Journal of Home Economics

Volume 26, Number (2), 2016

Journal of Home Economics

http://homeEcon.menofia.edu.eg **ISSN 1110-2578**

Impact of maternal nutrition and socio-economic status on birth weight of babies in Port Said Governorate, Egypt

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Abstract: Low birth weight (LBW) is a major public health problem in most developing countries including Egypt, being associated with a high incidence of neonatal mortality in these regions. There is, therefore, an urgent need to determine ways and means to prevent LBW and its consequences. This study was designed to study the impact of maternal nutrition and socio-economic status on birth weight of babies in Port Said Governorate, Egypt. Data shows that the prevalence of LBW in the stated health centers varies widely by pregnant mothers age, area, socioeconomic status (family income, parents education), the weight gain during the pregnancy etc. The mean weight gain of the pregnant mothers in this study was 7.39 ± 0.97 kg (The weight gain standard is 11 kg). Weight gain in pregnancy, maternal hemoglobin, serum iron and serum antioxidant vitamins were all found to be significant for LBW ($p <$ 0.05-0.001). Maternal nutritional status impacted significantly on newborn birth weight as poorly nourished mothers were observed to produce a higher percentage of LBW babies when compared to those who were better nourished. Therefore, the challenge of addressing the LBW problem therefore remains an urgent imperative for development.

Keywords: Socio-demographic, hemoglobin, iron, vitamins, dietary habits

Introduction

Birth weight is the single most important criterion for determining the neonatal and infant survival. Low birth weight (LBW) is a sensitive indicator of the socio-economic conditions and indirectly measures the health of the mother and the child. The World Health Organization (WHO) defined LBW as that below 2,500 g (Kramer, 1987). LBW is a major public health problem due to it's the main cause of mortality, morbidity and disability (Amosu and Degun, 2014). It has been shown that the mortality range can vary 100-fold across the spectrum of birth weight and rises continuously with decreasing weight (Wilcox, 2001).

It is generally recognized that being born with a LBW is a disadvantage for the infant. Pre-term birth is a direct cause of 27% of the 4 million neonatal deaths that occur globally every year (Lawn *et al.*, 2005). Pre-term birth and SGA are also important indirect causes of neonatal deaths. Low birth weight directly or indirectly may contribute up to 60–80% of all neonatal deaths (Lawn *et al.*, 2005). LBW infants are at higher risk of early growth retardation, infectious disease, developmental delay and death during infancy and childhood (McCormick, 1985; Ashworth, 1998).

During the newborn period LBW/ SGA (A small for gestational age) babies present increased risk of hypoglycemia, hypothermia, hypercoagulability, hyperbilirubinemia, hypotension, necrotizing enterocolitis, respiratory distress syndrome, lower Apgar scores, umbilical artery acidosis, more intubations and complications during delivery and approximately 20 times increased risk of neonatal death than babies born with an appropriate for gestational age (AGA) weight (Claussonet *et al.*, 1998; McIntire *et al.*, 1999; Jancevskaet *et al.*, 2012). Also, UNICEF and WHO (2004) reviewed that LBW due to restricted foetal growth affects the person throughout life and is associated with poor growth in childhood and a higher incidence of adult diseases, such as type 2 diabetes, hypertension and cardiovascular disease. An additional risk for girls is having smaller babies when they become mothers. Furthermore, Carlos and Marilia, (2013) reviewed that a clear phenomenological association has been demonstrated by many epidemiological studies between LBW and increased risk later in life, for many diseases such as IR, mortality by type 2 diabetes (T2D), hypertension(HT) and ischemic heart diseases (IHD), cardiovascular diseases (CVD), dyslipidemia, obesity, breast and testicular cancer, end-stage renal disease, osteoporosis, spontaneous hypothyroidism, adult asthma and hearing loss, cardiac hypertrophy, depression, liver cirrhosis, schizophrenia, polycystic ovary syndrome, precocious pubarche, hypospadias, cryptorchidism, low scores of alertness, mood instability, significant differences in academic and professional achievement.

LBW is a major public health problem in most developing countries, being associated with a high incidence of neonatal mortality in these regions (Wilcox, 2001). In Egypt, the average prevalence of LBW is estimated to be about 12% (UNICEF, 2004). The immediate consequences are higher morbidity and mortality rates in the perinatal and neonatal periods [Osrinand de L Costello, 2000]. The late consequences may include prolonged impairment of immunological defense mechanisms and neurological sequelae which interfere with the normal development of the child and on a national level, are serious obstacles to development (Davies and Stewart, 1995; Ferguson, 1998).

