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RESEARCH ARTICLE

Development of Nutritional Biochemistry Learning Goals and Core Competencies in the Dental Hygiene Curriculum

Hye-Young Yoon, Sun-Jung Shin, Bo-Mi Shin, Hyo-Jin Lee, Jin-Sun Choi, and Soo-Myoung Bae†

Department of Dental Hygiene, College of Dentistry, Research Institute of Oral Science, Gangneung-Wonju National University, Gangneung 25457, Korea

Background: In the dental hygiene curriculum, efforts are being made to introduce an integrated curriculum based on the competency of a dental hygienist. Because there is a connection and overlap in learning contents between Dental Nutrition and Oral Biochemistry, which are basic dental hygiene subjects, it is possible to integrate these two subjects. This study aims to derive Nutritional Biochemistry as an integrated curriculum for Dental Nutrition and Oral Biochemistry, and to develop learning goals and competencies for Dental Nutritional Biochemistry.

Methods: The learning contents of the integrated curriculum were composed by referring to the contents of the Dental Nutrition and Oral Biochemistry textbooks, and learning goals were derived from the learning contents. Moreover, competency was developed by analyzing the duties of a dental hygienist that can be performed through the learning goals. The Delphi survey was conducted twice to verify the content validity ratio (CVR) of the competence and the learning goal of the integrated curriculum.

Results: In the first Delphi survey, the CVR for two competencies was 0.56 or higher. Moreover, it was revised based on expert's opinions, and as a result of the second Delphi survey after the revision, the CVR was either increased or maintained. Eighty-five learning goals were derived by referring to the textbook. According to CVR and expert opinions, after the first Delphi survey, the number of learning goals was reduced to 69. After the second Delphi survey, 68 learning goals were finally derived.

Conclusion: The development process of the integrated curriculum conducted in this study can be utilized for integration between subjects in basic dental hygiene.

Key Words: Competency, Dental hygiene, Dental nutrition, Integrated curriculum, Oral biochemistry

Introduction

As people's economy and knowledge levels improve, the expectations for quality of medical care have increased, and their needs have also diversified[1]. Furthermore, as dental medical technology continues to grow and develop, dental hygienists, who play diverse and new roles in this modern society, are required[2]. Dental hygienists working in society should be able to perform basic duties required in the clinical field and develop the ability to provide comprehensive dental hygiene management based on critical thinking and integrated problem solving[3]. It was recognized that changes must be made to the curriculum of dental hygiene department in order to meet the changing environment and social needs. As a result, efforts are being made to form a curriculum based on this competency after defining the competency to actually perform the role of a dental hygienist or an integrated curriculum that integrates and applies skills and knowledge related to the job of a dental hygienist[4].

The integrated curriculum means integrated teaching and learning among subjects and is a curriculum that removes the boundaries that separate subjects[5]. In addition, the integrated curriculum can be said to be a curriculum

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†**Correspondence to:** Soo-Myoung Bae, *https://orcid.org/0000-0002-1802-4129*
Department of Dental Hygiene, College of Dentistry, Research Institute of Oral Science, Gangneung-Wonju National University, 7 Jukheon-gil, Gangneung 25457, Korea
Tel: +82-33-640-2756, Fax: +82-33-642-6410, E-mail: edelweiss@gwnu.ac.kr

that can broaden the scope of practical-focused thinking and enhance problem-solving ability through learning contents that allow understanding of the whole rather than fragmentary knowledge[6,7]. As the integrated curriculum focuses on creatively solving problems in the clinical field and improving the ability to apply them to clinical problems, it can be said to be a suitable curriculum for nurturing health-related professionals[8]. So far, studies, such as the development of a model for integrated curriculum in dental hygiene education[9,10], presentation of operation plan for integrated curriculum[2], confirmation of linkage of subject contents for integrated curriculum development[7], and confirmation of demand for integrated curriculum[11], have been conducted for the introduction of the integrated curriculum in the dental hygiene curriculum. These preceding studies provided basic data for the development of an integrated curriculum. However, most preceding studies have focused on the clinical dentistry course and practice, and case studies that specifically developed an integrated curriculum or studies focusing on basic dental hygiene are still lacking[11]. Among subjects covered by the Department of Dental Hygiene, basic dental hygiene is the most basic of the professional knowledge to be dealt with in the dental hygiene study. This is because it provides scientific evidence to solve clinical problems to strengthen the ability to link and integrate the knowledge acquired in various basic dental hygiene subjects and use it in the clinical field It is necessary to operate an integrated curriculum for basic dental hygiene subjects[7]. Although previous studies revealed overlapping educational contents among basic dental hygiene subjects, they are still being operated in a divided form for each subject, acting as a limiting factor in linking and integrating knowledge as well as developing utilization and problem-solving skills[7].

