Korean J Nutrition 29(10) : 1132~1141, 1996

Nutritional Evaluation of the School Lunch Program : The Nutrient Density and Nutrients that affect the Cost of a Meal*

Yim, Kyeong Sook

Department of Food and Nutrition, University of Suwon, Suwon, Korea

ABSTRACT

To provide appropriate nutrition informations and guidelines for the healthy school lunch program(SLP) menus, the nutritional quality of the SLP and the nutrients that affect the food cost of SLP were evaluated after analysis of recipes and food price lists of 776 menus collected from 10 elementary SLP schools in Seoul and Kyunggi province in Korea in the year of 1995. Index of nutritional quality of SLP menus were good enough, showing over 1.0 in all nutrients except vitamin A(0.86) in kyunggi province. The percent of calories from carbohydrates, protein and fat was 52%, 16% and 32%, while the polyunsaturated fatty acid/monounsaturated fatty acid/ saturated fatty acid(P/M/S) ratio was 1.0/0.95/1.15. On the other hand, the nutrient-cost evaluation showed that the most expensive nutrient for the RDA(Recommended Dietary Allowance) standard of SLP was origined from the cost of energy and vitamin A. In Pearson correlation analyses, the cost of SLP meals was positively associated with energy($r=0.244$, $p<0.001$), protein($r=0.306$, $p<0.001$) and carbohydrate($r=0.159$, $p<0.001$) in diet, while the most important predictor of the cost of SLP meals as revealed by Stepwise linear regression was protein ($R^2=9.35\%$). These findings indicate that the SLP meal provides sufficient nutrients with enough calories, but fat level is somewhat higher than the suggested value from Dietary Guidelines for Koreans. These data also suggest that meals which could offer enough vitamin A might be included in SLP menus and the cost of a SLP meal can be reduced when choosing the cheap protein source food. (*Korean J Nutrition* 29(10) : 1132~1141, 1996)

KEY WORDS : school lunch program(SLP) · Index of Nutritional Quality(INQ) · nutrient-cost evaluation · Fat intake · P/M/S.

Introduction

Providing balanced nutrients is especially important to the school-age children because of a consistent physical growth with continuing maturation of fine and gross motor skills[1]. As well as, by the end of this period, they are typically well into puberty. Moreover, because most food behaviors and preferences are established during childhood, this period is important for dietary intervention[2]. School-age children show a lot of problems in their food behaviors like skipping breakfast[3][4], frequent snack[4][5], rejecting vegetables[6], or overeating[7] to cause high incidence of obesity[5][8][9]. Thus, School Lunch Program(SLP) is going to more important as a means of provision not only sufficient

Accepted : November 5, 1996
*This research was supported by grants from the Miwon Research Institute of Korean Food & Dietary Culture(1995)

nutrients for child growth, but an opportunity to learn responsible choices of their dietary intake[10].

In recent years there has been a renewed interest in the nutrient density concept as a criterion of the nutritional quality of diets[11-13]. Nutrient density addresses the issues of overconsumption and the relationships between diet and disease. The Index of Nutritional Quality(INQ) is a concept related to nutrient density that allows the quantity of a nutrient per 1000 Kcal in a food, meal, or diet to be compared with a nutrient standard. With the concepts the nutritional qualities of foods and diets can be evaluated and compared easily, quickly, and independent of serving size of meal.

With the goal of good nutrition in SLP, cost management to meet the budget of SLP is also very valuable[14]. School is a representative non-profit organization, while SLP depends on the institutional food service system[15]. Thus one of meal management goals have match to a budget. This is because the marketplace offers much variety that good nutrition can be purchased within extremes in cost.

Since its inception in 1953, SLP has been expanded steadily in Korea. The most significant changes have occured during the enactment of the 7th National Economical and Social Development Plan(1992-1996). At the end of 1995, 75% of elementary schools in Seoul participated in the SLP[16]. In connection with SLP, some researchers have carried out studies on the management dimension, such as financial management activities[17], food service program[18], dietatian's job duties[19] and microbiological quality and safety control of food service system[20]. However, very little information is available about the nutritional quality and nutrient-cost evaluation of SLP menus in Korea. Even though there is one study that examined nutritional aspects of SLP, it analyzed the nutrients intake in terms of quantity, but not of quality[21].

This study has evaluated a) the nutritional quality of SLP meals by using INQ and b) the influencing nutrients to the cost of a SLP meal, as an effort to provide nutrition informations and guidelines for the healthy school meals.

Methods

1. Collection of SLP menu

During the period of April to December of 1995, SLP menu sets were collected from 10 selected schools located in Seoul and Kyunggi province in Korea ; Kangnam-gu(1), Songpa-gu(1), Eunpyung-gu (1), Guro-gu(1), and Seongbook-gu(1) in Seoul, and Anyang city(2), Guacheon city(2), and Songtan city(1) in Kyunggi province. Total 776 recipes of menus and each food purchase price lists, for the sets of consecutive 4 week menus of each season(April for the Spring season menu, June for the Summer season menu, October for the Fall season menu, and late November and December for the Winter season menu) were collected with the aids of school dietitians.