Many factors affect the duration of gestation and of foetal growth, and thus, the birth weight. They relate to the infant, the mother or the physical environment and play an important role in determining the infant's birth weight and future health (WHO (2004). The multiple causes of LBW, include early induction of labour or caesarean birth (for medical or non-medical reasons), multiple pregnancies, infections and chronic conditions such as diabetes and high blood pressure (Christopher and Siobhan, 2014; WHO, 2014). Other important causes could include low maternalnutrient intake, higher nutrient losses, and/or increased nutritional requirements i.e. malnutrition during pregnancy (Amosu and Degun, 2014). Maternal morbidity during pregnancy is highly prevalent in the low socio-economic groups (Sumithra, 2009) and protective mechanisms such as the bactericidal zinc peptide system in the amniotic fluid (Schlievert*et al.,* 1976), may be impaired partly because of malnutrition during pregnancy (Naeye*et al.,* 1997). All of these reasons indicated that the maternal nutrition is an important factor from a public health point of view because it is modifiable and therefore susceptible to public health interventions. There is, therefore, an urgent need to determine ways and means to prevent LBW and its consequences. This thesis was designed to study the maternal nutritional and socio-economic factors and their role in BW of the newborn in Port Said Governorate, Egypt.

Material and Methods

Chemicals and equipments

Standard vitamins (A, C, and E) were purchased from Sigma Chemical Co. (St. Louis, MO). All chemicals and buffers, except stipulated, were in analytical grade and purchased from Al-Gomhoria Company for Drugs, Chemicals and Medical Instruments, Cairo, Egypt.

Throughout this study, a SP Thermo Separation Products Liquid Chromatography (ThermoSeparation products, San Jose, CA) was used with a ConstaMetvic 4100 pump, a SpectraSeries AS100, Spectra System UV 1000 UV/Visible Spectrophotometer Detector, SpectraSystem FL 3000, and a PC 1000 system software. The columns used (Alltech, Deerfield, IL)were a Hypersil BDS-C18 (5 µm, 150 x 4.6–mm internal diameter) for PAH; a reversed phasewaterAdsorbosil C18 (5 µmol/L, 100 mm x 4.6–mm internal diameter) for vitamin C; and normal Ultrasphere Si (5 µmol/L, 250 mm x 4.6–mm internal diameter) for analysisof vitamins A and E.

Study protocol

The present study was conducted in the Department of Home Economics, Faculty of Specific Education, Port Said University, Port Said, Egypt from January 2015 to March 2016. The research reported in the thesis was approved by the Research Ethics Committee of Faculty of Home Economics, Minoufiya University, Shebin El-Kom, Egypt. Approval was granted prior to the commencement of data collection by questionnaire. This is a cross-sectional and descriptive study design for booked pregnant mothers who delivered in five randomly selected health facilities in Port Said City, Port Saied Governorate, Egypt.

The subjects were selected from each health facility as they became available. Two hundred and ninety two randomly selected pregnant mothers attending antenatal clinics in the health facilities were booked and advised to report regularly for antenatal care. Complete abdominal examination, clinical profile along with height, weight,weight gain in pregnancy, blood pressure, haematological and biochemical examinations were carried out by the clinics staff. All the newborns were weighed and their general physical conditions assessed immediately following delivery. All infants weighing below 2.5 kg were recorded as low birth weight (LBW) babies.

A field pretested interviewing questionnaire was used for data collection which covering the following points: pregnant mother age, sex, residence (urban or rural) and family size. Sociodemographic status of pregnant mothers and their families, socioeconomic score, which contained social variables including fathers' education and work (score 2-

10), mothers' education and work (scores 1-10) and crowding index (scores 1-5). The total score calculation was: Score from 19-25 means high social class, score from 12 to 18 means middle social class and score below 12 means low social class such as mentioned by Fahmy and El-Sherbini (1983).

Dietary recall and the record were used for mothers who were asked for all foods and fluids consumed while she was at home. Daily iron intake of each infant was calculated using the "Diet Analysis Program, 1995" (Lifestyles Technologies, Inc., Northbridge Point, Valencia, California) and was then compared with the Recommended Dietary Allowances (RDA, 1989).

