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Structural Equation Model of Dietary Style and Dietary Guidelines for Pregnant Women

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ABSTRACT

This study was conducted to analyze the effects of the dietary style of pregnant women according to their food choice attributes based on their level of adherence to dietary guidelines by establishing a structural equation model (SEM) for the relationship between food choice attributes and dietary guidelines compliance. Surveys were assembled from July to August 2017 and a statistical analysis of the 215 responses was conducted. The outcomes of factor analysis of dietary style, food choice attributes and level of adherence to dietary guidelines of pregnant women resulted in their being categorized into five, one and four categories, respectively. The evaluation model of the confirmatory factor test was also confirmed to be valid since the results produced the values of χ^2=408.785, ICFI=0.915, GFI=0.905, FI=0.922, NFI=0.832, AGFI=0.831, RMSEA=0.058 and RMR=0.045, which was acceptable, and certified the appropriateness of the model. In an effort to study the food choice attributes in conformity with the dietary style and level of adherence to dietary guidelines of pregnant women, a SEM was composed and examined. All tests indicated that the model met the offered levels for the fit index's goodness, and therefore, the all study model have proven to be suitable.

Key words: pregnant women, dietary style, dietary guideline, food choice, nutrition status

INTRODUCTION

Diet is the greatest factor in lifestyle and has a direct and positive relation with health (Farhud & Dariush D 2015). Poor diet like using fast foods and its consequences like obesity and cardiovascular is the common healthy problem in societies (Mozaffarian D *et al* 2011). In the case of pregnant women, most of them experience distinctive changes in appetite and food preference and encounter a great deal of difficulties in leading a desirable dietary life owing to the morning sickness that affects food intake (Han MH 2014). In addition, their nutritive conditions during pregnancy are closely connected with the development of fetuses and infants, and thus may have an effect on maternal health and prenatal development, as well as even on baby health after birth (Thompson JM *et al* 2010). Accordingly, having a proper dietary life is critical during (Lee JA *et al* 2004). However, it has been recently reported that a considerable number of females at childbearing age in Korea are underweight, overweight and short of certain nutrients (Bae HS 2006), and that there is a growing tendency of high-risk pregnancy that hampers pregnancy maintenance and prenatal development (Choi JH *et al* 2006; Lee SH *et al* 2006). In this regard, it is required to explore a proper dietary life of pregnant women.

Consumers who purchase foods have a choice of them by relying on minimal amounts of information attached on the product indications, and perform individually purchasing behaviors because of belief that the foods will satisfy their preferences as much as possible in terms of taste and nutrition (Lee EB 2013). In accordance with studies for food choice attributes, Wadolowska L *et al* (2008) divided them into the following figures: they include advertisement, functionality, health, price, senses and socio-cultural factors. Also, Connors M *et al* (2001) revealed that the factors most closely associated with food choice were time, taste, health, cost and social relationship. These attributes were also used in studies conducted aimed at Greece (Fotopoulos C *et al* 2009), Uruguay (Ares G & Gambaro A 2007), Austria (Lockie S *et al* 2001) and Finland (Lindeman M & Vaananen M 2000).

Maternal dietary habits can immediately affect the growing fetus, and awareness has grew during recent years that maternal diet may affect the result of pregnancy also the long term health of the child (Godfrey KM & Barker DJ 2001; Kind KL *et al* 2006). The dietary guidelines are established according to scientific evidences for the relation between nutritive conditions and health, and provide the people with

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essential dietary principles based on foods to be easily understood and applied to their actual lives so that they can maintain health and prevent diseases (Yoon SY 2009). To help women accomplish a nutritionally sufficient diet during pregnancy, most countries have dietary guidelines that recommend the number of daily servings that should be consumed from each of the core food groups (NHMRC 2010; USDA 2010). The dietary guidelines for breast-feeding and pregnant women were designed to reflect their health-nutrition problems and dietary traits investigated by the national health and nutrition examination survey on the basis of the dietary goals and overall guidelines for Koreans (Jang YA *et al* 2008; Ministry of Health & Welfare 2018).