2. Nutritional Analysis of SLP menus

The portions of recipe of each meal were analyzed by using a computerized dietary analysis program (METAB, Korea)[22]. The nutrient database of each food item was referred basically the Composition of Foods provided by Rural Nutrition Institute in Korea [23]. Some food items that were not reported in that book were referred the Composition of Foods provided by FAO(Food and Agriculture Organization) and USDA(United States Department of Agriculture) [24-25].

3. Analysis of INQ

To study the nutritional balance of SLP, the INQ of a meal was calculated by using a following formula [26].

$$INQ = \frac{\text{Amount of nutrient in 1000 kcal of a meal}}{\text{Recommended Dietary Allowance(RDA) of nutrient in SLP per 1000 kcal of a meal}}$$

$$= \frac{\text{each nutrient\% of SLP RDA standard}}{\text{energy \%of SLP RDA standard}}$$

(nutrient% of SLP RDA standard=nutrient content in a meal/SLP RDA standard of that nutrient per one meal$\times$100)

Korea SLP RDA[27] was used as a RDA standard of each nutrient ; thus all nutrients except Fe were from one-third of RDA for the 10-12 year-old boy while

Fe were from the one-third of RDA for a same aged girl.

4. Analysis of nutrient-cost evaluation

Nutrient-cost evaluation of the menu was followed the modified method of Schaus and Briggs[28]. To study which nutrient was cheap to supply, meal cost calculation for the supply of SLP RDA standard was performed.

Cost/SLP RDA standard

=cost of a meal/nutrient% of SLP RDA standard×100

Not only nutrients amount that can be served by 100 won, but nutrient% RDA standard per 100 won were also analyzed by using following fomulas.

Nutrient content/100 won

=nutrient content in a meal/cost of a meal×100

Nutrient% of SLP RDA standard/100 won

=nutrient% of SLP RDA standard/cost of a meal×100

5. Statistical Analysis

The SAS statistical program(for Windows, ver 6.03) [29] was used in all statistical analysis. Student t-test was used to evaluated the differrences between the nutrient contents of SLP of Seoul and those of Kyunggi province. One-way ANOVA was used to compare 4 season's nutrient content of SLP menus. When significant F ratios were detected, Duncan's multiple range test was performed to identify which season's differed significantly from one another. Pearson correlation coefficients were determined to assess relationship between the cost and each nutrient. To identify the nutrients that were mostly responsible for the cost of meal, a stepwise multiple regression model was used. In this analysis, the cost of each meal and each nutrient contents were put as the dependent and independent variables respectively. A multicollinearity was also inspected by Variance Inflation Factors(VIF). Because VIF of all independent variables was less than 10, it was turned out that there were no multicollinearity among variables. A p value$<$0.15 was used to choose the independent variables.

Results

The analysis of nutrient contents of 776 menus

Table 1. Nutritional analysis of the School Lunch Program menus in Seoul and Kyunggi province

Nutrient(unit)	SLP[1] RDA standard	Total	Seoul	Kyunggi
		(n=776)	(n=382)	(n=394)
Energy(kcal)	700	717.7 ± 101.8[2]	667.8 ± 71.4	765.9 ± 103.6
Protein(g)	20	28.5 ± 7.4	26.9 ± 6.3	29.9 ± 8.1
Fat(g)		25.0 ± 7.5	22.6 ± 6.2	27.2 ± 7.9
Cholesterol(mg)		68.6 ± 67.2	60.8 ± 58.2	76.1 ± 74.3
SFA(g)[3]		7.0 ± 1.8	6.6 ± 1.6	7.3 ± 1.8
MUFA(g)[4]		5.8 ± 2.4	5.2 ± 2.2	6.3 ± 2.4
PUFA(g)[5]		6.1 ± 3.3	5.2 ± 2.9	7.0 ± 3.3
Carbohydrate(g)		90.7 ± 15.4	85.2 ± 13.3	96.0 ± 15.4
Crude fiber(g)		2.1 ± 0.7	2.0 ± 0.7	2.2 ± 0.7
Ca(mg)	266.67	349.8 ± 70.7	336.7 ± 62.6	362.4 ± 75.7
P(mg)		508.3 ± 97.1	484.4 ± 86.1	531.5 ± 101.5
Fe(mg)	6	9.3 ± 10.9	8.9 ± 7.8	9.8 ± 6.7
Na(mg)		1756.6 ±1040.3	1321.0 ± 943.4	2178.7 ± 953.0
K(mg)		830.1 ± 222.2	763.3 ± 192.7	894.8 ± 229.9
Vitamin A(R.E)	200	210.9 ± 143.7	233.9 ± 143.4	188.6 ± 140.5
Vitamin B_1(mg)	0.35	0.57± 0.62	0.64± 0.66	0.49± 0.57***
Vitamin B_2(mg)	0.42	0.87± 0.90	0.88± 0.86	0.86± 0.94
Niacin(mg)	4.67	9.50± 7.8	8.5 ± 7.1	10.5 ± 8.3**
Vitamin C(mg)	16.79	22.7 ± 6.4	17.0 ± 12.4	28.2 ± 17.8***
Cost(won)		965.8 ± 213.6	939.6 ± 238.2	991.2 ± 183.6***