Therefore, to introduce an integrated curriculum basic dental hygiene, it is necessary to develop an integrated curriculum among the basic dental hygiene subjects with overlapping and interconnected educational contents. Among the basic dental hygiene subjects, Dental Nutrition is a study that aims to provide prevention and treatment methods for oral diseases and systemic diseases affecting oral diseases from a nutritional point of view[10]. In order to provide this nutritional prevention and treatment method, it is essential to understand the chemical properties, roles, and metabolic processes of various substances that make up the human body and the oral cavity. Because Oral Biochemistry deals with the types of substances constituting the human body and oral cavity, their chemical properties, roles, and metabolic processes, there is a link between the knowledge covered in Dental Nutrition and Oral Biochemistry[10]. Also, looking at the curriculum of Fones School (Bridgeport, CT, USA), Dental Nutrition and Oral Biochemistry are being integrated into the subjects of 'Nutritional Biochemistry'[12]. Touger-Decker[13] said that as the evidence proving the role of nutrition on the health and disease of the body and oral cavity is increasing, it is necessary to expand the operation by integrating nutrition with other basic or clinical subjects in medical and dental education. Based on the report of the American Nutrition Association, 'Oral Health and Nutrition,' the American Dental Association recommended topics of nutrition to be covered in the dentistry curriculum, such as 'Nutritional biochemistry,' 'Nutrition and oral health throughout the life span,' 'Diet education and intervention relative to oral health and disease'[14]. As with the change in the expansion of nutrition education content in the dental curriculum, nutrition needs to be integrated and operated into dental hygiene education, and Oral Biochemistry, a basic subject with high connectivity, needs to be integrated first. Furthermore, it is thought that the integrated operation of Dental Nutrition and Oral Biochemistry can strengthen the competence of dental hygienists to solve nutritional problems of subjects or patients by linking knowledge.

According to the connection between the learning purposes of these subjects and the current status of dental hygiene education courses abroad, in Korea, the integrated operation of Dental Nutrition and Oral Biochemistry will enhance the competence of dental hygienists in solving nutritional problems of patients (or subjects) by linking knowledge. Therefore, the purpose of this study is to develop an integrated curriculum of two subjects based on the competency of a dental hygienist that Dental Nutrition and Oral Biochemistry can strengthen.

Materials and Methods

1. Derivation of learning goals in the integrated curriculum

1) Composition of learning content to derive learning goals

(1) Extraction of learning content keywords

In order to organize the learning contents of the integrated curriculum, the learning contents in the Dental Nutrition and Oral Biochemistry textbooks were made into keywords. For keyword extraction, 'title of detailed content,' a sub-category of verse presented in a total of 8 textbooks, was targeted. The title of the verse was used as a keyword if there was no 'title of detailed content' in the sub-category of the verse. After listing the 'titles of detailed contents' of each textbook, the process of unifying them was carried out by comparing the learning contents covered in each of them. The unification process was carried out by unifying the 'title of detailed content' with similarity to the learning content or replacing it with a new term with an integrated meaning. After the unification, each textbook's 'title of detailed content' was selected as a keyword.