Hematological analysis

Blood samples were withdrawn from the antecubital vein into glass centrifuge tubes containing oxalate solution (1.34%) as anticoagulant. After centrifugation at 1500 *X g* for 10 minutes, plasma was withdrawn and used for analysis of blood lipid parameters and vitamins. The erythrocyte residue was washed with three successive portions of sodium chloride solution (0.9%) and then hemolyzed with deionized water for 30 minutes. Hemolysate was then centrifuged at 105,000 X *g* for 30 minutes, and the supernatant fractions was transferred to a clean test tube and analyzed for antioxidant enzymes (Stroev EA, Makarova, 1989).

Serum iron (Fe) content samples were determined by the adaptation the method mentioned by Singh *et al.,* (1991). One hundred µl of plasma sample were transferred into a digested glass tube and 2 ml of tri-acids mixture (containing nitric acid: perchloric acid: sulfuric acid in the ratio of 20: 4: 1 v/v respectively) were added to each tube. The tubes content were digested gradually as follow, 30 min at 70 0C; 30 min at 180 ^{0}C and 30 min at 220 ^{0}C. After digestion, the mixture was cooled, dissolved in MilliQ water, and the volume was increased to 10 ml in volumetric beaker. After filtration in ashless filter paper, aliquots were analyzed for Fe and Se content using of atomic absorption spectrophotometer, type Perkin - Elmer, Model 2380.

Blood hemoglobin (Hb) concentration was determined using cyanmethemoglobin method according to Villanova (1994). Anemia was diagnosed when Hb concentrations below the values adjusted for age groups (Wonke*et al.,* 2007). In infants from 6 months to 6 years mild, moderate and severe anemia was diagnosed if Hb level was 10-11, 7-9.9, or below 7 g/dl, respectively (Bermejo and García-López, 2009). The plasma ferritin concentrations and hematocrit value were assayed using specific Kits (Al-Gomhoria Company for Drugs, Chemicals and Medical Instruments, Cairo, Egypt) according to the methods mentioned in Tietz, (1999). The complete blood count was done using Coulter 1660 to determine the erythrocyte indices (mean corpuscular volume [MCV], mean corpuscular Hb [MCH], MCH concentration, and red cell diameter width.

Determination of vitamins

All vitamins (A, C, and E) were extracted according to methods previously detailedByEpler and Zeigler , (1993), Moeslinger et al., (1994) and Hung et al., (1980), respectively and were analyzed by HPLC techniques. For vitamins A and E, the chromatographic conditions were as follows: flow rate, 1.5 mL/min; detection, UV absorption at 265 nm, volume of injection, 20 µL; temperature, room temperature; and the mobile phase composition was an isocratic system of isopropanol:hexane (1:99). For vitamin C, the conditions were: flow rate, 1 mL/min; detection, UV absorption at 254 nm, volume of injection, 20 µL; temperature, room temperature, and mobile phase composition was an isocratic system of 100% methanol. Retention times and absorbance ratio against those of standards were used to identify the separated vitamins. Quantitative determination of each vitamin was determined from its respective peak area and corresponding response factor. The percent recoveries of vitamins were also studied by adding each vitamin to plasma after sample preparation and HPLC determination. Under such chromatographic conditions, mean values(±SD) of vitamins A, C, and E recoveries were 89.92 ±2.91, 92.01 ±3.25, and 88.11 ±2.34, respectively.

Statistical analysis

Data were summarized using means, SD, range for quantitative variables and number, and percentage for qualitative variables. Data obtained from the study were coded, entered and statistical analyzed using the software MINITAB 12 computer program (Minitab Inc., State College, PA).

Results and Discussion

Socio-demographic characteristics of the pregnant mothers studied group

In the present study Among 292 pregnant mothers enrolled, 45 (11.47%) women were not analyzed because of unavailability of consent for study or inadequate sample. The remaining enrolled 247 pregnant women and their newborn babies aged 0 to 12 months with a mean age of (29.8± 12.4 years for pregnant women) and (2.4 ± 1.8 months for the babies) years. The sociodemographic data are shown in Table (1). Based on the body weight, pregnant mothers were selected after borned low birth weight (LBW) babies. A logistic regression model was used to assess the effects of the significant explanatory variables in order to distinguish predictors of LBW. It was found that pregnant women from rural areas (60.32%), those from family size, 1 person (29.15%), those of illiterate mothers (32.72%), those of low social class (41.70%) and those of small age (38.05%) were the significant risk factors for LBW in these women.

