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FACULTY OF HEALTH SCIENCE
DEPARTMENT OF COMMUNITY MEDICINE

Prevalence and Predictors of Macrosomia Newborn: Northern-Norwegian Mother-and-Child Study

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A Thesis for the Degree of
Master in Public Health
June 2012

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ACKNOWLEDGEMENT

My heartfelt gratefulness goes to my supervisor Jon Øyvind Odland, Professor of International Health, Faculty of Health Sciences and Department of Community Medicine, University of Tromsø, for his valuable time, patience, and scholarly guidance in conducting this study from design to report writing.

My gratitude also goes to Dr. Mohammad Amirul Islam, Professor of Agricultural Statistics, Bangladesh Agricultural University, for his statistical support during the analysis. I am grateful to Dr. Mohammad Bellal Hossain, Associate Professor of Population Sciences, University of Dhaka for his valuable and critical suggestions throughout the whole study. I am indebted to my program coordinator, course coordinator and other professor and guest lecturers for their valuable comments and suggestions during the whole programme.

Along with others I am very much indebted to Gerd Sissel Furumo and Tor Gisle Lorentzen for providing academic and non-academic support over the years. I am also grateful to all my classmates and friends who helped me in different ways during my two years of the study. My heartiest thanks also go to international student councilor Line Vråberg who offered me so many valuable suggestions and warm welcomes in so many occasions in all my difficulties.

Last but not least, my heartfelt thank goes to my beloved wife and daughter, who always encouraged me to do this study and gave their patience during the entire period of carrying out this study.

Abstract

BACKGROUND The prevalence of macrosomia newborn has increased in Norway over the last few decades. In Norway, there is ample evidence that macrosomia is associated with elevated risk of complications both for the mother and the newborn. It is also evident that being born macrosomic is associated with future health risks.

OBJECTIVE The Study was aimed to understand the prevalence and predictors of macrosomic newborn in the three northern counties of Troms, Finnmark and Nordland in Norway.

METHODS Using data from The North Norwegian Mother-and-Child Cohort Study (MISA), 479 pregnant women who delivered their babies were included in this study. A simple questionnaire was administered to obtain personal information about current diet, smoking, and alcohol habits, medication and dietary supplements. Maternal weight was also measured while self-reported pre-pregnancy weight and height were collected from pregnant women. Permission was also obtained to consult their medical records.

RESULTS Mean birth weight and body mass index of children were 3617g (SD 493) and 14.27 (SD 1.22) respectively. Macrosomia (birth weight ≥4,000g) was observed among 101 (21.2%) newborns. Significant association between macrosomia and pre-pregnancy maternal weight, smoking at the beginning and at the end of pregnancy were observed in a bivariate analysis. Logistic regression analysis showed that maternal pre-pregnancy weight was a strong predictor of macrosomia among the included women. Non-smoking at the end of pregnancy was another significant determinant of macrosomia observed in regression analysis.

CONCLUSION Pre-pregnancy maternal weight was the most important predictor of macrosomia for the newborn baby. General pre-pregnancy health advise and dietary advise for young women will have a very positive impact on pregnancy outcome.

Prevalence and Predictors of Macrosomia of Newborn Children: The North-Norwegian Mother-and-Child Study

CHAPTER ONE

Introduction

Over the last few decades, macrosomia of the newborn (birth weight ≥4,000g) as an adverse pregnancy outcome has been increasing in many parts of the world especially in the developed countries[1-5]. Several studies have reported that between 15% and 25% of women have given birth to macrosomic infants in different populations during the last three decades[2, 6, 7]. Several researchers have demonstrated that advanced maternal age, ethnicity, maternal pre-pregnancy weight and height, maternal waist to hip ratio, gestational weight gain, multi-parity, gestational age, maternal diabetes or obesity, reduced maternal smoking, antecedent of a macrosomic delivery, male infant sex and changes in socio-demographic factors are the significant determinants of macrosomic babies[7-12].

Macrosomic infants increase the risk of perinatal and maternal complications as compared with normal birth weight baby. Maternal complications include postpartum haemorrhage, chorioamnionitis, prolonged labour, caesarean delivery and prolonged hospital stay[7, 10, 13, 14]. These babies are also at high risk of perinatal mortality such as shoulder dystocia, brachial plexus injury, skeletal injuries, meconium aspiration, perinatal asphyxia, hypoglycemia, clavicular fracture, respiratory distress and low

Apgar score increase[3, 8, 13, 15-17]. Macrosomic newborns are also associated with the future health risks such as overweight, diabetes, metabolic syndrome, neurological sequelae and cancer[4, 18, 19].

Macrosomia in Norway

The incidence of macrosomic newborn has been increasing in Norway like other developed countries in the world. In Norway, newborn macrosomia (newborns weighing 4,000 g or more) has increased from 16% to 20% in less than three decades [1, 4]. Most of the studies in Norway show that pregnancies with macrosomia are associated with elevated risks of both maternal and neonatal complications such as intrauterine death, artificial induction of labour, prolonged birth, shoulder dystocia, still births, birth asphyxia, intrapartal hypoxia, low Apgar score, injuries to the baby and the mother, increased use of operative deliveries, postpartum hemorrhages and neonatal hypoglycemia, hyperbilirubinemia and the use of neonatal intensive care[20-23]. Studies also found that maternal overweight/weight gain, maternal pre-pregnant BMI, fasting plasma glucose, gestational age, low level of pre-gestational physical activity and high serum insulin and non-high density lipoprotein (HDL)-cholesterol and low serum HDL-cholesterol are separately associated with the risk of macrosomic newborns in Norway[23-27].

