59.2)	166(42.7) 223(57.3)	81(37.3) 136(62.7)	0.199	- -	- -	-
Initiation of breastfeeding	Early Delayed	389(64.2) 217(35.8)	- -	- -	-	166(67.2) 81(32.8)	223(62.1) 136(37.9)	0.199
Gestational age at delivery	Term (≥37 weeks) Preterm (<37 weeks)	566(93.4) 40(6.6)	369(94.9) 20(5.1)	197(90.8) 20(9.2)	0.053	225(91.1) 22(8.9)	341(95.0) 18(5.0)	0.058
Childbirth weight at delivery	Normal or large birth weight (≥2500 grams) Low birth weight (<2500 grams)	560(92.4) 46(7.6)	372(95.6) 17(4.4)	188(86.6) 29(13.4)	<0.001	223(90.3) 24(9.7)	337(93.9) 22(6.1)	0.101

Note: *Missing data.

Table 3 Multivariable Logistic Regression Analyses of Factors Associated with Delay Initiation of Breastfeeding Among Working Mothers with Children Under the Age of Two Years in Abu Dhabi, the United Arab Emirates

Variables		Delayed Initiation of Breastfeeding		
		Crude Odds Ratio (OR)(95% Confidence Interval (CI)	Adjusted OR (95% CI)	P-value
Maternal age, years		1.06(1.02, 1.09)	1.04(1.01, 1.08)	0.022
Nationality	Non-Arab Arab(Reference)	2.40(1.68, 3.42)	2.24(1.53, 3.27)	<0.001
Mode of delivery	Caesarean delivery Vaginal delivery(Reference)	3.40(2.36, 4.90)	2.70(1.84, 3.96)	<0.001
Rooming-in	No Yes(Reference)	4.84(2.09, 11.18)	3.85(1.56, 9.51)	0.003
Child birth weight at delivery	Low birth weight (<2500 grams) Normal or large birth weight (≥2500 grams) (reference)	3.38(181, 6.30)	2.47(1.23, 4.94)	0.011

Among the mothers who ceased breastfeeding (n=242), 56 of their children were ≤ 6 months old, 76 were >6 months −12 months, and the rest (110) were >12 months <24 months.

In multivariable logistic regression analysis, factors associated with cessation of breastfeeding among working mothers were being non-Arab nationality (AOR 1.59, 95% CI 1.09, 2.31), and mother with high-income rating (AOR 2.79, 95% CI 1.36, 5.75) (Table 4).

Discussion

The main findings of the current study were the estimation of the employment rate, prevalence, and factors associated with delayed initiation and cessation of breastfeeding among working mothers in Abu Dhabi, UAE.

The rate of employment was 37.6%. Higher rates are expected as the women workforce has considerably increased in the UAE, and women are continuously achieving good performance in many positions.[21]

Despite the low rate of employment of mothers in different countries, working mothers face more challenges in comparison to non-working mothers regarding breastfeeding practices, such as insufficient breastfeeding support from society and healthcare providers, short maternity leave periods, difficulties associated with combining

Table 4 Multivariable Logistic Regression Analyses of Factors Associated Cessation of Breastfeeding Among Working Mothers with Children Under the Age of Two Years in Abu Dhabi, the United Arab Emirates

Variables		Cessation of Breastfeeding		
		Crude Odds Ratio (OR)(95%Confidence Interval (CI)	Adjusted OR (95% CI)	P-value
Maternal education	≥Secondary level <Secondary level(reference)	2.51(1.08, 5.84)	2.11(0.89, 4.98)	0.088
Paternal education	≥Secondary level <Secondary level(reference)	3.30(1.13, 9.62)	2.82(0.96, 8.34)	0.060
Nationality	Non-Arab Arab(Reference)	1.73(1.20, 2.48)	1.59(1.09, 2.31)	0.016
Pre-pregnancy BMI	Normal BMI Abnormal BMI (abnormal)	1.49(1.07, 2.09)	1.38(0.98, 1.95)	0.067
Income rating	≥good <good (reference)	2.47(1.21, 5.04)	2.79(1.36, 5.75)	0.005

breastfeeding and other maternal responsibilities, and emotional stress.[25–27]

Among the 606 working mothers, 217 (35.8%) delayed initiation of breastfeeding. This delay was found to be associated with various factors, namely, older maternal age, being of non-Arab nationality, caesarean section, non-rooming-in, and mothers with low birth weight children.

The rate of early initiation of breastfeeding (64.2%) was similar to the previously reported rates in Nepal (64%)[28] and in India (60%).[29] However, it was higher than the reported rate in the neighboring country Saudi Arabia (34.3%).[30] The discrepancy of rates among countries may be attributed to the influence of other interactions of sociodemographics such as maternal education and income[31] and obstetrical factors such as CS.[32]

In this study, the association between the high rate of early initiation of breastfeeding among working mothers and low EBF was similarly reported in previous studies.[12,13] For example, in Ghana, although 91% of the mothers early initiated breastfeeding, the EBF rate was low (10.3%).[12] This indicates that successful breastfeeding may require, besides early initiation of breastfeeding, other factors such as breastfeeding education, especially among working mothers.

The older age may contribute to delayed breastfeeding initiation through CS as there was an association between older age and CS.[13] Other studies reported a similar association between older age and CS.[32,33]

Interestingly, non-Arab mothers were more likely to delay initiation AOR=2.24 (1.53, 3.27) and to ceased breastfeeding AOR=1.59 (1.09, 2.31) in comparison to Arab ones. Breastfeeding practices variations, such as early initiation of breastfeeding among nationalities, were documented in previous studies, including the neighboring Kingdom of Saudi Arabia (KSA).[34,35] Furthermore, the rate of CS was high among non-Arab mothers.[36] This may negatively influence the early initiation[36] and cessation of breastfeeding[37] among non-Arab mothers. This indicates a need for more research to investigate such variations in breastfeeding practices among working mothers with different nationalities background, especially in a country like the UAE with a very diverse workforce.[21]

The results revealed that mothers' delivery via CS was almost three times at risk of delayed initiation of breastfeeding AOR=2.70 (1.84, 3.96). Likewise to the results in the literature, it was well documented that CS is the main risk factor of delayed initiation of breastfeeding among working and non-working mothers, including the UAE country and others.[38–42]

In most of the studies, including systematic reviews, CS has been reported as a well-documented risk factor for not initiating breastfeeding within the first hour of life, both in the UAE and in many other countries.[38–42] High CS rates have been correlated to many adverse effects, such as maternal mortality, neonatal mortality, infant mortality, LBW, and stillbirths.[43] In the current study, the rate of CS was high (30.4%). Therefore, any effort to reduce this high rate will ultimately improve breastfeeding practices, including early initiation and breastfeeding maintenance.