Studies worldwide have examined the effect of socio-economic status (SES) indicators, including maternal education, on birth weight. Maternal illiteracy and low SES have been shown to be major risk factors for LBW (Mavalankar*et al.,* 1992; Sumithra, 2009). In the developing world, lacking proper health systems and resources, the level of maternal education may be of prime importance in the determination of health outcomes of mothersand their infants and children. In the Javier *et al.,*(2004) study, it is reviewed that there are many known risk factors, the most important of which are socio-economic factors, medical risks before or during gestation and maternal lifestyles. However, although interventions exist to prevent many of these factors before and during pregnancy, the incidence of LBW has not decreased. Also, Joshi *et al.,* (2007) reported that the main factors which were significantly associated with LBW were maternal education, stature, age at delivery; short inter pregnancy interval, inadequate antenatal care, and per capita income of family. Furthermore, Arnaud and Vincent (2007) studied the relationship between mother's education and birth weight and find modest but heterogenous positive effects of maternal education on birth weight with an increase from the baseline weight ranging from 2% to 6%. In this direction, Sumithra (2009) reported that there is a significant protective effect of higher maternal education (beyond high school). Optimal weight gain during pregnancy and a desirable foetal outcome may be a result of synergisitic effects of improved food intake, food supplementation, improved micronutrient intake, education and the environment of the pregnant woman and her family. Additionally, in similar study carried out by Amany and Samaa (2012) found that multivariate analysis revealed that, low level of education, decreased birth spacing and history of anemia before pregnancy were associated with increased risk of anemia, LBW complications ($p<0.05$, OR = 18.821, 10.582 and 3.362 respectively). All the present data with the others indicated that factors relating to the care of women, environmental hygiene and sanitation, household food security, and poverty are all likely to operate simultaneously with a low level of maternal literacy in the aetiology of LBW.

Table 1. Socio-demographic characteristics of the pregnant mothors studied group (n=247)

Variables	Number	Percentage (%)	Statistical analysis
Family size (person):			
– 1	72	29.15	p<0.05
– 2-3	63	25.51	
– 4-5	55	22.26	
– >5	57	23.18	
Level of mothers education:			
– Illiterate/can read and write	81	32.72	p<0.05
– Primary/preparatory	73	29.56	
– Secondary school	64	25.91	
– University or higher	29	11.74	
Residence:			
– Urban	98	39.68	p<0.01
– Rural	149	60.32	
Social class:			
– Low	103	41.70	p<0.01
– Middle	85	34.41	
– High	59	23.89	
Age (years)			
– < 20	94	38.05	p<0.05
– 20-30	51	20.65	
– 32-40	55	22.27	
– > 40	47	10.03	

* Non-significant (*P* >0.05).

Maternal weight gain in pregnancy of the mothers studied group

The mothers' weights were measured before and immediately after delivery of the baby, placenta and membranes. Primiparous mothers were found to gain significantly less weight than multiparous mothers (*p*<0.05).The mean weight gain in this study population was 7.39 ±□0.97 kg. Primiparous mothers recorded the lowest mean weight gain of 6.02 ±□0.965 kg, weight gain in pregnancy increasing with increase in parity as seen in Table (2). In similar studies, Jelliffe, (1966) and Amosu and Degun (2014) found that triceps skin fold thickness of the mothers as measured using a Harpenden caliper was expressed as a percentage of normal values. This variable indicates the amount of adipose tissue in the upper arm, with primiparous mothers recording lower percentage than the multiparae.Such as shown in Table (3) the high LBW incidence recorded in mothers with weight gain of 7 kg and below, while the lowest LBW incidence recorded with mothers gained 9 kg and above. The relationship between weight gain in pregnancy and newborn birth weight has been known for several decades (Beilly and Kurkland, 1945), and recently by Amosu and Degun (2014). Therefore, even now its importance to pregnancy outcome is being increasingly recognized. This importance is reflected in the recommendation that pregnant women should be encouraged to gain at least 11kg during gestation (UN, 2004).

Table 2. Parity and maternal weight gain during pregnancy of mothers studied group (n=247)

Parity	Frequency (n)	Mean ± SD (kg)	Statistical analysis
Primiparous	69	6.02± 0.96	p<0.05
Para 1	38	6.71± 0.85	
Para 2	48	6.92± 1.01	
Para 3	31	7.85± 0.59	
≥ Para 4	61	9.39± 1.42	

Table 3. Maternal weight gain in pregnancy of the mothers studied group (n=247)

Weight gain in pregnancy (kg)	Number of mothers/newborns	Statistical analysis
< 7	155	p<0.001
7.1 - 8	44	
> 8.1-9	39	
> 9	9	

Hematological and biochemical parameters of pregnant mothers and their LBW babies of studied group