(2) Composition of learning contents of the integrated curriculum

The number of textbooks containing the keyword was identified for each keyword extracted from each textbook. Among the keywords of Oral Biochemistry extracted from 6 textbooks, keywords included in 4 or more textbooks (66.7%) were extracted into minor-categories constituting the educational contents of the integrated curriculum. Among the keywords of Dental Nutrition extracted from 5 textbooks, keywords included in 3 or more textbooks (60%) were also extracted into minor-categories constituting the educational contents of the integrated curriculum. After minor-category extraction, the title of the verse to which the extracted minor-category keyword belongs was extracted as a middle category. The chapter's title to which the extracted keyword of the middle-category belongs was set as 'major-category' after middle-category extraction. Additionally, non-extracted keywords that were related to the extracted keywords were selected for the composition of each category.

2) Derivation of learning goals for integrated curriculum

In order to derive the learning goals, after listing all the learning goals in the Dental Nutrition and Oral Biochemistry textbooks, the learning goals were classified according to the 'minor-category' selected as the educational contents of the integrated curriculum. Overlapping learning objectives were deleted through classification. After judging the expected or induced learning results when students learn about the learning contents of 'minor-category' by referring to Bloom's educational goal classification system[15], the learning goals classified according to 'minor-category' were revised, supplemented, and added.

3. Derivation of competencies in the integrated curriculum

The duties of a dental hygienist that can be performed through the learning goals of the integrated curriculum were confirmed based on the research contents of Park et al.[1]. Furthermore, the competency of a dental hygienist that can be achieved through the learning goals was confirmed based on the research contents of Bae et al.[4]. The competencies of the integrated curriculum were derived by referring to the learning goals of the integrated curriculum and the duties and competencies of dental hygienists that can be performed and achieved through the learning goals.

4. Delphi survey for assessing the content validity of learning goals, contents, and competencies

1) Composition of study subjects

A Delphi survey was conducted to verify the content validity of the learning content, learning goals, and competencies of the integrated curriculum derived from this study. The Delphi survey was conducted with 12 professors with experience teaching Dental Nutrition or Oral Biochemistry at dental hygiene departments located in Gangwon-do, Gyeongsangbuk-do, Gyeonggi-do, Daejeon, Busan, Seoul, and Chungcheongnam-do as experts.

2) Process of Delphi survey

The second Delphi survey was conducted after the contents were revised to reflect the results of the first Delphi survey. The final learning goals, contents, and competencies were derived by reflecting on the results of the Delphi surveys twice.

For the first Delphi survey, a questionnaire was constructed to evaluate the content validity of the learning goals, content, and competencies derived from this study on a 5-point Liker scale. This questionnaire was delivered by e-mail, and the survey was conducted from January 18, 2022 to February 17, 2022. The positive response rate (the ratio of selecting 'very valid' and 'valid'), the validity response average, standard deviation, and the content validity ratio (CVR) were calculated and compared for the analysis of the results of the first Delphi survey. As a result, among the values of each analysis criterion, the content was interpreted as having high validity and small differences of opinion when the positive response rate was 75% or more, the validity response average was 4.0 or more, and the standard deviation was less than 1.0[16-20]. Additionally, in the case of CVR, as the number of experts was 12, it was judged that the content had validity if the CVR value was 0.56 or more[21].

The contents were processed by comprehensively collecting the values of the four analysis criteria and the experts'opinions[20]. The contents are 'maintained' if the values of the four analysis criteria are all satisfied with the standard values or if there is one that does not satisfy the standard values but it is determined that there is no need for revision by the researcher's judgment. For an analysis criteria value that did not meet the standard values, the content was processed as 'revised' if two or more experts gave the same opinion for revision. In addition, if the values of the four analysis criterion did not satisfy the standards or all of them did not meet the standards, but two or more experts requested the deletion, the contents were 'deleted.' After that, if most of the learning contents in the major category were deleted and only one of them remained, the remaining ones were 'moved' to another major category.

In the 2nd Delphi survey, the questionnaire was constructed to evaluate the validity of the processed contents according to the results of the 1st Delphi survey on a 5-point Likert scale. Moreover, it surveyed the same subjects as the 1st Delphi survey by mail from April 22 to May 20, 2022. The results of the 2nd Delphi survey were also interpreted and processed the same way as the 1st Delphi survey. Finally, competencies, learning contents, and learning goals were derived.