Numerous researches have been conducted on macrosomic infants or overweight as adverse pregnancy outcomes in Norway as a whole even though studies among northern Norwegian women are quiet absent in this regard. More specifically

systemic research on prevalence and determinants of macrosomic newborn among women in the northern counties of Troms, Finnmark and Nordland in Norway has not been conducted yet. Although large numbers of studies have been conducted and a number of studies are now underway in arctic and sub-arctic areas of Norway and Russia that explore the long-term effects of contaminants on maternal and child health[28, 29]. Therefore, the present study is an attempt to understand the prevalence and predictors of macrosomic newborn among women in these regions.

Objectives of the study

The present study is an attempt to comprehend the prevalence and determinants of macrosomic newborn as pregnancy outcomes among the north Norwegian mothers. More specifically, the study objectives are:

i) to understand the prevalence of macrosomic newborn among the three northern counties of Troms, Finnmark and Nordland in Norway; and

ii) to identify the socio-economic and demographic factors of macrosomic newborn in the same region.

Research Questions

The following research questions are formulated to meet the research objectives:

i) What is the prevalence of macrosomic newborn in northern Norway and

ii) What are the most important socio-economic and demographic factors that influence macrosomic newborn among women in northern Norway.

Significance of the Study/Policy Implications

Since there has not been any study conducted on macrosmic newborns in northern Norway the present study will help to understand the prevalence and the risk factors of marcrosomic newborn in the region. It will also draw the attention of policy makers to improve the maternal and child health status in the region along with helping the battle for the present obstetrics challenge in Norway. It will therefore contribute to the academic discourse on reproductive health within the discipline of public health and most likely will come up with the ideas for future research on the subject.

Organization of the Thesis

This thesis comprises of four chapters. The first chapter has introduced the brief background of global context of macrosomic newborn particularly in Norway. The research questions (the objectives and justifications for the study) have also been described in this chapter. Chapter Two has been framed with detailed methodology describing the study area and study population. Different dependent and independent variables and statistical analyses have been demonstrated in this chapter. Chapter Three has the main findings of the thesis. The quantitative results of macrosomic newborn have been interpreted using univariate, bivariate and

multivariate analyses in this chapter. Chapter Four has concluded the thesis with a recapitulation of the themes discussed in the previous chapters summarizing and analyzing the findings. It has also recommended strategies for the mothers to improve the pregnancy outcomes.

CHAPTER TWO

Materials and Methods

Study Area and Population

The North Norwegian mother-and-child study (also known as the MISA study) took place from 2007 until 2009 in different regions of northern Norway. The study population lived in the northern counties of Nordland, Troms and Finnmark. Pregnant women in the study area were invited by a written invitation administered by ultrasound clinics personnel or midwife consultations linked to places illustrated in Figure 1. The participating delivery departments were: Nordland Hospital (Bødo and Lofoten), University Hospital of North Norway Trust (Tromsø and the labour wards of North-Troms (Nordreisa) and Mid-Troms (Lenvik)), and Finnmark Hospital (Kirkenes, Hammerfest and the labour ward of Alta).

