Development of SPORT D-IET Smartphone Application for Thai Female Football Players

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Abstract

The objectives of this study were: (1) to design and develop sportD-iet smartphone application for the dietary intake assessment in Thai female football players; (2) to assess nutritional status using sportD-iet application during light, moderate, and heavy training; and (3) to evaluate satisfaction and compliance of using sportD-iet application among Thai female football players. Fifteen female football players of Bangkokthonburi University, who have android touchscreen smartphone were recruited. A questionnaire was used to collect the satisfaction information. The results showed that: (1) SportD-iet application was developed in android operating system, consisted of eight operations as follows; interpreting optimal energy availability and macronutrient needs operation, searching and recording food and beverage operation, searching and recording activity/exercise operation, displaying summary and assessing energy availability operation, reporting nutrition operation, displaying energy graph operation, displaying recorded data operation, and user references operation. When the app was reviewed by experts, they were satisfied with the design and development. (2) Thai female football players have low energy availability (15±11 kilocalorie/kilogram fat-free mass/day) and low energy intake (1,204±398 kilocalorie/day). Subjects consumed low carbohydrate (3.0 ± 1.1 gram/kilogram/day) and protein intake (1.0±0.4 gram/kilogram/day). This amount of carbohydrate consumed by the athletes was less than the recommendations from the American College of Sports Medicine. However, fat intake was higher than the recommendations (32±9% of total energy from fat). (3) Subjects were satisfied with sportD-iet application (4.0±1.0 score). SportD-iet application was able to determine the dietary intake and the users were satisfied. It was also revealed that Thai college female football athletes consumed low energy intake and had low energy availability, and consuming low carbohydrate intake.

Keywords: Female football players, Energy availability, Sport nutrition application, Self-monitoring, Diet application on smartphone

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Introduction

In 2014, FIFA (Fédération Internationale de Football Association) (2014) surveyed female football player population from women's football member associations and found that there are estimates around 30 million. In 2015, FIFA (2015) hold the FIFA Women's World Cup in Canada, and Thailand women's national football team was included in the World Cup. Since then, Thailand women's national football team gained popularity and interests by Thai population. Previous studies investigating the dietary assessment of female football players has shown these athletes to consume insufficient energy intake (Melin et. al, 2015; Martin et. al, 2006; Mullinix et. al, 2003). The insufficient energy intake combined with poor quality dietary choices can lead to low energy availability (low energy availability is defined a less than 30 kilocalorie/kilogramkg of Fat Free Mass/day and more than 45 kilocalorie/kilogramkg of Fat Free Mass/day as an optimum energy intake) Prolonged low energy availability can which leads to a syndrome called the female athlete triad (comprises of eating disorder, menstrual disorder, and low bone mineral) and others health and performance such as delayed recovery, suppression of immune function, increase injury, disruption of reproductive function, lack of micronutrients such as iron/anemia, vitamin B, C, D, and low bone mass density (BMD) (Mountjoy et. al, 2015; Loucks et. al, 2011; and American College of Sports Medicine, 2009).

The GSMA (Group Special Mobile) has surveyed the usage of service application on smartphone such as mobile health, mobile financial services, mobile education, mobile identity and security etc. in six regions around the world and found that 18% of the users in Asia–Pacific region are focused on mobile health (Erik et. al, 2015). This result implies that mean most of people are starting to care and worry about their health. As the result, the traditional dietary and nutrition assessment has evoled into a diet application on smartphone such as FOOD I Eat, 60 day decreased waist decreased disease (Erik et. al, 2015). The diet applications are supported by the iOS and android operating systems. Anuja and Sapan (2013) summarized the advantages and disadvantages of iOS and android operating system, and comparison difference between iOS and Android operating system. They concluded that on the android operating system, an android smartphone can be used as a have android smartphone can be used as a USB storage device, any application can be downloaded from Google android app market that is free of cost, free license, and open source. On the other hand, the iOS operation system cannot interact with the screen if user is wearing regular gloves, will not be able to run flash or shockwaves videos, no free license, and no open source. Moreover, the estimated number of available apps downloaded from Google Play Store from December 2009 to February 2016 is 2 million apps and in June 2016 are 2.2 million apps (Statista, 2016) more than the number of available application in the Apple App Store from July 2008 to June 2016 is 2 million mobile apps (Statista, 2016). The number of android smartphone user of Thailand in 2015 is 24,000,000, which is more than the number of iOS smartphone user of Thailand in 2015 of 8,300,000 (Kevin, 2015).