Non-rooming-in mothers were almost four times AOR 3.85 (1.56, 9.51) at risk of delayed initiation of breastfeeding. This is similar to the previous studies that have identified non-rooming-in among the most significant factors associated with non-breeding.[44,45] According to the WHO, mothers with healthy full-term babies, including those born with CS, should stay in the same room together for the entire duration of 24 hours, except for periods of up to an hour for hospital procedures, starting from the time they come to their room after delivery, or as soon as they can respond to their babies in the case of CS.[46] Several studies have found a strong association between rooming-in and improved breastfeeding outcomes.[47,48] Research shows the importance of rooming-in stems from the fact that following birth, whether, at home or at a hospital, mothers' and infants' physical and emotional needs for each other will continue. The more time the mother and newborn spend together, the better the breastfeeding practices. When together, mothers quickly learn their babies' needs and how best to care for, soothe, and comfort their newborns. Studies have revealed that mothers who room-in with their babies increase their milk production, breastfeed for longer periods, and are more likely to breastfeed exclusively compared to mothers who have limited contact with their infants (ie those with babies in the nursery at night).[49–51] Researchers agree that rooming-in is positively associated with successful breastfeeding practices. A study in the UAE reported that mothers who kept their infants in the same room after delivery had a successful rate of breastfeeding 6 times higher than mothers who kept their infants in separate rooms.[45]

Working mothers are at greater risk of delivering LBW infants, especially those exposed to unfavorable working conditions.[52] LBW infants face many breastfeeding problems. The present study has showed that LBW infants are

two and half times AOR=2.47 (1.23, 4.94) at risk of delayed initiation of breastfeeding compared to normal birth infants. This could be explained by the fact that LBW infants may need more care in the neonatal intensive care unit.[53] In line with the current results, many studies reported that LBW is a risk factor for poor breastfeeding practices, including delayed initiation of breastfeeding.[35,54] Thus, WHO recommends that LBW infants who can breastfeed should be put to the breast as soon as possible after birth and, when clinically stable, should be exclusively breastfed until six months of age.[55]

Breastfeeding among LBW infants can be improved through interventions targeting reducing the high rate of LBW and more support to the mothers with LBW infants.

Cessation of breastfeeding, especially at the age of 6 months and below, was found to be associated with poor infant and child outcomes.[19,26] In the current study, among mothers who ceased breastfeeding 242/606 (40.8%), 56 of them stopped breastfeeding at six months and below. A plethora of studies reported a return to work as one of the leading causes of early breastfeeding cessation.[56] A recent report concluded that exclusive breastfeeding, late weaning, and maternal closeness, associated with advanced motor and vision maturation, independently influence autonomous behaviors in healthy children.[57] Therefore, as a strategic plan, every effort should be directed to support all mothers to continue breastfeeding till two years and beyond. The measures that can assist the continuance of breastfeeding include having flexible work schedules and proximity of workplace to home, and creating a breastfeeding-friendly workplace.[13,28,30]

As the influence of family income on breastfeeding cessation has been equivocal,[25,31,58] the current results go with high income associated with breastfeeding cessation. This association is scaling up even beyond the household level to country-level as in high-income countries, more than 1 in 5 never receive breastmilk.[58]

The study has several strengths, such as it was the first study on breastfeeding practices among working mothers that included a large sample size including both Emirati and non-Emirati mothers from both the health centers and the community in Abu Dhabi. On the other hand, there were some limitations. First, the recall bias as the study included children less than two years. Second, the nature of the study as the study was a cross-sectional one while a longitudinal study could provide more accurate information, ie, some children who were breastfeeding during the time of the data collection might stop breastfeeding later on. Third, unlike previous studies,[30] it did not include data regarding the causes of breastfeeding cessation. Further studies that overcome the current limitations would be of great value to fully picture breastfeeding practices among working mothers. Therefore, in the future, more qualitative studies, including mothers from all emirates in the UAE, should be conducted to explore how returning to work affects mothers' decision to early discontinue any breastfeeding and early initiate formula feeding. Also, future work will be conducted comparing working mothers with non-working mothers regarding breastfeeding practices.

Conclusions

Policies to increase breastfeeding should address how both the time and circumstances of a mother's return to employment postpartum influence whether the mother decides to start breastfeeding. The study highlighted the need for urgent actions to improve the working mothers' conditions to promote optimal breastfeeding practices, including both early initiation and continuation of breastfeeding among all mothers in the UAE regardless of employment status. Health authorities should consider factors associated with delayed breastfeeding initiation and cessation of breastfeeding among working mothers in the UAE, such as older maternal age, caesarean section, non-rooming-in, and low birth weight children. Also, policies to improve EBF rates among professional working mothers should include maternity leave extension to enable mothers to continue breastfeeding.

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Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current

journal; gave final approval for the version to be published; and agreed to be accountable for all aspects of the work.

Disclosure

The authors declare no conflict of interests.

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Paper 8

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Risk Factors Associated with Initiation of Breastfeeding among Mothers with Low Birth Weight Babies: A Cross-sectional Multicenter Study in Abu Dhabi, United Arab Emirates

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Abstract

BACKGROUND: Early initiation of breastfeeding is important for good lactation outcomes and has long been recommended by the World Health Organization. Recommendations are based on research showing that breastfeeding saves children's lives, particularly among vulnerable populations such as low birth weight (LBW) neonates. In spite of a consistent rise in LBW deliveries, and in spite of the importance of breastfeeding for the survival of LBW neonates, a dearth of research exists regarding early initiation of breastfeeding for this population.

AIM: The aim of this study was to investigate the prevalence of, and factors associated with the initiation of breastfeeding among mothers with children aged <2 years who were LBW in Abu Dhabi, United Arab Emirates (UAE).

METHODS: The data for this cross-sectional study were extracted from a larger project on the evaluation of breastfeeding practices in Abu Dhabi. The original data were collected from seven health-care centers located in different urban and suburban areas of Abu Dhabi during 2017. A structured questionnaire was used by trained research assistants who collected relevant data from mothers during the interview.

RESULTS: The study included a total of 1822 mothers of children below the age of 2 years; 175 (9.6%) of those children were identified as LBW. The mean standard deviation [SD] ages of the mothers and the children were 30.5 (5.0) years and 6.0 (5.1) months, respectively. The mean birth weight (SD) of the LBW children was 2079.6 (255.0) grams. Forty (29.9%) mothers of LBW children initiated breastfeeding within the 1st h. Sixty-four (47.8%) were delivered vaginally, and 70 (52.2%) were delivered through cesarean section (CS). In multivariable logistic regression analysis, the only factor associated with delayed initiation of breastfeeding among the LBW children was CS (adjusted odds ratio 2.33; 95% confidence interval 1.07, 5.07).

CONCLUSION: The prevalence of LBW was 9.6%, and it was associated with delayed initiation of breastfeeding as compared to the normal birth weight babies. While early initiation of breastfeeding should be promoted for all newborns, LBW infants are recognized as a vulnerable group and thus require additional support. There should be more emphasis on promoting and facilitating breastfeeding for LBW babies, especially those delivered by CS.

Background

The World Health Organization (WHO) has estimated that more than 20 million low birth weight (LBW) infants are born annually [1]. These LBW infants are at increased risk of several health problems such as growth retardation, infectious diseases, and developmental delay during infancy, childhood, and/or later stages of life [2].

