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Dietary assessment, nutrition knowledge, and pregnancy outcome in high-risk pregnant Korean women

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Background: The nutritional status of pregnant women has a significant impact on maternal health, fetal growth, and pregnancy outcomes. The purpose of this study was to investigate the associations among advanced maternal age, eating habits, knowledge level, and obstetric outcome in pregnant women. *Methods*: We conducted an observational single center study of 168 pregnant women. The participants were divided into three groups by age: group I ($\leq$29 years old, n = 36), group II (30 to 34 years old, n = 87), and group III ($\geq$35 years old, n = 45). We studied general features, dietary habits, nutritional knowledge and necessity of education, and understanding of dietary guidelines and practice of them. *Results*: The pre-pregnancy weight of pregnant women significantly increased with age ($p = 0.002$), and the group I pregnant women were more likely to be underweight, while rates of overweight and obesity were higher in the group III women than the other groups ($p < 0.001$). Frequencies of hypertension and gestational diabetes tended to increase as the age of mother increased. In the assessment of level of knowledge of information about pregnancy, childbearing, and infant care, pregnant women who responded "do not know at all or do not know" was higher in group I than group III ($p = 0.025$). During pregnancy, the experience of having received counseling or education was less common in group I compared to the other groups, but the difference was not statistically significant. The total score for dietary action guidelines was lower in group I, but the difference was not statistically significant. *Conclusion*: The pregnancy outcome will be good, despite advanced maternal age, if they have good nutritional status, a healthy lifestyle, good and knowledge of nutrition.

Keywords

Education; Nutrition; Age; Pregnancy

1. Introduction

Maternal age is the one most important factor that can cause poor health of a newborn [1]. Lately, as the education level and social advancement of women in Korea has increased, the average age at first marriage has increased and the average age of first childbirth has been delayed [2]. According to a report from the Korea National Statistis in 2020, the average age at first marriage for women was 30.6 years and the first childbirth age was 32.3 years [2].

Older age is usually related to higher incidences of maternal hypertension; diabetes; cardiovascular, neurological, renal, and pulmonary complications; and serious blood-losing obstetric problems such as placenta previa and abruption of the placenta [1]. In addition, having a low body mass index (BMI) during pre-pregnancy or the effort of losing weight during pregnancy might cause malnutrition of the fetus and increase the likelihood of a low birth weight infant [3]. Dietary recommendations and education during pregnancy are important, but adequate guidelines and intention are controversial [4]. Actually, poor quality and inadequate amount of dietary intake during pregnancy may cause low body mass index and severe anemia, which can result in maternal death, prematurity and low birth weight of the infant, miscarriage, premature rupture of membranes, and cesarean section [5]. One possible reason is thought to be the lack of understanding, education, and health care during the perinatal period among pregnant women [6].

Currently, Korean government policy includes a pregnancy and childbirth cost support policy and the maternal child health policy. The pregnancy and childbirth policy are a cost support for infertile couples and low-income families, and the maternal child health policy includes support for medical expenses for premature infants and children with congenital dysfunction and support for high-risk pregnant women [7].

In a prospective observational study, we investigated general features, dietary habits, nutritional knowledge and need for education, and understanding of dietary guidelines and practice of them according to age in pregnant women. Second, we investigated obstetric characteristics of pregnant women, eating habits, and nutrition knowledge level and the relationship of these factors to clinical characteristics of infants and pregnancy outcome.

Table 1. General characteristics and lifestyle of the study subjects.