However, most diet applications are designed and developted for weight loss and probably inappropriate for athletes (Jospe et. al, 2015; Ramage et. al, 2014; Carter et. al, 2013). Thus far, there is no design and development for sport nutrition application in Thailand. Therefore, this study aims to design and develop a

sportD-iet smartphone application for the dietary intake assessment in Thai female football players in android operating system

The objectives

1. To design and develop the sportD-iet application to calculate optimal energy availability, energy intake, energy expenditure, macronutrient requirement, and assess energy availability for Thai female football players

2. To assess the nutritional status of Thai female football players using sportD-iet application during light, moderate, and heavy training

3. To evaluate the satisfaction of using sportD-iet application among Thai female football players

Material and Methods

Study design of this study was mixed method design (sequential: quantitative followed by qualitative) which implied collecting and analyzing quantitative and then qualitative data from comment and interview after used sport D-iet application in two consecutive phases within one study.

The design and development of sportD-iet application consists of four steps as following;

Step 1: Studied and gathered the calculation equation such as optimal energy availability, energy expenditure, macronutrients needs, energy availability assessment equation, and nutrition guideline for female football player, and the food database derives from the previous study (Ekhathai, 2013) where more than 2,700 items of five food group and reliable source of food databases on energy and macronutrients consisting of carbohydrate, protein, and fat for users selects and searchs food and beverage.

Step 2: Invite programmer and graphical designer to design and develop sportD-iet application under the purpose was self-assessment dietary intake by assessing energy availability from the record food and activity data. Researcher created scope of design and development by determining from step 1: how can I know my energy needs per day? How much energy have I burned? How much calories & nutrients have I consumed? and have I consumed enough? as show in Figure 1.

☐ The key of sportD-iet application is the dietary intake assessment or the energy availability assessment. Researcher created it according to determine from have I consumed enough? By designing 2D-cartoon animation changes body to easily understand as follows: lack of energy is thin body; adequate but not sufficiently store energy is normal body; optimal energy is strength body see in Figure 2.

☐ The dietary intake recommendation from the American College of Sports Medicine, researcher designed it by showing “!” symbol in red, yellow, and green color according to define and classify the color of the Relative Energy Deficiency in Sport (RED-S) Clinical Assessment Tool (CAT) developed by the International Olympic Committee (IOC) to assess dietary intake and help user make decision to correctly consume diet (Mountjoy, 2015) see in Figure 2.

☐ The process of running operation in sportD-iet smartphone application showed in Figure 3.

Moreover, researcher adds more extra features and the attractive in 2D-cartoon animation to log in sportD-iet application and record food and activity data (see in part the result of satisfaction evaluation).

Step 3: The satisfaction evaluation of sportD-iet application before releasing to subjects by thirteen experts and six athletes (sample group, try-out). The experts were chosen according to the inclusion criteria of a person work in the field of football, and in sport nutrition. The experts are a football coach; three advisors of this study; and nine sports nutrition students. The try-out (n=6) was recruited from online questionnaire according to the inclusion criteria of this study following female football player, aged >18 years old, having android smartphone, athlete of university team or/and female football club or/and nation team, ability to read and write Thai language, and having e-mail account or line. Exclusion criteria: retire playing football

☐Experts and athletes (sample group) try-outs sportD-iet application 2 weeks. The evaluation consisted of installation, efficiency, usability, speed, data correction, and overview of design. They tested 8 operations of sportD-iet application and give satisfaction score of each operation according to likert scale five levels in satisfaction questionnaire with efficiency (Likert, R.A, 1961) and comments for program improvement. All data were analyzed by using descriptive statistic evaluates the satisfaction of sportD-iet application and then modified program as follow; software bug, satisfaction scores were between 1.00 and 2.50 (บุญชม ศรีสะอาด, 2545, น. 50-100), and comment and suggestion that similarly mentioned by more than half of the experts and six athletes (sample group). After improved and updated version, sportD-iet application distributed to fifteen subjects.

Step 4: Data collection and satisfaction evaluation after used the sportD-iet application.