There is sufficient evidence to show the benefits of early breastfeeding initiation within the 1st h of life to reduce the risk of neonatal morbidity and mortality in comparison to delayed breastfeeding [3], [4]. This simple intervention of early breastfeeding initiation is of greater significance when LBW infants are considered, as these infants are at increased risk of early growth retardation, infectious disease, developmental delay, and death during infancy and childhood in view of the increased risks described above [1].

Therefore, the WHO has set a target 30% reduction in the number of infants born with LBW by the year 2025 [1]. To achieve this, it is necessary first to estimate the prevalence of LBW and second to investigate the patterns of breastfeeding among this population.

According to UNICEF country estimates, the prevalence of LBW in the United Arab Emirates (UAE) was 6% in 2012 [5]. The factors affecting birth weight in the UAE, as revealed by the report, include closely spaced multiple pregnancies beginning at an early age, childbearing into the mothers' 40's, high rates of gestational diabetes, and high prevalence of maternal anemia [5]. Updated information on LBW in the UAE is crucial for effective policy planning.

Mothers of LBW and preterm babies produce milk that has sufficient amounts of specific nutrients needed for their growth, particularly essential amino acids that are customized for the infants' nutritional requirements [6]. Therefore, the most spectacular and remarkable health

benefits related to breastfeeding would likely be among the LBW and premature infants. Furthermore, breast milk is superior to formula feeding and, in premature infants, has been linked to better gastrointestinal, immunological, and psychological development [7]. Breast milk fulfills all the nutritional requirements of infants during the first 6 months of life [8], and its benefits extend to provide protection against diarrheal diseases, common childhood illnesses, and malnutrition, including both obesity and undernutrition [9].

The UAE Ministry of Health and all other health authorities focus on the promotion and support of breastfeeding. Various policy initiatives, including the Innocenti Declaration (1990), the Baby-Friendly Hospital Initiative (1991), and the Global Strategy for Infant and Young Child Feeding (2002), have been adopted by the UAE to improve breastfeeding outcomes [10]. Although the incidence of LBW babies continues to be high, there is insufficient data on breastfeeding patterns for this group within the existing literature. A previous study in the UAE which surveyed 1088 women, including both Emiratis and expatriates, found that almost 70% of pregnant women in the UAE suffered from Vitamin D deficiency, which is considered a risk factor for poor pregnancy outcomes such as LBW babies [11]. Accordingly, the WHO recommends that LBW infants who are able to breastfeed should be put to the breast as soon as possible after birth and when clinically stable and should be exclusively breastfed until 6 months of age [2].

Despite the full awareness of its importance, achieving the early initiation of breastfeeding for LBW and preterm newborns can be a great challenge. Several obstacles to the practice have been reported in the literature, of which the most evident are physiological limitations. Maturation to suck and swallow is only achieved in the period between the 32nd and 35th weeks of gestation, which complicates the determination of an ideal time to initiate breastfeeding for preterm newborns [12], [13]. In addition to its effects on the nutritive sucking process; prematurity can also be associated with neurological deficits [14].

There is limited data on the initiation of breastfeeding for LBW infants in the UAE. Thus, the aim of this study was to investigate the prevalence of breastfeeding and the factors associated with its initiation among mothers with LBW children aged <2 years in Abu Dhabi.

Methods

Participants and data collection

The subsample analyzed for this study was extracted from a cross-sectional study, where the sample was mainly recruited from the community as well as from seven governmental maternal and child health centers located in different geographical areas of Abu Dhabi. A total of 1578 Emirati and non-Emirati mothers with young children attending the centers during the study days and another 267 mothers from the community were approached by trained bilingual (Arabic and English) female research assistants during the period from March 2017 to September 2017. A total of 1822 consenting mothers who met the inclusion criteria of having at least one child <2 years of age were interviewed by research assistants using a structured questionnaire. The subsample from the original large study that was considered for the analysis for the current study contained 175 subjects, larger than the sample size of a previous study conducted in Abu Dhabi [5].

Study instrument

A pre-tested questionnaire including family demographics (e.g. education, age, nationality, and occupation), infant information (e.g., birth weight and height, and mode of delivery), and infant feeding practices (e.g. initiation of breastfeeding and exclusive breastfeeding) was administered to all participants. More details regarding the methodology used for the analysis of the primary data set have been described in the previous study [15].

Study inclusion and exclusion criteria

From the original sample of 1822 mothers, data were extracted based on the following criteria: Mothers whose babies were born with birth weight <2500 g, gestational age (≥33 weeks), and who had completed all questions regarding breastfeeding and its initiation (i.e., mothers with missing data were excluded from the study). Infants with a birth weight of <1000 g (extreme LBW) were excluded because of the assumption that medical complications would have significantly interfered with the early initiation of breastfeeding [2].

Statistical analysis

LBW cases were sorted (n = 175) from the total data using Excel. One hundred and thirty-four children were included based on the inclusion criteria for this study, and the data were transferred into Statistical Package for the Social Sciences (SPSS Statistics for Windows, Version 20.0. NY: IBM Corp.). T-test and Chi-square tests were applied to analyze continuous and categorical data, respectively. To control the confounding variables, any variables with significant p-value (<0.20) in univariate analysis were entered in multivariable logistic analysis with initiation of breastfeeding (early initiation coded as 0 and delayed initiation coded as 1) as the dependent variable. Other variables such as age, gestational age, child's gender, mode of delivery,

and occupation were set as the independent variables. Odds ratio (OR), adjusted odds ratio (AOR), and 95% confidence interval (CI) were calculated. Statistical significance was set at $p < 0.05$. Results were displayed using means (standard deviation [SD]) for continuous variables, while frequencies and percentages were used to describe categorical variables to interpret participants' responses.

Definitions

- LBW: In accordance with the WHO criteria, a birth weight of <2500 g [1]
- Gestational age: A measure of the age of a pregnancy in weeks that is taken from the beginning of the woman's last menstrual period
- Term birth: It is the birth of a baby at ≥37 weeks GA
- Preterm birth: It is the birth of a baby at <37 weeks GA
- Early initiation of breastfeeding: Breastfeeding initiated within 1 h after birth
- Delayed initiation of breastfeeding: Breastfeeding initiated within more than 1 h after birth
- Breastfeeding advice and/or discussion: Positive or negative information about breastfeeding received before or after delivery
- Arab nationality: Included all Emirati mothers and other Arab nationalities
- Non-Arab nationality: Included Asian mothers and other nationalities
- Family income: It was rated based on the mother answer to the following question, "Considering your monthly family income, how would you rate your and your family's overall financial well-being?" <good or ≥good.

Results

One hundred and seventy-five (9.6%) of the 1822 infants in the original sample were categorized as LBW, and, of those, 134 mother-child dyads were included in this study based on the above-mentioned criteria.

The mean (SD) ages of the mothers and the children were 30.5 (5.0) years and 6.0 (5.1) months, respectively. The mothers' ages ranged from 19 to 44 years; 2 (1.5%) of them were ≤20 years and 33 (24.6%) of them were ≥35 years.

