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**ORIGINAL ARTICLE**

# Examining Effect of Multivitamin Intake and Socio-economic States on Birth Weight of Infants in Pregnant Women with singleton pregnancies

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**ABSTRACT**
*Maternal nutrition is one of the most important factors affecting birth weight of infants. Vitamin is very important in this regard. Pregnant women's need to multivitamin as well as their weight gain can lead to weight gain and birth weight in infants. Although body weight gain is desirable in most individuals with lower BMI, this matter could be problematic in those with high BMI. In this study, effects of multivitamin intake in women with singleton pregnancies and various socioeconomic states were measured. Moreover, the effect of multivitamin intake on birth weight was assessed. In addition, the effect of socio-economic states on these two variables was investigated. This study was conducted on 150 pregnant women from 17th week of pregnancy and onwards. The subjects were randomly divided into two groups. Then, their personal characteristics as well as socioeconomic states were recorded. From 17th week of pregnancy to 37th week of pregnancy, one group was prescribed placebo while multivitamin was given to the second group on daily bases. By 37th week of pregnancy, prenatal and postnatal weight gains of women were recorded. Obtained data were analyzed using SAS statistical software. The difference between means of above-mentioned variables was assessed using t-test; moreover, the means were compared using LS mean. In this study, the effect of variables under study on above-mentioned variables was assessed with the help of analysis of general linear model (GLM). Pearson correlation coefficients of the variables were measured. Then, the effect of each variable on birth weight of infants was assessed using multiple regression analysis. Birth weight of infants in the experimental and control groups were respectively as 3.31 and 3.28 kg. The difference was not statistically significant. In analysis of general linear model, the effect of birth weight on paternal education, housing status and age was significant (p<0.05). In comparing the means, the highest birth weight was observed in the group whose fathers had bachelor degree or higher than that (p<0.01). Birth weight of infant whose parents had private house was also significantly higher (p<0.01). Pearson correlation of the trait under study and other variables were also evaluates in which the correlations between maternal BMI and weight gain and spouse's education and infants' birth weight were significant. The most accurate multiple regression equation for estimating infant's birth weight based on maternal age and BMI was obtained. Based on these results, multivitamin intake did not have any effect on infant's birth weight. Moreover, parental socio-economic states had a significant effect on infant's birth weight. The best equation to estimate this trait using variables such as maternal age and BMI was obtained.*
***Keywords:*** *Pregnancy, Multivitamin, birth weight of infants and BMI*

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## INTRODUCTION

Several factors are involved in the process of pregnancy and its outcome. Maternal nutrition is considered as the most important factor in pregnancy (1). Mother (pregnant woman) gain weight under the influence of fetal growth and nutrition as well as growth of placenta and associated organs with pregnancy (1, 2, 3, 4). Both BMI and weight gain are linked with fetal weight and birth weight (1, 6).

Maternal malnutrition and overweight lower than appropriate range have adverse effects on infant's health and weight (2, 7).

A complete and balanced diet ensures successful delivery as well as maternal and fetal health (2, 5).

Appropriate diet during pregnancy includes receiving energy, protein, vitamins as well as adequate and balanced minerals. Deficit or surplus of each nutrient is associated with adverse effects (2).