☐**Participant recruitment**

Twenty subjects were recruited to participate in this study via football coach and meet inclusion criteria as follows: female, age 18-23years old, with play and competition football experience ≥ 1 year, be Bangkokthonburi university football team, healthy and with no medical history, having android touchscreen smartphone, willing to answer the questionnaire and ability to read and write Thai language, available Line and e-mail addresses on Gmail or Hotmail or Outlook account. Exclusion criteria: injury, pregnant and lactating woman, smoking, and drinking alcohol. Subjects who meet the inclusion were informed their right and signed the inform consent for an agreement to take part in the study. However, there were withdrawing five subjects as follows; two subjects had injury and three subjects want to leave this study. Thus, this study had fifteen subjects.

☐**SportD-iet application instruction**

User create an account and filled in their personal data in 1st Operation: interpreting optimal energy availability and macronutrient needs. Then, application is running to 4th Operation: displaying summary and assessing energy availability such as optimal energy availability, energy intake, energy expenditure, the proportion of carbohydrate, protein, and fat is in grams, and the completed list food and activity. Then, user goes to 2nd Operation: searching and recording food and beverage. After user added their dietary intake in each meal, application will calculate and reporte the amount of energy and macronutrient in 4th Operation: displaying summary and assessing energy availability, 5th Operation: reporting nutrition, and 6th Operation: displaying graph energy. Then, user goes to 3rd Operation: searching and recording activity/exercise, application will calculate and reporte the amount of energy expenditure in 4th Operation: displaying summary and assessing energy availability and 6th Operation: displaying graph

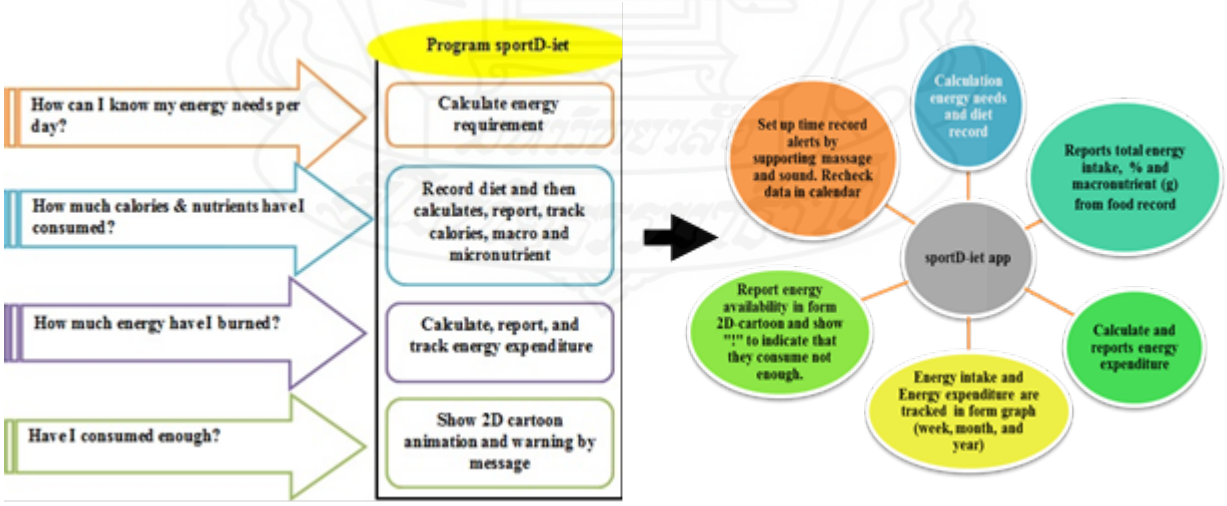
energy. And then 4th Operation: displaying summary and assessing energy availability will assess energy availability whether the athlete has consume enough energy or not by using total energy intake and total energy expended, as express in 2D-cartoon animation and already showed "!" and the recommendation (Figure 2 and Figure 3).

☐Data collection

All subjects connectedly recorded 3-days food and activity per week according to the day and program that they trained (light, moderate, and heavy training levels) until 4 weeks. Their body mass and body composition were measured before (week 0) and after (week 4). And then all subjects evaluate satisfaction after used the sportD-iet application.