Variable		Group I (n = 36)	Group II (n = 87)	Group III (n = 45)	Total (n = 168)	*p*-value
Age (years)		26.83 ± 0.37[(1)]	32.10 ± 0.14	37.16 ± 0.32	32.33 ± 0.31	<0.001[(3)]
Height (cm)		160.58 ± 0.87	161.65 ± 0.55	159.65 ± 0.91	160.89 ± 0.42	0.123
Pre-pregnant weight (kg)		51.16 ± 1.14	56.59 ± 1.19	59.57 ± 1.75	56.22 ± 0.84	0.002[(a,b)]
Pre-pregnancy body mass index (kg/m^2)		19.85 ± 0.44	21.62 ± 0.41	23.32 ± 0.59	21.70 ± 0.29	<0.001[(a,b,c)]
Underweight		10 (27.8)[(2)]	9 (10.3)	2 (4.4)	21 (12.5)	<0.001[(4)]
Normal		22 (61.0)	56 (64.4)	22 (48.9)	100 (59.5)	
Overweight		2 (5.6)	12 (13.8)	10 (22.3)	24 (14.3)	
Obese		2 (5.6)	10 (11.5)	11 (24.4)	23 (13.7)	
Parity	Primipara	29 (80.6)	57 (65.5)	16 (35.6)	102 (60.7)	<0.001
	Multipara	7 (19.4)	30 (34.5)	29 (64.4)	66 (39.3)	
Prenatal complications	Hypertension	1 (2.8)	7 (8.0)	4 (8.9)	12 (7.1)	0.309[(4)]
	Gestational diabetes	1 (2.8)	4 (4.6)	5 (11.1)	10 (6.0)	0.104
	Placenta previa, amniotic fluid disease	1 (2.8)	7 (8.0)	4 (8.9)	12 (7.1)	0.309
Education	≤ High school	11 (30.6)	22 (25.3)	25 (55.5)	58 (34.5)	0.008
	Junior college	14 (38.8)	28 (32.2)	8 (17.8)	50 (29.8)	
	≥ College	11 (30.6)	37 (42.5)	12 (26.7)	60 (35.7)	
Job	Unemployed	12 (33.3)	30 (34.5)	20 (44.4)	62 (36.9)	0.002
	Specialized job	2 (5.6)	27 (31.0)	5 (11.1)	34 (20.2)	
	Office & service workers	20 (55.5)	22 (25.3)	13 (28.9)	55 (32.8)	
	Others	2 (5.6)	8 (9.2)	7 (15.6)	17 (10.1)	
Drinking	Current drinker	2 (5.6)	0 (0)	0 (0)	2 (1.2)	0.105
	Ex-drinker	12 (33.3)	39 (44.8)	15 (33.3)	66 (39.3)	
	Non-drinker	22 (61.1)	48 (55.2)	30 (66.7)	100 (59.5)	
Smoking	Current smoker	0 (0)	0 (0)	1 (2.2)	1 (0.6)	0.508
	Ex-smoker	3 (8.3)	6 (6.9)	5 (11.1)	14 (8.3)	
	Non-smoker	33 (91.7)	81 (93.1)	39 (86.7)	153 (91.1)	
Exercise	3–5/week	1 (2.8)	7 (8.0)	5 (11.2)	13 (7.7)	0.690
	1–2/week	11 (30.6)	23 (26.4)	10 (22.2)	44 (26.2)	
	Never	24 (66.7)	57 (65.5)	30 (66.7)	111 (66.1)	

[(1)] Mean ± SE; group I: ≤29 years, group II: 30–34 years, group III: >34 years; [(2)] Number of subjects (%); [(3)] Significantly different among the three groups using one-way ANOVA; [(4)] Significantly different among the three groups by chi-squared test. [(a)] There exists the significant difference between group I and group II. [(b)] There exists the significant difference between group I and group III. [(c)] There exists the significant difference between group II and group III.

2. Subjects and methods

2.1 Study population and general characteristics

We recruited patients who visited a tertiary center hospital obstetric and gynecologic clinic.

All subjects gave their informed voluntarily consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Institutional Review Board (IRB) (approval number: 2013-01-031).

A total of 168 participants were divided into three groups by age: group I (≤29 years old, n = 36), group II (30 to 34 years old, n = 87), and group III (≥35 years old, n = 45). Ninety-eight subjects had a delivery in our hospital during the investigational period, and the outcomes of pregnancy were compared.