The mean (SD) birth weight was 2079.6 (255.0) grams; the birth weights ranged from 1000 to 2450 grams. Of the total 134 mothers, only one was unmarried (i.e., widowed or divorced).

Forty (29.9%) mothers reported early initiation of breastfeeding (within 1 h); the remaining 94 (70.1%) mothers reported initiation of breastfeeding after at least 1 h.

Of the 134 mothers, 64 (47.8%) delivered vaginally and 70 (52.2%) by cesarean section (CS). However, the parent education level was not significantly associated with breastfeeding initiation; paternal was more educated than their counterpart (only one father had less than secondary education level in compared to four mothers). Eleven mothers did not receive breastfeeding advice during pregnancy.

Although pre-pregnancy body mass index, and maternal occupation were not significant with initiation of breastfeeding in bivariate analysis, $p < 0.2$ (Table 1).

Table 1: Sociodemographic characteristics of mothers with low birth weight babies in Abu Dhabi, UAE

Variable	Total (n=134)	Initiation of breastfeeding		
		Early (n=40)	Delayed (n=94)	p-value
	Mean (SD)	Mean (SD)	Mean (SD)	
Maternal age, years	30.5 (5.0)	30.7 (5.3)	30.4 (4.9)	0.776
Child age, months	6.0 (5.1)	5.7 (4.9)	6.1 (5.2)	0.682
Birth order	2.0 (1.2)	2.0 (1.3)	2.0 (1.2)	0.772
Gestational age at delivery, weeks	37.9 (2.1)	38.0 (1.7)	37.8 (2.3)	0.574
Mother height, cm	160.9 (5.9)	160.7 (6.3)	161.0 (5.7)	0.783
Mother weight pre-pregnancy, kg	60.4 (9.7)	61.8 (10.2)	59.8(9.5)	0.288
Pre-pregnancy BMI, kg/m^2	23.3 (3.6)	24.0 (4.2)	23.1 (3.4)	0.179
	n (%)	n (%)	n (%)	p-value
Maternal education				
<Secondary level	4 (3.0)	2 (5.0)	2 (2.1)	0.582
≥Secondary level	130 (97.0)	38 (95.0)	92 (97.9)	
Maternal occupation				
Unemployed	97 (72.4)	25 (62.5)	72 (76.6)	0.095
Employed	37 (27.6)	15 (37.5)	22 (23.4)	
Nationality				
Arab	85 (63.4)	28 (70.0)	57 (60.6)	0.303
Non-Arab	49 (36.6)	12 (30.0)	37 (39.4)	
Mode of delivery				
Vaginal delivery	64 (47.8)	25 (62.5)	39 (41.5)	0.026
Cesarean delivery	70 (52.2)	15 (37.5)	55 (58.5)	
Exclusive breastfeeding				
Yes	24 (17.9)	6 (15.0)	18 (19.1)	0.567
No	110 (82.1)	34 (85.0)	76 (80.9)	
Rooming in				
Yes	121 (90.3)	38 (95.0)	83 (88.3)	0.230
No	13 (9.7)	2 (5.0)	11 (11.7)	
Child gender				
Male	49 (36.6)	13 (32.5)	36 (49)	0.524
Female	85 (63.4)	27 (67.5)	58 (61.7)	
Family income				
<Good	4 (3.0)	2 (5)	2 (2.1)	0.582
≥Good	130 (97.0)	38 (95.0)	92 (97.9)	
Gestational age at delivery				
Term	94 (70.1)	30 (75.0)	64 (68.1)	0.423
Preterm	40 (29.9)	10 (25.0)	30 (31.9)	

UAE: United Arab Emirates, SD: Standard deviation, BMI: Body mass index

In multivariable logistic regression analysis, the only factor associated with the delay of breastfeeding initiation among LBW children was CS (AOR 2.33; 95% CI 1.07, 5.07), (Table 2).

Table 2: Multivariable logistic regression analyses of factors associated with delayed initiation of breastfeeding among mothers with low birth weight babies in Abu Dhabi, UAE

Variable	Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)	p-value
Pre-pregnancy BMI, kg/m^2	0.93 (0.85, 1.03)	0.93 (0.84, 1.03)	0.148
Maternal occupation			
Employed	0.51 (0.23, 1.13)	0.55 (0.24, 1.25)	0.125
Unemployment (reference)			
Mode of delivery			
Cesarean section	2.35 (1.10, 5.03)	2.33 (1.07, 5.07)	0.033
Vaginal delivery (reference)			

UAE: United Arab Emirates, CI: Confidence interval, BMI: Body mass index

Discussion

To the best of the authors' knowledge, this is the first population-based study using data collected from different health-care centers located in urban and suburban parts of Abu Dhabi, to estimate the prevalence of LBW and assess the timing of breastfeeding among LBW infants.

The prevalence of LBW was (9.6%), which is higher than the reported prevalence in 2009 (6.1%) [16]. The rate of early initiation of breastfeeding among the group was 29.9%. Initiation of breastfeeding was more frequently delayed in the case infants delivered by CS.

Among all of the studied factors, CS delivery was the most frequent factor associated with delayed initiation of breastfeeding for LBW infants. CS is a well-documented risk factor for delayed initiation of breastfeeding both in the UAE and in many other countries [17, [18], [19], [20].

The previously documented rate for early initiation of breastfeeding in the UAE was 80.6%, reported by Radwan [19]. The rate of early initiation of breastfeeding among the total sample (1822 mother-infant dyads) of the original study from which the current subsample was extracted, was found to be lower (59.8%) [15]. When early initiation was subsequently computed for the LBW subgroup, the rate dropped even further to 29.9%.

It is worth mentioning that as an important and practical step toward supporting the survival and health of both infants and women, breastfeeding is a central part of the 2030 Agenda for Sustainable Development and is linked to many of the Sustainable Development Goals [21]. Accordingly, the American Academy of Pediatrics (AAP) Committee on Nutrition recommends breastfeeding as the optimal content and method of infant feeding for LBW premature infants in the 1st year of life [22]. The AAP's position statement is mainly based on a strong evidence-based research which indicates several nutritional, immunologic, and physiological benefits gained by those LBW infants who receive their own mothers' milk [23], [24]. As several studies support the benefits of breastfeeding for the LBW infants, we should put much emphasis on its early initiation.

Other studies showed that chances to breastfeed earlier would develop the sucking reflex of babies in which they could suck the breast milk properly and continuously [25]. In Indonesia, researchers found that the onset of lactation of more than 6 h among LBW was associated with 5 times the risk of non-optimal breastfeeding practices [26]. Hospitals should provide mothers of LBW infants support to initiate breastfeeding as early as possible.

The results of previous studies have supported the importance of early initiation of breastfeeding as one of the determinant factors in the mortality of LBW neonates [26]. Premature birth is one of the main causes for LBW and can be expected to have a negative impact on the initiation of breastfeeding due to physiological immaturity.

In spite of the lack of statistical significance, the current study showed that the LBW infants with delayed initiation of breastfeeding in the study population were considered to be relatively immature. This may raise one further point which needs to be addressed by future research: Whether there is any difference between mothers of mature LBW infants and mothers of preterm LBW infants in their perceptions and practices regarding breastfeeding in general and its early initiation in particular.