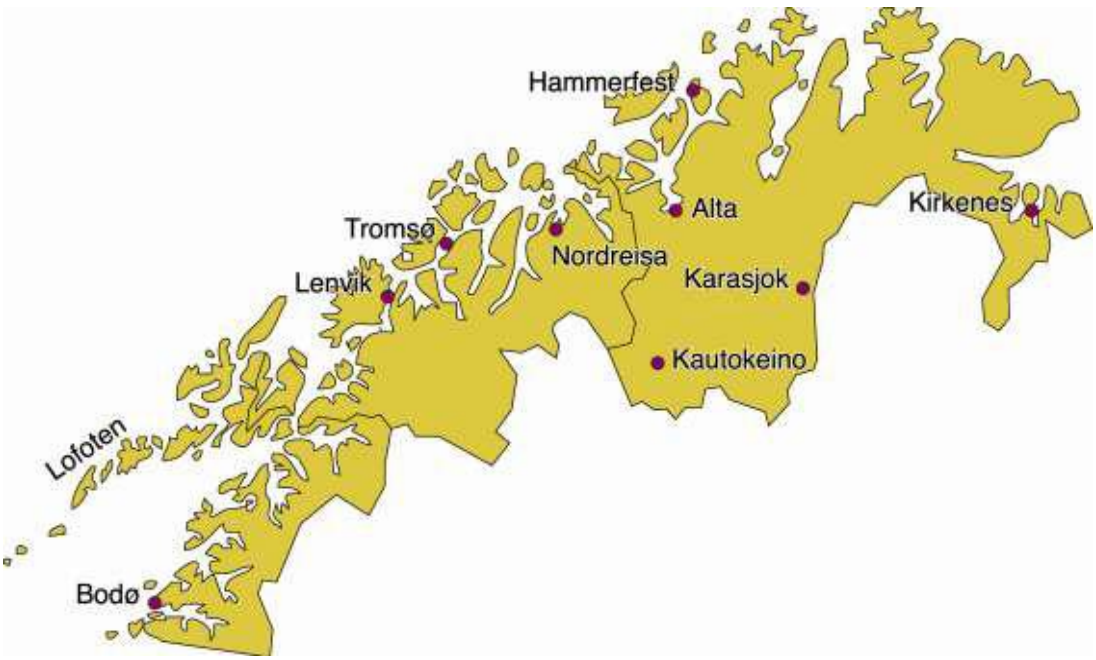

Figure 1 Map of the MISA study area (Source: Rod Wolstenholme, UiT, adapted from Hansen 2011)

The MISA study adopted a cohort study design. It had three different sampling points, for instance, P1 – week 20 in the 2nd trimester, P2 – 3 days postpartum and P3 – 6 weeks postpartum. Initially, 2600 pregnant women were invited to participate in this study, however, 609 women were responded and 557 were registered. Finally, 479 women who gave birth their children have been selected as sample size after various kinds of exclusions, for example, lack of consent, avoided further contact, etc[30]. The study was accepted by the Regional Ethical Committee of Northern Norway.

Data Collection

The data collection procedure used in the MISA cohort is presented in Figure 2. In the MISA study, the participants completed a detailed information questionnaire pertaining to personal characteristics, obstetric history, diet and life style. Permission was obtained to consult their medical records. In addition, at all blood sampling points a simple questionnaire was administered to obtain personal information about current diet, smoking and alcohol habits, medication and dietary supplements. Maternal weight was measured at each period, and self-reported pre-pregnancy weight and height were attained from pregnant women[30]. Although alcohol habits, maternal weight and pre-pregnancy height are the important determinants of macrosomia newborn, these variables were not used in this study due to the significant missing information (approximately 50%).

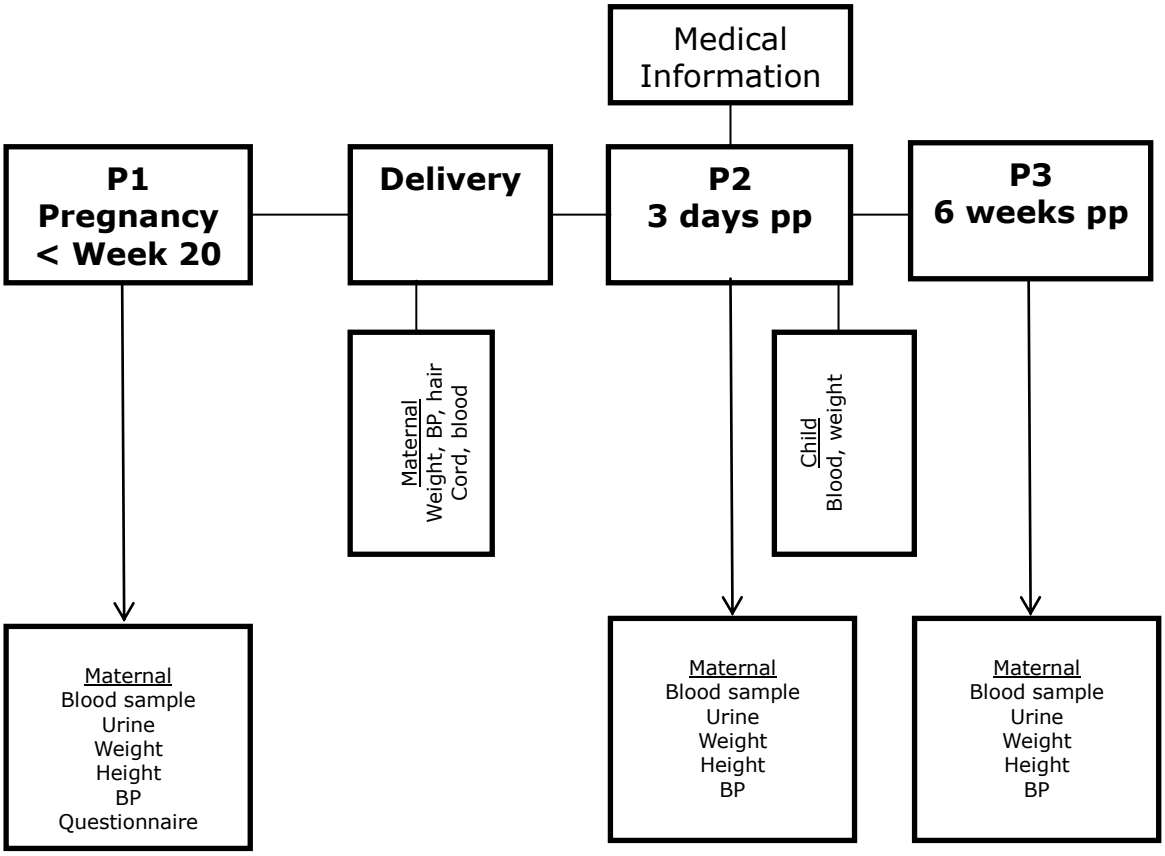

Figure 2 Flow chart of the MISA Study (Source: adapted from Hansen 2011)