1) SLP : school lunch program
2) Mean±S.D
3) SFA : Saturated fatty acid
4) MUFA : Monounsaturated fatty acid
5) PUFA : Polyunsaturated fatty acid
**p$<$0.01, ***p$<$0.001 significantly different from SLP in Seoul by t-test

from the selected 10 SLP elementary schools are illustrated in Table 1. The served SLP menu contained, an average, 718 Kcal of energy, 28.5g of protein, 2.08g of crude fiber, 210.9 RE of vitamin A, 0.57mg of vitamin B_1, 0.87mg of vitamin B_2, 9.50mg of niacin, 22.67mg of vitamin C, 349.8mg of Ca, 9.33mg of Fe, and 68.6mg of cholesterol, and the Ca/P ratio was 0.69. Thus, all the nutrient contents were over the SLP RDA standard. When compared with SLP of Seoul, SLP of Kyunggi provided significant higher niacin and vitamin C, but less vitamin B_1. The others like energy, carbohydrate, protein and fat were not showed any statistical significance, even though these were contained somewhat higher in Kyunggi than in Seoul. The mean cost of a SLP meal was 965 won. However, the costs of SLPs were significantly higher in Kyunggi than in Seoul.

Both contents of energy and the sources of energy were not different significantly among 4 seasonal meals(Table 2). However, crude fiber, niacin and vitamin C were significantly higher in spring meals than in other season's meals, vitamin B_2 showed highest value in winter than in other season. On the other hand, SLP of spring showed the highest cost of meal.

The percentage of kilocalories derived from carbohydrates, protein and fat in SLP was, an average, 52%, 16% and 32%, respectively(Fig. 1). The percentage of polyunsaturated fatty acid, monounsaturated fatty acid, and saturated fatty acid contents in SLP was 32%, 30%, and 38%, respectively(P/M/S= 1.0/0.95/1.15)(Fig. 2).

The nutrient density analysis based on INQ as well as nutrient-cost evaluation of SLP menus are shown in Table 3. The INQ of all nutrients were over 1.00 and especially the INQ of vitamin B_2 and niacin were

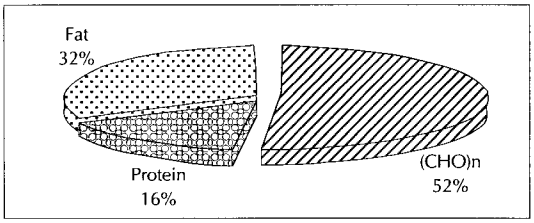

Fig. 1. The percentage of kilocalories from carbohydrate, protein and fat from the school lunch program menus.

Table 2. Nutritional analysis of the School Lunch Program menus for 4 seasons

Nutrient(unit)	Spring	Summer	Fall	Winter
	(n=191)	(n=191)	(n=187)	(n=209)
Energy(kcal)	716.2 ± 107.8[1)]	712.1 ± 104.4	724.6 ± 102.4	717.8 ± 93.3
Protein(g)	29.2 ± 8.2	28.7 ± 7.1	28.4 ± 7.4	27.7 ± 6.9
Fat(g)	25.0 ± 8.1	24.5 ± 7.3	25.3 ± 7.4	25.1 ± 7.2
Cholesterol(mg)	68.3 ± 67.0	64.5 ± 58.1	74.1 ± 83.9	67.5 ± 58.0
SFA(g)[2)]	6.9 ± 1.8	6.9 ± 1.7	7.1 ± 1.8	7.0 ± 1.8
MUFA(g)[3)]	5.8 ± 2.5	5.6 ± 2.3	6.0 ± 2.5	5.8 ± 2.2
PUFA(g)[4)]	6.0 ± 3.3	5.8 ± 3.1	6.2 ± 3.3	6.3 ± 3.3
Carbohydrate(g)	90.7 ± 15.4	89.9 ± 14.4	91.8 ± 14.9	91.0 ± 16.6
Crude fiber(g)	2.2 ± 0.8[a]	2.1 ± 0.6[ab]	2.0 ± 0.7[b]	2.0 ± 0.6[b]
Ca(mg)	353.8 ± 77.9	353.7 ± 67.7	344.3 ± 68.9	347.7 ± 68.1
P(mg)	513.3 ± 109.7	509.1 ± 90.7	509.3 ± 96.8	5.203± 91.1
Fe(mg)	9.3 ± 8.0	10.1 ± 5.4	8.6 ± 6.2	7.2 ± 5.8
Na(mg)	1801.2 ±1126.8	1734.6 ± 955.1	1667.0 ±1016.5	1816.5 ±1055.6
K(mg)	844.4 ± 222.6	845.4 ± 235.1	819.5 ± 215.3	812.9 ± 215.4
Vitamin A(R.E)	231.7 ± 160.1	206.8 ± 141.0	202.5 ± 134.1	203.5 ± 137.6
Vitamin B_1(mg)	0.54± 0.50	0.52± 0.51	0.60± 0.76	0.60 ± 0.67
Vitamin B_2(mg)	0.78± 0.78[b]	0.84± 0.80[b]	0.81± 0.88[b]	1.03 ± 10.6[b]
Niacin(mg)	10.9 ± 10.3[a]	9.0 ± 7.6[b]	8.9 ± 6.4[b]	9.2 ± 4.2[b]
Vitamin C(mg)	25.3 ± 18.7[a]	20.7 ± 13.4[b]	20.9 ± 15.0[b]	23.7 ± 17.3[b]
Cost(won)	997.4 ± 220.3[a]	989.6 ± 195.7[ab]	934.7 ± 220.3[c]	946.2 ± 212.7[bc]