The current study is consistent with the previous studies, which have shown that the practice of delayed initiation of breastfeeding was mainly among mothers with LBW infants [27], [28]. This may have several explanations. The lack of, or delayed initiation, may happen because of the limited knowledge and support of medical staff that babies with LBW were able to be trained to suck mother's breast milk as early as possible. Furthermore, the inadequate counseling for mothers in giving breast milk extract if their babies were unable to suck breast milk directly from their mother's breast milk.

Other studies have identified factors that could be related to the initiation of breastfeeding. Child gender [29], paternal education [18], [19], [30], rooming-in [18], [19], and breastfeeding support [31] have been reported as the main factors influencing the initiation of breastfeeding. This inconsistency with the current study findings may be attributed to the different nature of previous studies, such as inclusion of LBW infants in the index study and other limitations described in the next section. Rooming-in was reportedly associated with early initiation of breastfeeding in several previous studies conducted in the UAE [18], [19]. However, this association was not identified in the current study and possibly could be explained by the inability of the neonate to suck the mother's milk, despite the skin-to-skin contact and rooming-in. Therefore, newborns should be checked by qualified health-care professionals to determine their ability to breastfeed. The two main factors that should promptly be identified by health-care professionals are unsatisfactory health status and extreme LBW (i.e., <1000 g) [2]. If these factors are not identified as early as possible, skin-to-skin contact might be unadvisable for the newborn. However, if the recommended level of care is not available, then skin-to-skin contact might be advisable. The message here is that while skin-to-skin contact and rooming-in remain essential for breastfeeding initiation, both stability and birth weight need to be checked and taken into consideration too. A recent study recommended the consideration of safety issues for all infants who are rooming-in, including full-term babies [32].

The current results further showed that 11 mothers did not receive breastfeeding advice

during pregnancy. Several previous studies reported the significant association between breastfeeding communication channels (i.e., advice, discussion, support) and early initiation of breastfeeding [33], [34]. Another important consideration is the time factor. For example, postnatal advice on breastfeeding may be of low benefit and affect breastfeeding practices, even if it is given as early as 1-h after delivery.

Preterm newborns are generally able to suck and swallow in the period between the 32nd and 35th weeks of gestation [12], [13]. Thus, prospective mothers should be informed about early initiation of breastfeeding well ahead of time, i.e., during the first trimester or even before pregnancy.

Therefore, support from medical services for mothers during admission in hospital and after discharging, as well as the support from medical staff about lactation management, is important factors that needed to be considered for mothers of LBW babies.

Other options, such as extracting breast milk, should also be addressed well in advance and prepare potential mothers of preterm babies for breastfeeding options. Meier *et al*. reported that extracting the breast milk as early and often as possible would increase the mother's ability in practicing breastfeeding to their LBW infant [35].

In addition, the information and support provided should be evidence-based, individualized, and delivered effectively, especially for vulnerable infants [36]. In the UAE, a previous study emphasized the importance of verifying breastfeeding information obtained from non-professional sources such as family members [37]. Since preterm delivery and the accompanying risks of perinatal morbidity and LBW cannot easily be predicted, breastfeeding education should start as early as possible.

In conclusion, this study showed high rates of LBW and CS, and among LBW, delivery by CS was the main risk factor of delayed initiation of breastfeeding. Efforts for reducing the rates of LBW and CS may ultimately improve early initiation of breastfeeding, and ultimately improve chances for infant's survival.

Limitations

While this is the first study to tackle breastfeeding practices among mothers of LBW infants in the UAE, we acknowledge several limitations. First, our study was comprised of a small sample. A larger sample would have resulted in more reliable analyses and conclusions. Second, recall bias may have affected reporting in this study, since mothers had to recall events for children who were close to 2 years. Third, this study did not include morbidity participant data (both mothers and children) and mortality data about LBW children who were not included in the study (i.e., infants hospitalized who subsequently died). This could be of importance as the literature has documented a high rate of mortality among this vulnerable group [31], [32]; therefore, the prevalence of LBW may have been underestimated in the current study.

Conclusion

The analysis of the project data revealed a higher LBW prevalence in Abu Dhabi than previously reported, and it was associated with delayed initiation of breastfeeding. Intervention strategies for reducing CS rates by limiting cesarean delivery on maternal request are needed to promote early initiation of breastfeeding, particularly for LBW infants. This will ultimately have a significant impact on their health and wellbeing. Therefore, further studies are needed to overcome the current limitations and to have a better understanding of the above-mentioned points.

In future research, it would be advisable to examine and collect data on other factors that potentially influence the initiation of breastfeeding, such as social, cultural, and psychological factors, in addition to data on the physical status of the mothers and infants.

Ethics Approval and Consent to Participate

The original study from which these data were extracted was approved (ZU17_006_F) by the Research Ethics Committee at Zayed University UAE. As the data were also collected from the health centers, another clearance was obtained from the Abu Dhabi Health Services Company. Informed consent was obtained from participants. Several measures were taken to ensure privacy and confidentiality throughout the study period by excluding personal identifiers.

Availability of Data and Materials

The data that support the findings of the current study are available from the corresponding author on request.

Authors' Contributions

ZT designed the study and recruited the participants. ZT and AAH analyzed the data and wrote

the manuscript. LS and DP contributed to the design of the study, data collection, and manuscript writing. All authors contributed, read, and approved the final manuscript.

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Paper 9

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Factors associated with preterm birth and low birth weight in Abu Dhabi, United Arab Emirates

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Article

Factors Associated with Preterm Birth and Low Birth Weight in Abu Dhabi, the United Arab Emirates

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Abstract: Both preterm birth and low birth weight (LBW) represent major public health problems worldwide due to their association with the catastrophic effects of morbidity and mortality. Few data exist about such adverse pregnancy outcomes. The current study aimed to investigate the prevalence of and factors associated with preterm birth and LBW among mothers of children under two years in Abu Dhabi, United Arab Emirates. Data were collected in clinical and non-clinical settings across various geographical areas in Abu Dhabi. The data were analyzed using both descriptive and inferential statistics. A total of 1610 mother–child pairs were included in the current study. Preterm birth rate was 102 (6.3%) with a 95% confidence interval [CI] (6.1%, 6.5%) and the LBW rate was 151 (9.4%) with a 95% CI (9.3%, 9.5%). The mean (SD) of gestational age (GA) and birth weight at delivery was 39.1 (1.9) weeks and 3080.3 (518.6) grams, respectively. Factors that were positively associated with preterm birth were Arab mothers, maternal education level below secondary, caesarean section, and LBW. LBW was associated with female children, caesarean section (CS), first child order, and preterm birth. The current study highlighted the need for further interventional research to tackle these public health issues such as reducing the high CS rate and improving maternal education.