Dependent Variables

The dependent variables have been used in this study are birth weight (BW) and body mass index of child (BMIC). Both variables have been used as dichotomous variables. BW has been categorized as birth weight <4,000g and birth weight ≥4,000g. Babies born with weight less than 4000g has been defined as non-macrosomic while weight equal or more than 4000g has been defined as macrosomic newborn. On the other hand, BMIC has been categorized as BMIC <15 and BMIC ≥15. The 90th percentile of BMIC has been considered as cut off point. Babies born with less than 15 BMIC has

been defined as non-macrosomic and newborn equal or more than 15 BMIC has been defined as macrosomic in this study. Thus, the two dependent variables were measured whether a mother gave birth newborn weighted <4,000g or ≥4,000g (<4,000g = 0, ≥4,000g = 1) and whether a mother gave birth child BMI <15 or ≥15 (<15 = 0, ≥15 = 1).

Independent Variables

Demographic, socioeconomic and spatial factors of the respondents have been considered as independent variables. The following variables from the MISA study were included in this study as independent variables: place of residence; household income; maternal age; ethnic background; years of education and occupation of the respondents; education and occupation of respondents' husbands; marital status; pre-pregnancy weight; smoking at the beginning of pregnancy; smoking at the end of pregnancy and daily exposed to passive smoking.

Statistical Analysis

Data has been summarized, tabulated and analyzed using SPSS 16.0 software. Bi-variate analyses were performed based on cross tabulations using chi-square tests, and multivariate analyses have been performed in terms of linear logistic regression analysis. The aim of the models was to examine the effect of demographic and socio-economic factors on macrosomia based on BW and BMIC.

Ethical considerations

The MISA study was approved by the Regional Committees for Medical Research Ethics and the Norwegian Data Inspectorate. Participation was voluntary, and the women signed an informed consent form[30].

CHAPTER THREE

Results

Sample Characteristics

Different socio-economic, demographic and pregnancy characteristics are presented in Table 1. Study found that more than half of them (54.7%) were from Troms County and 29.2% were from Nordland, while the remaining of the respondents (16.1%) was from Finnmark County. Only 7.9% of the respondents were from Sami, the indigenous people in Norway and rest of the respondents (92.1%) belonged to the Norwegian ethnicity. The majority (67.2%) of the respondents belonged to the 25 to 35 age group followed by 18.4% and 14.4% in the less than 25 and more than 35 age groups respectively. The literacy rate of the mothers was extremely high (100%). More than eighty percent mothers had equal or more than twelve years of education while the remaining of the mothers (17.6%) had less than twelve years of education. More than sixty percent of the respondents' annual household income was equal or more than 600 000 Norwegian kroner while 38.7% had less than 600 000 Norwegian kroner. Majority of the respondents were cohabited (60.1%) followed by married (35.7%) and single (4.2%). More than half of the women (56.7%) had 60 to 80 kg weight before they got pregnancy while 31.5% had less than 60 kg pre-pregnancy weight. On the other hand, 11.8% women had extremely pre-pregnancy weight of 80 kg. Among respondents, 17.9% had smoking habit at the beginning of the pregnancy while 8.3% smoked at the end of pregnancy. Nearly six percent (5.6%) respondents also reported that they were daily exposed to passive smoking during their pregnancy. Bleeding during pregnancy was 7.4% among women while induced abortion was about four percent. About one-fifth of the respondents also reported that they had previous

cesarean section experience. Experience of miscarriage before 12 weeks of gestational age was 22.4% while 23.4% of the respondents argued that they used contraceptive pills before six months of pregnancy.

Table 1 Percentage Distribution of Sample Characteristics

Sample charactersistics	N (%)
Geogrphic Location (N=479)	
Finnmark	77 (16.1)
Troms	262 (54.7)
Nordland	140 (29.2)
Ethnic Background (N=479)	
Sami	38 (7.9)
Non-sami/Norwegian	441 (92.1)
Mothers Age in years(N=479, Mean=30.47, SD=4.95)	
< 25	88 (18.4)
25-35	322 (67.2)
> 35	69 (14.4)
Years of Schooling in years (N=460, Mean=15.66, SD=2.84)	
< 12	81 (17.6)
≥ 12	379 (82.4)
Mothers Household Annual Income in NOK (N=444, Mean=, SD=)	
< 600 000	172 (38.7)
≥ 600 000	272 (61.3)
Marital Status (N=476)	
Unmarried/Single	20 (4.2)
Married	170 (35.7)
Cohabited	286 (60.1)
Pre-pregnancy weight in Kg(N=381, Mean=67.11, SD=11.49)	
< 60	120 (31.5)
60-80	216 (56.7)
> 80	45 (11.8)
Smoking at the beginning of Pregnancy (N=430)	
Yes	77 (17.9)
No	353 (82.1)
Smoking at the end of Pregnancy (N=385)	
Yes	32 (8.3)
No	353 (91.7)
Daily Exposed to Passive Smoking (N=465)	
Yes	26 (5.6)
No	439 (94.4)
Bleeding during Pregnancy (N=349)	
Yes	26 (7.4)
No	323 (92.6)
Induced Abortion (N=386)	
Yes	15 (3.9)
No	371 (96.1)
Previous Caesarian Section (N=233)	
Yes	50 (21.5)
No	183 (78.5)