Data of the hematological findings among pregnant mothers and their LBW babies are shown in Tables (4-5). From such data it could be noticed that the mean hemoglobin (Hb) level and mean corpuscular volume (MCV) of pregnant mothers were 9.17±0.72 g/dL and 69.57±4.12 fL which significantly decreased to 8.25±0.61 g/dL ($p<0.05$) and 61.41±5.07fL ($p<0.01$) in LBW babies, respectively. The opposite direction was observed for the red blood cell distribution width (RDW) which recorded 15.37±1.19% in pregnant women and significantly ($p<0.01$) increased to 17.22±1.10% in LBW babies. Such as metioned by Ann *et al.,* (2002) measurement of Hgb, the concentration of oxygen carrying protein, is a more sensitive and direct test for anemia, a complication concomitance with the LBW public health problem, than others tests such measurement of hematocrit (Hct), the percentage of whole blood that is occupied by RBCs. Anemia generally is defined as Hgb values below the 5th percentile in a healthy reference population: less than 11.0 g/dL for infants 6 months to 2 years of age. Hgb measurement is inexpensive, readily available test for anemia and is used most commonly to screen for iron deficiency. MCV, the average volume of RBCs, is reported in automated analyses, but it also can be calculated as the ratio of Hct to RBC count. MCV is useful for categorizing anemia as microcytic, normocytic, and macrocytic. Also, RDW measures variations in the size of RBCs and increases with iron deficiency. In one study of adults, high RDW (>15%) was 71% to 100% sensitive and 50% specific in diagnosing iron deficiency. Another study of 12-month- old infants found that high RDW (>14%) was 100% sensitive and 82% specific. Because of its relatively low specificity, RDW is not as useful alone as a screening test, but it is used frequently in conjunction with MCV to differentiate among various causes of anemia. For example, RDW is high in iron deficiency anemia (IDA), but low in thalassemia minor (Booth and Aukett, 1997 and Ann *et al.,*2002). Also, data in Table (5) indicated that mothers whose Hb was below 7 g/dL were associated with the highest percentage of LBW (38.87%), while with increasing maternal Hb level, LBW incidence decreased. This is also in conformity with results from studies by Bhatia *et al.,* (1981), Chadha*et al.,* (1992) andAmosu and Degun (2014).

Table 4. Hematologic parameters of maternal and LBW babies of studied group (n=247)

Parameters		Pregnant mothers	LBW babies	Statistical analysis
Hb (g/dL)	Range	6.91-10.33	6.05-9.77	p<0.05
	Mean ± SD	9.17±0.72	8.25±0.61	
RDW (%)	Range	11.79-17.81	12.57-21.88	p<0.05
	Mean ± SD	15.37±1.19	17.22±1.10	
MCV (fL)	Range	65.29-75.76	57.08-66.52	p<0.05
	Mean ± SD	69.57±4.12	61.41±5.07	

Table 5. Serum hemoglobin level of maternal and LBW babies of studied group (n=247)

Parity (g/dL)	Number of pregnant mothers	Number of LBW babies	Statistical analysis
< 7	79	96 (38.87%)	p<0.05
7.1 - 8	75	82 (33.20%)	
8.1-9	56	61 (24.70%)	
9.1-10	28	8 (3.23%)	
> 10	9	0.0	

Date in table (6) is shown the iron profile among pregnant mothers and their LBW babies of studied group. From such data it could be noticed that the mean serum iron and serum ferritin levels of pregnant mothers were 62.96±14.29 µg/dL and 35.79±7.57 % which significantly (p<0.001 and p<0.01) decreased to 41.45±11.87µg/dL and 21.36±9.05 in LBW babies, respectively. Such as mentioned by Fairbanks (1991) serum iron concentration can be measured directly and generally decreases as iron stores are depleted. However, serum iron may not reflect iron stores accurately because it is influenced by several additional factors,including iron absorption from meals, infection, inflammation, and diurnal variation (Oski, 1993). Also, Wu *et al*., (2002) reported that iron deficiency is responsible for lost productivity and premature death in adults and has been implicated as a cause of perinatal complications such as LBW and premature delivery in affected mothers (CDC, 2002;UNICEF and WHO, 2004). In children, the initial manifestations may be subtle and amenable to treatment. Long-term findings attributable to iron deficiency include increased susceptibility to infection and poor growth (Ioli, 2002, UNICEF and WHO, 2004).