The instrument for data collection was the satisfaction questionnaire. The satisfaction score was used likert scale (five levels) (Likert, R.A, 1961). The mean satisfaction scores criteria (บุญชม ศรีสะอาด, 2545, น . 50-100) as follows: Mean 4.51-5.00 = strongly satisfied opinion, Mean 3.51-4.50 = satisfied opinion; Mean 2.51-3.50 = somewhat satisfied opinion; Mean 1.51-2.50 = dissatisfied opinion; Mean 1.0-1.50 = strongly dissatisfied opinion

Statistics analysis: all of quantitative data was analyzed by using the IBM Statistical Package for Social Science (IBM SPSS Statistic) version 19 and a significant difference at $p < 0.05$. The personal information determined by descriptive statistic such as percentage, mean, and standard deviation. A paired t-test was used to compare differences of body mass, lean body mass, sum of 7-skinfold, and % body fat between before (wk. 0) and after (wk. 4). One-way ANOVA used to compare differences of energy intake, energy expenditure, energy availability, and macronutrient and between types of training. Descriptive statistic used to evaluate the satisfaction of sportD-iet application as mean and standard deviation.



(A) (B)

Figure 1 Conceptual frameworks for designing sportD-iet application (A) and the scope of design and development (B)

(A) (B) (C)

Figure 2 2D-cartoon animation changes body and showing "!" symbol: lack of energy is thin body (A); adequate but not sufficiently store energy is normal body (B); optimal energy is strength body (C)

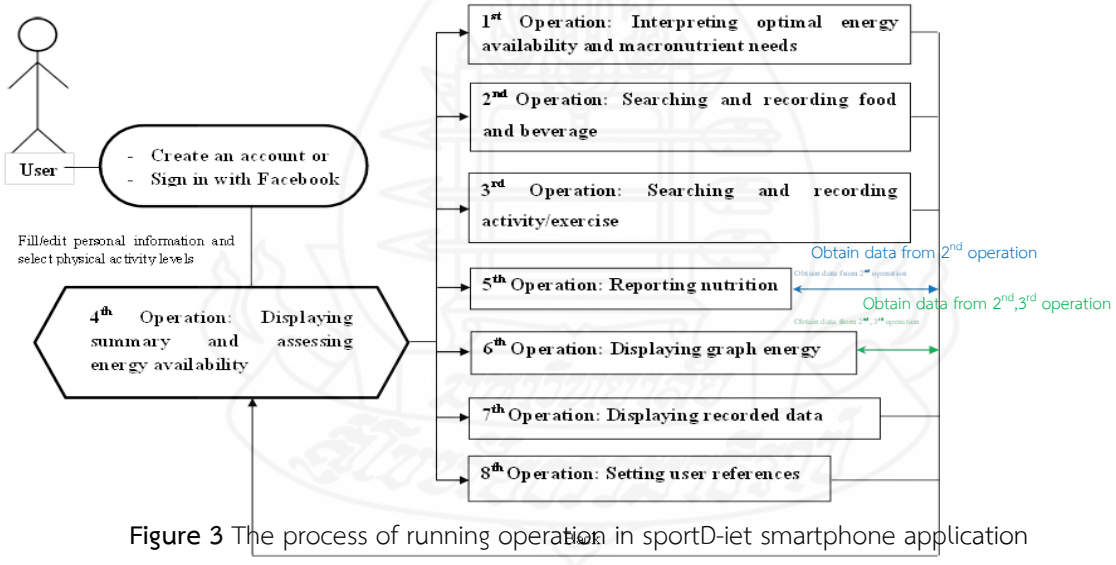


Figure 3 The process of running operation in sportD-iet smartphone application

Results

1. The result of design and development of sportD-iet application

Table 1 The mean satisfaction scores evaluated by the experts and athletes

	Main topic satisfaction	Experts (n = 13)	opinion	Athletes* try out (n= 6)	opinion
1.	The installation and registration of SportD-iet application	3.8 ± 0.6	satisfied	4.7 ± 0.4	strongly satisfied
2.	The efficiency of SportD-iet application	3.8 ± 0.6	satisfied	4.5 ± 0.4	satisfied
3.	The usage of SportD-iet application	3.7 ± 0.5	satisfied	4.4 ± 0.3	satisfied
4.	The speed of SportD-iet application	3.5 ± 0.8	somewhat satisfied	4.0 ± 0.4	satisfied
5.	The data correction of SportD-iet application	3.8 ± 0.7	satisfied	4.2 ± 0.6	satisfied
6.	The overview of SportD-iet application	4.0 ± 0.6	satisfied	3.7 ± 0.3	satisfied
	Total	4.0 ± 0.5	satisfied	4.3 ± 0.4	satisfied