Miscarriage before week 12 (N=388)	
Yes	87 (22.4)
No	301 (77.6)
Contraceptives pills before 6 months of Pregnancy (N=338)	
Yes	79 (23.4)
No	259 (76.6)

N= Number of Frequency

Pregnancy Outcomes

Major pregnancy outcomes among the north Norwegian mothers are presented in Table 2. The major pregnancy outcomes in this study were BW and BMIC which have been used as dependent variables for further analyses. Other pregnancy outcomes were baby's length, head circumference and Apgar score after 1 and 5 minutes of delivery. Study found that the mean BW and BMIC were 3617.68g and 14.27 respectively. The mean length of the baby was 50.27cm, while the mean head circumference was 35.5. The mean Apgar score after 1 minute and Apgar score after 5 minute were 8.62 and 9.49, respectively.

Table 2 Major Pregnancy Outcomes among North Norwegian Mothers

Pregnancy outcomes	Mean	Range	SD
Birth Weight in gm	3617.68	1720-5030	493.72
BMIC	14.27	10.16-18.21	1.22
Length in cm	50.27	41-57	2.06
Head Circumference	35.50	27-40	1.49
Apgar Score after 1 minute	8.62	0-10	1.45
Apgar Score after 5 minute	9.49	0-10	1.13

SD= standard deviation

Prevalence of Macrosomia

Prevalence of macrosomia based on BW and BMIC among the North Norwegian mothers is exhibited in Table 3. Study revealed that the prevalence of macrosomia by BW was 21.2% among the study population. However, this prevalence was 25.8% when macrosomia was based on BMIC.

Table 3 Prevalence of Macrosomic Newborn based on BW and BMIC among the North Norwegian Mothers

Northern Counties	Macrosomic Newborn by BW		Macrosomic Newborn by BMIC	
	N	%	N	%
Finnmark	13	16.9	15	21.7
Troms	51	19.5	60	24.6
Nordland	37	26.6	36	30.8
Total	101	**21.2**	111	**25.8**

Macrosomia based on Birth Weight

Bivariate Analysis

In this study, macrosomia was assessed in terms of different demographic and socio-economic characteristics of women using chi-square test (Table 4). Bivariate analysis showed that pre-pregnancy weight and smoking at the end of pregnancy were significantly associated with macrosomia (*p*-values are included in the table). The study found that there was an association between pre-pregnancy weight and macrosomia where BW increased with the increasing pre-pregnancy weight. Analysis also revealed that women who had pre-pregnancy weight less than 60kg gave birth only 10% macrosomic newborn while this rate was 24.3% and 35.6% who had pre-pregnancy weight between 60 to 80kg and more than 80kg, respectively. Smoking at the end of pregnancy had also significant association with macrosomia. Analysis

demonstrated that 93.8% women who smoked at the end of pregnancy had given birth baby less than 4000g, whereas the corresponding percentage was 77.2 who did not smoke. However, respondents' geographic location, ethnic background, age, years of schooling, marital status, household income, smoking at the beginning of pregnancy and passive smoking during pregnancy had no significant association with macrosomia.

Table 4 Association between Macrosomia based on Birth Weight and Demographic and Socioeconomic Characteristics, using Chi-square Test

Population charactersistics	N	Birth Weight	
		Non-macrosomic (<4000g)	Macrosomic (≥4000g)
Geogrphic Location (*P*=.154)			
Finnmark	77	64 (83.1)	13 (16.9)
Troms	261	210 (80.5)	51 (19.5)
Nordland	139	102 (73.4)	37 (26.6)
Ethnic Background (*P*=.665)			
Sami	38	31 (81.6)	7 (18.4)
Non-sami/Norwegian	439	345(78.6)	94 (21.4)
Mothers Age in years (*P*=.145)			
< 25	88	75 (85.2)	13 (14.8)
25-35	320	251 (78.4)	69 (21.6)
> 35	69	50 (72.5)	19 (27.5)
Years of Schooling in years (*P*=.065)			
< 12	81	70 (86.4)	11 (13.6)
≥ 12	377	291 (77.2)	86 (22.8)
Mothers Household Annual Income in NOK (*P*=.906)			
< 600 000	172	136 (79.1)	36 (20.9)
≥ 600 000	271	213 (78.6)	58 (21.4)
Marital Status (*P*=.172)			
Unmarried/Single	20	16 (80.0)	4 (20.0)
Married	169	125 (74.0)	44 (26.0)
Cohabited	285	232 (81.4)	53 (18.6)
Pre-pregnancy weight in Kg (*P*=.0000)			
< 60	120	108 (90.0)	12 (10.0)
60-80	214	162(75.7)	52 (24.3)
> 80	45	29 (64.4)	16 (35.6)
Smoking at the beginning of Pregnancy (*P*=.056)			
Yes	77	67 (87.0)	10 (13.0)
No	351	271 (77.2)	80 (22.8)
Smoking at the end of Pregnancy (*P*=.029)			
Yes	32	30 (93.8)	2 (6.2)
No	351	271 (77.2)	80 (22.8)
Daily Exposed to Passive Smoking (*P*=.846)			

