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Original Article

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Development of Nutritional Counseling Materials for ASD Children: Focusing on the Food Exchange List

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ABSTRACT

Children with autism spectrum disorder (ASD) often present with selective eating behaviors and dietary imbalances, which contribute to nutritional deficiencies that can adversely impact growth and development. Despite increasing awareness of the role of nutrition in ASD management, existing nutritional interventions frequently fail to accommodate the unique dietary needs of this population. This study aimed to develop tailored nutritional counseling materials for ASD children by adapting the food exchange list framework originally designed for individuals with diabetes. A comprehensive food database was constructed using data from the Korean Diabetes Association, the Korea Rural Development Administration, and related resources, specifically addressing the dietary habits and nutritional deficiencies observed in ASD children. Representative foods were selected, standardized for exchange units, and visually documented through photographs to enhance usability. These elements were integrated into a practical, visually engaging educational brochure, which includes detailed food exchange unit tables, photographic representations of portion sizes, and portion standards to guide caregivers in meal planning. The materials focus on enhancing dietary diversity, correcting common nutrient deficiencies, and fostering balanced eating habits. However, limitations exist in adapting a diabetes-centric framework, which may not fully capture the unique dietary preferences and challenges of ASD children. Nevertheless, the developed materials provide a valuable resource for nutritional education and intervention, supporting the health and development of ASD children. Further research is required to refine these materials and evaluate their effectiveness across diverse settings and populations.

Keywords: Autism spectrum disorder; Food preferences; Diet therapy

INTRODUCTION

Autism spectrum disorder (ASD) is a lifelong neurodevelopmental disorder characterized by dysfunction in the functional domain such as social behavior, communication abilities, restricted, repetitive, and stereotyped behavior patterns [1]. The prevalence of ASD is continuously increasing worldwide, and according to Statistics Korea, the prevalence rate of ASD children aged 0–9 in 2024 was 4.8 per 1,000 people, with a significant increase particularly among children aged 4–6 (3.5% at age 4, 26.5% at age 5, and 21.6% at age 6) [2].

Conflict of Interest
The authors declare that they have no competing interests.

Author Contributions
Conceptualization: Yoon SI, Cho JA; Data curation: Won S, Yoon SI; Formal analysis: Won S; Funding acquisition: Cho JA; Investigation: Yoon SI; Methodology: Won S, Kim Y, Park J; Project administration: Won S, Yoon SI; Resources: Cho JA; Software: Won S; Supervision: Yoon SI; Validation: Yoon SI; Visualization: Yoon SI, Cho JA; Writing - original draft: Won S, Yoon SI; Writing - review & editing: Won S, Yoon SI, Cho JA.

This increasing trend is primarily attributed to improved early diagnosis and expanded diagnostic criteria, highlighting the need for systematic intervention approaches.

ASD children exhibit characteristic eating behavior problems along with hypersensitivity to sensory stimulation [3-5]. These eating behavior problems manifest in various forms, including selective eating, aggressive eating behavior, picky eating, gluttony of appetite, food spitting, and rejection of new foods [6]. These issues extend beyond mere behavioral problems and can lead to nutritional imbalance [3-5]. Unlike typically developed (TD) children, ASD children are less likely to naturally overcome these biased eating habits during growth [7,8], necessitating active intervention to prevent potential developmental delays.

Previous studies have shown that ASD children demonstrate deficiencies in essential nutrients such as vitamin D, vitamin B_{12}, calcium, with significantly lower intake across food groups compared to TD children [9]. The eating habits score, as measured by the Brief Autism Mealtime Behavior Inventory score, was significantly higher than that of TD children, with more frequent observations of problematic behaviors such as aggression, rejection of new foods, and repetitive consumption of the same food during meals [10].

A survey examining the nutritional education needs of parents of ASD children revealed high preference and demand for individualized education [11]. Given that parents' knowledge and attitudes as primary caregivers significantly influence children's proper nutritional intake and dietary habit formation, customized nutritional education for parents is essential.