We calculated gestational age starting from the first day of the last menstruation and performed ultrasonography only in cases of uncertainty. Data collected included age, height, body weight before pregnancy, educational level, gestational age, occupation, any medical/surgical complications during pregnancy, parity, drinking, and smoking. BMI was obtained through height and weight, and the BMI categories were defined as follows: underweight (BMI <18.5), normal weight (BMI 18.5–22.9), overweight (BMI 23–27.4), and obese (BMI ≥27.5) [8].

2.2 Dietary assessment survey

The mini dietary assessment (MDA) [9] consists of 10 questionnaires that can be roughly grouped as questions about foods that are recommended (milk and dairy products, meats, fish, eggs, beans, tofu, vegetables, fruits, etc.), about foods that are not suggested (fried foods, stir-fried foods, simple sugars like ice-cream, salty foods), and about the balance of the diet (regular meals, variety of dietary foods). Different numbers of points are given for the degrees of agreement; 5 points for "strongly doing so" 3 points for "doing so" and

Table 2. The mean corrected mini dietary assessment index score (MDA) of study subjects.

	Group I (n = 36)	Group II (n = 87)	Group III (n = 45)	Total (n = 168)	*p*-value
1. Consuming more than one serving of milk or dairy products every day.	3.44 ± 0.25[(1)]	3.14 ± 0.16	3.09 ± 0.19	3.19 ± 0.11	0.492[(2)]
2. Eating at least 3 to 4 servings of meat, fish, egg, beans, or tofu every day.	2.72 ± 0.20	2.33 ± 0.13	2.11 ± 0.16	2.36 ± 0.09	0.073
3. Eating vegetables and Kim-chi at every meal.	2.61 ± 0.19	2.91 ± 0.15	2.82 ± 0.20	2.82 ± 0.10	0.532
4. Eating one serving of fruit or fruit juice every day.	3.56 ± 0.26	3.55 ± 0.16	3.09 ± 0.37	3.43 ± 0.12	0.256
5. Eating more than one serving of fried or stir-fried food every two days.	4.11 ± 0.20	3.67 ± 0.14	3.76 ± 0.19	3.79 ± 0.10	0.221
6. Eating more than one serving of fatty meat every three days.	3.72 ± 0.23	4.08 ± 0.12	4.33 ± 0.16	4.07 ± 0.09	0.066
7. Adding table salt or sauce to food generally.	3.83 ± 0.24	4.36 ± 0.12	4.29 ± 0.18	4.23 ± 0.10	0.094
8. Having three regular meals a day.	2.39 ± 0.24	2.33 ± 0.16	2.87 ± 0.22	2.49 ± 0.11	0.121
9. Eating ice-cream, cake, snacks, soda between meals every day.	3.33 ± 0.20	4.15 ± 0.13	4.16 ± 0.20	3.98 ± 0.10	0.003[(a,b)]
10. Eat a variety of foods (eating a balanced diet).	2.72 ± 0.20	3.07 ± 0.13	3.40 ± 0.18	3.08 ± 0.10	0.045[(a,b)]
MDA total score	32.22 ± 0.76	33.63 ± 0.57	34.04 ± 0.97	33.44 ± 0.42	0.304

[(1)] Mean ± SE; group I: ≤29 years, group II: 30–34 years, group III: >34 years; [(2)] Significantly different between the three groups using one-way ANOVA. [(a)] There exists the significant difference between group I and group II. [(b)] There exists the significant difference between group I and group III.

1 point for "not doing so" and the score is summed with a maximum of fifty, with higher points interpreted as a better-quality diet.

2.3 Nutrition knowledge and practice of the dietary guidelines during pregnancy

We checked nutritional knowledge, interest in nutrition during pregnancy/lactation, what the participants thought about the proper time for nutrition education, and how much they were willing to participate in nutrition education. We used the dietary action guidelines for pregnant women/lactating women of the Korean diet guideline 2012 [10], which is made and distributed by the Ministry of Health and Welfare to modify inappropriate dietary habits that could lead to chronic medical conditions. We gave 3 points for "practicing", 2 points for "trying to practice", and 1 point for "not practicing or cannot practice", and evaluated the practice as "fair" when the sum of points from 5 questionnaires was 12 or higher.