N= Number of Frequency

Multivariate Analysis

A binary logistic regression model was fitted to explore the predictors of macrosomia based on BW among the north Norwegian women (Table 5). The response variable was BW (weight less than 4000g = 0, weight equal to or more than 4000g = 1). The explanatory variables used in the model were respondents' geographic location, ethnic background, age, marital status, years of schooling household income, pre-pregnancy weight, smoking at the beginning of pregnancy, smoking at the end of pregnancy and passive smoking during pregnancy. Logistic analysis suggested that women who had pre-pregnancy weight in between 60 to 80kg were four times greater chance of giving birth macrosomia newborn compared with women who had less than 60kg pre-pregnancy weight. Analysis further revealed that women who had pre-pregnancy weight more than 80kg had five times more chance of giving birth macrosomia newborn relative to women who had less than 60kg pre-pregnancy weight. Although smoking at the end of pregnancy found to be significant in bivariate analysis, it was not found significant in multivariate analysis.

Table 5 Logistic Regression Estimates of Demographic and Socioeconomic Characteristics' effects on Macrosomia based on Birth Weight

Independent Varibales	OR	*p*-value	CI 95%
Geogrphic Location (*r* = Finnmark)			
Troms	0.89	> 0.05	0.31-2.56
Nordland	2.33	> 0.05	0.44-12.35
Ethnic Background (*r* = Sami)			
Non-sami/Norwegian	0.92	> 0.05	0.22-3.76
Mothers Age in years (*r* = < 25)			
25-35	1.31	> 0.05	0.38-4.51
> 35	2.04	> 0.05	0.41-10.11
Years of Schooling in years (*r* = < 12)			
≥ 12	0.80	> 0.05	0.25-2.52
Mothers Household Annual Income in NOK (*r* = < 600 000)			
≥ 600 000	0.67	> 0.05	0.28-1.61
Marital Status (*r* = Unmarried/Single)			
Married	0.42	> 0.05	0.06-2.87
Cohabited	0.21	> 0.05	0.03-1.32
Pre-pregnancy weight in Kg (*r* = < 60)			
60-80	4.01	< 0.05	1.44-11.17
> 80	5.06	< 0.05	1.36-18.80
Smoking at the beginning of Pregnancy (*r* = Yes)			
No	1.33	> 0.05	0.36-4.92
Smoking at the end of Pregnancy (*r* = Yes)			
No	4.84	> 0.05	0.43-54.41
Daily Exposed to Passive Smoking (*r* = Yes)			
No	0.65	> 0.05	0.09-4.68

OR= Odd Ratio
CI= Confidence Interval

Macrosomia based on Body Mass Index of Child

Bivariate Analysis

Macrosomia based on BMIC was assessed in terms of different demographic and socio-economic characteristics of women using chi-square test (Table 6). Bivariate analysis showed that pre-pregnancy weight of the women and smoking at the end of pregnancy were significantly associated with macrosomia (*p*-values are included in the table). The study revealed that there was an association between pre-pregnancy weight and macrosomia where BMIC increased with the increasing pre-pregnancy weight. Analysis demonstrated that women who had pre-pregnancy weight less than

60kg gave birth only 14.9% macrosomic infants while the corresponding percentages were 28.9% and 39.5% who had pre-pregnancy weight 60 to 80kg and more than 80kg, respectively. Analysis also suggested that smoking at the end of pregnancy and at the end of pregnancy had significant association with macrosomia in the study. More than eighty percent women who smoked at the beginning of pregnancy gave birth non-macrosomic newborn, while the corresponding percentage was 72.7 who did not smoke. It is also found that women who smoked at the end of the pregnancy were more likely to give birth baby <15 BMI when compared with women who did not smoke. However, respondents' geographic location, ethnic background, age, years of schooling, marital status, household income and passive smoking during pregnancy had no significant association with macrosomia.

Table 6 Association between Macrosomia based on Body Mass Index of Child and Demographic and Socioeconomic Characteristics, using Chi-square Test