The food exchange list is a tool for meal planning that categorize foods with similar nutrient content into six food groups (grains, meats, vegetables, fats and oils, milk, and fruits). Foods in each group are standardized to one exchange unit, which provide comparable portions containing similar amounts of energy and macronutrient [12]. This system enables the design of individualized meal plans that consider factors such as age, sex, medical conditions, and physical activity level, while also promoting both dietary variety and nutritional balance. The food exchange list serves as an evidence-based and practical resource in nutrition education and intervention, particularly for patients.

Initially developed to help individuals with diabetics manage their diets, the food exchange list is now used for nutrition education and management in patients with various conditions. Notably, individuals with obesity can utilize this tool to organize meals that adjust energy intake to meet individual needs, and they can select low-fat options within the meats and milk categories to support weight loss [13]. Additionally, specialized food exchange lists have been established for patients with renal diseases who require careful monitoring of mineral intake, including sodium, potassium, and phosphorus, enabling appropriate food choices and meal planning [14]. The effectiveness of the food exchange list in nutrition education has been supported by numerous studies. Kendall and Jansen [15] (1990) compared nutrient-based education with a food group-based approach using the exchange list among patients with non-insulin-dependent diabetes. Their findings revealed that the exchange list group demonstrated significant improvement in nutritional understanding, highlighting its utility in practical meal planning [15]. Sidahmed et al. [16] (2014) developed and implemented a Mediterranean-style food exchange list in a dietary intervention study. The approach led to improved dietary adherence and reductions in both body weight and C-reactive protein levels, underscoring its positive impact on health outcomes [16]. Multiple additional studies have corroborated these findings [17,18].

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This study aims to develop customized nutritional counseling materials by adapting the clinically validated food exchange list originally designed for patients with diabetes [12], while incorporating the specific eating behaviors and nutritional requirements of ASD children. This approach can be particularly valuable in gradually expanding the limited food choices of ASD children and supplementing nutritional deficiencies. The nutritional counseling materials developed through this study are expected to contribute as a practical tool supporting the improvement of nutritional status and healthy development of ASD children.

MATERIALS AND METHODS

Data collection for food exchange list development

A foundational food exchange list framework was established by analyzing two primary sources: the 'Guidelines for Using Food Exchange lists for Diabetes Meal Planning' from the Korean Diabetes Association (KDA) [12] and Daejeon St. Mary's Hospital. Basic definitions and concepts of food exchange lists were referenced from the 2020 Dietary Reference Intakes for Koreans (K-DRIs) [19], and the exact nutrient content of foods was determined using the National Standard Food Composition Table (10th revision) of the Rural Development Administration (RDA) [20]. From these sources, we constructed an initial database that categorized foods into standardized food groups based on their nutritional composition. Each food group's classification criteria established by the standard nutrient specifications defined in the diabetic food exchange list, which provided the structural framework for subsequent modifications [12]. This initial framework served as the basis for further customization to meet the specific needs of ASD children.

Food intake assessment

To address the limitations of existing diabetes-focused exchange lists that do not distinguish between foods for adults and children, we reviewed studies. Prior studies that investigated food intake in ASD children using Food Frequency Questionnaire, 3-day food records, etc. were included in the review [4,21,22]. In addition, studies that performed meta-analyses of multiple studies were reviewed to increase reliability [23]. This evaluation included the National Standard Food Composition Table (10th revision) from the RDA [20]. Foods were included in the database based on the following criteria: frequency of consumption ≥ 1 serving per week in the target population, nutritional value that meets specific deficiency needs, and sensory characteristics appropriate for ASD children. Foods consumed < 1 serving per week were excluded from the final database.

Selection of representative foods and material development

Based on the collected database, foods were classified into six major food groups: grains, proteins, vegetables, fats and oils, milk, and fruits. For each food group, standardized exchange units were established according to their macronutrient content. Within each food group, we selected representative foods based on two primary criteria: foods frequently consumed by children and foods rich in nutrients commonly deficient in ASD children. These representative foods were photographed to visually demonstrate one exchange unit. The photography process was standardized using controlled lighting, a white background, and consistent plating methods to ensure accurate visual estimation of portion sizes. The photographs were incorporated into educational materials along with exchange unit tables. Additionally, we included actual-size references of the tableware used in the photographs to help users accurately estimate portion size.