2.4 Pregnancy outcome

We studied birth weight, length, gestational age, head and chest circumference of the newborn, method of delivery, maternal disease (hypertension and/or gestational diabetes), and maternal hemoglobin and hematocrit before delivery, according to the medical records of the hospital.

2.5 Statistical analysis

We used SPSS version 18.0 (SPSS Inc, Chicago, IL, USA) to analyze the data, and the results are shown as percentages and mean ± standard deviation. The chi-squared test was used to compare frequency variables, and ANOVA were used to compare mean variables. We calculated the Cronbach alpha index to validate the credibility of the surveys, and statistical significance was defined as a p value less than 0.05.

3. Results

3.1 General characteristics and lifestyle

The mean age of the participants was 32.33 years. There was no difference in height between the groups, but body weight increased significantly with age. Group II and group III women weighed more than those in group I ($p = 0.002$), and BMI also increased with age ($p < 0.001$), which was consistent with the statistics that stated BMI was in a proportional relation with age. The BMI of group I and II was within the normal range, which is 18.5–22.9 kg/m^2 and group III was overweight, which is 23–24.9 kg/m^2 for the Korean population.

Among all subjects, the primipara was 60.7% and the multipara was 39.3%, and the primipara ratio was significantly higher in group I. Regardless of parity, the incidence of hypertension in pregnancy was 2.8% in group I and 8.9% in group III. The incidence of gestational diabetes mellitus was 2.8% in group I and 11.1% in group III. Incidence seemed to increase with the age of the subject, but the relationship was not statistically significant.

In education level, group III had the highest high school graduation rate, and group II had the highest college graduation rate, showing a significant difference between the three groups. Pregnancy itself modified the alcohol consumption and cigarette smoking habits of the subjects; however, there was no difference among the groups (Table 1).

3.2 Dietary assessment survey according to age

The dietary assessment is shown in Table 2. The questions about eating less suggested foods such as ice-cream, cake, snacks, and soda (question #9), and about eating a balanced diet (question #10) scored high in the older groups, and there were no differences among groups in the responses to other questions. Reducing salt intake and high-fat meat intake scored 4.23 and 4.07 respectively, which were high scores.

Table 3. Nutrition knowledge of study subjects.

Category		Group I (n = 36)	Group II (n = 87)	Group III (n = 45)	Total (n = 168)	*p*-value
Level of knowledge about nutrition in pregnancy	Do not know at all or do not know	18 (50.0)[(1)]	21 (24.2)	11 (24.4)	50 (29.8)	0.025[(2)]
	Normal	15 (41.7)	53 (60.8)	31 (68.9)	99 (58.9)	
	Know a little or know	3 (8.3)	13 (14.9)	3 (6.7)	19 (11.3)	
Trying to get nutrition information	Making an effort	27 (75.0)	55 (63.2)	29 (64.4)	111 (66.1)	0.438
	Not making an effort	9 (25.0)	32 (36.8)	16 (35.6)	57 (33.9)	
Nutrition counseling experience	Yes	1 (2.8)	8 (9.2)	4 (8.9)	13 (7.7)	0.441
	No	35 (97.2)	79 (90.8)	41 (91.1)	155 (92.3)	

[(1)] Number of subjects (%); group I: ≤29 years, group II: 30–34 years, group III: >34 years; [(2)] Significantly different among the three groups by chi-squared test.

Table 4. Needs assessment of pregnant women for a nutrition program.