Doucet and Generive (2008) conducted a study on 500 patients by which they concluded that vitamins and minerals are effective on appetite control and energy balance, which results in regulation of nutrient absorption and weight gain (8).
Szeto et al (2008) conducted experiments on rats by which they concluded that high-dose intake of multivitamin during pregnancy can lead to weight gain and metabolic syndrome in male infants. They concluded that multivitamin regulate nutrients intake with the help of central nervous system. This causes weight gain and increased insulin resistance. It also may lead to metabolic syndrome after birth (9).
Vitamins have serious effects on maternal health, placental and fetal development and birth weight. They also facilitate labor (5, 1, and 2).
Vahration et al (2004) conducted a study by which they reported that multivitamin intake could reduce preterm delivery (2). Some vitamins, such as folic acid are needed both before pregnancy and during pregnancy (1). Some vitamins should be taken according to physical, nutritional and prenatal states (1, 5). Some vitamins such as fat-soluble vitamin, if taken non-prescribed (or surplus), may have adverse effects on both mother and fetus (1, 5). In general, pregnant women have an urgent need for vitamins during pregnancy (5).
Multivitamin supplementation should be prescribed for women at high risk, such as pregnant teens, women with multiple pregnancies, those with small gap between pregnancy and those with a history of giving birth to LBW infant (low birth weight infants) and maternal malnutrition (1, 5).
Multivitamin intake in those with low weight and malnutrition complications can improve absorption and metabolism of energy, protein and minerals. It may also improves fetal health status and may increase birth weight (1, 8, 2, and 3).
Kaur et al (2011) concluded an experiment in India by which they concluded that vitamin D increases fetal growth, which improves placental growth. The group that received vitamin D supplements whose infants' birth weight was significantly higher (3).
Goldenberg and Neggars (2011) conducted a study by which they concluded that if pregnant women with low BMI have high-energy diet and take multivitamin, this might lead to maternal weight gain and birth weight gain. However, birth weight of infants of the group who only had high-energy diet did not increase (6).
Hasan et al (2009) conducted a research in which they found out no relationship between multivitamin intake and abortion (10). They conducted several experiments on pregnant women with HIV by which they concluded that multivitamin intake during pregnancy improves infants' weight gain and birth weight. Then, the risk of intrauterine fetal mortality as well as infant mortality may decrease. This effect was attributed to improved maternal immunogenic profile (11, 12).
However, Garshasb (2008) conducted a study on pregnant women by which they showed that if BMI increases, the risk of complications such as macrosomia, diabetes and cesarean delivery my increase (13).
In an experiment carried out on women with malnutrition in poor countries, it was shown that multivitamins prescription improved birth weight; however, it did change the rate of fetal death and preterm labor (5, 8).
Polyzos, et al (2007) performed an experiment by which they concluded that there is no significant relationship between vitamin C and E intake and reduced risk of preeclampsia and preterm labor in pregnant women with adequate nutrition (14).
Moreover, surplus intake of multivitamins and folic acid intake before pregnancy did not have any effect on possibility of twin pregnancy (Twining), although multivitamin supplement is essential during twin pregnancy for fetal health (15, 16).
However, in routine prenatal care at the health centers, iron supplement and multivitamin or mineral multivitamin are given routinely to all pregnant women after $18^{th}$ week of pregnancy. Nonetheless, participation in this project and multivitamin intake as well as maternal demands dependent on different states, particularly nutritional demands were not evaluated properly (nonetheless, it was studied whether infants' birth weight is dependent on parental socio-economic states and multivitamin intake).
Forster et al (2009) concluded a study on pregnant women in Australia by which they concluded that 29% took folic acid before pregnancy while 52% took multivitamins during pregnancy (17). Wehby et al (2009) reported in Brazil that only 14 percent of pregnant women took multivitamin. Moreover, it was shown that those who took multivitamin had significantly higher educational level, gestational age, and birth weight. In addition, increased number of ultrasonography was carried out during pregnancy in this group. This indicated higher levels of social life (18).
In this study, effect of multivitamin intake among pregnant women with singleton pregnancies, who did not have an urgent need that necessitated prescription of multivitamin other than nutritional deficiencies, as well as effect of different social, educational and economic states was evaluated on birth weight.

## MATERIALS AND METHODS

This was a clinical-trial study conducted on pregnant women.