Results

1. Validity of the competency of the integrated curriculum

As a result of the first Delphi survey on the two competencies that can be achieved through the integrated curriculum, the positive response rate for both competencies was 83.3%, the average was 4.17 out of 5, the standard deviation was 0.72, and the CVR was 0.67 (Table 1). All the analysis criteria satisfied the standard values, but as with other opinions, three experts were of the same opinion that it is necessary to include dietary counseling and diet control education.

As a result of the 2nd Delphi survey, all analysis criteria for the revised and supplemented competency met the standard values (Table 1). Therefore, the competencies of the integrated curriculum derived from this study are as follows: *"1. Dietary counseling and education can be provided to patients/subjects in consideration of the nutritional characteristics of their life span. 2. It is possible to identify health problems of patients/subjects due to deficiency or excess of nutrients."*

2. Validity of the learning purpose of the integrated curriculum

Information on learning purpose of the integrated curriculum was required to verify the validity of the integrated curriculum's learning contents and goals. Therefore, the learning purpose was derived, and the validity of the derived learning objectives was also verified. Table 1 shows the results of the 1st and 2nd Delphi surveys on learning purpose. The learning purpose finally derived by reflecting expert opinions are as follows. *"1. The purpose is to understand the relationship between the 'function of the body and oral cavity' and 'nutritional intake' based on*

Table 1. Results of Delphi Survey on the Competencies and Learning Purpose of the Integrated Curriculum

Division	Draft	1st Delphi survey				After 1st Delphi survey	2nd Delphi survey			
		%	Mean	SD	CVR		%	Mean	SD	CVR
Competency	1. Dietary control education can be provided to patients/subjects in consideration of the nutritional characteristics of their life span	83.3	4.17	0.72	0.67	1. Dietary counseling and education can be provided to patients/subjects in consideration of the nutritional characteristics of their life span.	91.7	4.50	0.65	0.83
	2. It is possible to identify health problems of patients/subjects due to deficiency or excess of nutrients.	83.3	4.17	0.72	0.67	2. It is possible to identify health problems of patients/subjects due to deficiency or excess of nutrients.	83.3	4.50	0.76	0.67
Learning purpose	1. The purpose is to understand the relationship between the 'function of body and oral cavity' and 'nutritional intake' based on knowledge of 'role and metabolism of components in the body' and 'metabolism of hard and soft tissues in the oral cavity.' Further, it is to guide the subjects who visit the dentist to follow a dietary life for 'prevention of oral disease' and 'promoting and maintaining oral function'.	91.7	4.08	0.51	0.83	1. The purpose is to understand the relationship between the 'function of the body and oral cavity' and 'nutritional intake' based on knowledge of 'the role and energy metabolism of nutrients constituting the body' and 'metabolism of hard and soft tissues in the oral cavity.' Further, it is to provide nutritional guidance in consideration of the characteristics of life span so that the subjects can follow a dietary life for 'prevention of oral disease' and 'promoting and maintaining oral function.'	100	4.58	0.49	1.00

%: positive response rate, Mean: average of validity score, SD: standard deviation, CVR: content validity ratio.

knowledge of 'the role and energy metabolism of nutrients constituting the body' and 'metabolism of hard and soft tissues in the oral cavity.' Further, it is to provide nutritional guidance in consideration of the characteristics of life span so that the subjects can follow a dietary life for 'prevention of oral disease' and 'promoting and maintaining oral function.'"

3. Validity of the learning goals of the integrated curriculum

Through the study, 85 learning goals were derived along with the learning contents, which consisted of 16 major categories, 54 middle categories, and 128 minor categories. As a result of the 1st Delphi survey, by combining the values of the four analysis criteria and opinions of experts, out of a total of 85 learning goals, 5 learning goals were 'revised' and 17 learning goals were 'deleted.'

In the 2nd Delphi investigation, the validity of 'deleted,' 'maintained,' 'revised,' 'moved,' and 'added' processing contents after the 1st Delphi investigation was confirmed.