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Development of nutrient source food table

For all foods included in the food exchange list database, we calculated both macro and micronutrient contents based on one exchange unit. This data was organized into comprehensive nutrient source tables to support nutritional intervention education. The nutrient content calculations were based on the RDA's food composition database [20]. All foods included in each food group were sorted by nutrient content and then ranked from 1 to 15, excluding foods that are difficult to purchase in the marketplace or difficult for children to consume. These rankings particularly emphasized nutrients commonly deficient in ASD children. The resulting tables were designed to be used in conjunction with the food exchange list, providing a practical tool for addressing specific nutritional deficiencies through food selection.

RESULTS

Database development for food exchange list

The initial food exchange database was established based on two primary sources: the KDA's food exchange list and Daejeon St. Mary's Hospital's clinical food exchange list. The standardized nutrient criteria for each food group followed the guidelines provided by the KDA's food exchange list (**Table 1**). To better accommodate children's dietary preferences and nutritional needs, we supplemented this foundation with additional food items that are commonly consumed by children, assessed by frequency (1 ≥ serving per month) from our previous survey. These additions included items such as ramen, various bread products (twisted bread stick and waffle), cakes, and flavored milk varieties (strawberry, banana, and chocolate). Furthermore, we strategically included nutrient-dense foods like dried kelp (high in potassium and dietary fiber) and webfoot octopus (rich in vitamin D) to address specific nutritional deficiencies common in ASD children (**Table 2**).

Table 1. Food group and macronutrient component in the food exchange list

Food group	No.	Energy (kcal)	Carbohydrate (g)	Protein (g)	Fat (g)
Total food	300	-	-	-	-
Grains	46	100	23	2	-
Proteins	82	-	-	-	-
Low-fat	38	50	-	8	2
Medium-fat	28	75	-	8	5
High-fat	16	100	-	8	8
Vegetables	76	20	3	2	-
Fats and oils	31	45	-	-	5
Milk	13	-	-	-	-
Whole milk	12	125	10	6	7
Low-fat milk	1	80	10	6	2
Fruits	52	50	12	-	-

Table 2. Additional foods for each food group

Food group	Additional foods
Grains	Soybeans (20), kidney beans (20), ramyeon noodles (40), twisted donuts (kkwabaegi) (25), waffles (35), chocolate cake (25), pancake (35)
Proteins	
Low-fat	Webfoot octopus (100)
Vegetables	Kelp (dried) (20)
Milk	
Whole milk	Strawberry flavored milk (200), banana flavored milk (150), chocolate milk (200)

Parentheses indicate the amount of 1 exchange unit (g).

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The resulting comprehensive database systematically categorized a total of 300-foods: 46 grains, 82 proteins (38 low-fat, 28 medium-fat, and 16 high-fat), 76 vegetables, 31 fats and oils, 13 milk (12 whole milk and 1 low-fat milk), and 52 fruits. A detailed list of foods is presented in **Table 3**. The nutritional content of each food item was standardized using the RDA's Food Composition Database (10th version) [15]. Exchange units were calculated by converting the standard 100g nutritional values according to the established criteria.

Development of educational brochure materials

A comprehensive educational brochure was developed in B5 format, consisting of 10 pages structured to facilitate understanding of food exchange concepts and portion control. The entire brochure, including the cover page, has been added as supplementary material (**Figure 1**). The front page introduces the fundamental principles of the food exchange system and features a food balance wheel diagram, emphasizing the importance of consuming a variety of foods from all six food groups to develop healthy eating habits. Pages 2 through 8 contain detailed food exchange unit tables for each food group, accompanied by representative food photographs that visually demonstrate standard exchange unit portions.