Accordingly, the present study was conducted to analyze the dietary patterns during pregnancy, and provide basic materials for desirable dietary life and nutrition education by developing a model for food choice attributes of dietary life and the level of compliance to dietary guidelines for pregnant women.

SUBJECTS AND METHOD

1. Subjects

The sample populations are participants at three times of "Symposium about baby nursing for pregnant women" in Seoul from July to August 2017. The questionnaires were distributed to 270 people, and 215 usable responses were obtained, giving a response rate of 79.6%. Expected completion time for the survey was 30~45 min in compliance with responses offered, and did not limit time for survey completion. Survey instruments, protocols, and the procedure for acquiring informed consent for this research were consented by the institutional review committees (SMWU-1707-HR-064). Information about the study was offered and consent was got from all participants before completing the survey questionnaire. The 109 (50.7%) pregnant women were over 30 weeks pregnant period and 84 (39.1%) pregnant women were 20~29 weeks pregnant period. Most of them (74.0%) had morning sickness and 26% of them had not morning sickness.

2. Questionnaire

The questionnaire for dietary style was composed of 20 items with reference to related previous studies (Kim KH 2005; Grunert K *et al* 2011; Yoon HR *et al* 2016) and consisted of 5 items on food choice attributes (Lockie S *et al* 2001; Wadolowska L *et al* 2008; Fotopoulos C *et al* 2009). The questionnaire pregnant women's level of adherence to dietary guidelines was composed with 'Dietary action guide for pregnant and lactating women' (Jang YA *et al* 2008; Ministry of Health & Welfare 2018) and consisted of 18 items evaluated with 5-point Likert scale.

3. Research Hypotheses

A SEM was used to investigate the effect of pregnant women's dietary styles on their food selection attributes and the level of compliance with the dietary guidelines.

Hypothesis 1. Dietary style will be substantially different depending on the food choice attributes.

Hypothesis 2. Food choice attributes will be substantially dissimilar depending on the level of adherence to dietary guidelines.

Hypothesis 3. Dietary style will be substantially different depending on the level of compliance to dietary guidelines.

4. Statistical Analysis

The assembled data were evaluated with SPSS 21.0 for Windows and AMOS (Analysis of Moment Structure) 22.0 Statistical programs. Exploratory factor and reliability tests were executed for estimation the unidimensionality of multiple items that contained of each factor. After assessing the validity of the measurement items by conducting confirmatory factor analysis, SEM (structural equation model) was used to find out the path coefficients of the study model.

RESULTS

1. Exploratory Factor Test on Measurement Models

1) Dietary Style of Pregnant Women

According to the results of exploratory factor analysis (EFA) on dietary style items, 5 factors were extracted (Table 1). The coefficients of Cronbach's alpha indicated a reliability of 0.807, 0.826, 0.866, 0.704 and 0.725. and explanatory power was 66.104%. Factor 1 was called 'Convenience oriented', factor 2 'Economy oriented', factor 3 'Trend oriented' factor 4 'Healthy oriented', and factor 5 'Gourmet oriented'.

Table 1. Explorative factor analysis on dietary style, food choice attributes and level of adherence to dietary guidelines of pregnant women