Charactersistics	N	BMIC	
		Non-macrosomia (<15)	Macrosomia (≥15)
Geogrphic Location (*P*=.318)			
Finnmark	69	54 (78.3)	15 (21.7)
Troms	244	184 (75.4)	60 (24.6)
Nordland	117	81 (69.2)	36 (30.8)
Ethnic Background (*P*=.907)			
Sami	36	27 (75.0)	9 (25.0)
Non-sami/Norwegian	394	292(74.1)	102 (25.9)
Mothers Age in years (*P*=.656)			
< 25	81	63 (77.8)	18 (22.2)
25-35	284	207 (72.9)	77 (27.1)
> 35	65	49 (75.4)	16 (24.6)
Years of Schooling in years (*P*=.374)			
< 12	74	58 (78.4)	16 (21.6)
≥ 12	342	251 (73.4)	91 (26.6)
Mothers Household Annual Income in NOK (*P*=.271)			
< 600 000	155	110 (71.0)	45 (29.0)
≥ 600 000	245	186 (75.9)	59 (24.1)
Marital Status (*P*=.266)			
Unmarried/Single	19	14 (73.7)	5 (26.3)
Married	151	105 (69.5)	46 (30.5)
Cohabited	259	199 (76.8)	60 (23.2)
Pre-pregnancy weight in Kg (*P*=.002)			
< 60	114	97 (85.1)	17 (14.9)
60-80	201	143(71.1)	58 (28.9)
> 80	43	26 (60.5)	17 (39.5)
Smoking at the beginning of Pregnancy (*P*=.049)			
Yes	69	58 (84.1)	11 (15.9)
No	315	229 (72.7)	86 (27.3)
Smoking at the end of Pregnancy (*P*=.007)			
Yes	28	27 (96.4)	1 (3.6)
No	316	232 (73.4)	84 (26.6)
Daily Exposed to Passive Smoking (*P*=.332)			
Yes	23	19 (82.6)	4 (17.4)
No	396	291 (73.5)	105 (26.5)

N= Number of Frequency

A binary logistic regression model was employed to explore the determinants of macrosomia based on BMIC among the north Norwegian women (Table 7). The response variable was BMIC; BMIC less than 15 (non-macrosomic) = 0, BMIC equal to or more than 15 (macrosomic) = 1. The explanatory variables used in the model were

respondents' geographic location, ethnic background, age, years of schooling marital status, household income, pre-pregnancy weight, smoking at the beginning of pregnancy, smoking at the end of pregnancy and passive smoking during pregnancy.

Table 7 Logistic Regression Estimates of Demographic and Socioeconomic Characteristics' effects on Macrosomia based on Body Mass Index of Child

Independent Varibales	OR	*p*-value	CI 95%
Geogrphic Location (*r* = Finnmark)			
Troms	0.96	> 0.05	0.34-2.74
Nordland	1.11	> 0.05	0.19-6.45
Ethnic Background (*r* = Sami)			
Non-sami/Norwegian	0.32	> 0.05	0.09-1.19
Mothers Age in years (*r* = < 25)			
25-35	0.87	> 0.05	0.27-2.76
> 35	0.76	> 0.05	0.16-3.50
Years of Schooling in years (*r* = < 12)			
≥ 12	1.13	> 0.05	0.35-3.68
Mothers Household Annual Income in NOK (*r* = < 600 000)			
≥ 600 000	0.58	> 0.05	0.24-1.41
Marital Status (*r* = Unmarried/Single)			
Married	0.49	> 0.05	0.07-.58
Cohabited	0.39	> 0.05	0.06-2.58
Pre-pregnancy weight in Kg (*r* = < 60)			
60-80	3.59	< 0.05	1.31-9.87
> 80	6.39	< 0.05	1.84-22.20
Smoking at the beginning of Pregnancy (*r* = Yes)			
No	0.91	> 0.05	0.25-3.31
Smoking at the end of Pregnancy (*r* = Yes)			
No	5.60	> 0.05	0.43-54.41
Daily Exposed to Passive Smoking (*r* = Yes)			
No	2.04	> 0.05	0.17-24.00

OR= Odd Ratio
CI= Confidence Interval

Logistic regression analysis suggested that women who had pre-pregnancy weight in between 60 to 80kg were more than three times higher chance to give birth macrosomic newborn compared with women who had less than 60kg pre-pregnancy weight. The analysis also showed that women who had pre-pregnancy weight more than 80kg had more than six times higher chance of giving birth macrosomic infants relative to women who had less than 60kg pre-pregnancy weight. Regression analysis

found that women who did not smoke at the end of pregnancy were five times more likely to give birth macrosomic baby when compared with women who did smoke.

CHAPTER FOUR

Discussion and Conclusion

Findings of prevalence and predictors of macrosomic newborn of three counties of Northern Norway have been presented in this chapter following the research questions. Even though the prevalence of newborn macrosomia is high in other parts of Norway, systematic study on macrosomic newborn in Troms, Finnmark and Nordland has not been investigated yet. Thus, the present study aimed to understand the prevalence and determinants of macrosomic newborn as pregnancy outcomes among the north Norwegian mothers. In the present study, macrosomia newborn has been defined as babies born with weight equal or more than 4000g or BMI of 15 or above. The present study is from the North Norwegian mother-and-child cohort study that took place from 2007 until 2009. From this cohort, a total of 479 pregnant women who delivered their babies have been taken from three northern counties of Norway as sample. Finally, the collected data has been presented by using uni-variate, bi-variate and multivariate analyses.

In the present study, BW and BMIC have been taken into account as pregnancy outcomes to understand the prevalence and determinants of macrosomic infants among north Norwegian mothers. Study found that the mean BW was 3617g and SD was 493 which are very close to the Norwegian Mother and Child Cohort Study (MoBa) where mean BW and SD were 3682g and 488 respectively[26]. Others studies from the northern Norway also demonstrated almost similar mean BW and SD. These studies also found that the mean BMIC and SD were 14.2 and 1.2 respectively which is

almost consistent with the other study in northern Norway where mean BMIC was 13.9 and SD was 1.3[31-33].