Table 3. Food composition of food exchange list

Food group	Included food list
Grains (n = 46)	White rice (cooked), barley (cooked), brown rice (cooked), rice porridge (cooked), white rice, barley, Job's tears, sorghum, foxtail millet, glutinous rice, red beans, brown rice, millet, mung beans, green peas, oats, soybeans, kidney beans, mixed grain powder, wheat flour, garaetteok (cylindrical rice cake), baekseolgi (steamed white rice cake), songpyeon (rice cake with sesame seeds), sirutteok (steamed rice cake), injeolmi (rice cake coated with bean powder), jeolpyeon (sliced rice cake), dried noodles, boiled noodles, fresh udon noodles, dried chewy noodles, fresh knife-cut noodles, dried spaghetti, boiled spaghetti, fresh sweet potato starch noodles, ramen noodles, potato, sweet potato, fresh glutinous corn, acorn jelly, corn, dried scorched rice, chestnut, oatmeal, ginkgo nut, cornflakes, white bread
Proteins (n = 82)	
Low-fat (n = 38)	Chicken (breast), pork (loin), beef (shank), beef (round), duck meat, beef jerky, flounder, halibut, cod, frozen pollock, butterfish, salmon, yellow croaker, cuttlefish, semi-dried pollock, dried shredded squid, dried yellow corvina, dried pollock, anchovy, whitebait, filefish fillet, steamed fish cake, imitation crab meat, salted pollock roe, cockle, blue crab, octopus minor, flying fish roe, octopus, squid, sea squirt, shrimp (medium-sized), shrimp (large-sized), abalone, mussel, sea cucumber, sea pineapple, webfoot octopus
Mid-fat (n = 28)	Chicken (with skin), pork (tenderloin), beef (sirloin), beef (tenderloin), beef (brisket), salad ham, cutlassfish, mackerel, pacific saury, croaker, Spanish mackerel, Atka mackerel, eel, horse mackerel, gizzard shad, herring, semi-dried saury, smelt, smoked salmon, fried fish cake, egg, quail egg, black beans, yellow soybeans, firm tofu, soft tofu, silken tofu, soybean curd residue
High-fat (n = 16)	Pork ribs, bacon, Vienna sausage, frankfurter sausage, beef ribs, oxtail, pork belly, canned mackerel, canned Pacific saury, canned tuna, cheddar cheese, ricotta cheese, mozzarella cheese, gouda cheese, cream cheese, fried tofu
Vegetables (n = 76)	Korean wild chive (gomchi), eggplant, sweet potato stems, bracken (boiled), chili leaves, perilla leaves, ripe pumpkin (raw), pickled radish (danmuji), sweet pumpkin, wild garlic (dallae), carrot, green onion, bellflower root (doraji), sedum (dolnamul), water dropwort (Minari), garlic, garlic scapes, butterbur, radish, dried radish strips, boiled radish greens, leek, napa cabbage, red cabbage, broccoli, lettuce, celery, bean sprouts, spinach, mugwort, crown daisy, mallow, zucchini, cabbage, iceberg lettuce, onion, young radish greens, cucumber, lotus root, burdock root, daylily (wonchuri), bamboo shoots (raw), bamboo shoots (canned), chamnamul (Pimpinella brachycarpa), bok choy, dried chwinamul (wild greens), chicory, kale, cauliflower, soybean sprouts, bell pepper, green chili, green garlic, sweet pepper, konjac, laver (gim), seaweed (maesaengi), seaweed (raw), seaweed (hijiki, raw), agar jelly, seaweed (paraeseaweed, raw), dried kelp, oyster mushrooms (raw), pine mushrooms (raw), white mushrooms (raw), enoki mushrooms (raw), dried shiitake mushrooms, fresh shiitake mushrooms, gat kimchi (leaf mustard kimchi), radish kimchi (kkakdugi), water kimchi (nabak kimchi), dongchimi (radish water kimchi), napa cabbage kimchi, chonggak kimchi (ponytail kimchi), young radish kimchi, carrot juice
Fat and oils (n = 31)	Black sesame (dried), sesame seeds (dried), peanuts, almonds, pine nuts, seasoned cashew nuts, pistachios, sunflower seeds, walnuts, pumpkin seeds (dried), seasoned pumpkin seeds, toasted sesame seeds, peanut butter, margarine, butter, shortening, light mayonnaise, mayonnaise, Italian dressing, thousand island dressing, French dressing, perilla oil, rice bran oil, corn oil, olive oil, safflower oil, canola oil, sesame oil, soybean oil, grapeseed oil, sunflower seed oil
Milk (n = 13)	
Whole milk (n = 12)	Soy milk, lactose-free milk, regular milk, whole milk powder, milk powder, yogurt (set type), yogurt (liquid type), soft ice cream, condensed milk, strawberry milk, banana milk, chocolate milk
Low-fat milk (n = 1)	Low-fat milk
Fruits (n = 52)	Sweet persimmon, soft persimmon, dried persimmon, mandarin orange, kumquat, orange, yuzu, grapefruit, hallabong (Jeju orange), canned mandarin orange, strawberry, raspberry, fresh fig, dried fig, fresh banana, dried banana, white peach, nectarine, yellow peach, canned white peach, canned yellow peach, blueberry, canned blueberry, pineapple, canned pineapple, shine muscat, kyoho grape, raisin, apple juice, orange juice, pineapple juice, grape juice, durian, lychee, mango, plum, musk melon, pear, fuji apple, apricot, Pomegranate, watermelon, cherry, plum, Korean melon, cherry, gold kiwi, green kiwi, papaya, canned fruit cocktail, cherry tomato, tomato