Data presented as mean ± SD; * Athletes (try out) was a sample group (did not want to join in this research)

SportD-iet application was developed in android operating system. The eight operation of sportD-iet application were designed to be user-friendly, convenient, and easy to understand. SportD-iet application was tested by experts and athletes (sample group) before releasing to subjects by evaluating the satisfaction in performance in the following areas; installation, efficiency, usability, speed, data correction, and overview of design from thirteen experts and six athletes (sample group). From Table 1 found that thirteen experts and six athletes were satisfied with the overall performance of sportD-iet application (4.0±0.5 score and 4.3±0.4 score, respectively). In addition, experts and athletes were satisfied with the 2D-cartoon animation to assess dietary intake or the energy availability assessment (3.8 ± 0.6 score and 4.5 ± 0.4 score, respectively) and the speed of changing cartoon body such as thin, normal, strength and showing “!” color symbol such as red, yellow, and green (3.5 ± 0.8 score and 4.0 ± 0.4 score, respectively)

2. The nutritional status of Thai female football players using sportD-iet application during light, moderate, and heavy training

2.1 Demographic characteristics of the study subjects

Table 2.1 The General characteristics of subjects

Characteristics	Total (n=15)
Age (years)	19.8±0.9
Body mass (kg)	55.0±10.0
Height (cm)	157 ± 6.0
BMI (kg/m2)	22.3± 4.0
Estimated lean body mass (kg)§	41.3 ± 7.5
Sum of 7-Skinfold (mm)	113.7 ± 34.0
Estimated Body fat (%)┼	22.0 ± 5.3

Data presented as mean ±SD

§Lean body mass (kg) was estimated from calculation (assumes body fat = 25% according to reference of Body fat (%) for type of sport by Asker J and Michael G, 2010 [344] and Body fat (%) for gender by Leigh P, 2010 [367] was 13 – 25 % for Female soccer).

┼Body fat (%) estimated from the Jackson/Pollock 7-Site Caliper Method equation.

From Table 2.1 found that Subjects have age, body mass, height, body mass index, lean body mass, sum of 7-Skinfold, and percentage of body fat were 19.8 ± 0.9 years, 55.0±10.0 kg, 157 ± 6.0 cm, 22.3± 4.0 kg/m2, 41.3 ± 7.5 kg, 113.7 ± 34.0 mm, and 22.0 ± 5.3 %, respectively.

2.2 The comparison of body mass and body composition at week 0 and week 4

Table 2.2 The comparison of body mass (kg) and body composition of subjects at week 0(before) and week 4 (after)

Variables (n = 15)	Before (Wk. 0)	After (Wk. 4)	95%CI		P-value
			Lower	Upper	
Body mass (kg)	55.0± 10.0	54.7±10.0	-0.3	1.0	0.30
Lean body mass (kg)§	41.3±7.5	41.0±7.2	-0.2	0.8	0.30
Sum of 7-Skinfold (mm)*	113.7±34.0	105.1±29.5	1.8	15.3	0.02
Body fat (%)*,┼	22.0 ± 5.3	21.0 ± 5.0	0.3	2.3	0.02

Data presented as mean ± SD

*Significantly difference between week 0 and 4 at $p < 0.05$ using paired t-test

§Lean body mass (kg) was estimated from calculation by researcher assumes body fat = 25% according to reference of Body fat (%) for type of sport and gender (Asker J and Michael G, 2010; and Leigh P, 2010)

┼Body fat (%) estimated from the Jackson/Pollock 7-Site Caliper Method equation (Jackson AS, 1979)

From Table 2.2, the sum of 7-skinfolds significantly decreased (9.0 ± 12.2 mm, p<0.05), especially percentage of body fat (1.3 ± 2.0%, p<0.05) whereas body mass and lean body mass remained the same throughout the study (0.4 ± 1.2 kg, p=0.30 and 0.3 ±1.0 kg, p=0.30, respectively).