Variable	Question	Factor					Cronbach's alpha
		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	
Dietary style	Enjoy eating instant and processed foods	0.852					0.807
	Often purchase processed foods	0.742					
	Often eat delivery foods	0.733					
	Have bread and milk as a meal at a busy time	0.694					
	Save time spent on preparing and eating a meal as much as possible	0.666					
	Consider discount or event products first when buying groceries		0.834				0.826
	Always check price when buying groceries		0.824				
	Buy groceries after comparing price		0.814				
	Buy cheaper product when quality is similar		0.737				
	Try to have a variety of foods			0.875			0.866
	Enjoy eating trendy foods			0.854			
	Know famous restaurants and foods			0.812			
	Check ingredient, additives when buying groceries				0.827		0.704
	Consider about nutrition when eating				0.731		
	Buy organic food				0.705		
	Periodically eat supplementary health foods				0.590		
	Put taste before nutrition when choosing food					0.757	0.725
	Purchase if it looks tasty					0.741	
	Like to search for famous restaurants					0.645	
	Explained variance	2.937	2.812	2.585	2.392	1.835	
	Explained rate (%)	15.458	14.798	13.603	12.587	9.656	
	Cumulative percentage	15.458	30.256	43.859	56.446	66.104	
Food choice attributes		Factor					
	Nutrition is an important factor when choosing foods.			0.789			0.620
	Sanitation is an important factor when choosing foods.			0.747			
	Price is an important factor when choosing foods.			0.624			
	Brand is an important factor when choosing foods.			0.609			
	Taste is an important factor when choosing foods.			0.602			
	Explained variance			1.877			
	Explained rate (%)			67.542			

Table 1. Continued

Variable	Question	Factor				Cronbach's alpha
		Factor 1	Factor 2	Factor 3	Factor 4	
Level of adherence to dietary guidelines	Eat lean meat, fishes, etc. after cooking them sufficiently	0.890				0.861
	Eat stored foods after heating them sufficiently	0.876				
	Choose clean foods when purchasing them and eating out	0.803				
	To reduce sodium intakes, eat less soup blandly		0.857			0.824
	Eat Kimchi blandly		0.825			
	Use less condiments such as salt, soy sauce and soybean paste when cooking and eating foods		0.812			
	For proper weight gain, regularly perform suitable physical activities			0.813		0.707
	For postnatal weight control, gradually start exercise			0.796		
	Drink enough water			0.706		
	Eat protein foods such as fishes, lean meat, bean products and eggs once or more every day				0.797	0.628
	Eat often yogurt, cheese, fishes with bones				0.724	
	Eat a variety of vegetables and fruits every day				0.684	
	Explained variance	2.449	2.235	1.904	14.565	
	Explained rate (%)	20.410	18.626	15.865	14.565	
	Cumulative percentage	20.410	39.036	54.901	69.466	

2) Food Choice Attributes of Pregnant Women

The results of the food choice attributes items as determined by the EFA are showed in Table 1. The items were named ‘Nutrition’, ‘Sanitation’, ‘Price’, ‘Brand’ and ‘Taste’. Reliability and validity were established by 0.620 of Cronbach’s alpha, and 67.542% of the explain power for the factors on the food choice attributes.

3) Level of Adherence to Dietary Guidelines of Pregnant Women

Table 1 describes the results of the 12 items of level of adherence to dietary guidelines as implied by the EFA. Four factors were certified and explained 69.466% of the results. The Cronbach's alpha reliability coefficients for factors 1 (0.861), 2 (0.824), 3 (0.707) and 4 (0.628) named ‘Sanitary’, ‘Sodium intake', ‘Life habit’ and ‘Body composition food intake’.

2. Correlation Analysis

The results imply that multicollinearity was not a problem with most variables since the highest correlation coefficient was 0.542 (Table 2). The highest expected correlation was between ‘Trend oriented’ and ‘Gourmet oriented’ (r=0.542, p<0.01), followed ‘Sodium intake’ and ‘Life habit’ (r=0.340, p<0.01), ‘Convenience oriented’ and ‘Gourmet oriented’ (r=0.31, p<0.01) and ‘Trend oriented’ and ‘Food choice attributes’ (r=0.316, p<0.01).

3. Confirmatory Factor Analysis on the Measurement Model

The confirmatory factor analysis for the measurement model are indicated in Table 3. Goodness-of-fit index results for the model are approved level for each index. And the model was verified as suitable due to the optimal results showed the values of χ^2=408.785, GFI=0.905, CFI=0.915, IFI=0.922, NFI=0.832, RMR=0.045, AGFI=0.831 and RMSEA=0.058, which accepted the suggested standards, and also certified the appropriateness of the model as well.