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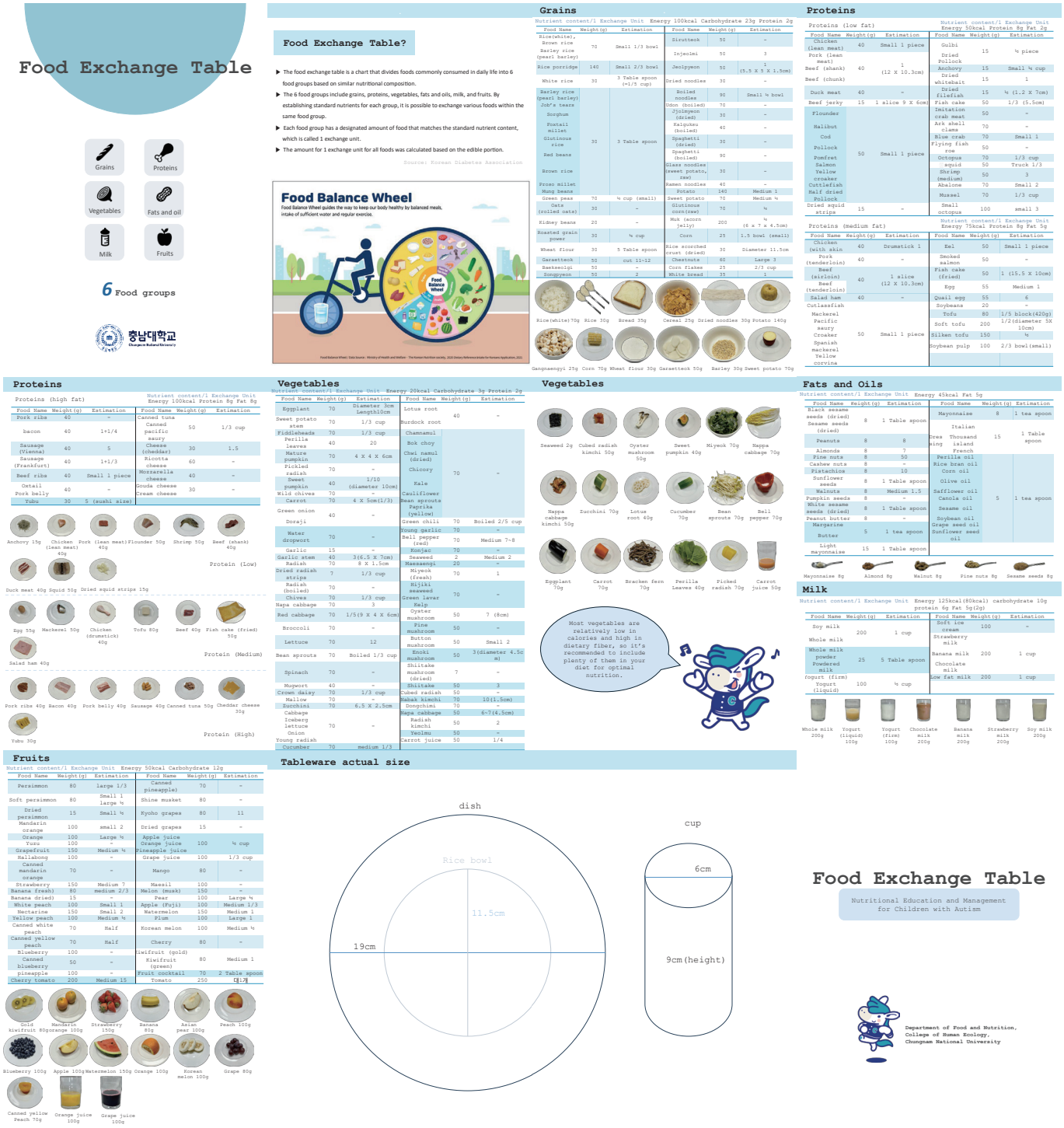