1) Mean±S.D
2) SFA : Saturated fatty acid
3) MUFA : Monounsaturated fatty acid
4) PUFA : Polyunsaturated fatty acid
Within a row, nutrient contents not sharing a common superscript differed significantly according to one-way ANOVA and Duncan's multiple range test($P<0.05$)

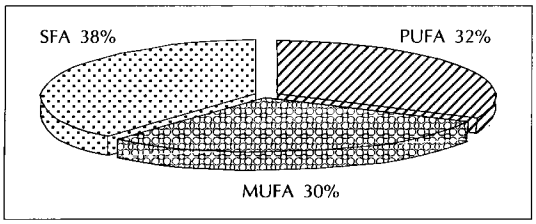

Fig. 2. Proportions of polyunsaturated fatty acid(PUFA), monounsaturated fatty acid(MUFA) and saturated fatty acid(SFA) on data from the school lunch program menus.

about 2. The INQs of vitamin B_1 and Fe were 1.59 and 1.51, respectively. The Seoul SLP menus offered less than SLP RDA standard on energy(95.4%) while the Kyunggi SLP menus provided enough nutrients except in vitamin A(94.3%). On the other hand, the cost for the SLP RDA standard of vitamin B_2(466 won/RDA standard) and niacin(475 won/RDA standard) were low and those of vitamin A(915 won/standard) and energy(943 won/standard) were relatively high. The nutrient percentage of standard per 100 won were ranged from 10.6% in case of energy to 21.4% in case of vitamin B_2.

Pearson's correlation coefficients were computed to assess the correlation between cost and each nutrient in SLP meals(Table 4). All other nutrients except fat, vitamin A, vitamin B_1, and cholesterol showed positive correlation with the cost of the meal. While energy($r=0.244$, $p<0.001$), protein($r=0.306$, $p<0.001$) and carbohydrate($r=0.159$, $p<0.001$) were significantly correlated with the cost, fat($r=0.068$, NS) was not associated with the cost. On the other hand, saturated fatty acid($r=-0.092$, $p<0.05$) and monounsaturated fatty acid($r=-0.076$, $p<0.05$) were negatively correlated with the cost.

The stepwise multiple regression model was demonstrated, as a means of assess to the association between cost and all nutrients, and the results are shown in Table 5. When all nutrients were considered separately as an explanatory variable, the best prediction(highest R^2) of the cost of SLP meals was observed in protein(partial $R^2=9.35\%$). Next sequence of orders was as follows ; niacin(partial $R^2=4.01\%$), Fe(partial $R^2=2.27\%$), vitamin B_2(partial $R^2=0.58\%$), vitamin C(partial $R^2=0.58\%$), and energy(partial $R^2=0.33\%$). Thus, these six nutrients could explain the variation of the cost by model $R^2=17.8\%$.

Discussion

The results of this study indicate that the SLP menu of elementary school in Korea have a relatively good nutritional quality and P/M/S ratio throughout the season. The amount of fat offered in SLP lunches was exceeded the Dietary Guidelines for Koreans[30].

Table 3. INQ(Index of Nutritional Quality) and Nutrient-Cost evaluation of the School Lunch Program menus

Nutrient (unit)	% of SLP[a] RDA standard[b]	INQ[c]	% of SLP RDA standard	INQ	% of SLP RDA standard	INQ	Cost/ SLP RDA standard[d]	Nutrient content/ 100 won[e]	Nutrient % of SLP RDA standard/ 100 won[f]
	Total (n=776)	Total	Seoul (n=382)	Seoul	Kyunggi (n=394)	Kyunggi	Total (n=776)	Total (n=776)	Total (n=776)
	%(Mean±SD)	(Mean±SD)	%(Mean±SD)	(Mean±SD)	%(Mean±SD)	(Mean±SD)	won		%
Energy(kcal)	102.4± 14.5	1.00±0.00	95.4± 10.2	1.00±0.00	109.4± 14.8	1.00±0.00	943	74.3	10.6
Protein(g)	142.3± 37.0	1.39±0.48	134.5± 31.5	1.41±0.40	149.5± 40.5	1.37±0.39	679	2.9	14.5
Vitamin A(RE)	105.5± 71.8	1.03±0.39	117.0± 71.7	1.23±0.35	94.3± 70.2	0.86±0.30	915	21.8	10.9
Vitamin B_1(mg)	162.9±177.1	1.59±0.41	182.9±188.6	1.92±0.39	140.6±162.9	1.28±0.44	593	0.06	16.9
Vitamin B_2(mg)	207.1±214.3	2.02±0.97	209.5±204.8	2.20±1.01	204.8±223.8	1.87±0.76	466	0.09	21.4
Niacin(mg)	203.4±167.0	1.99±0.63	182.0±152.0	1.90±0.53	224.8±177.7	2.05±0.45	475	0.98	21.1
Vitamin C(mg)	136.0± 38.4	1.33±0.21	102.0± 74.4	1.07±0.30	169.2±106.8	1.55±0.25	710	2.3	13.8
Ca(mg)	131.2± 26.5	1.28±0.37	148.5± 23.5	1.56±0.22	135.9± 28.4	1.24±0.18	736	36.2	13.6
Fe(mg)	155.0±181.7	1.51±0.49	148.3±130.0	1.55±0.44	163.3±111.7	1.49±0.35	623	1.0	16.0