Category		Frequency	%
Nutrition information source (multiple response analysis)	Public organization	13	9.2
	Pregnancy care products portal sites	6	4.3
	On-line community-based blogs or café	68	48.2
	Medical service organizations	13	9.2
	Acquaintances, friends, experienced hands	21	14.9
	Book, magazine, newspaper	18	12.8
	Others	2	1.4
Reasonable period of nutrition education for pregnant women	Before pregnancy	95	56.5
	Early stages of pregnancy	63	37.5
	Second trimester	3	1.8
	Third trimester	6	3.6
	Breastfeeding period	1	0.6
Nutrition education participation	Will participate	97	57.7
	Will not participate	8	4.8
	Do not know	63	37.5

The mean score of the overall questionnaire was 33.44. The scores of each group were 32.22 for group I, 33.63 for group II, and 34.04 for group III, and there were no statistically significant differences among the groups (Table 2).

3.3 Nutrition knowledge according to the age

We evaluated the level of general knowledge during pregnancy. Fifty percent of the subjects in the group I answered "do not know at all or do not know", while only 24.4% of group III answered in that category. The percentage of subjects who answered that they have average knowledge was 58.9%. 66.1% of subjects said they had attempted to obtain nutrition information during pregnancy, and the rest said that they did not. Nutrition counseling experience during pregnancy was lower in the group I than the other groups. However, among the overall subjects, only 7.7% had nutrition counseling (Table 3).

Information sources were mostly blogs or internet cafés (48.2%), followed by friends and neighbors, books and magazines, and medical centers. Of the subjects, 56.5% were aware of the importance of nutrition education before and during the first half of pregnancy. Slightly more than half (57.7%) of the subjects were willing to participate in nutrition education, and the remainder were not (Table 4).

3.4 Practice of the dietary guidelines according to age

The degree of actual practice of dietary action guidelines for pregnant women/lactating women was processed with the highest score at three points. Group I had lower scores than group II, but the difference was not statistically significant. The mean sum of scores for five questions was 10.86 points, which was lower than 12, meaning that the overall practice of the guidelines was not very successful. In detail, "not drinking alcoholic beverage" scored the highest points at 2.89, and "drinking milk or dairy products every day" was least practiced, with a score of 1.86. One hundred and twenty participants (71.4%) were not aware of the dietary action guidelines for pregnancy, which was much greater than the number who were aware (48 subjects; 28.6%). The percentage who did not know about the guidelines was largest in group I and smallest in group II, but there was no statistically significant difference (Table 5).

3.5 Pregnancy outcome

Newborn weight in group 1 was significantly lower than in the other two groups ($p = 0.025$).

We divided the participants according to their newborns' birth weight into low birth weight, normal weight, and high birth weight groups. Group I and group III mothers had 50%,

Table 5. Practice of dietary action guidelines for pregnant women/lactating women.

	Group I (n = 36)	Group II (n = 87)	Group III (n = 45)	Total (n = 168)	*p*-value
Practice scores for dietary action guidelines					
Drinking more than 3–4 servings of milk or dairy products every day	1.78 ± 0.10[(1)]	1.89 ± 0.07	1.87 ± 0.08	1.86 ± 0.05	0.690
Eating meat, fish, vegetables, and fruit every day	1.94 ± 0.10	2.16 ± 0.06	2.13 ± 0.08	2.11 ± 0.04	0.138
Preparing the proper amount of clean food	2.11 ± 0.09	2.18 ± 0.06	2.02 ± 0.08	2.13 ± 0.04	0.245
Not drinking alcoholic beverages	2.94 ± 0.04	2.84 ± 0.05	2.93 ± 0.05	2.89 ± 0.03	0.276
Increasing physical activity and exercising every day	1.92 ± 0.11	1.93 ± 0.07	1.96 ± 0.10	1.93 ± 0.05	0.962
Total score	10.69 ± 0.24	11.00 ± 0.17	10.91 ± 0.22	10.86 ± 0.12	0.608
Frequency of awareness of dietary action guidelines					
Agree or strongly agree	7 (19.4)[(2)]	30 (34.5)	11 (24.4)	48 (28.6)	0.189
Strongly disagree	29 (80.6)	57 (65.5)	34 (75.6)	120 (71.4)	

[(1)] Mean ± SE; group I: ≤29 years, group II: 30–34 years, group III: >34 years; [(2)] Number of subjects (%).

and 20.6% low-birth-weight newborns, respectively. Overall, 21.4% of the newborns were born with low birth weight, and birth weight groups was a significant difference (p = 0.015), but there was no difference in gestational age. Head circumference and chest circumference of newborns born to group III mothers were larger than those of newborns born to group I mothers (p = 0.039, p = 0.019), and were in the normal range based on the Korea pediatric developmental standard value (2007) presented in [11].