Figure 1. Brochure component. The conceptual framework of a food exchange system for nutrition education for autism spectrum disorder children, a balanced diet wheel, a list of food exchanges by food group, and the actual size of the photographed utensils are organized in a 12-page brochure.

The final two pages (p. 9–10) present a practical guide for portion size estimation, featuring actual-size reference images of commonly used tableware. These reference images were carefully calibrated to the B5 scale to ensure accurate portion size estimation in real-world settings. This standardized measurement system enables users to replicate exchange unit portions accurately in their daily meal preparation.

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Development of nutrient source foods database

A comprehensive nutrient source food database was developed to address nutritional deficiencies commonly observed in ASD children through dietary intervention. We compiled a systematic compilation of nutrient-rich food sources, categorized by food groups and ranked according to nutrient content density. Each nutrient category includes major food sources that can effectively supplement identified deficiencies. Special consideration was given to fat and sodium, where both deficient and excessive intake patterns were observed in the target population. For these nutrients, the database includes guidelines for both supplementation and intake moderation, providing a balanced approach to nutritional management. Potassium was presented as representative nutrient (**Figure 2**).

The major source foods for 19 nutrients were categorized, focusing on nutrients that are commonly deficient in ASD children, and fat and sodium were added to prevent overconsumption. Nutrients with insufficient national and international analytical data were excluded to ensure the reliability of the nutritional assessment and the nutrient-source foods were ranked after excluding foods that were not among the high-frequency and high-consumption foods for children in the age group according to the Korea National Health and Nutrition Examination Survey (KNHANES).

An example of a 1-day meal plan meeting the nutritional requirements of children is presented using the food exchange list. Based on the 2020 K-DRI [19], this example was designed to provide the recommended energy intake of 1,400 kcal for children aged 3 to 5 years (**Figure 3**).

DISCUSSION

This study developed educational brochures materials to promote proper eating habits and support healthy growth and development in ASD children. They exhibit distinct eating habits characterized by selective eating, rejections of new foods, and repetition of eating certain foods, primarily due to sensory sensitivity and limited behavioral characteristics [6]. These eating behaviors frequently lead to nutritional imbalances that may impact their growth and development [3-5]. Previous research has documented both eating imbalances and specific nutrient deficiencies in ASD children, while surveys of their parents have indicated high demand and willingness to participate in nutritional education programs [11].

Various international studies have applied structured nutrition education or parent-focused behavioral intervention programs for ASD children, demonstrating their practical effectiveness and applicability.