a. SLP : school lunch program
b. % of SLP RDA(Recommended Dietary Allowance) standard=Nutrient/SLP RDA standard per one meal×100
c. INQ=Each nutrient% of SLP RDA standard/Energy% of SLP RDA standard
d. Cost/SLP RDA standard=Cost/nutrient% of SLP RDA standard×100
e. Nutrient content/100 won=Nutrient content/cost×100
f. Nutrient% of SLP RDA standard/100 won=Nutrient% of SLP RDA standard/cost×100

Table 4. Pearson correlation coefficients for cost and nutrients of the School Lunch Program nenus

	Protein	Fat	Cho-lesterol	SFA	MUFA	PUFA	Car-bohy-drate	Crude fiber	Ca	P	Fe	Na	K	Vit A	Vit B_1	Vit B_2	Niacin	Vit C	Cost
Energy	0.508***	0.719***	0.176***	0.436***	0.493***	0.550***	0.597***	0.215***	0.238***	0.481***	0.058	0.398***	0.422**	−0.079*	−0.020	0.020	0.089*	0.299***	0.244***
Protein		0.314***	0.138***	0.097**	0.078*	0.137***	0.017	0.033***	0.530***	0.785***	0.114**	0.258***	0.353***	−0.089*	0.047	−0.019	−0.072*	0.152***	0.306***
Fat			0.155***	0.632***	0.179***	0.777***	−0.036	0.019	0.129***	0.273***	0.014	0.204***	0.234***	−0.008	−0.040	−0.030	−0.062	0.267***	0.068
Cholesterol				0.316***	0.350***	0.079*	0.030	0.018	0.043	0.271*	−0.051	−0.004	0.165***	0.029	0.109**	−0.047	0.042	0.080*	0.021
SFA					0.894*	0.439***	−0.023	0.0016	0.039	0.169***	−0.101**	0.099**	0.261***	−0.031	0.008	−0.033	−0.045	0.169***	−0.092*
MUFA						0.608***	−0.013	0.009	−0.009	0.143***	−0.056	0.091*	0.215***	−0.030	−0.016	−0.044	−0.043	0.192***	−0.076*
PUFA							−0.006	0.020	0.036	0.129***	0.030	0.120***	0.183***	−0.012	−0.129***	−0.097**	−0.049	0.234***	−0.018
Carbohydrate								0.304***	0.030	0.129***	0.018	0.304***	0.260***	−0.073*	−0.020	0.074*	0.247***	0.121***	0.159***
Crude fiber									0.196***	0.154***	0.094**	0.361***	0.410***	0.063	0.124***	0.100**	0.247***	0.138***	0.232***
Ca										0.695***	−0.035	0.251***	0.359***	−0.057	0.064	−0.069	−0.054	0.070*	0.146***
P											0.070*	0.262***	0.436***	−0.035	0.070	−0.078*	0.003	0.158***	0.257***
Fe												0.075*	−0.111**	−0.076*	0.129***	0.106**	0.023	−0.005	0.206***
Na													0.431***	−0.124	−0.033	0.091*	0.168***	0.155***	0.152***
K														0.163***	−0.060	−0.142***	0.239***	0.273***	0.130***
Vit A															−.046	−0.127***	0.094**	0.104**	−0.015
Vit B_1																0.302***	0.009	−0.143***	0.052
Vit B_2																	0.160***	−0.075*	0.130***
Niacin																		0.096**	0.178***
Vit C																			0.130***

*p<0.05, **p<0.01, ***p<0.001 by pearson correlation

Table 5. Stepwise multiple regression for cost of the school lunch program

Dependent variable	Step	Indepentent variable (entered)	Parameter estimate	Standard Error	Partial R^2	Model R^2	P value
Cost	1	Protein	8.7717	0.9825	0.0934	0.0934	0.0001
	2	Niacin	2.7384	0.4576	0.0401	0.1335	0.0001
	3	Fe	2.1111	0.4183	0.0227	0.1612	0.0001
	4	Vitamin B_2	1.6336	0.6096	0.0077	0.1689	0.0075
	5	Vitamin C	1.0134	0.4364	0.0058	0.1747	0.0205
	6	Energy(kcal)	0.1458	0.0832	0.0033	0.1780	0.0800

n=776

Independent variables include all nutrients, such as energy, protein, fat, cholesterol, saturated fatty acid, monounsaturated fatty acid, polyunsaturated fty acid, carbohydrate, crude fiber, Ca, P, Fe, Na, K, vitamin A, vitamin B_1, vitamin B_2, niacin and vitamin C

However, Vitamin A content in SLP menus of Kyunggi province was less than SLP RDA standard. On the other hand, the cost of energy and vitamin A was high to provide the SLP RDA standard, whereas that of vitamin B_2 and niacin was low. Protein was the most important predictor for the cost of the SLP meal.