We found that hemoglobin (Hb) and hematocrit (Hct) measured immediately before delivery dropped by a greater percentage when maternal age was low. Average Hb and Hct levels were higher than the diagnostic values for anemia in pregnant women set by the CDC (Centers for Disease Control) [12], which are 11 g/dL and 33%, respectively. However, when we set the cut-off value for anemia in the second half of pregnancy (by CDC) at 11.0 g/dL, 35.7% of group I, 18.0% of group II, 14.7% of group III, and 19.4% of the total group were categorized as having iron-deficiency anemia by their Hb values. By Hct criteria (Hct less than 33%), 31.6% of the total group of subjects, 50.0% of group I, 28.0% of group II, and 29.4% of group III were anemic. The older groups had experienced a greater number of abortions, but the difference was not statistically significant (Table 6).

4. Discussion

This study detected differences in nutrition knowledge and dietary practices of pregnant women according to age, and evaluated possible differences in birth outcome.

The anthropometric survey of pre-pregnancy outcome of the study subjects showed that the greater the age, the higher the BMI. Our study showed a higher percentage (12.5%) of subjects whose BMI is lower than 18.5 compared to the result (7.0%) of the National Health and Nutrition Examination Survey (2011) [13]. Our results were similar to those of a study that investigated pregnant women in Suwon province [14].

The incidences of hypertension and gestational diabetes tended to increase as maternal age increased, but the associations were not statistically significant. The incidence of prenatal complications, especially hypertension and diabetes, increases in pregnant women age 35 years and older. Ten to twenty percent of chronic hypertension occurs among the older age group (35 and older). Type II diabetes mellitus (DM), gestational DM also increase with age [15]. In this study, the incidence of hypertension in group III was 8.9%, which was a similar result to that of Heo *et al.* [16] (7.7%) and higher than that found by Jang *et al.* [13] (4.3%). The incidence of gestational DM was threefold higher in group III than group I. This is consistent with previously reported data in which the incidence of gestational DM was two- to threefold higher in pregnant women age 35 years and older than in 20- to 25-year-old pregnant women [17]. There has been a report that American multiparae in the older age group have a higher incidence of hypertension and gestational DM. In our study, prenatal complications tended to increase with age, but the relationship was not statistically significant, probably due to the small number of subjects. Therefore, further study is needed.

Pregnancy itself modified alcohol consumption and cigarette smoking habits of the subjects; however, there were no differences among the groups. Alcohol drinking during pregnancy can cause low birth weight, prematurity, and a reduction in the immune system of the newborn. Cigarette smoking can result in aging of the placenta, decreased blood flow through the placenta, fetal growth restriction, and prematurity [18]. Since these social habits can have complex effects on fetal health, it is very important to modify these behaviors.

Result of dietary assessment based on age showed that group III was better at reducing ice-cream, snacks, cake, and sodas, and having more balanced meals than group I (p = 0.003, p = 0.045). Each item compared to salt intake and high fat meat, fried snacks and a score for it was the result of higher intake adjustment I similar to Choi's study [19]. Group III had generally better evaluations in other questionnaires but the differences among groups were not statistically significant. During pregnancy, the subjects were examined for

Table 6. Pregnancy outcome according to age.