Initially, a pilot study was conducted on pregnant women with predetermined terms. After 17th week of pregnancy, 16 subjects were selected and divided into two groups. Each group included eight individuals. In the first group, multivitamin was not prescribed anymore while the second group was given multivitamin on daily bases. It was concluded that the group taking multivitamin gained weight more than what was expected. However, weight gain was not associated with preeclampsia. After statistical analysis of results obtained from the initial experiment (pilot) and studying related researches conducted in this area and considering opinions of statistics expert, it was decided to conduct a primary experiment on 150 subjects. The patients were pregnant women who were not eligible to intake multivitamin. In other words, they were pregnant women with singleton pregnancies; they had no history of any specific disease, the gap between pregnancies was not more than 18 months; they had middle to high socioeconomic states; they had average to high BMI; they had no history of giving birth to low birth weight and abnormal infants. Since there was no standard definition for economic status, a definition was provided for this item with the help of expert in the fields of epidemiology and statistics. Certain information such as number of children, mother's education, father's education, mother's occupation, father's primary occupation, father's secondary occupation, location of residency, housing status, monthly income was obtained from each patient. Those patients who had lower than two children, a steady job, a private house, and sufficient monthly income were defined as having proper economic status. Those patients who had more than two children, no steady job, rental house, low monthly income were defined as having low economic status. Those who were within the range between these two groups were defined as having middle economic groups. The selected patients were clinically monitored up to 17th week of pregnancy. After 17th week of pregnancy, they were randomly assigned to one of the two groups mentioned above. Each group consisted of 75 subjects. Dose of multivitamin was determined based on articles studied as well as FDA recommendation, which was prepared according to Table 1 (5, 7, 4, and 1). Predetermined number of multivitamin and placebo tablets was provided. From 17th week of pregnancy to 37th week of pregnancy, the control group received placebo tablets while the experimental group received multivitamin tablets within 20 weeks. At beginning of the experiment, BMI of the patients was recorded. During the experiment, the patients were initially monitored on monthly bases. Then, they were monitored twice a week after 28th week of pregnancy. Their weight gain and blood pressure were recorded. Common evaluations were also carried out.

**Table 1**: Combination of multivitamin tablets

| Vitamin | Unit | Amount |
|---|---|---|
| A | I.U. | 5000 |
| $D_3$ | I.U. | 400 |
| E | I.U. | 30 |
| C | mg | 60 |
| Thiamin | mg | 1/5 |
| Riboflavin | mg | 1/7 |
| Niacin | mg | 20 |
| $B_6$ | mg | 2 |
| Pantothenic Acid | mg | 10 |
| Biotin | mcg | 50 |
| Folic Acid | mcg | 400 |
| $B_{12}$ | mcg | 6 |

During the test, patients' specific information such as age, BMI, number of pregnancy, number of children, education, occupation, spouse's educational, spouse's primary job, spouse's secondary job, income, location of residence (urban and rural), housing status (private, rental), weight gain during the experiment (20 weeks) and birth weight were recorded. Qualitative variables such as education, occupation, spouse's education, spouse's primary job, spouse's secondary job, income, location of residence and housing status were scored. Then, data were entered in Excel software. Then, they were statistically analyzed using SAS (Statistical Analysis System) (19).

Effect of taking or not taking multivitamin on birth weight of infants was compared using t-statistics and dual t-statistics. The means were compared using LS means method.

GLM (General Linear Model) procedure was used to examine the effect of factors under study on birth weight of infants. For this purpose, according to correlation between research variables, a number of variables were considered as main factors while other variables were considered as covariates. Those variables whose effect was found significant were compared using LS mean method (19, 20).
Pearson correlation between maternal BMI and maternal weight gain during pregnancy and birth weight of infants and other variables were calculated. Level of significance of each correlation was calculated. Multiple regression analysis of effect of each variable on maternal weight gain and birth weight of infants was conducted. For this purpose, calculating multiple regression equation by forward selection method was used.
Stepwise multiple regression technique by forward selection method means that initially all variables are entered in the model according to value of correlation. Then, the variables that decrease accuracy of the model are respectively eliminated in order to determine the most accurate probable regression equations. Then, accuracy of above equations is calculated.
Prediction models for linear, quadratic, triadic, logarithmic and exponential models were calculated. Then, accuracy of these models was assessed. Finally, the most accurate estimation model to estimate birth weight of infants based on variables under study was determined (19, 20).