It should be noted that this paper was focused on the average nutrients that were offered in SLP meals, but not on the foods that children actually consume. Thus, their consumed nutrient content may differ from the results presented here, because children do not consume all the food that they are served.

The SLP meals, as it offered, provided all important nutrients with excess of calories. To meet the established guidelines, the SLP meals must be planned to provide about one third of RDA for the school-age group[27]. Even though SLP in Seoul provided less calories than SLP RDA standard, it doesn't necessarily indicate a problem because the amount of food students offered is usually variable depending on their need for food energy[31].

The INQ of all nutrients in SLP menus were over 1.0. The INQ of riboflavin(2.02) and niacin(1.99) were very high while that of vitamin A(1.03) was relatively low. The INQ of vitamin A in SLP menus of Kyunggi was less than 1.0, and it might suggest that calorie intake should be exceeded the RDA calorie level to meet the RDA level of vitamin A. Wyse et al.[12] have reported that when the INQ is greater than 1, the food can be considered to have a good source of nutrient under consideration ; conversely, an INQ value of less than 1 means that calorie intake would have to be supplus to meet the RDA for that nutrient.

Comparing to the published data from other investigations, it was turned out that the SLP has provided better balanced diet than boxed lunch. According to the previous Jinju province study[52], energy, Ca, Fe, vitamin B_1, vitamin B_2, niacin, vitamin C were not sufficient enough to meet one-third of RDA in boxed lunch. Another result studied in Chungbuk province indicates that all the nutrients in a boxed lunch were less than one-third of RDA in that age group[53].

The P/M/S ratio in SLP meals was 1.0/0.95/1.15, such that SLP meals showed desirable range of fatty acid intake[34]. However, the percentage of calories from fats in SLP meals(32%) was higher than that of the Korean National Nutrition Survey in 1993(18.2%)[35] or those of boxed lunch meal(6.5 - 6.8%[32] and 14.8%[33]. The value of 32% of energy from fat in SLP is also much higher than dietary guidelines for Koreans (20%) established by the Korean Nutrition Society[30]. Such high-fat content in SLP might be caused partly by the frequent use of deep frying method. This cooking method is known to be easy and quick to prepare meanwhile the deep fried food is highly palatable to children. It should also be noted the fact that some fat exchange occurs between foodstuff and frying oil during deep frying[56]. The fried food absorbs frying oil and also loses out its fat into frying oil. Farthermore because qualitative and quantitative changes could occur in fat composition during deep frying, the actual lipid intaked from the fried food may be different from those in the raw food material or in frying oil.

Comparing to the American Dietary Goals which recommend 30% fat intake[37], the SLP menu of Korea is ideal. Moreover, the calorie distribution of SLP menus is similar to the data from NHANES III(1988-1991) of USA ; 53% from carbohydrates, 14% from protein and 34% from fat[38]. Therefore, this data sug-

gests that westernized food or cooking methods are used in the prepartion of SLP meals.

The analysis of Korean National Nutrition Surveys indicates that the percentage of calories derived from fat is increasing. According to the survey of 1970, 1980, 1990 and 1993, the percentage of kilocalories from fat was averaged 8.9%, 9.6%, 13.9% and 18.2%, respectively[35]. Similar to this general trends, the percentage of calories derived from fat in SLP meals also tends to increase. SLP meals contained 17% fat in 1987[39], 27% fat in 1990[5] and 27.6% in 1994-1995 survey in Seoul[21]. This high fat meal pattern in Korean SLP is also similar to that of the United States. The School Nutrition Dietary Assessment Study in America has reported that schools offered high fat lunches, 37% energy from the fat[20], proclaiming that regulations should be proposed to reduce the total fat offered in NSLP(national school lunch program) lunches to the amount in the Dietary guidelines of $<30\%$[37]. As a means of solution, they also suggested to change menu choices and meal preparation methods[40][41].

To establish the future health promotion, it is important to modify the SLP meals to contain proper fat intake. At first, school meals were initiated to provide meals to some poor children in America[42]. Nowadays, its purpose is expanded to ensure school meals to implement the Dietary Guidelines for Americans and to minimize the risks of both chronic degenerative and dietary deficiency diseases, as a part of larger effort to implement prevention-oriented health objectives in schools[43]. Therefore, the role of school nutrition is very important to achieve the goals for health promotion and disease prevention[44] such that dietary modification to intake moderate fat in SLP is necessary to establish the healthy future food preferences and diet behavior. Reports said that children's preference for high-fat foods was derived from the frequent exposure to them[45]. Actually, in industrialized societies, readily and cheaply available food to children are those of snacks and fast foods which contained high fat. According to the previous study, children consumed high calories from snack(27.4%)[5] and liked fast food[8] in Korea. It turned out that the resulting preferences for high-fat foods were associated with high intake of fat and closely related with obesity and a number of chronic diseases[46]. Many people are well aware of the negative consequences of a high fat diet, whereas it is very difficult to reduce fat intake. Therefore, the effects of moderate fat diet in SLP is essential for the future healthy dietary behavior of the people.