Keywords: preterm birth; low birth weight; caesarean section; maternal education; United Arab Emirates

1. Introduction

According to the World Health Organization (WHO), every year an estimated 15 million babies are born preterm (<37 weeks of gestation) and this global trend is rising. Among 184 countries, the rate of preterm birth ranges from 5% to 18% of babies born [1]. Reports indicate a trend of preterm birth rate from 9.8% (8.3–10.9) in 2000 to 10.6% (9.0–12.0) in 2014. Of the estimated 14.84 million preterm births in 2014, the majority (81·1%) occurred in Asia and sub-Saharan Africa [2].

Preterm birth complications are considered the leading cause of death among children under five years of age and in 2015, they were responsible for approximately 1 million deaths [3]. A variety of factors including demographic and socioeconomic status have been reported to be associated with preterm birth such as maternal age, parity, previous preterm birth, multiple gestation, pregnancy induced hypertension, antepartum hemorrhage, prolonged pre-labor rupture of membranes, and urinary tract infections [4].

Another major health problem is Low Birth Weight (LBW). According to WHO, LBW is defined as a birth weight of less than 2500 g [5]. LBW may result from preterm birth, intrauterine growth restriction (IUGR), or both [6]. WHO has estimated that more than 20 million LBW infants are born

annually [5]. These LBW infants are at an increased risk of several health problems such as growth retardation, infectious diseases, and developmental delay, which may occur during infancy, childhood, and ultimately, later stages of life [7]. Therefore, to protect infants and young children's health, WHO has set a target of a 30% reduction in LBW by 2025 [5]. The reduction of LBW rates globally has also been considered as an important target of the United Nation's Millennium Development Goal (MDG) for reducing child mortality [8].

A meta-analysis study identified several long-term negative outcomes associated with both preterm birth and LBW, such as lower educational qualifications, decreased rate of employment, and an increased rate of receipt of social benefits in adulthood [9].

According to the joint UNICEF and WHO study of global, regional, and country estimates of LBW in 2000, the incidence of LBW in the Middle East and the Gulf countries was reported as Oman (9%), Lebanon (6%), Syria (6%), Algeria (7%), Kuwait (7%), Libya (7%), Tunisia (7%), Bahrain (8%), Jordan (10%), Qatar (10%), Morocco (11%), Saudi Arabia (11%), Egypt (12%), and Yemen (32%) [10].

In Oman, study results confirm that high rates of consanguinity, premature births, number of increased pregnancies at an older maternal age, and changing lifestyles are some important factors related to the increasing rate of LBW [11]. Several studies have indicated a significant correlation between preterm birth and LBW [12–14]. Therefore, logic follows that these two adverse pregnancy outcomes should be investigated together and not merely separately. In Abu Dhabi, it was documented that LBW babies were 30.83 times more likely to require treatment in the neonatal intensive care unit in comparison to the babies of a normal birth weight [15]. The catastrophic effects of both preterm birth and LBW in terms of morbidity and mortality for both short and long term consequences, such as an increased rate of caesarean sections (CS), stillbirth, neonatal asphyxia, and mortality, were documented in the literature [9,16,17].

In the United Arab Emirates (UAE), data are limited regarding these adverse pregnancy outcomes, i.e., preterm birth and LBW, especially at the community level. Most available data for Abu Dhabi are not up to date and are mainly clinical in form [15].

The current study aimed to investigate the prevalence of and factors associated with preterm birth and low birth weight among mothers of children under two years in Abu Dhabi, United Arab Emirates.

2. Materials and Methods

2.1. Participants and Data Collection

This study's sample is based on secondary data from an original sample obtained from mothers with at least one child under the age of two years. Participants for the original study included UAE nationals and non-nationals in the Emirate of Abu Dhabi, which represents 87% of the geographical landmass of UAE [18]. All data were collected between March and September of 2017 from the community and seven Ambulatory Maternal Child Health Centers. Mothers with young children attending the centers as well as from the community were approached by trained bilingual (Arabic and English) female research assistants who provided oral and written information about the study. Consenting mothers who met the inclusion criteria of having at least one singleton birth child under two years of age were interviewed by the research assistants using a structured questionnaire. The study was approved (ZU17_006_F) by the Research Ethics Committee at Zayed University UAE. In addition, another clearance was obtained from the Abu Dhabi Health Services Company. Informed consent was gained from all participants. Both confidentiality and privacy were maintained by excluding all personal identifiers during the period of data collection.

2.2. Study Instrument

A pre-tested questionnaire included family sociodemographic (e.g., age, nationality, education, occupation, family income, etc.) and child information (e.g., gestational age at delivery, birth weight, mode of delivery, child gender, etc.).

Birth outcomes (e.g., gestational age and birth weight) information was provided from the children's health cards.

More details regarding the methodology of the primary data were described in the previous study [19].

2.3. Study Inclusion and Exclusion Criteria

From the total 1822 mother–child pairs, any data with completed variables were included in the analysis (N = 1610). The remaining 212 participants were excluded due to some missing data such as maternal education, paternal education, GA, mode of delivery, etc.

2.4. Statistical Analysis

The data were analyzed using Statistical Product and Service Solutions (IBM SPSS Statistics for Windows, Version 20.0. IBM Corp., Armonk, NY, USA). The data were analyzed using both descriptive and inferential statistics. Gestational age at delivery (term and preterm) and birth weight at delivery (normal birth weight and LBW) were analyzed as the dependent variables, independently. Term babies were coded as (0) and preterm babies were coded as (1). Normal weight birth was coded as (0) and LBW as (1). Other variables such as sociodemographic characteristic (e.g., age, nationality, parent education, maternal occupation, etc.) and child information (e.g., child gender, mode of delivery, etc.) were considered the independent variables.

T-test and Chi-square tests were applied to analyze the continuous and categorical data, respectively. Furthermore, significant continuous variables, for example, child order (1st order and >1st order) were categorized for analysis. Variables that were found to be statistically significant (p-value < 0.05) in the bivariate analysis were then further analyzed using multivariable logistic analysis for each dependent variable (preterm and LBW). To ensure the robustness of the logistic models, the insignificant variables in the bivariate analysis were also added to the models and stepwise model selection methods were applied. Finally, odds Ratio [OR] and 95% Confidence Interval [CI] were calculated with a significance level of p-value < 0.05.

2.5. Definitions

Gestational age (GA) was defined as a measure of the age of a pregnancy in weeks, which is taken from the beginning of the woman's last menstrual period. Term birth was defined as the birth of a baby at ≥37 weeks GA. Preterm birth was defined as the birth of a baby at <37 weeks GA. Normal birth weight was defined as the weight of a baby immediately after delivery (≥2500 g). Low birth weight was defined as the weight of a baby immediately after delivery (<2500 g). Arab nationality was defined as those who self-identified themselves as Emirati or another Arab origin. Non-Arab nationality was defined as those who self-identified themselves as Asian or any other non-Arab origin. Family income was defined based on the mother's answer to the following question, "Considering your monthly family income, how would you rate your and your family's overall financial well-being?" <good or ≥good.

3. Results

A total of 1610 mother–child pairs were included in the study from the original sample (N = 1822). The mean (standard deviation) [SD] of maternal age and children's age were 30.1 (5.1) years and 8.1 (5.9) months, respectively.