For the 17 learning goals 'deleted' after the 1st Delphi survey, the validity of the processing of deletion was confirmed. As a result, all analysis criteria for 4 out of 17 learning goals satisfied the standard value. In addition, for the validity of the 12 learning goals, some analysis criteria did not satisfy the standard value. Specifically, in the case of one learning goal, all the analysis criteria did not satisfy the standard value. After the 2nd Delphi survey, 16 of the 17 learning goals were finally 'deleted.'

Of the 61 'maintained' learning goals, all analysis

Table 2. Final Derived Learning Goals and Contents of the Integrated Curriculum and the Results of the 2nd Delphi Survey

The final derived learning goals and contents	2nd Delphi survey			
	%	Mean	SD	CVR
Learning goals				
Category 1. Healthy eating and dental nutritional biochemistry				
Can explain the definition of dental nutritional biochemistry.	91.7	4.67	0.65	0.83
Can explain the significance of learning dental nutritional biochemistry for dental hygienists.	91.7	4.67	0.65	0.83
Category 2. Chemical reaction in body				
Can explain ATP and energy metabolism.	83.3	4.33	0.78	0.67
Can explain the role of enzymes in metabolism.	83.3	4.33	0.78	0.67
Category 3. Dietary reference intakes for Koreans				
Can explain the types of dietary reference intakes.	83.3	4.50	0.80	0.67
Can explain the significance of dietary reference intakes for Koreans.	75.0	4.42	0.90	0.50
Can understand basal metabolism.	91.7	4.67	0.65	0.83
Can explain the factor that affect basal metabolism.	100	4.75	0.45	1.00
Can explain the relationship between exercise and estimated energy requirement.	66.7	4.08	1.24	0.33
Can understand the energy of food.	83.3	4.58	0.79	0.67
Category 4. Dietary life and health				
Can explain the process of change of dietary life.	83.3	4.25	1.14	0.67
Can explain food composition.	91.7	4.58	0.67	0.83
Can explain the dietary guidelines of Koreans.	100	4.75	0.45	1.00
Can explain the nutritional characteristics of the growth-period.	91.7	4.67	0.65	0.83
Can explain the nutritional characteristics of adulthood.	91.7	4.67	0.65	0.83
Can explain the nutritional characteristics of the elderly.	91.7	4.67	0.65	0.83
Category 5. Digestive organs and saliva				
Can explain the structure and function of the digestive organs.	91.7	4.50	0.90	0.83
Can explain the enzymes and digestion process required for digestion of nutrients.	91.7	4.67	0.65	0.83
Can explain the function of saliva.	91.7	4.58	0.67	0.83
Can understand the composition of saliva.	83.3	4.50	0.80	0.67
Category 6. Carbohydrates				
Can explain the structure and types of carbohydrates.	100	4.67	0.49	1.00
Can explain the process of digestion, absorption and metabolism of carbohydrates.	100	4.67	0.49	1.00
Can explain hormones involved in maintaining homeostasis of blood sugar and their actions.	83.3	4.50	1.00	0.67
Can explain the role of carbohydrates in the body.	100	4.67	0.49	1.00
Can classify foods that provide carbohydrates.	100	4.67	0.49	1.00
Can confirm the recommended daily intake of carbohydrates and explain the problems that can occur when carbohydrates are deficient or excessive.	100	4.67	0.49	1.00
Can explain the relationship between carbohydrates and the occurrence of dental caries.	91.7	4.58	0.67	0.83
Category 7. Fat				
Can explain the structure and types of fat.	100	4.67	0.49	1.00
Can explain the process of digestion, absorption and metabolism of fat.	100	4.67	0.49	1.00
Can explain the role of fat in the body.	100	4.67	0.49	1.00
Can classify foods that provide fat.	100	4.67	0.49	1.00
Can confirm the recommended daily intake of fat and explain the problems that can occur when fat are deficient or excessive.	100	4.67	0.49	1.00
Category 8. Proteins				
Can explain the structure and types of proteins.	83.3	4.42	0.79	0.67
Can explain the structure and types of amino acids.	66.7	3.67	1.23	0.33
Can explain the process of digestion, absorption and metabolism of proteins.	100	4.58	0.51	1.00
Can explain the role of proteins in the body.	100	4.58	0.51	1.00
Can classify foods that provide proteins.	100	4.58	0.51	1.00
Can confirm the recommended daily intake of proteins and explain the problems that can occur when proteins are deficient or excessive.	91.7	4.58	0.67	0.83
Can explain the relationship between protein and oral disease.	91.7	4.58	0.67	0.83
Can understand the synthesis and use of proteins in the body.	83.3	4.33	0.98	0.67