2.3 The comparison of energy intake, exercise energy expenditure, and energy availability during light, moderate, and heavy training

Table 2.3 Mean energy intake, exercise energy expenditure, and energy availability during light, moderate, and heavy training estimated by the sportD-iet application

Variables (n=15)	Types of training			Average	P-value
	Light	Moderate	Heavy		
Energy intake (kcal/d)	1,205±394	1,143±404	1,264±394	1,204±398	0.25
Exercise Energy Expenditure (kilocalorie /2 hours.)	503 ± 88[a]	676±119[b]	806±142[c]	630±171	0.00
Energy availability	18 ± 11[b]	12 ± 11[a]	13 ± 11[a,b]	15 ± 11	0.00

Data presented as mean ± SD

Different superscripts (a,b, and c) symbolize significantly difference between types of training light, moderate and heavy at $p< 0.05$ using one-way ANOVA followed by Scheffe's multiple rang test.

From Table 2.3 found that the mean daily energy intake, exercise energy expenditure, and energy availability was 1,204±398 kcal/d, 630±171 kilocalorie /2 hours, and 15±11 kcal/kgFFM/d. The differences in exercise energy expenditure and energy availability between light, moderate, heavy training sessions were significantly different (p<0.05). Mean exercise energy expenditure in during light training session was significantly lower than moderate (-173.3±18.3 kcal/d, p<0.000) and heavy training (-303.2±18.3 kcal/d, p<0.000). Mean exercise energy expenditure in moderate training was significantly low than heavy training (-130±20.7 kcal/d, p<0.000). Mean energy availability of light training was significantly higher than moderate (6.0 ±2.0 kcal/kg fat free mass/day, p<0.006) and heavy training (4.4±2.0 kcal/kgFFM/d, p<0.05). However, the energy intake between light, moderate the heavy training sessions were not different.

2.4 The comparison of dietary intake during light, moderate, and heavy training

Table 2.4 Mean intake of carbohydrate, protein, and fat during light, moderate, and heavy training sessions estimated by the sportD-iet application

Variables (n=15)	Types of training			Average	P-value
	Light	Moderate	Heavy		
Energy intake (kcal/d)	1,205±394	1,143±404	1,264±394	1,204±398	0.25
Carbohydrate					
Per day (g/ d)	158±52	151±51	167±51	159±52	0.26
Per unit BM (g/kg/d)[§]	3.0 ±1.1	3.2 ± 1.0	3.2 ±1.3	3.0± 1.1	0.10
Total carbohydrate energy ratio (%)	53.2± 9.6	54.0± 9.6	53.3 ± 9.9	53.4±9.6	0.88

Data presented as mean ± SD; significantly difference between light, moderate and heavy training at $p < 0.05$ using one-way ANOVA followed by Scheffe's multiple rang test.

Calculation of macronutrient intakes from three-day food records per week by using sportD-iet application;

[£]Carbohydrate per unit body mass (BM): light = 4-5 g/kgBM; moderate = 5-7 g/kg BM; heavy = 7-10 g/kg BM (American College of Sports Medicine, 2009)

Table 2.4 Mean intake of carbohydrate, protein, and fat during light, moderate, and heavy training sessions estimated by the sportD-iet application (cont.)

Variables (n=15)	Types of training			Average	P-value
	Light	Moderate	Heavy		
Protein					
Per day (g/ d)	46±20	41±17	48±20	45±20	0.12
Per unit BM (g/kg/d)[┼]	1.0 ± 0.4	1.0 ± 0.3	1.0 ± 0.4	1.0 ± 0.4	0.14
Total protein energy ratio (%)	15.2 ± 3.9	14.6 ± 4.2	15.4 ± 4.3	15.1±4.1	0.58
Fat					
Per day (g/ d)	43±20	42±21	45±20	44±20	0.62
Per unit BM (g/kg/d)	0.8 ± 0.5	0.8 ± 0.4	0.9 ±0.5	0.8 ±0.5	0.73
Total fat energy ratio (%)[‡]	32.0±9.3	31.7 ± 8.7	31.7±7.8	31.8±8.7	0.98

Data presented as mean ± SD

Calculation of macronutrient intakes from three-day food records per week by using sportD-iet application

Significantly difference between light, moderate and heavy training at $p < 0.05$ using one-way ANOVA followed by Scheffe's multiple rang test.