		Group I	Group II	Group III	Total	*p*-value
		(n = 14)	(n = 50)	(n = 34)	(n = 98)	
Birth weight	Mean birth weight (g)	2409.29 ± 225.51	2968.00 ± 82.47	2849.41 ± 120.60	2847.04 ± 69.30	0.025(1)
	LBW	7 (50.0)	7 (14.0)	7 (20.6)	21 (21.4)	
	NBW	7 (50.0)	43 (86.0)	27 (79.4)	77 (78.6)	0.015(2)
	HBW	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Duration of gestation	Mean gestational age in weeks	35.70 ± 1.22	37.43 ± 0.32	36.60 ± 0.53	36.89 ± 0.30	0.130
	Preterm	5 (35.7)	9 (18.0)	11 (32.4)	25 (25.5)	
	Mature	9 (64.3)	41 (82.0)	23 (67.6)	73 (74.5)	0.213
	Post mature	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Mode of delivery	Vaginal delivery	8 (57.1)	19 (38.0)	10 (29.4)	37 (37.8)	0.197
	Cesarean section	6 (42.9)	31 (62.0)	24 (70.6)	61 (62.2)	
Birth height (cm)		45.96 ± 1.44	48.71 ± 0.50	48.29 ± 0.65	48.17 ± 0.40	0.073
Head circumference (cm)		31.82 ± 0.95	33.77 ± 0.30	33.43 ± 0.043^{b}	33.37 ± 0.26	0.039$^{(a,b)}$
Chest circumference (cm)		29.61 ± 1.23	32.48 ± 0.40	31.62 ± 0.58	31.77 ± 0.35	0.019$^{(a,b)}$
Hemoglobin status of the pregnant woman (g/dL)		11.06 ± 0.45	11.87 ± 0.16	11.96 ± 0.21	11.79 ± 0.13	0.064
Hematocrit status of the pregnant woman (%)		32.56 ± 1.27	34.78 ± 0.43	35.31 ± 0.58	34.65 ± 0.36	0.043$^{(a,b)}$
Abortion experience		3 (21.4%)	12 (24.0%)	12 (35.5%)	27 (27.6)	0.313

Group I: ≤29 years, group II: 30–34 years, group III: >34 years.

LBW, Low birth weight (<2500 g); NBW, Normal birth weight (2500 g ≤ birth weight <4000 g); HBW, High birth weight (≥4000 g); VLBW, Very low birth weight (<1500 g); ELBW, Extreme low birth weight (<1000 g).

Preterm infant (<37 weeks); Mature infant (37 weeks ≤ gestational age <42 weeks); Post mature infant (≥43 weeks).

(1) Significantly different among the three groups by chi-squared test; (2) Significantly different among the three groups by one-way ANOVA; $^{(a)}$There exists the significant difference between group I and group II. $^{(b)}$ There exists the significant difference between group I and group III.

nutrition-related knowledge, and their training needs were assessed. Group I had a higher percentage of respondents who "do not know at all or do not know" about nutrition knowledge than group III (p = 0.025). Of the total group, 64.5% said they made an effort to obtain more information about nutrition. It may be natural that there are significant differences between the three groups in response to the frequency of intake of sugar-rich foods or the diversity of meals. Considering that group I has a high proportion of primipara, a high proportion of multipara in group III, and a high proportion of comorbid diseases such as gestational diabetes in group III, it is thought that group III have paid more attention to information about diet. Group I went through consultation during pregnancy less frequently than the other groups, but the difference was not statistically significant. Only 7.7% of the total group of subjects had received nutritional education or consultation. This was a very low level compared to the 29.1% who had educational experience in the Yun study [20]. Modifying dietary habits during pregnancy can have tremendous results [21]; therefore, pregnancy is a good opportunity to set the foundation of nutritional knowledge and to establish better habits and make an effort to maintain them [22]. It would be important to attempt proper intervention regarding nutrition in pregnant women, and to improve the accessibility of obstetric care. Especially considering the increase in high-risk pregnancy due to older age, nutritional management is crucial to prevent various complications of pregnancy. More subjects in group I responded that they "do not know" about dietary action guidelines for pregnant women/lactating women, while fewer women in group III answered that they "do not know". The practice score of the guidelines was also better in group III, but the difference was not statistically significant. All of the criteria, with the exception of cutting alcoholic beverages, were rarely met. This is probably due to poor awareness of the dietary guidelines. In Korea, dietary guidelines for pregnant and lactating women have already been prepared [10]. According to the results of this study, there are differences in educational needs and practice depending on the maternal age, and educational programs and dietary counseling services should be provided reflecting this.