Table 1 describes the characteristics of the mothers based on the gestational age of the study children.

Among the LBW (151), 70 (46.3%) reportedly delivered vaginally, 51 (33.8%) by planned CS, and 30 (19.9%) by emergency CS.

In multivariable stepwise logistic regression analysis (Table 2), factors that were positively associated with preterm birth were Arab mothers (adjusted odds ratio [AOR] 2.02, 95% CI 1.19, 3.43),

maternal education level below secondary (AOR 4.38, 95% CI1.95, 9.81), CS (AOR 2.35, 95% CI 1.48, 3.73), and LBW (AOR 17.62, 95% CI 11.05, 28.10).

Table 1. Characteristics of the mothers with children below two years of age in Abu Dhabi, the UAE, from March to September 2017 based on gestational age at delivery.

Variables		Gestational Age						
		Total (N = 1610)		Term (n = 1508)		Preterm (GA < 37 weeks (n = 102)		
		Mean (SD)		Mean (SD)		Mean (SD)		p-Value
Maternal age, years		30.1 (5.1)		30.1 (5.1)		30.4 (5.6)		0.578
Child order		2.2 (1.2)		2.2 (1.2)		3.3 (1.3)		0.393
Birth weight, grams		3080.3 (518.6)		3127.3 (473.0)		2385.6 (652.6)		<0.001
Maternal pre-pregnancy BMI (kg/m^2)		23.9 (3.9)		23.9 (3.7)		24.0 (5.5)		0.824
		N	%	N	%	N	%	p-value
Child gender	Male	790	49.1	743	49.3	47	46.1	0.533
	Female	820	50.9	765	50.7	55	53.9	
Nationality	Arab	1049	65.2	970	64.3	79	77.5	0.007
	Non-Arab	561	34.8	538	35.7	23	22.5	
Marital status	Married	1588	98.6	1489	98.7	99	97.1	0.157
	Divorced/Single	22	1.4	19	1.3	3	2.9	
Mode of delivery	Vaginal	1121	69.6	1076	71.4	45	44.1	<0.001
	CS	489	30.4	432	28.6	57	55.9	
Maternal education	<Secondary level	64	4.0	54	3.6	10	9.8	0.002
	≥Secondary level	1546	96.0	1454	96.4	92	90.2	
Paternal education	<Secondary level	31	1.9	27	1.8	4	3.9	0.130
	≥Secondary level	1579	98.1	1481	98.2	98	96.1	
Maternal occupation	Housewife	996	62.2	934	62.3	62	60.8	0.729
	Employed	606	37.8	566	37.7	40	39.2	
Family income	<Good	102	6.4	96	6.4	6	5.9	0.856
	≥Good	1504	93.6	1408	93.6	96	94.1	
Birth weight	Normal birth weight (≥2500 g)	1459	90.6	1414	93.8	45	44.1	<0.001
	Low birth weight (<2500 g)	151	9.4	94	6.2	57	55.9	

Table 2. Multivariable stepwise logistic regression analyses of factors associated with preterm birth among mothers with children below two years of age in Abu Dhabi, the UAE, from March to September 2017.

Variable		Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	p-Value
Nationality	Arab versus Non-Arab	1.91 (1.18, 3.06)	2.02 (1.19, 3.43)	0.009
Maternal education	< Secondary versus ≥ Secondary	2.93 (1.44, 5.93)	4.38 (1.95, 9.81)	<0.001
Mode of delivery	Caesarean section versus Vaginal	3.16 (2.10, 4.74)	2.35 (1.48, 3.73)	<0.001
Birth weight	Low birth weight (<2500 g) versus Normal birth weight (≥2500 g)	19.05 (12.23, 29.68)	17.62 (11.05, 28.10)	<0.001

Table 3 describes the characteristics of mothers based on the birth weight of the study children.

Table 3. Characteristics of mothers with children below two years of age in Abu Dhabi, the UAE, from March to September 2017 based on birth weight at delivery.

Variable		Birth Weight						
		Total (N = 1610)		Normal (n = 1459)		LBW (n = 151)		
		Mean (SD)		Mean (SD)		Mean (SD)		p-Value
Maternal age (years)		30.1 (5.1)		30.0 (5.2)		30.6 (5.0)		0.252
Child order		2.2 (1.2)		2.2 (1.2)		2.0 (1.2)		0.020
Gestational age, weeks		39.1 (1.9)		39.4 (1.6)		37.0 (3.1)		<0.001
Maternal pre-pregnancy BMI (kg/m^2)		23.9 (3.9)		23.9 (3.9)		23.5 (3.8)		0.252
		N	%	N	%	N	%	p-Value
Child gender	Male	790	49.1	737	50.5	53	35.1	<0.001
	Female	820	50.9	722	49.5	98	64.9	
Nationality	Arab	1049	65.2	949	65.0	100	66.2	0.772
	Non-Arab	561	34.8	510	35.0	51	33.8	
Marital status	Married	1588	98.6	1439	98.6	149	98.7	0.963
	Divorced/Single	22	1.4	20	1.4	2	1.3	
Mode of delivery	Vaginal delivery	1121	69.6	1051	72.0	70	46.4	<0.001
	Caesarean section	489	30.4	408	28.0	81	53.6	
Maternal education	<Secondary level	64	4.0	59	4.0	5	3.3	0.661
	≥Secondary level	1546	96.0	1400	96.0	146	96.7	
Paternal education	<Secondary level	31	1.9	29	2.0	2	1.3	0.572
	≥Secondary level	1579	98.1	1430	98.0	149	98.7	
Maternal occupation	Housewife	996	62.2	891	61.4	105	69.5	0.096
	Employed	606	37.8	560	38.6	46	30.5	
Family income	<good	102	6.4	97	6.7	5	3.3	0.222
	≥good	1504	93.6	1358	93.3	146	96.7	
Child order	1st order	582	36.1	509	34.9	73	48.3	0.001
	>1st order	1028	63.9	950	65.1	78	51.7	
Gestational age	Term (GA ≥ 37 weeks)	1508	93.7	1414	96.9	94	62.3	<0.001
	Preterm (<37 weeks)	102	6.3	45	3.1	57	37.7	

In an additional multivariable stepwise logistic regression analysis (Table 4), factors that were positively associated with LBW were female child (AOR 2.08, 95% CI 1.41, 3.08), CS (AOR 2.29, 95% CI 1.57, 3.35), first child order (AOR 1.98, 95% CI 1.35, 2.89), and preterm birth (AOR 17.64, 95% CI 11.03, 28.21).

Table 4. Multivariable stepwise logistic regression analyses of factors associated with low birth weight among mothers with children below two years of age in Abu Dhabi, UAE, from March to September 2017.