As a result of evaluating the convergent validity based on

Table 2. Correlation analysis for variables of pregnant women

Variables[1)]	A	B	C	D	E	F	G	H	I	J
A	1.0000									
B	0.070	1.0000								
C	0.297**	0.117	1.0000							
D	−0.084	−0.104*	−0.119	1.0000						
E	0.317**	−0.006	0.542**	0.184**	1.0000					
F	0.018	0.291**	0.316**	0.156**	0.279**	1.0000				
G	−0.285**	0.075	0.055	0.246**	0.117	0.215**	1.0000			
H	−0.218**	−0.038	0.056	0.259**	−0.006	0.114	0.136**	1.0000		
I	−0.214**	−0.029	0.135*	0.243**	0.034	0.115	0.150**	0.340**	1.0000	
J	−0.315**	−0.047	0.046	0.297**	−0.003	0.030	0.309**	0.266**	0.272**	1.0000

1) A: Convenience oriented, B: Economy oriented, C: Trend oriented, D: Health oriented, E: Gourmet oriented, F: Food choice attributes, G: Sanitary, H: Sodium intake, I: Life habit, J: Body composition food intake.
* $p<0.05$, ** $p<0.01$.

Table 3. Goodness of fit in confirmatory factor analysis and hypothetical model fit index of pregnant women

	Model	χ^{2}[1)] (p-value)	χ^{2}/df[2)]	GFI[3)]	AGFI[4)]	IFI[5)]	NFI[6)]	CFI[7)]	RMR[8)]	RMSEA[9)]
Goodness of fit in confirmatory factor analysis	Optimum model	p>(.05)	<2	.90~1	.90~1	.90~1	.90~1	.90~1	<0.05	<0.5
	Hypothetical model	408.875 (.000)	1.711	0.905	0.831	0.922	0.832	0.915	0.045	0.058

1) χ^{2}: Chi-square.
2) χ^{2}/df: Chi-square divided by degree of freedom.
3) GFI: Goodness of fit index.
4) AGFI: Adjusted goodness of fit index.
5) IFI: Incremental fit index.
6) NFI: Normed fit index.
7) CFI: Comparative fit index.
8) RMR: Root mean residual.
9) RMSEA: Root means squared error of approximation.

the standardized regression coefficient value after the measurement model's confirmatory factor analysis, the following variables among those of dietary patterns were eliminated: 'Have bread and milk as a meal at a busy time', 'Save time spent on preparing or eating a meal as much as possible', 'Buy organic foods', 'Periodically eat supplementary health foods', and 'Put taste before nutrition when choosing food'. For the level of adherence to dietary guidelines, the following factors were eliminated because they failed to meet the standard value: 'Drink enough water', 'Eat protein foods such as fish, lean meat, bean product and egg once or more every day', 'Often eat yogurt, cheese, fish with bones', and 'Eat a diversity of fruits and vegetables every day', and thus the 'Body composition food intake factors' were removed. Consequently, the validity of the measurement model was secured. The t (C.R.) value for the standardized factor value of measured variables was found to be significant by exceeding generally 2.88 (<0.05), and the factor loading was also shown to be generally 0.5 or more. Accordingly, it is considered that the proposed models in this study meet generally the sample data. In addition, the concept reliability was generally 0.7 or more and the AVE was found to be generally 0.5 or more, thus the convergent validity was confirmed.

4. The Measurement Model's Fit Test

The results of hypothetical model fit shows as χ^2=423.837, IFI=0.917, CFI=0.915, GFI=0.872, AGFI=0.828, NFI=0.826, RMSEA=0.059 and RMR=0.049 (Table 4). Although the χ^2 value was unveiled to be inadequate, the current hypothetical model in Fig. 1 was identified to be adequate since the other indices like CMIN/DF, IFI, CFI and RMR were revealed to be appropriate, and GFI, GFI, AGFI and NFI satisfied the suggested standards.

DISCUSSION

This study analyzes the effects of the dietary style of pregnant women according to their food choice attributes on their level of compliance dietary guidelines through the construction of a model on the relationship between food choice attributes and level of adherence to dietary guidelines.