On the other side, ferritin is a storage compound for iron, and serum ferritin levels normally correlate with total iron stores. As iron stores are depleted, serum ferritin levels decline and are the earliest marker of iron deficiency (Ann et al., 2002). Serum ferritin has high specificity for iron deficiency, especially when combined with other markers such as Hgb. However, the test is expensive and has limited availability in a clinic setting; therefore, it is not used commonly for screening. In addition, serum ferritin is an acute-phase reactant that can become elevated in the setting of inflammation, chronic infection, anemia or other diseases (Fairbanks, 1991; Oski, 1993; El-Tarabily, 2016). Also, decreasing induced in serum iron and ferritin represent a biochemical parameter complication concomitance with the LBW public health problem.

Table 6. Biochemical parameters of maternal and LBW babies of studied group (n=247)

Parameters		Pregnant mothers	LBW babies	Statistical analysis
Serum iron (µg/dL)	Range	56.10-77.15	36.50-53.48	p<0.001
	Mean ± SD	62.96±14.29	41.45±11.87	
Serum ferritin (%)	Range	29.14-40.15	17.54-28.61	p<0.01
	Mean ± SD	35.79±7.57	21.36±9.05	

Antioxidant vitamins

The reducing in antioxidant enzymes defense potential of erythrocytes was contrary with significant decreasing (p>0.05) in antioxidant vitamins in pregnant mothers and their LBW babies (Tables 7). The mean levels of vitamins A, C and E pregnant mothers were 0.93±0.19, 44.55±10.51 and 23.05±6.07 µmol/L which significantly decreased to 0.84±0.12, 39.65±7.90 and 21.74±5.91µmol/L in LBW babies, respectively.

According to these results, the decreasing in antioxidant vitamins in plasma could be attributed to their consumption in scavenge, quench and/or trap different ROS resulted from LBW injury. Vitamins include A, E and C, the non-enzymatic antioxidants that prevent or retards the oxidation of sensitive molecules found in the body. Vitamin E is considered as primarily intracellular antioxidants associated with cell membranes (krinskey, 1992). It is family of substance with different degrees of unsaturation e.g. tocopherols and tacotrienols, and of methylation e.g. mono, di-and trimethyanalog (Packer, 1992). α-tocopherol is the form of vitamin E determined to be biologically most active. Vitamin E is a potent peroxyl radical scavenger (Burton *et al*., 1986) and can protect polyunsaturated fatty acids (PUFA) within phospholipids of biological membranes and in plasma lipoproteins (Jialal*et al*., 1995). β-carotene i.e. precursor of vitamin A and other carotenoids belong to the large family of conjugated polyenes. Carotenoids are bleached when exposed to radicals such as those that arise during lipid peroxidation, which indicates that these pigments; must also intercept active oxygen species. Their long, conjugated double bond systems make them excellent substrates for radical attack (Kennedy *et al*., 1991). They have antioxidant activity through its property as singlet oxygen (1 O_2) quenchers and their ability to trap peroxyl radicals (Truscott, 1990; Stahl and Sies 1993). They are also able to inhibit free radical reactions (PalozzaandKrinsky, (1992). Vitamin C is an important antioxidant. Its water solubility allows it to be widely available in both the extracellular and intracellular spaces in most biological systems (Halliwell and Gutteridge 1990). Antioxidant roles of ascorbic acid can be' summarized in the following*:* scavenge $O_2^{\cdot -}$ and $OH^{\cdot}$ with the formation of the sernidehydro-ascorbate free radical that is subsequently reduced by GSH to generate dehydroascorbate and GSSG, as most cells contain a GSH-dependent dehydroascorbatereductase that generates ascorbate and GSSG (Anderson *et al*.,1988), scavenges water-soluble peroxyl (RO_2) radicals (Frei, 1991), Scavenges thiyl and sulphenyl radicals, powerful scavenger and quencher of single O_2 in aqueous solution (Halliwell and Gutterige 1990), “Repairs” and so prevents damage by, radicals arising by attack of OH upon uric acid, inhibits lipid peroxidation by hemoglobin or myoglobin H_2O_2 mixtures and prevents heme breakdown to release iron ions by being preferentially oxidized by ferrylprotiens (Halliwell&Gutteridge 1990), reduces α- tocopheryl radicals in membranes back to the lipid-soluble chain-breaking antioxidant α-tocopherol(Slater, 1984), reduces nitroxide radicals, e.g. the radicals formed by attack of O_2 or OH upon desferrioxamine (Hoffman and Garewell 1995), it also protects plasma lipids against peroxidation induced by activated neutrophils (Frei. 1991), and protects against oxidants present in cigarette smoke. (Hialliwell and Qutteridge 1990). The antioxidant vitamins levels may be also important indicators of the adverse effects caused by LBW public health problem.