Group II and group III showed better results for birth weight (p = 0.025), head circumference (p = 0.039), and chest circumference (p = 0.019) of the newborn and maternal hematocrit (p = 0.043) than group I. The incidence of low birth weight was highest in group I and lowest in group II (p = 0.015). Group I had shorter gestational age, shorter birth height, and lower maternal hemoglobin, but the differences were not statistically significant. In this study, almost one-third (28.6%) of pregnant women age 29 years and under were underweight, and when pre-pregnant BMI was below the normal range, they were more likely to have iron deficiency and deliver a low-birth-weight baby. We should make an effort to improve iron-deficiency anemia of pregnant women age 29 years and under. It is well known that healthy weight before pregnancy and proper weight gain during pregnancy play a crucial role in uterine environment changes, pregnancy outcome, and fetal health [23]. The most

important factor in the outcome of pregnancy in the oldest group of women is age [24]. In a comparison of older (>35 years old) primiparae with pregnant women between the ages of 20 and 25 years, low-birth-weight infants who weighed less than 2500 g accounted for 8.2% of the infants born to the older group, while only 3.6% of those born to the younger group had low birth weights [25]. The incidence of prematurity, low birth weight, and large babies is expected to be higher when maternal age is greater than 35 years [26, 27]. This study, however, suggests that good outcomes can be expected even in the oldest group with good nutritional support. Several studies support this conclusion. Dickute *et al.* [26] stated that pregnancy outcome is expected to be good when a pregnant woman is married, has a high income, or has stable social welfare. Grimes and Gross [28] reported that age over 35 years and the incidence of delivering a low-birth-weight child are not likely to be related. While medical and surgical complications occur more frequently with older age, perinatal mortality is not higher in the older group, and they even report better outcomes [29]. With early screening and proper management of complications of pregnancy, there is no difference in the outcome of pregnancy between mothers over and under age 35 years [30]. Since body weight before pregnancy is an important factor reflecting nutritional state, the outcome of pregnancy may depend on body weight [31]. Taken together, when a primipara is older, there should be concern about various complications during pregnancy and delivery; however, a good outcome can be obtained if nutrition and body weight are managed properly before conception. Socioeconomic state and proper prenatal care also influence the outcome of pregnancy.

The limitations of this study are that it did not include a detailed analysis of implementation status and nutrient intake and was performed at a single institution. In addition, it is regrettable that the mini nutritional assessment performed on the subject was not tailored to pregnant women, so it is thought that it needs to be developed in the future. Although the nutritional status of older pregnant women is better, if nutrition knowledge is good and proper eating habits are maintained, a good pregnancy outcome can be expected.

5. Conclusions

It is obvious that older pregnant women need delicate management in that the disease prevalence rate is higher than that of younger pregnant women. Pregnant women with younger age had a relatively low pre-pregnancy BMI, a higher rate of low birth weight, and low nutritional knowledge. In other words, in order to obtain a good childbirth result, appropriate weight must be considered before pregnancy, and priority management factors must be applied differently depending on the age of the pregnant woman. Nutritional information and service routes to be provided according to the age of the pregnant woman should be diverse and individualized.

Author contributions

MJK and YP conceived and designed the conceptualization; MJK and THK performed the methodology and investigation; MJK, HSL, and HHL contributed data curation and analysis; MJK and HSL wrote the paper; THK and YP reviewed and edited the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

All subjects gave their informed voluntarily consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Institutional Review Board (IRB) (approval number: 2013-01-031).

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Conflict of interest

The authors declare no conflict of interest.

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