The results of testing Hypothesis 1: For the food choice attributes by dietary pattern, those were found to be not

Table 4. Hypothetical model fit index of pregnant women

Model	χ^2[1] (*p*-value)	χ^2/df[2]	GFI[3]	AGIF[4]	IFI[5]	NFI[6]	CFI[7]	RMR[8]	RMSEA[9]
Goodness of fit criteria	*p*>(.05)	<2	.90~1	.90~1	.90~1	.90~1	.90~1	<0.05	<0.5
Hypothetical model	423.837 (0.000)	1.752	0.872	0.828	0.917	0.826	0.915	0.049	0.059
Result	Unfit	Fit	Acceptable	Acceptable	Fit	Acceptable	Fit	Fit	Unfit

[1] χ^2: Chi-square.
[2] χ^2/df: Chi-square divided by degree of freedom.
[3] GFI: Goodness of fit index.
[4] AGFI: Adjusted goodness of fit index.
[5] IFI: Incremental fit index.
[6] NFI: Normed fit index.
[7] CFI: Comparative fit index.
[8] RMR: Root mean residual.
[9] RMSEA: Root mean squared error of approximation.

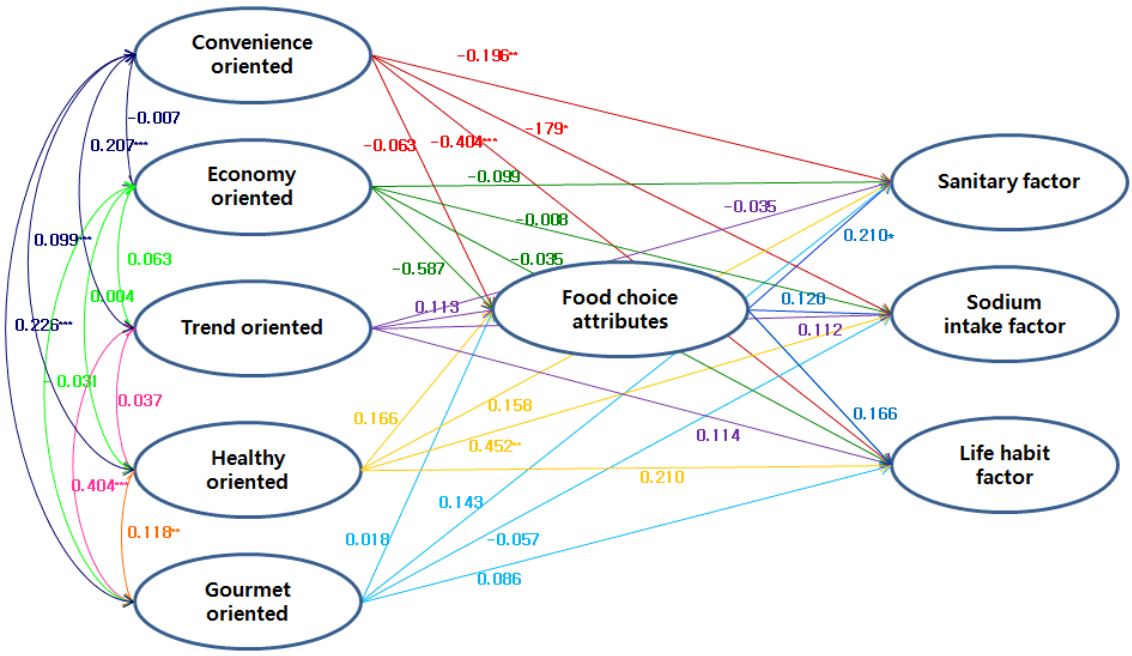

Fig. 1. Final results of the model analysis using AMOS.

significant in all factors. But it was shown that the convenience and economy oriented pattern had a negative effect on the food choice attributes, and that the trend oriented, health oriented and taste oriented pattern had a positive effect on them. Englund-Ögge L *et al* (2014) indicated that increasing uptake of foods related a prudent dietary pattern is more important than totally excluding fast food, processed food, junk food, and snacks. Also, Lee EB (2013) reported that consumers checked more carefully all items of the product indications such as expiration date, price, packaging, manufacturer, main ingredient, food additive and nutrient after pregnancy than before, thus indicating that pregnancy has a great impact on purchasing foods.