Variable		Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	p-Value
Child gender	Female versus Male	1.89 (1.33, 2.68)	2.08 (1.41, 3.08)	<0.001
Mode of delivery	Caesarean section versus Vaginal	3.0 (2.12, 4.19)	2.29 (1.57, 3.35)	<0.001
Child order	1st order versus >1st order	1.75 (1.25, 2.45)	1.98 (1.35, 2.89)	<0.001
Gestational age	Preterm (<37 weeks) versus Term (GA ≥37 weeks)	19.05 (12.23, 29.68)	17.64 (11.03, 28.21)	<0.001

4. Discussion

The main findings of the current study are the estimation of rates for both preterm birth 6.3% and LBW 9.4% and the identification of the main risk factors associated with preterm birth and LBW in Abu Dhabi, UAE.

The rate of preterm birth (6.3%) was slightly higher in comparison to the previous rate reported in Abu Dhabi (6%) [19], but was similar to Saudi Arabia (6.5%) [2] and lower than those found in Oman, 9.7% [14], and Kenya, 18.3% [4].

A similar LBW rate of 9.4% was reported in Iran [20]. However, the rate of LBW in the current study is higher than what was previously reported by UNICEF, namely, the country estimates were 6.1% [21] and for Abu Dhabi, in particular, 8.8% [15]. However, the current LBW rate (9.4%) is lower than previously reported and as compared to neighboring countries such as Yemen, 18% [22], Oman, 13.7% [14], and the African continent, as seen in Sudan, 12.5% [23], Ethiopia, 10.4% [13], and Nigeria, 16% [24] or South East Asia as seen in Pakistan, 10.04% [16]. The differences in rates could be explained by the nature of the studies, for instance, delivery at tertiary hospitals [23,24] may be associated with high preterm births due to dealing with complicated pregnancies, such as preterm birth, unlike the current study, which was community-based.

The current study showed that preterm birth and LBW were significantly associated with each other, i.e., a preterm baby is almost 18 times more at risk of being LBW and vice versa. Consistent with the present results, a plethora of studies have documented this significant association [16,25,26] which highlights the importance of intervention programs that aim at reducing both outcomes.

This study revealed that Arab mothers were twice as likely to deliver a preterm baby compared to non-Arab mothers. In line with the current results, several studies showed similar findings [27,28]. Some of the important pregnancy outcomes, such as preterm birth and LBW, were found to vary by nationality [28]. Such differences among nationalities require more investigation, especially in a country like the UAE with multiple nationalities [18].

In the present study, maternal education was found to be associated only with preterm birth, and mothers who had below secondary level education had a four times higher risk of delivering a preterm baby. This is in line with previous observations in different countries including Gulf countries [29,30]. The literature has revealed significant associations between low maternal education and the risk of poor neonatal health outcomes [23,31]. For instance, in Italy, a population-based study revealed that low maternal education was a risk factor for both preterm birth and LBW [31].

Female gender was found to be at double the risk of having LBW (AOR 2.08, 95% CI 1.41, 3.08) than their counterparts. The present results are in agreement with the previous studies, including the neighboring country Oman [12,14].

There are several explanations for the difference in LBW by baby's gender and it should be noted that male babies usually weigh more than their female counterparts, which may serve as a protective factor [32]. In addition, there is an increase in mortality rates which are associated with LBW male gender counterparts as the gender differences in infants' mortality were observed in the previous studies [33], especially among male infants born between 24 and 26 weeks [34]. For example, systematic review and meta-analysis of more than 30 million births showed an elevated risk of stillbirth in males by about 10% [33]. Therefore, to have an accurate estimation of LBW and its associated factors, future research needs to take into account perinatal mortality and its association with gender.

A baby who is delivered by CS was almost 2.5 times more at risk of being preterm and LBW. Similar to the current results, previous studies found CS to be associated with both preterm birth [35] and LBW [17]. However, the preterm births were not classified into subtypes i.e., spontaneous versus indicated [36], and more than half of the preterm birth babies were delivered via CS (55.9%). This is in line with the trend of increasing indicated preterm deliveries over spontaneous ones [37].

Unfortunately, various studies have documented an epidemic of CS which has been reported to have adverse pregnancy outcomes, such as preterm birth and LBW [35–38]. Among preterm births and LBW that were delivered by CS, more than half of those deliveries were planned. This might be due to

the abuse of planned CS as it was observed to be wrongfully associated with term LBW, especially in private hospitals in Brazil [39]. Adding to that, in the present study, 62.3% of the LBW were term LBW. Therefore, WHO's recommendations [1] need to be followed, namely, the induction or caesarean birth should not be planned before 39 completed weeks unless medically indicated for the benefit of the mother, the fetus, or both. In addition, the effect of CS is not only confined to the index birth, but it was identified as a risk factor for preterm birth in subsequent births as compared to vaginal delivery [40,41].

There are some controversial results around the association between LBW and CS. While some researchers reported CS as a protective factor [27], others in the nearby country reported this method of delivery as a risk factor for LBW [20], similar to the present findings. For example, Hailu and Kebede [27] reported that Cesarean delivery (AOR 0.415, 95% CI 0.183, 0.941) had a preventive effect of LBW. This could be explained by the CS rates. When the rate is within the WHO recommended range, it will be protective against LBW; otherwise it will be a risk. Therefore, all efforts should be directed to reduce the high rate and to identify the possible indications of CS in the studied area. This study can be considered as a call to action to reduce the high rates of caesarean section in the UAE and across the globe.

The risk for LBW nearly doubled among first child order (AOR 1.98, 95% CI 1.35, 2.89). This finding was supported by various other studies in Sudan [23], Pakistan [16], China [41], and India [42].

Both not having previous children and caesarean births were associated with preterm birth and LBW [43], however in the current study, first child order was not associated with preterm birth. The association between first child order and LBW may be due to the increased rate of CS among primipara mothers [44].

Unlike the current study, previous research found preterm birth and LBW to be associated with other factors as well—for example, LBW with maternal age [12,45] and maternal BMI [45,46] and preterm birth with maternal age [4,14] and maternal BMI [14,46,47].

The discrepancies in factors associated with preterm and LBW as reported in the literature could be explained by the interrelation of various factors. For example, in Finland, Goisiset al. [48] reported that advanced maternal age is not independently associated with the risk of preterm birth or LBW among mothers who have had at least two live births. This should encourage researchers to investigate their local area and to develop solutions based on the local findings.

This study revealed valuable information from a large sample of the community, which can be used by healthcare planners to improve pregnancy outcomes. However, some limitations need to be considered while analyzing the current results and need to be covered in future studies, aiming to give a better description for these important public health issues among the UAE populations. First, this study did not include morbidity information among the study participants (both mothers and children) and mortality information among LBW children who were not included in the sample (i.e., hospitalized infants and subsequent deaths). This could be of importance as the literature documented a high rate of mortality among this vulnerable group [23,49], i.e., this may cause underestimation of the LBW rate. Second, factors related to maternal health that were found to be associated with adverse pregnancy outcomes, such as anemia [49,50] and periodontal diseases [51,52], were not included. Third, the missing data from the original study might bias the current results.

5. Conclusions

The rates of preterm birth and LBW were found to be high in our study. In addition, preterm birth was found to be strongly positively associated with LBW. The current study highlights the need for further interventional research to tackle these public health issues, such as reducing the high CS rate and improving maternal education.

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Appendix 3

List of author's selected publications

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