In the United States, the *Autism Eats* program was developed as a 10-week intervention with two booster sessions, targeting both children and their caregivers. The program provided personalized strategies for improving eating habits and promoting healthy dietary practices. It led to significant improvements in food variety, mealtime behaviors, and caregiver engagement [24]. In Japan, a parent education program for caregivers of ASD children consisted of two educational sessions and discussions. The program focused on teaching strategies based on the factors influencing children's food preferences. Through the use of visual materials, case examples, and cooperation with occupational therapists, the program significantly improved parental self-efficacy related to mealtime and increased the number

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Potassium

Adequate Intake (AI) : 2,400mg

<Top food sources per serving>

Rank	Food	Content (mg/serving)	Rank	Food	Content (mg/serving)
1	Korean melon, 150g	675	16	Yogurt (semo-solid), 100g	174
2	Spinach, 70g	553	17	Cabbage, 70g	169
3	Potato, 140g	469	18	Beef (lean meat), 60g	149
4	Tomato, 150g	375	19	Young radish kimchi, 40g	140
5	Soybeans, 20g	351	20	Cucumber, 70g	137
6	Banana, 100g	346	21	Red pepper powder, 5g	127
7	Fruit drink, 100g	330	22	Napa cabbage kimchi, 40g	125
8	Instant noodles (including seasoning), 120g	326	23	Anchovies, 15g	116
9	Milk, 200g	286	24	Apple, 100g	107
10	Sweet Potato, 70g	265	25	Tofu, 80g	106
11	Napa cabbage, 70g	232	26	Onion, 70g	102
12	Chicken, 60g	223	27	White rice, 90g	80
13	Pork (lean meat), 60g	195	28	Egg, 60g	79
14	Peach, 100g	188	29	Soy sauce, 5g	21
15	Radish, 70g	188	30	Red pepper paste (Gochujang), 5g	21

Source : Dietary Reference Intakes for Koreans 2020,Ministry of Health and Welfare, The Korean Nutrition Society

<Top food sources per 1 exchange unit>

	Grains	Content (mg)
1	Potato	576.8
2	Red beans	378.9
3	Soybeans	369.6
4	Chestnut	263.4
5	Sweet potato	262.50
6	Green peas	249.20
7	Glutinous corn (raw)	212.10
8	Kidney beans	146
9	Roasted grain powder (Misugaru)	126
10	Oats (hulled oats)	121.5
11	Sorghum	110.1
12	Foxtail Millet	100.8
13	White bread	98
14	Steamed rice cake (siru-tteok)	97.5
15	Brown rice (cooked)	85.40

	Vegetables	Content (mg)
1	Kelp (dried)	5250
2	Seaweed (raw)	778.4
3	Tomato	625
4	Spinach	483.7
5	Cherry tomato	418
6	Lettuce	413.7
7	Malabar spinach (auk)	298.2
8	Cauliflower	282.1
9	Chinese chives	277.2
10	Broccoli	255.5
11	Young radish	228.2
12	Carrot	209.3
13	Lptus root	191.2
14	Button mushroom (raw)	191
15	Enoki mushroom (raw)	184.5

	Fruits	Content (mg)
1	Korean melon	675
2	Japanese apricot	451.5
3	Melon (muskmelon)	448.8
4	Nectarine (peach)	346.5
5	White peach	324
6	Cherry	257.6
7	Strawberry	250.5
8	Plum	246
9	Kiwi (green)	227.2
10	Kiwi (gold)	209.6
11	Pineapple	194
12	Banana (raw)	177.5
13	Shine Muscat (grape)	164
14	Watermelon	163.5
15	Pineapple juice	156

Figure 2. Example of hierarchical classification of nutrient-dense foods for addressing nutritional deficiencies in children with autism spectrum disorder.

of foods consumed by the children [25]. In addition, a randomized clinical trial comparing the effectiveness of parent training and parent education for addressing behavioral problems in ASD children, while not specifically aimed at improving eating behaviors, showed that structured parent training led to a significant reduction in problem behaviors. This highlights the important role of systematic parental involvement in managing problematic behavior [26].