[£]Carbohydrate per unit body mass (BM): light = 4-5 g/kgBM; moderate = 5-7 g/kg BM; heavy = 7-10 g/kg BM (American College of Sports Medicine, 2009)

[┼]Protein per unit BM: Light = 0.8-1.0 g/kg BM; Moderate = 1.2-1.7 g/kg BM; Heavy = 1.7-2.0 g/kg BM (American College of Sports Medicine, 2009)

[‡] Total energy distribution (%): carbohydrate = 60 – 70%; protein = 10-15%; Fat = 20-25% (American College of Sports Medicine, 2009)

In terms of dietary intake (Table 2.4), there were no differences in carbohydrate, protein, and fat intake between light, moderate and heavy training sessions. The mean macronutrient intake was 3.0±1.1 gram/kilogram/day of carbohydrate, 1.0±0.4 g/kg/d of protein, and 0.8 ±0.5 g/kg/d of fat.

3. The satisfaction scores of the sportD-iet application among Thai female football players

Table 3 Mean intakes of carbohydrate, protein, and fat during light, moderate, and heavy training sessions estimated by the sportD-iet application

Number	Main topic satisfaction	Subjects (n= 15)	opinion
1.	The installation and registration of SportD-iet application	4.2 ± 1.0	satisfied
2.	The usage of displaying summary and assessing energy availability operation	4.0 ± 1.0	satisfied
3.	The usage of searching and recording food and beverage operation	3.6 ± 1.0	satisfied
4.	The usage of searching and recording activity/exercise operation	3.8 ± 1.0	satisfied
5.	The usage of interpreting optimal energy availability and macronutrient needs operation	4.0 ± 1.0	satisfied
6.	The usage of reporting nutrition operation	4.0 ± 1.0	satisfied
7.	The usage of displaying graph energy operation	4.1 ± 1.0	satisfied
8.	The usage of setting user references operation	4.0 ± 1.0	satisfied
9.	The overview of using sportD-iet application	4.1 ± 1.0	satisfied
	Total	**4.0 ± 1.0**	satisfied

Data presented as mean ± SD

Table 3 demonstrated that most subjects (69%) were satisfied with the sportD-iet application (4.0±1.0 score). Subjects were satisfied with 2D cartoon animation that helps them understand when nutritional status (the energy availability assessment) (4.1 ± 1.0 score). However, subjects were less satisfied with the number of food and beverage database (2.8 ± 1.1 score). In the comments part, subjects reported that originally the 2D-cartoon is thin and changes its shape when they input or did not input data and 2D-cartoon is easy to understand and suggested the application developer for the option of cartoon customisation, e.g. if user can change the color of the cartoon's clothes. Other than that, the sujbects reported that the data in the application is easy to comprehend and use, the color is fresh and not too bright, the alphabet size is perfect, not too small and not too big, but sportD-iet application should add food database more

Furthermore, subjects gave a small suggest for development in new feature was sportD-iet application should add more features of cartoon such as hairstyle and shoes and should add more download channel such as iOS operation system.

Discussion

The sportD-iet application was developed in the andriod operating system and consisted of eight operations, which was developed to to enable users to complete a dietary intake assessment by recording food and activity data, and calculated their energy availability so users can manage their dietary intake. During the development stage of the sportD-iet application, thirteen experts and six athletes (try-out) were satisfied with overall effective in the development and design of sportD-iet application. It was similar to the study of Jospe et. al (2015), who found sport dietitians to have a positive perception to diet application and they use it to assess or track dietary intakes with client.