Nutrient-cost evaluation resulted that the cost of vitamin A was one of the highest to meet the SLP RDA standard. Together with the data from Korean National Nutrition Survey[35] that Koreans have consumed low amount of vitamin A than the suggestion of RDA, it is suggested to change food sources for vitamin A in SLP meals. The data presented by the stepwise multiple regression analysis also showed that protein seemed to be a good predictor for the cost of SLP meal, such that careful choosing of protein rich food is, in part, necessary to reduce the cost of a SLP meal.

The control of cost is important in both profit and non-profit organizations[15]. Schools, as non-profit operations, do not have a conscious profit motive, but SLP's financial management is also important due to its limited budget. As a institutional food service system, SLP has some limitations in the diversity of food choices and cooking methods. Considering these limits, the success of SLP critically depends on the effective management of menu planning within a limited budget, as Schaus and Briggs proposed the nutritionally economic foods in order to identify good nutritional buys within the limitations of food cost expenditures[28].

In conclusion, the present data indicates that a SLP meal in Seoul and Kyunggi province has been providing important nutrients in excess of calories but with higher fat than in the Korean common diet. To be a more reasonable SLP menu, the following modifications are recommended : 1) fat content should be reduced up to less than 20% to improve the people's health in future, 2) alternative cheaper source of vitamin A is needed, 3) careful choosing of protein rich food is necessary to make the strategy successful within a limitation of budget.

Literature Cited

1) Pipes PL, Tromms CM. Nutrition in infancy and child-

hood. 5th ed, Mosby, 1993
2) Simmons-Morton BG, Parcel G, Baranowski T, Forthofer R, O'Hara N. Promoting children's diet and physical activity among children : Results of a school based intervention study. *Am J Pub Health* 81 : 986-991, 1991
3) Chung SJ, CHoi SH, Mo S, Lee SK. An ecological survey of food and nutrition of children attending an elementary school withour a school lunch program in a low income group of Seoul. *Kor J Diet Culture* 6 : 369-180, 1991
4) Mo S, Chung SJ, Lee SK, Baek SK, Jeon MJ, Han CW. Nutrition survey of children attending an elementary school without a school lunch program, in a low income group of Seoul. 2. A study on nutrient intake. *Kor J Nutr* 23 : 521-530, 1990
5) Lee YN, Kim G, Lee SK, CHung SJ, CHoi KS, Kwon SJ, Lee EW, Mo S, Yoo DI. Nutrition survey of children attending an elementary school with a school lunch program, in the socioeconomically high apartment compound of Seoul. *Kor J Nutr* 25 : 56-72, 1992
6) Birch LL. The role of experience in children's food acceptance patterns. *J Am Diet Assoc* 87(suppl 9) : s36-s40, 1987
7) Schlicker SA, Borra ST, Regan C. The weight and fitness status of United States children. *Nutr Rev* 52 : 11-17, 1994
8) Yim KS, Yoon EY, Kim CI, Kim K, Kim CI, Mo S, CHoi H. Eating behavior, obesity and serum lipid levels in children. *Kor J Nutr* 26 : 31-41, 1993
9) Moon HN, Hong SJ, Suh SJ. The prevalence of obesity in children and aldolescents. *Kor J Nutr* 25 : 413-418, 1992
10) Smith SF, James MA. School lunch as a nutrition education resource for fourth graders. *J Nutr Education* 12 : 46-49, 1980
11) Hansen RG, Wyse BW. Expression of nutrient allowances per 1,000 kilocalories. *J Am Diet Assoc* 76 : 223-227, 1980
12) Wyse BW, Windham CT, Hansen RG. Nutrition intervention : Panacea or Pandora's box? *J Am Diet Assoc* 85 : 1984-1090, 1985
13) Hansen RG, Windham CT, Wyse BW. Nutrient density and food labeling. *Clin Nutrition* 4 : 164-170, 1985
14) Kinder F, Green NR, Harris N. Meal management, 6th ed, pp, Macmillan, 1984
15) Spears MC. Food service organization. A managerial and systems approach. 2nd ed, *Macmillan, NY*, 1991
16) Reference Report of School Lunch Program Section, Office of School Public Health, The Bureau of Education of Seoul(Unpublished), 1996
17) Choi EH, Lee JM, Kwak TK. Analysis of financial management activities in elementary school foodservices. *J Kor Diet Assoc* 2 : 123-140, 1996
18) Park JK. The status of school food service program and its improvement proposal in Korea. *Kor J Nutr* 23 : 213-218, 1990
19) Kwak TK, Kim JL. Evaluation of central commissary school service operations' practices and their dietitians' job duties. *Kor J Diet Culture* 9 : 159-170, 1994
20) Kim HY, Jeong HJ. A study about microbiological quality and safety control of a central commissary school foodservice system in Daejeon city area. *Kor J Diet Culture* 10 : 67-74, 1995
21) Park SI. Analysis of food and nutrient intake of menu for elementary school foodservices in Seoul. *Kor J Diet Culture* 11 : 61-69, 1996
22) Pro-Nutrition Service Software Package, Metab Software Co, Seoul, Korea, 1994
23) Food Composition Table. 4th Revision, Rural Nutrition Institute, RDA, Korea, 1991
24) FAO. Food Composition Tables for the Near East, 1982
25) Composition of Foods. Agriculture handbook. Science and Education Administration. US Department of Agriculture : No 8-6(Soups, sauces and gravies), 1980 : No 8-8(Breakfast cereals), 1982 : No 8-12(Nuts and Seed products), 1984 : No 8-21(Fast Foods), 1988 : No 8-17, 1989 : No 8-20, 1989, No 8, 1989 supplement, 1990
26) Windham CT, Wyse BW, Hansen RG. Nutrient density of diets in the USDA Nationwide Food Consumption Survey, 1977-1978. II. Adequacy of nutrient density consumption practices. *J Am Diet Assoc* 82 : 34-43, 1983
27) Korean Educational Law Committee, The Law of Education, Revised ed, pp.1334, 1995
28) Schaus EE, Briggs GM. Nutritionally economic foods. *J Nutr Edu* 15 : 130-131, 1983
29) SAS/STAT User's Guide, version 6.03 edition, SAS Institute Inc, Cary, NC, USA, 1988
30) Recommended dietary allowances for Koreans, 6th Revision, Korean Nutrition Society, 1995
31) Burghardt JA, Gordon AR, Fraker TM. Meals offered in the National School Lunch Program and the School Breakfast program. *Am J Clin Nutr* 61 : 187s-198s, 1995
32) Lee JH. Study on nutritional contents of lunchboxes carried by 5th grade students in Jinju. *Kor J Nutr 23 : 317-328, 1990*
33) Baek SK, Choi KS, Kim BH, Yoon HY, Mo S, Kim IS, Kang SG, Kim JN. A study of ecological aspect of food and nutrition of elementary school children in remote villages of Chung Buk province. *Kor J Ciet Culture 5 : 217-228, 1990*
34) Chang NS. Desirable pattern of fatty acid intake. *Kor J Nutr* 26 : 486-503, 1993
35) '93 Korean National Nutrition Survey Report. Ministry of