## FINDINGS

Mean and standard deviation of traits such as age, BMI of the subjects are given in Table 2.

**Table 2**: mean of main traits of the subjects under study

| Variables | Standard deviation ± Mean |
|---|---|
| BMI | 25.83 ± 5.006 |
| Age (years old) | 26.95 ± 4.861 |

Mean comparisons of birth weight variable were performed whose results are given in Table 3 in which birth weights of the infants in the two groups were not significantly different.

**Table 3**: Comparison between BMI and birth weight (kg) in the experimental and control groups.

| Variable | Control group | Experimental group | Level of significance |
|---|---|---|---|
| | Standard deviation ± Mean | Standard deviation ± Mean | |
| BMI | 24.93 ± 0.87 | 25.07 ± 0.93 | $0.08^{ns}$ |
| Birth weight (kg) | 3.31 ± 0.06 | 3.28 ± 0.13 | $0.87^{ns}$ |

* Dissimilar letters indicates significant statistical difference

Results of analysis of general linear model of effect of variables under study on birth weight of infants are given in Table 4. In this model, variables cited as independent of trait were considered as the main factors while variables such as maternal age, BMI and weight gain, which were correlated with birth weight, were considered as covariates. Then, analysis was performed.

**Table 4**: examining effect of variables under study on birth weight of infants

| Variables | Level of significance |
|---|---|
| Main factors | |
| Multivitamin intake | 0.2911 |
| Number of pregnancy | 0.3818 |
| Number of children | 0.4161 |
| Mother's education | 0.5891 |
| Mother's occupation | 0.0631 |
| Father's education | 0.0113* |
| Father's primary occupation | 0.7948 |
| Father's secondary occupation | 0.8880 |
| Location of residency | 0.8945 |
| Housing status | 0.0485* |
| Income | 0.1633 |
| Covariates | |
| Age | 0.0418 |
| BMI | 0.1275 |
| Maternal overweight | 0.4342 |

* Indicates significance at 0.05 level of significance

The effect of parents' education and housing status on birth weight were significant (P <0/05). Accordingly, the mean birth weight of infant was evaluated with respect to these two variables. The results are given in Table 5. Accordingly, father's education had a significant effect on birth weight (P <0.01). Spouse's educational level up to higher than diploma was classified in a group. However, the mean of bachelor degree and higher than that was higher and significant. Moreover, effects of housing status on birth weight was significant (P <0.05). Accordingly, those who had a private house whose infants had higher birth weight than those who had rental house.

**Table 5**: Comparison of mean birth weight (kg) with different educational levels of fathers and housing ownership

| Variable | Birth weight if infants (kg)<br>Standard deviation ± Mean |
|---|---|
| Father's education | |
| Lower than diploma | 2.89[a] ± 0.39 |
| Diploma | 2.77[a] ± 0.38 |
| Higher than diploma | 2.78[a] ± 0.44 |
| Bachelor and higher than that | 4.71[b] ± 0.51 |
| Housing status | |
| Rental | 3.11a ± 0.33 |
| Private | 3.47b ± 0.35 |

* Dissimilar letters indicate statistically significant difference

Pearson correlation of variables such as maternal BMI, maternal weight gain and infant's birth weight and other variables are presented in Table 6.