The results of the nutrition status assessment, which was collected by the sportD-iet application during light, moderate, and heavy training sessions, found the sum of 7-skinfolds significantly decreased (9.0 ± 12.2 mm, $p< 0.05$), especially percentage of body fat (1.3 ± 2.0%, $p<0.05$). However, body mass and lean body mass remained the same throughout the study (0.4 ± 1.2 kg, $p=0.30$ and 0.3 ±1.0 kg, $p=0.30$, respectively). It was similar with Ramage et. al (2014) and Hebden et. al (2013) who suggested that self-monitoring of food record and activity/exercise could help weight maintenance. Furthermore, the dietary intake assessment with sportD-iet application found that subjects have low energy availability below 30 kcal/kgFFM/d (15±11.3 kcal/kgFFM/d) and low energy intake (1,204±398kcal/d) during light, moderate, and heavy training, which was collected from the 3-days food and activity record through 4 weeks. It was similar with Melin et. al (2015) where they assessed energy availability in forty female endurance athletes with and without menstrual disorder by measuring 7-days weighted dietary record and exercise. They found low energy availability and low energy intake in elite female endurance athletes (19.1 kcal/kgFFM/d, energy intake =1,983 kcal/d) and elite female with menstrual disorder (28.6 ± 2.4 kcal/kgFFM/d). Moreover, Martin et. al (2006) and Mullinix et. al (2003) reported that female football players consumed less energy intake than energy expenditure, they consumed energy intake was between 1,904 ± 366 and 2291 ± 310 kcal/d whereas estimate energy expenditure was 2,154 ± 596 kcal. Our subjects also consumed low carbohydrate (3.0 ± 1.1 g/kg/day) and protein (1.0±0.4g/kg/day) during light, moderate, and heavy training sessions. This amount of carbohydrate intake was less than the recommendation given by the American College of Sports Medicine was 6-10 g/kg/d of carbohydrate whereas fat intake was higher than the recommendations as 20-25%of total energy from fat. However, it is speculated that the female football players this study underestimated their energy intake than the previous studies. A possible source of error includes under-reporting by the subjects. It was similar with Seunghee Kye et. al (2014) who found that the under-reporting of energy intake was higher in woman (23.0%) than men (14.4%) aged 19 years by using 24-hour dietary recalls in the Korean National Health and Nutrition Examination Survey. Luana et. al (2010) found that 65.6% of underreporting of energy intake among obese adolescent subjects (47 normal-weight and 49 obese), especially carbohydrate intake (19.3%) by using 3-day dietary record.

In terms of the satisfaction rating to the sportD-iet application among Thai female football players. Subjects were satisfied after used sportD-iet application (4.0±1.0 score). It was similar with Mavra (2017) who reported that participants preferred to use diet application to assess and track their dietary intake. Lieffers and Hanning (2012) suggested that diet application was convenient and easy to use for keeping track of dietary intake. This study used 2D-cartoon animation to assess dietary intake or energy availability. Experts and subjects were satisfied with 2D cartoon animation that helps them to easily understand when assessed dietary intake (3.7 ± 0.6 score and 4.1 ± 1.0 score, respectively). It was similar with Thompson and Riding (1990) who reported that animation facilitates learning in mathematical demonstration. Kieras (1992) found that students who learned the operation of an energy system from the animated graphic performed significantly better than those who learned from a static graphic or lacked a graphic. Beside, Mavra et. al (2017) demonstrated that the diet application could assess energy, macronutrient, and micronutrient intakes almost the measured food intake/waste method. in part of comment, most of subject's comment told that sportD-iet application should add more food database (2.8±1.1score). Similar with the study of Tsai, (2007) found that subject's opinion with food database was less satisfied.

However, there were some limitations in this study as follows: the short duration of the study period, small sample size to use sportD-iet application, subjects were not screened and assessed for disordered eating behaviors, menstrual history, and bone health, subject of this study was only female football player of Bangkokthonburi University. There were some strengths in this study as follows: the energy and macronutrients data in each foodmenu from food database (Ekhathai, 2013); the physical activity database; the assessment and calculation energy availability, energy intake, exercise energy expenditure, and macronutrients needs; the recommendation for optimal dietary intake.

Recomendation for future research, this application should be tested in a longer duration and in larger sample size. Subjects should be screened eating disorder behaviors and menstrual disorder. This study should invite subject with different type of sport, division level, and sex. In addition, add channel to download sportD-iet application such as iOS operating system. Add more features of 2D-cartoon animation such as change hair, skin, and shoe.

Conclusion

SportD-iet application was developed in android system and consisted of eight operations. Thai college female football athletes had low energy intake and low energy availability, especially low in carbohydrate intake. Body mass and lean body mass remained the same throughout the study. SportD-iet application was satisfied from experts and female football player subjects with the effective performance as well as able to determine the dietary intake.

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