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Daily energy intake 1,400kcal									
	Grains	Proteins			Vegetables	Fats and Oils	Milk		Fruits
		low-fat	mid-fat	high-fat			low-fat	whole	
1 day exchange unit	6	1	2	-	6	3	-	2	2
1 meal exchange unit	1.5~2	1			2	1			

Food group	Breakfast	Snack	Lunch	Snack	Dinner
	Sandwich Steamed pumpkin Milk	Banana	Brown rice Seaweed soup Yellow croaker Fried mushrooms Roasted seaweed	Yogurt (semi-solid) Cereal Blueberry Strawberry	Chicken fried rice Soybean paste soup Braised lotus root Radish kimchi
Grains	2 exchange unit		2 exchange unit	0.5 exchange unit	1.5 exchange unit
	White bread 70g		Brown rice 140g	Cereal 13g	White rice 100g
Proteins	1 exchange unit		1 exchange unit		1 exchange unit
	Ham (roast) 40g		Beef 20g Yellow croaker 25g		Chicken 20g Egg 30g
Vegetables	2 exchange unit		2 exchange unit		2 exchange unit
	Lettuce 35g Pickled cucumber 20g Pumpkin 70g		Wakame 35g Oyster mushroom 35g Seasoned seaweed 4g		Onion 20g Carrot 15g Malva leaves 35g Lotus root 20g Radish kimchi 20g
Fats and Oils	1 exchange unit		1 exchange unit		1 exchange unit
	Butter 5g		Sesame oil 2.5g Bean oil 2.5g		Olive oil 5g
Milk	1 exchange unit			1 exchange unit	
	Milk 200ml			Yogurt (semi-solid) 100g	
Fruits		1 exchange unit		1 exchange unit	
		Banana 80g		Blueberry 50g Strawberry 75g	

Figure 3. Example of a 1-day meal plan for children aged 3 to 5 years requiring 1,400 kcal.

These studies collectively demonstrate that structured educational approaches can be effective in improving eating behaviors and dietary adherence in ASD children, offering valuable insights for the development of intervention programs in other contexts.

First, the food exchange table originally developed for the caloric intake and planned diet of diabetic patients was revised and supplemented according to the food intake status of ASD children aged 3 to 6. Utilizing data from KNHANES and RDA, we identified and incorporated commonly consumed foods into the exchange table database. This resulted in the addition of

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300 new food items across various categories, including grains (breads and cakes), low-fat proteins, vegetables, and milk. Representative foods were selected from this database and photographed to provide visual references for exchange unit portions, which were then compiled into a comprehensive brochure.

The database was further utilized to create nutrient-based food source tables, ranking items from 1st to 15th based on nutrient content within each food group. These tables served as educational tools to emphasize the importance of obtaining nutrients through dietary sources.

This research is meaningful as it developed practical nutrition education materials tailored to Korean dietary patterns and the specific needs of ASD children. In Korea, there has been a lack of structured resources suitable for ASD children, and particularly, no materials utilizing the food exchange list have been previously available. Accordingly, this study proposed approaches to help plan balanced meals and expand food choices by considering the characteristic features of ASD, such as sensory sensitivity and food selectivity. Furthermore, recognizing the crucial role of parents in managing behavioral problems in ASD children, the developed materials were designed to be practical and accessible for caregivers to implement in daily child-rearing. These materials are also expected to have valuable applications in clinical nutrition practice.

However, this study has several limitations. The primary constraint lies in the adaptation of a diabetic exchange system, which may not fully capture the unique dietary patterns of ASD children. In particular, ASD children have significantly lower intake diversity in fruit and vegetables, and the milk group compared to typically developing children [27].

Therefore, it is necessary to review the exchange unit in consideration of the dietary group intake and nutrient requirements of ASD children. In addition, there is no exchange unit for sugary foods that ASD children frequently consume, such as jelly, candy, and chocolate. It is judged that sugar-processed products were not included for blood sugar control because the food exchange table borrowed in this study was established based on diabetic patients. This limitation poses challenges in providing practical guidance for snack consumption in real-world settings.

CONCLUSION

This research successfully developed nutritional education materials tailored for parents of ASD children. The educational package included a comprehensive brochure featuring food exchange concepts, balanced diet guidelines, and visual representations of exchange units across six food groups. Supplementary materials include nutrient source tables designed to address specific nutritional deficiencies through dietary modifications.

Given the increasing prevalence of ASD, these educational materials represent a valuable resource for implementing customized nutrition education programs aimed at promoting healthy dietary patterns and supporting optimal growth and development in ASD children.

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