Table 2. Continued

The final derived learning goals and contents	2nd Delphi survey			
	%	Mean	SD	CVR
Category 9. Minerals and water				
Can explain the process of digestion and absorption of minerals.	83.3	4.42	1.00	0.67
Can explain the types of minerals and the role of each mineral.	100	4.67	0.49	1.00
Can classify foods that provide minerals.	100	4.67	0.49	1.00
Can confirm the recommended daily intake of minerals and explain the problems that can occur when minerals are deficient or excessive.	91.7	4.58	0.67	0.83
Can explain the function of water.	100	4.67	0.49	1.00
Can explain the source of water.	100	4.67	0.49	1.00
Can confirm the recommended daily intake of water and explain problems that can occur when there is a deficiency or excess.	91.7	4.58	0.67	0.83
Category 10. Nutritional meaning of vitamins				
Can explain the process of digestion and absorption of vitamins.	83.3	4.42	1.00	0.67
Can explain the types of vitamins and the role of each vitamin.	100	4.67	0.49	1.00
Can classify foods that provide vitamins.	100	4.67	0.49	1.00
Can confirm the recommended daily intake of vitamins and explain the problems that can occur when vitamins are deficient or excessive.	91.7	4.67	0.65	0.83
Category 11. Calcification of bones and teeth				
Can explain the characteristics of calcification after understanding the calcification mechanism of bones and teeth.	91.7	4.42	0.67	0.83
Can explain the types and actions of calcium-regulating hormones.	83.3	4.25	0.75	0.67
Can understand the mechanism of calcification.	66.7	4.08	0.90	0.33
Can explain the concentration of calcium and phosphate in serum.	66.7	4.08	1.08	0.33
Category 12. Chemical composition of teeth and periodontal tissue				
Can understand the main components of connective tissue, such as collagen fibers, elastic fibers, proteoglycans, and adhesion proteins.	83.3	4.42	0.79	0.67
Can understand the chemical composition of periodontal tissue.	66.7	4.00	1.21	0.33
Can explain the inorganic components of teeth.	91.7	4.58	0.67	0.83
Can explain the organic components of teeth.	83.3	4.50	0.80	0.67
Can explain factors that cause masticatory disturbance dysmascsis.	100	4.75	0.45	1.00
Category 13. Dietary counseling of dental patients/subjects				
Can explain the relationship between diet and dental caries.	100	4.75	0.45	1.00
Can explain the relationship between diet and periodontal disease.	100	4.75	0.45	1.00
Can explain the characteristics of carious foods.	91.7	4.67	0.65	0.83
Can explain the characteristics of anti-caries foods.	91.7	4.67	0.65	0.83
Can explain the need for alternative sweeteners in the prevention of dental caries.	83.3	4.58	0.79	0.67
Can evaluate dental patients/subjects for dietary counseling.	83.3	4.50	0.80	0.67
Can implement the dietary prescription process for oral health.	91.7	4.67	0.65	0.83
Can plan dietary adjustments for oral health.	91.7	4.67	0.65	0.83
Learning contents (13 major categories, 38 medium categories, and 99 minor categories)	86.2	4.38	0.76	0.72

%: positive response rate, Mean: average of validity score, SD: standard deviation, CVR: content validity ratio.

values of 59 learning goals met the standard value; however, 2 of 59 learning goals were finally revised from 'caries' to 'dental caries' and from 'patient' to 'patient/subject' according to the expert opinion. One of the two 'maintained' learning objectives, in which only the CVR value did not meet the standard value, was further revised according to the expert's opinion.