**Table 6:** Correlation between traits under study and level of significance

| Variable | Age | | BMI | | Gestational weight gain | | Infant's birth weight | |
|---|---|---|---|---|---|---|---|---|
| | Level of significance | correlation | Level of significance | correlation | Level of significance | correlation | Level of significance | correlation |
| Age | | 1 | 0.555 | 0.78 | 0.422 | -0.106 | 0.270 | -0.145 |
| Maternal BMI | 0.555 | 0.78 | | 1 | 0.043 | -0.263* | 0.052 | 0.252 |
| Number of pregnancy of mother | 0.002 | 0.392** | 0.217 | 0.162 | 0.151 | -0.188 | 0.445 | -0.10 |
| Number of children of parents | 0.0001 | 0.462** | 0.05 | 0.254* | 0.81 | -0.227 | 0.536 | -0.081 |
| Mother's education | 0.256 | 0.149 | 0.293 | -0.138 | 0.938 | 0.010 | 0.434 | 0.103 |
| Mother's occupation | 0.0367 | -0.119 | 0.518 | 0.085 | 0.875 | 0.021 | 0.985 | -0.02 |
| Father's education | 0.285 | 0.140 | 0.766 | 0.039 | 0.777 | 0.037 | 0.001 | 0.422** |
| Father's primary occupation | 0.053 | 0.251 | 0.995 | 0.001 | 0.872 | 0.021 | 0.623 | 0.065 |
| Father's secondary occupation | 0.027 | -0.285* | 0.429 | -0.104 | 0.761 | 0.040 | 0.131 | -0.197 |
| Monthly income | 0.001 | 0.414** | 0.699 | 0.051 | 0.212 | 0.163 | 0.057 | 0.247 |
| Location of residency | 0.366 | -0.119 | 0.211 | -0.164 | 0.742 | -0.43 | 0.674 | 0.055 |
| Housing status | 0.227 | 0.158 | 0.772 | 0.038 | 0.920 | 0.013 | 0.174 | 0.178 |
| Gestational weight gain | 0.422 | -0.106 | 0.043 | -0.263* | | 1 | 0.308 | 0.134 |
| Infant's birth weight | 0.27 | -0.145 | 0.52 | 0.252 | 0.308 | 0.134 | | 1 |

* Indicates significance at 0.05 level of significance and ** indicates significance at 0.10 level of significance

Correlations between variables of maternal age, number of pregnancy, number of children, monthly income and father's secondary occupation are significant. Correlations between variables of maternal BMI and gestational weight gain and number of children of the parents are significant and negative. Correlation between infant's birth weight and father's education is highly significant. Multivariate regression analysis of effects of each variable on infant's birth weight was calculated for linear, quadratic, triadic, logarithmic and exponential regressions. Only following four linear regression were significant on birth weight.

Infant's birth weight = 3.733 – 0.016 maternal age $r^2 = 2.1\%$

Infant's birth weight = 2.596 + 0.027 maternal BMI $r^2 = 6.4\%$
Infant's birth weight = 3.104 + 0.016 maternal weight gain $r^2 = 1.8\%$
Infant's birth weight = 3.06 – 0.19 maternal age + 0.28 maternal BMI $r^2 = 9.1\%$

**DISCUSSION**

Based on results, there was no significant difference between groups considering mean birth weight of infants. In practice, the difference was only 3 grams. These results are not in line with those obtained by Genevive and Doucet [8] and Szeto et al [9]. They reported that multivitamin intake leads to increased maternal weight gain (8, 9). However, the former conducted their study on those patients with low BMI while the mean BMI of the patients was equal to 25.83 in this study, i.e. the subjects had high weights. Incidentally, multivitamin regulates appetite and prevent excess fat storage (due to high BMI); as a result, it may lead to fetal growth. In conclusion, the mean weight gain in the control group was 4.24 kg more than the experimental group. However, infants delivered in both groups had similar weights. Moreover, although BMI of both groups was proper, the experimental group had lower mean body weight during labor. This is important in terms of facilitating the labor. It also ensures both maternal and fetus health during labor.

These results are in line with those obtained by a number of researchers who concluded that multivitamin intake might lead to fetal health and growth and might facilitates the labor (1, 5, 8, and 3). These results are particularly in line with those obtained by Vahratian who concluded that multivitamin intake could reduce preterm delivery [2]. These results are also particularly in line with those obtained by Kaur et al who concluded that taking vitamin D improves placental growth; as a result, infant's birth weight increases, despite the fact fetal weight did not differ significantly although weight was especially lower at the end of pregnancy [3].