The results of testing Hypothesis 2: The food choice attributes affected positively all the factors of the level of adherence to dietary life, in particular, exerted significant influence on the sanitation factor by 0.210 (p<0.05). Yoon SY (2009) revealed that 'choose safe foods and manage them in a sanitary way' among the adherence attitudes of pregnant women to dietary guidelines accounted for 70.8% and showed a relatively higher percentage. In addition, Kim KD & Lee JY (2010) found that housewives selected as a subject in the study usually required lots of information on food safety. Moreover, Lee EB (2013) also reported that, concerning the necessity of food safety education for pregnant, 97.8% of subjects responded 'very necessary' and 'necessary'. It is believed that a wider access to food safety information was not sufficiently provided to pregnant women as much as they thought.

The results of testing Hypothesis 3: With regard to the level of adherence to dietary life by dietary pattern, the convenience oriented pregnant women had a significantly negative effect on all the factors of adherence to dietary guidelines such as sanitation (−0.196, p<0.01), sodium intake (−0.179, p<0.05) and lifestyle (−0.404, p<0.001). In addition, the economy oriented pregnant women exerted also negative influence on all the factors of the level of adherence to dietary life, but those effects were not significant. Seiga-Riz AM *et al* (2001) reported nutrient intake problems caused by skipping a meal, and showing that, as a result of investigating an effect of it during pregnancy on newborn health, the birth rate of premature babies was 9~10% in case of having regularly three meals a day, and 19% in the pregnant women who have only one meal a day. Ibrahim M & Forsyth S (2002) and Lebowitz SF (1992) reported also that skipping a meal during pregnancy impeded prenatal development. Furthermore, in a study for the correlation between the dietary life and health-related factors of pregnant women and their pregnancy results (Lee SL 2005) there was a tendency that irregular meals during pregnancy are observed higher in the premature, then the normal, delivery group. In this context, given that the level of adherence to dietary guidelines was found to be low in the convenience- and economy oriented pregnant women in the present study, it is considered that, for their healthy delivery and desirable dietary patterns, nutrition education should be required.

The health oriented pattern affects positively all the factors of the level of adherence to dietary life, especially resulting in a significant effect on 'sodium intake factor' by 0.452 (<0.01). It is known that pregnant women experience a physiological need to intake side dishes due to the excessive intake of grains, which leads to the excessive intake of table salt, and thereby raising the possibility of a rise in blood pressure, edema and gestational toxicities (Kwon OY 2015). Yoon SY (2009) indicated that 34.7% of respondents put relatively well 'Avoid salty foods, and have a low-salt diet' into practice. In addition, as a result of exploring the perceived significance for main considerations required in the dietary life of pregnant women (Lee SL 2005) it was found that they placed the most importance on nutritionally balanced menu composition, and followed by low-salt foods and healthy seasonal food reserves.

With regard to the level of adherence to dietary life, the taste oriented pattern exerted positive, but insignificant, influence on the sanitation factor and life habit factor, and negative, but insignificant, effect on the sodium intake factor by 0.057. Lee SL (2005) revealed that, as a result of exploring the taste preference in pregnant women, the preference for sweet, salty, hot, sour and greasy taste tended to increase more in the premature than the normal, delivery group and especially the frequency preferring a salty taste accounted for 55.7% in the premature delivery group and 46.7% in the normal delivery group, consequently showing that salty foods was more preferred than other ones. Thus, these results were shown to be similar to those of our study.

In conclusion, the results of the present study revealed that the dietary life of pregnant women had an effect on the food choice attributes and the adherence to dietary guidelines. In

this regard, desirable dietary habits are needed for pregnant women by providing them with nutrition education so that they can establish proper dietary patterns and give birth to healthy children.

CONFLICT OF INTEREST

The authors declare no potential of interests.

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