Of the five 'revised' learning goals after the 1st Delphi survey, all analysis criteria of one learning goal satisfied the standard value. Only the CVR value for the other four learning objectives did not satisfy the standard value. Of these four learning goals, two learning goals were ultimately 'deleted' as a result of the opinions of two experts. The final derived learning goals are shown in Table 2.

In the case of learning contents, 13 major categories, 42 medium categories, and 105 minor categories were derived

according to the results of the first Delphi survey. Moreover, after the second Delphi survey, 13 major categories, 38 medium categories, and 99 minor categories were finally derived.

Discussion

The integrated curriculum is an efficient educational method for dental hygienists who perform roles through an integrated course based on a wide range of knowledge from biomedical and behavioral science to basic and clinical knowledge. Furthermore, as it focuses on interpreting, synthesizing, and utilizing knowledge based on practice, it can be said that it is a curriculum that must be considered in the reformation of dental hygiene education[22].

Currently, the basic dental hygiene curriculum still consists of various subjects in a subject-based segmented form. Thus, it is an inappropriate method for acquiring basic dental hygiene knowledge, which provides critical thinking and scientific evidence for decision-making in clinical practice[7]. In the study of Kwon et al.[23], which confirmed the convergence factors affected by the basic dental hygiene subjects, the students' satisfaction with the basic dental hygiene subjects was low. Their confidence level was also low when they came into contact with clinical practice with knowledge through the basic dental hygiene subjects, suggesting the need for curriculum reform in the basic dental hygiene field.

In other previous studies, the overlap and linkage of the educational contents covered in each basic dental hygiene subject were checked to introduce an integrated curriculum in the field of basic dental hygiene. As a result, it was confirmed that the integrated curriculum within the basic dental hygiene field was applicable as all basic dental hygiene subjects had overlapping educational contents[7]. However, in this previous study, only basic dental hygiene subjects, which are subjects of the licensing examination, were studied, whereas other subjects, such as Dental Nutrition, Oral Biochemistry, and Dental Pharmacology, were excluded. Kim[10] said that Nutrition, which deals with nutritional knowledge and guidance methods, is necessary for the dental hygiene department curriculum to provide systematic and scientific guidance to subjects needing improvement in dietary habits. Furthermore, as biochemistry deals with the functions and objects of macromolecules constituting the human body, it is essential in the curriculum for dental hygienists closely related to the human body.

Although Dental Nutrition and Oral Biochemistry are essential subjects to perform the role of a dental hygienist, among the 81 universities to which the Department of Dental Hygiene belongs, approximately 59 (72.8%) did not offer both 'Dental Nutrition' and 'Oral Biochemistry' courses. In addition, in the case of the 3-year dental hygiene department, only about 9 universities offered these subjects out of a total of 54 universities (results not shown). This situation may be a problem caused by the lack of class time as the curriculum is operated in a divided form based on subjects. This problem can be solved by removing the learning of overlapping contents by operating the integrated curriculum. Dental Nutrition and Oral Biochemistry can be approached as an integrated curriculum because the learning contents are linked and overlapped. In the United States, they are already being integrated and operated as a subject called 'Nutritional Biochemistry'[12]. Also, in this study, when the educational contents were identified as keywords in each textbook of Dental Nutrition and Oral Biochemistry, it was confirmed that a number of keywords (approximately 30%) were overlapped (results not shown).

Therefore, in this study, drafts were prepared from each textbook to derive an integrated curriculum that integrated Dental Nutrition and Oral Biochemistry. After conducting two Delphi surveys, 2 competencies and 68 learning goals were finally derived by reflecting the expert's opinions. The Delphi survey on the competencies derived from this study confirmed that the values of the analysis criteria were improved the second time than the first time. Further, it can be said that it was derived in a form agreed by most experts. Furthermore, the derived competencies suggest the duties and roles of dental hygienists that can be performed based on the knowledge learned in this integrated curriculum. As dietary factors and systemic health are closely related to oral disease, one of the roles of a dental hygienist is to provide professional education and management to prevent oral diseases and maintain