Table 7. Antioxidant vitamins level of maternal and LBW babies of studied group (n=247)

Parameters		Pregnant mothers	LBW babies	Statistical analysis
Vit A (µmol/L)	Range	0.81-1.24	0.73-0.95	p<0.05
	Mean ± SD	0.93±0.19	0.84±0.12	
Vit C (µmol/L)	Range	39.16-48.95	36.66-44.06	p<0.05
	Mean ± SD	44.55±10.51	39.65±7.90	
Vit E (µmol/L)	Range	20.55-27.41	19.05-24.56	p<0.05
	Mean ± SD	23.05±6.07	21.74±5.91	

Association between LBW newborns and dietary habits among maternal studied group

Association between LBW newborns and dietary habits among maternal studied group are shown in Table (8). Data shows associations between maternal feeding habits and LBW based on daily breakfast taking (p<0.05), drinking tea (p<0.01), drinking tea with or after meal (p<0.05), taking meat (p<0.001), chicken (p<0.01)and fish (p<0.001), taking vegetables and fruits (p<0.01) and daily iron intake (p<0.001). The present data are in accordance with that obtained by Amany and Samaa (2012) and El-Tarabily, (2016). They reported that associations between feeding habits and IDA, a complication concomitance with the LBW public health problem, based on daily breakfast taking, consumption of tea after meals and adequacy of iron intake. Infants who were consuming iron containing foods below 50% of RDA of iron were significantly associated with IDA ($P = 0.027$).

In similar study, Sumithra (2009) reviewed that micronutrient deficiencies during pregnancy have been shown to have serious implications on the developing foetus. Nearly half the pregnant women still suffer from varying degree of anaemia, with the highest prevalence in India, which also has the highest number of maternal deaths in the Asian region. Of specific concern is compliance with iron supplementation, cultural beliefs regarding diet in pregnancy, and the issue of nutrition

Table 8. Association between LBW newborns and some dietary habits among maternal studied group (n=247)

Variables	Number of Pregnant mothers	Percentage (%)	Statistical analysis
Taking breakfast daily:			p<0.05
– Yes	105	42.43	
– No	142	58.57	
Drinking tea /day			p<0.01
– 0-1	99	39.87	
– >1	148	60.13	
Drinking tea with or after meal:			p<0.001
– Yes	171	69.38	
– No	86	30.62	
Taking meat/week:			p<0.001
– 0-1	172	69.49	
– >1	85	30.51	
Taking chicken/week:			p<0.01
– 0-1	157	63.36	
– >1	90	36.64	
Taking fish/week:			p<0.001
– 0-1	190	76.84	
– >1	57	23.16	
Taking vegetables/week:			p<0.01
– 0-1	155	62.95	
– >1	92	37.05	
Taking fruits/week:			p<0.01
– 0-1	153	61.83	
– >1	94	38.17	
Daily iron intake:			p<0.001
– Above 50% of RDA	79	31.85	
– Below 50% of RDA	168	68.15	

* Non-significant (*P* >0.05).

supplementation and fortification. Also, Wu *et al*., (2002) reported that iron deficiency is responsible for lost productivity and premature death in adults and has been implicated as a cause of perinatal complications such as LBW and premature delivery in affected mothers (CDC, 2002;

UNICEF and WHO, 2004). In children, the initial manifestations may be subtle and amenable to treatment. Long-term findings attributable to iron deficiency include increased susceptibility to infection and poor growth (Ioli, 2002, UNICEF and WHO, 2004).

In developed countries IDA is more commonly due to insufficient iron intake. Iron deficiency anemia (anemia resulting from lack of adequate iron to meet needs for red blood cell formation) affects 3% children under 2 years of age, up to 3% of adolescent females and less than 1% of adolescent males (Tender and Chang, 2002). Reduction of iron deficiency and anemia in these vulnerable populations remains a national health objective for 2010 (CDC, 2002). Women in developing countries are always in a state of precarious iron balance during their reproductive years. Their iron stores are not well developed because of poor nutritional intake, recurrent infections, menstrual blood loss and repeated pregnancies (Brabin*et al*., 2001; El-Tarabily, 2016).