The study found that the prevalence of macrosomic newborn among the north Norwegian mothers is 21.2% which shows consistent increasing trend of macrosomia in Norway where newborn macrosomia (newborns weighing 4,000 g or more) has increased from 16% to 20% in less than three decades[1, 4]. Numerous studies in other countries also demonstrated that during the last three decades an overall 15% to 25% increase in the proportion of women giving birth to macrosomic infants, which is also congruent with the present study[2, 6, 7].

Within the study population, pre-pregnancy weight and smoking at the end of pregnancy were significant risk factors for macrosomia which is consistent with other studies in Norway[24, 34]. Several studies from other countries also demonstrated a significant relationship between macrosomia newborn and maternal pre-pregnancy weight or maternal BMI and maternal smoking[3, 7, 14, 35, 36]. A recent study in Chile found that macrosomia rates were higher among overweight group (BMI of 25 or greater) as compared with the non-overweight group[37]. In the present study, pre-pregnancy BMI was not calculated due to almost 50% missing information regarding mothers' height. However, findings revealed that mothers who had more than 60kg pre-pregnancy weight were five to six times more likely to give birth macrosomia newborn. It suggests that maternal overweight was itself enough to accelerate fetal growth among the north Norwegian mothers. Another recent study in Norway found

that birth weight of babies increased with increasing maternal pre-pregnancy BMI. However, this study did not investigate the relationship between macrosomia and maternal pre-pregnancy weight[27].

Several studies demonstrated that mothers of macrosomic infants were less likely to have smoked during the pregnancy which is resembled with bivariate analysis in the present study; however, the logistic regression model did not find non-smoking mothers as the determinant of macrosomic newborn[7, 35].

The study also found that the prevalence of newborn macrosomia was 25.8% when BMIC has been used as outcome variable, which is higher than generally accepted measurement of macrosomia by BW. Although, pre-pregnancy weight found to be the only determinant of macrosomia newborn in the first model (Table 5), pre-pregnancy maternal weight and non-smoking at the end of pregnancy were the significant predictors of maccosomia newborn in the second model (Table 7). However, no study has found that used BMIC as responsible variable to comprehend the determinants of macrosomia. Nevertheless, the findings of this study are consistent with other studies from Norway and many other countries[7, 14, 24, 34-36].

Study argued that the causes of macrosomia newborn include both genetic and environmental factors. The rapid increase in the prevalence of macrosomia has also environmental causes which might be more relevant for the northern population due to high exposure to environmental contaminants[14, 31-34, 38, 39]. Therefore, the present

study suggests further investigation to find out the relationship between macrosomia newborn and environmental exposure in northern Norway.

This study also suggests that macrosomia is associated with maternal and neonatal complications in Norway such as intrauterine death, artificial induction of labor, prolonged birth, shoulder dystocia, still births, birth asphyxia, intrapartal hypoxia, low Apgar score, injuries to the baby and the mother, increased use of operative deliveries, postpartum hemorrhages and neonatal hypoglycemia, hyperbilirubinemia and the use of neonatal intensive care, urgent policy is needed to be taken for the north Norwegian girls especially for women[20-23]. The risk of giving birth to macrosomic infants may be reduced by intervention before or during pregnancy addressed to high-risk women. Among the risk factors identified in the present study, high maternal pre-pregnancy weight is the most important evidence to try to modify. Another factor, for instance, smoking at the end of pregnancy is less obvious to manipulate. Overweight women who are planning for pregnancy should attempt to reduce their weight. The north Norwegian mothers need to go through routine exercise especially before and during pregnancy as the study in Norway suggests that regular exercise during pregnancy reduces the odds of giving birth to newborns with excessive birth weight by 23-28%[26]. Unfortunately, there was no information on exercise during pregnancy in the present study; thus, future research should accommodate this aspect as well. Secondly, preventive measure should include guidance about nutrition in order to reduce the prevalence of pre-pregnancy overweight as limited weight gain in pregnancy seems to reduce the risk of macrosomia particularly for obese women[34].

The major strength of the present study is that it has both cross-sectional and prospective longitudinal aspects. In addition, this study is externally valid to the existing literature on macrosomic newborn in Norway during the last three decades. However, the present study has some selection bias due to “study tiredness” (i.e., requests to participate in too many studies) contributed to the low participation. This was difficult to overcome even with vigorous promotion strategies. Moreover, the time commitment and the frequency of sample donation may also have led to lower participation. Consequently, it is likely that the study cohort is not as representative of the maternal population of Northern Norway as planned[30].

In summary, the prevalence and predictors of macrosomia that are demonstrated in the present study very much consistent with the current literature in Norway and other developed countries in the world. The study found that pre-pregnancy weight and non-smoking at the end of pregnancy are the main determinants of macrosomia newborn in northern Norway. General pre-pregnancy health advise and dietary advise for young women will have a very positive impact on pregnancy outcome.

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