Results of analysis of general linear model (GLM) and examining effects of various factors on infants' birth weight showed that father's education and housing status as main factors and age as covariate had significant effects on infants' birth weight.

Based on results presented in Table 5 on comparison of mean relevant to father's education, educational level up to higher than diploma was classified in one group while education level as bachelor degree and higher than that was classified in another independent group.

The housing status has also a significant effect on infant's birth weight. The mean weight of infants whose parents had private house was significantly higher than those who had rental house.

Both of these factors indicate socio-economic status of the parents. This indicated that infants whose parents had higher socio-economic status had higher mean birth weight. This is because maternal nutrition improves as socio-economic status increases; moreover, health (mental and physical) status as well as prenatal care improves. Such cases improve fetal growth and increase birth weight. These results are consistent with those obtained by several researchers [6, 7, 9, 3, 5, and 8].

Wehby et al [18] conducted a study in Brazil by which they concluded that birth weight of infant whose pregnant women use multivitamins is higher. These had higher than average level of education and performed higher than average number of ultrasonography during pregnancy. They also concluded that these individuals had higher levels of social life. The results are consistent with those obtained in this study.

Those infants whose mothers were obese (with higher BMI) gain weight on a constant base. However, the former mother weight gain is lower than those with lower BMI. These results are in line with those obtained by Goldenberg, Neggars [6] who concluded that if women with low BMI have high-energy diet and take multivitamin, both maternal weight and infant's birth weight increases.

Correlation between variables of infant's birth weight and level of education of the spouse was high, positive and significant (P <0/01). This indicates that if souse's educational level increases, infant's birth weight also increase. As a result, this relationship is robust and reliable. It can be justified that spouse's education is considered as an important factor determining socio-economic status. As it was cited before, if socio- economic status of parents increases, birth weight of the infants also increases. These results are in line with those obtained by several researchers [7, 9, 8, 5, 3, and 6].

Regression equation for estimating infant's birth weight based on the variables with the strongest correlation (relationship) with birth weight was evaluated. Finally, four models (regression equation) with the highest accuracy were obtained. Using variables such as maternal age, BMI and weight gain in the last 20 weeks of pregnancy, one-variable equation were calculated. However, two-variable regression equations between maternal age and BMI had the highest accuracy.

In this model, maternal BMI has a positive effect on infant's birth weight. In other words, if maternal BMI increases, birth weight of infant increases as well. However, maternal age has a negative effect. In other words, if maternal age increases, it may have a negative effect in the model.

Although no article or research was found in which infant's birth weight was estimated based on other relevant factors, the relationship between maternal BMI and birth weight of infant was reported similar as this study in a number of researches [1, 6, and 13].

Garshasbi [13] conducted a study in which he showed that if maternal BMI increases, the risk of potential complications including gestational diabetes, preclampsia, gestational hypertension and macrosomia increases.

However, effect of maternal age on infant's birth weight was not studied. It can be justified since the mean age (Table 2) was as 26.95 years old in this experiment. Certainly, as maternal age increases, infant's birth weight decreases due to reduced efficiency of metabolic systems and risk of complication in old pregnant women.

This is the case in this study since mean maternal age is high in this study. However, similar study should be conducted on pregnant women who are younger than average (preferably less than 20 years old) to support these results. It is possible that contradictory results will be obtained. However, it should be noted that currently age of marriage in women has increased. Then, these results are consistent with current conditions in the target community.

It is noteworthy that infant's birth weight can be determined with high accuracy using multiple estimation methods; especially fetus weight can be determined using ultrasonography at final stages of pregnancy. However, method proposed in this study can be used to determine infant's birth weight in case that there is no access to ultrasonography or there is an urgent need to decrease cost. This method can also be used by midwives and nurses responsible for monitoring the infants' growth. However, further research is necessary to increase accuracy of these models using more factors and samples in order to obtain applicable and accurate models.

Overall, multivitamin intakes, maternal age, socio-economic status of the parents are effective on infants' birth weight. Father's educational level has a high significant effect on infants' birth weight.

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