Iron deficiency is the most commonly recognized nutritional deficiency in both the developed and the developing world (WHO, 2014; El-Tarabily, 2016; Elhassaneen*et al.*, 2016). It is estimated that < 50 per cent of women do not have adequate iron stores for pregnancy. Requirements for absorbed iron increase during pregnancy from 0.8 mg/day in the first trimester to 7.5 mg/day in the third trimester (RDA, 1989). Average requirement during the entire gestation is approximately 4.4 mg/ day. An adequate iron balance during pregnancy implies body iron reserves of >500 mg at conception. The physiologic iron requirements in the second half of gestation cannot be fulfilled solely through dietary iron (Milman, 2006). Data of the present study indicated that IDA has been shown to be associated with LBW and preterm delivery (See table 8). In this direction, Zhou *et al*., (1998) suggested that the effect of maternal anaemia on preterm delivery was the most detectable during the 1st trimester, before maternal plasma volume expanded.

The mechanisms that operate by which poor iron status may affect birth weight and preterm births are still incompletely understood. Some of the mechanisms are hypotheses by Rasmussen (2001), Sloan *et al.*, (2002), Cogswell*et al.*, (2003) and Sumithra, (2009), El-Tarabily, (2016), Elhassaneen*et al.,* (2016) which could be summarized as follow: 1) iron deficiency may affect immune function adversely and thus increase the host susceptibility to genital tract infections, 2) iron deficiency may increase the stress hormones norepinephrine and cortisol, 3) low haemoglobin concentrations i.e. iron deficiency may cause chronic hypoxia, which can activate the body's stress response and thus increase circulating levels of corticotrophin releasing hormone, 4) iron deficiency may increase the oxidative stress of the placenta, blood serum and RBC's, and 5) iron deficiency may decrease the enzymatic and non-enzymatic antioxidant defense system in RBC's.

Conclusion

This study has established that maternal nutritional status impacted significantly on newborn birth weight, as poorly nourished mothers were observed to produce a higher percentage of LBW babies in comparison to those who were better nourished. The challenge of addressing the problem therefore remains an urgent imperative for development. Also, antioxidant vitamins and levels of hematological and biochemical parameters may be also important indicators of the adverse effects caused by LBW public health problem. Finally, some of the mechanisms that operate by which maternal malnutrition status may affect birth weight and preterm births were proposed/explained in the present study.

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Journal of Home Economics, Volume 26, Number (2), 2016

تأثير تغذية الأمهات والحالة الإجتماعية والإقتصادية على وزن الأطفال فى محافظة بور سعيد

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الملخص العربى:

تعد مشكلة المواليد ناقصى الوزن أحد المشاكل الصحية الهامة فى أغلب الدول النامية بما فيها مصر، والتى ترتبط إرتباطا وثيقا بالمعدل العالى لموت الأجنة فى تلك البلدان. لذلك كانت هناك الحاجة الملحة لراسة طرق محددة لمنع تلك الظاهرة وما يترتب عليها من مشاكل. لذلك صممت الدراسة الحالية لمعرفة مدى تأثير تغذية الأمهات والحالة الإجتماعية والإقتصادية على وزن الأطفال فى محافظة بور سعيد. ولقد أشارت النتائج المتحصل عليها أن معدل إنتشار المواليد ناقصى الوزن فى المراكز الواقعة تحت الدراسة يتأثر معنويا بعمر الأمهات أثناء مرحلة الحمل والمناطق التى يقطنونها (ريف أم حضر) والحالة الإجتماعية والإقتصادية (دخل الأسرة- مستوى التعليم) وغيرها وكذلك الوزن المكتسب للأم أثناء فترة الحمل والذى سجل فى هذه الدراسة ٧,٣٩ كيلوجرام (المستوى المثالى الموصى به عالميا ١١ كيلوجرام). كما سجلت علاقات معنوية ($p< 0.05$-0.001) بين الوزن المكتسب أثناء الحمل ومستوى هيموجلوبين الدم والحديد والفيتامينات المضادة للأكسدة بالسيرم للأمهات الحوامل ومعدل الحصول على المواليد ناقصى الوزن. كما كان للحالة والعادات الغذائية للأمهات أثناء فترة الحمل تأثيرا كبيرا على تلك الظاهرة والتى زاد معدلها بتعرض تلك الأمهات لسوء التغذية والأمراض المتعلقة بها. وبالتالي فإن التحدي المتمثل في معالجة تلك المشكلة (زيادة معدل المواليد ناقصى الوزن) يبقى ضرورة ملحة للتنمية.

الكلمات المفتاحية: الظروف الإجتماعية والديموجرافية- الهيموجلوبين- الحديد- الفيتامينات- العادات الغذائية.