oral health by identifying the characteristics of patients/subjects[4]. It is thought that this integrated curriculum can impact improving dental hygienists' ability to perform this role. The learning goals of the integrated curriculum were derived based on the learning contents in the Dental Nutrition and Oral Biochemistry textbooks. They were revised and supplemented with the contents required and expected to achieve competency. Because the competency validation in this study was to evaluate whether the competency is achievable through learning goals and content, the relevance of learning objectives and content and competency was also verified. The experts agreed upon most learning goals because the analysis criteria met the standard values until the 2nd Delphi survey; however, experts differed in opinion on some learning goals until the 2nd Delphi survey. The difference of experts' opinion was mainly about the deletion of contents overlapping with other subjects. In this study, most of the learning goals overlapping with other subjects were 'deleted.' Therefore, it is thought that a broad understanding of the integrated curriculum knowledge derived from this study will be possible only when other subjects with overlapping content are opened together. These subjects are Oral Histology, Oral Physiology, Microbiology, and Preventive Dentistry. Another expert's opinion was that concrete content and presentation of learning time were necessary to verify the validity of the learning goals. It is thought that this can be supplemented and presented through case studies of the operation of the integrated curriculum in the future. In addition, experts who participated in the Delphi survey suggested that the integrated curriculum be called 'Dental Nutrition Biochemistry,' considering the composition and characteristics of the learning goals and competencies of the integrated curriculum derived from this study. The learning content was used to derive the learning goal. Although it was not specifically presented in the research results, the learning content consisting of 13 major categories, 38 medium categories, and 99 minor categories was finally derived by reflecting experts' opinions through the Delphi survey.

When evaluating the integrated curriculum of medical colleges that have already introduced and operated an integrated curriculum, the negative response ratios of professors and students were similar to the positive response ratios[6,24]. In addition, as a result of identifying the problems of the integrated curriculum operation and for its successful operation, it is suggested that smooth consultation and cooperation between the professors in charge is important and that an organization that plays the role of coordination should be introduced[6,24]. Nevertheless, considering that the students' awareness of the necessity of the integrated curriculum is higher after the introduction than before the introduction, it can be seen that it is necessary to guide the direction of improvement through continuous monitoring so that the integrated curriculum can be established[6]. Similarly, in dental hygiene education, it is necessary to prepare for the problems identified through prior research and to actively prepare the operation contents and the operation process and evaluation to establish an integrated education curriculum.

While this study has a limitation in that it did not reflect the consensus of all the experts who participated in the Delphi survey, it is meaningful in that it is a case where a specific integrated curriculum was developed for basic dental hygiene subjects at a time when related research was needed. The integrated curriculum development process in this study can be used to integrate other subjects with linkage and overlap. It can contribute to establishing an integrated dental hygiene education curriculum and further improve dental hygienists' professionalism.

Notes

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Ethical approval

This article was exempted from the Institutional Bioethics Committee of Gangneung-Wonju National University because it was a study using secondary data (GWNU IRB-R2021-4).

Author contributions

Conceptualization: Hye-Young Yoon and Soo-Myoung Bae. Data acquisition: Hye-Young Yoon, Sun-Jung Shin,

Bo-Mi Shin, Hyo-Jin Lee, Jin-Sun Choi, and Soo-Myoung Bae. Formal analysis: Hye-Young Yoon, Sun-Jung Shin, Bo-Mi Shin, Hyo-Jin Lee, Jin-Sun Choi, and Soo-Myoung Bae. Supervision: Soo-Myoung Bae. Writing–original draft: Hye-Young Yoon, and Soo-Myoung Bae. Writing–review & editing: Hye-Young Yoon, Sun-Jung Shin, Bo-Mi Shin, Hyo-Jin Lee, Jin-Sun Choi, and Soo-Myoung Bae.

ORCID

Hye-Young Yoon, *https://orcid.org/0000-0001-9914-9507*
Sun-Jung Shin, *https://orcid.org/0000-0001-9156-6998*
Bo-Mi Shin, *https://orcid.org/0000-0003-3763-152X*
Hyo-Jin Lee, *https://orcid.org/0000-0002-3465-1747*
Jin-Sun Choi, *https://orcid.org/0000-0002-9945-1375*
Soo-Myoung Bae, *https://orcid.org/0000-0002-1802-4129*

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