Health and Wealfare, 1995

36) Varela G, Ruiz-Roso B. Some effects of deep frying on dietary fat intake. *Nut Rev* 50 : 256-262, 1992

37) US Department of Health and Human Services. US Department of Agriculture. Dietary guidelines for Americans. 3rd ed. Washington DC, USA : US Government Printing Office, 1989

38) Third National Health and Nutrition Examination Survey, Phase 1, 1988-1991(In Nutrition Assessment by Lee RD, Nieman DC, pp.172, Mosby, USA, 1996)

39) Lee KS, Choi KS, Yoon EY, Lee SY, Kim CI, Park YS, Mo S, Lee WM. Effect of school lunch program on urban elementary school children. *Kor J Nutr* 21 : 392-409, 1988

40) Chapman N, Gordon AR, Burghardt JA. Factors affecting the fat content of National School Lunch Program lunches. *Am J Clin Nutr* 61 : 199s-204s, 1995

41) Pannell DV. Why school meals are high in fat and some suggested solutions. *Am J Clin Nutr* 61 : 245s-246s, 1995

42) Dwyer J. The school nutrition dietary assessment study. *Am J Clin Nutr* 61 : 173s-177s, 1995

43) Burghardt JA, Devaney BL. Background of the school nutrition dietary assessment study. *Am J Clin Nutr* 61 : 178s-181s, 1995

44) Burghardt JA. School nutrition dietary assessment study : Overview of the study design. *Am J Clin Nutr* 61 : 182s-186s, 1995

45) Birch LL. Children's preferences for high-fat foods. *Nut Rev* 50 : 249-255, 1992

46) Kromhout D. Dietary fats : Long-term implications for health. *Nut Rev* 50 : 49-53, 1992

= 국문초록 =

학교급식식단의 영양평가 : 식단의 영양밀도 및 식단가에 영향을 미치는 영양소 연구

임 경 숙

수원대학교 식품영양학과

바람직한 학교급식식단을 작성하기 위한 영양정보를 제공하고자, 서울과 경기지역에 위치한 10개 급식초등학교의 4계절에 시행된 776식단을 분석하여 학교급식식단의 영양밀도평가와 식단가에 영향을 미치는 영양소에 대한 연구를 시행하였다. 학교급식식단의 영양밀도지수는 모두 1 이상으로 우수하였고, 탄수화물, 단백질, 지방으로부터 공급받은 열량은 각각 52%, 16%, 32% 이었으며 또한 P/M/S 비율은 1.0/0.95/1.15 이었다. 반면 경기지역 급식학교식단의 비타민 A가 권장기준의 94.3%로서 부족하였고, 또한 비타민 A는 영양소-단가 비교연구결과 학교급식 영양기준량을 공급하기 위해 가장 많은 비용이 필요하였다. 열량, 단백질, 탄수화물은 식단가에 정비례하였으나 지방은 상관관계가 없었고 포화지방산과 단불포화지방산 함량은 식단가에 반비례하였으며, 이에 대한 단계별 회귀분석결과 단백질이 식단가의 가장 좋은 설명변수였다(R^2=9.35%). 이상의 결과에서 학교급식의 영양적 질은 우수함을 알 수 있었으며, 지방공급량이 비교적 높아 조리방법 등의 개선을 통한 지방 제한이 필요함을 알았다. 또한 학교급식에 저렴하게 사용될 수 있는 비타민 A 공급 식품의 개발이 필요하며, 아울러 단백질 식품의 선별적인 사용으로 학교급식 식단가의 균형을 유지할 수 있으리라 본다.