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Original Research Article

Food composition database reliability in calculations of diet offers

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ABSTRACT

This study analysed food offers and compared food composition of daily menus of two most common hospital diets, pancreatic and diabetic diet. In diets that are concentrated on the minimisation of some food components (as minimisation of carbohydrate content in diabetic diet or fat intake minimisation in the pancreatic diet), use of a reliable Food Composition database (FCDB) is an important factor. By use of four FCDBs, Croatian, Danish, USDA and the hospital FCDB, the food composition was analysed. Seven daily offers per two seasons were analysed (seasons: Spring/Summer & Autumn/Winter). Descriptive statistics as well as multivariate tools were used to investigate differences in the food composition, when different FCDB's were the basis of calculations. Multivariate analysis detected food composition differences in booth diets, when different FCDBs were used (content of energy, proteins, sodium, magnesium, iron & zinc) as well as for offers in different seasons. To be sure that the differences are significant we applied the Bland-Altman test. The results showed different biases and ranges – but none of the food component showed to be significantly different, what would lead to a potential rejection of some of the used FCDB. Those results are a strong confirmation that the Bland-Altman test ensures objective conclusions; like which FCDB is applicable for food composition analysis and menu planning.

1. Introduction

Food composition analysis is the basis of a diet analysis or diet planning. Diet in general, describes the practice of taking exact quantities and types of food to achieve a specific goal. Diet therapy defines food consumption subordinated to different medical conditions and must meet certain nutritional requirements (ADA, 2014). Inadequate intake of certain macronutrients, as well as micronutrients, has a negative impact on the consumers' condition. Different needs of individuals during the development and application of diets and menus should be considered, especially if the individual is a patient (SG, 2008).

Control of some food components and/or contents of macro- and/or micro-nutrients become extremely important. Mostly used diet therapies in Croatian hospitals are diet therapies for diabetes mellitus (DD) and chronic pancreatitis (CP). Diabetes mellitus is a metabolic disorder characterized by hyperglycaemia, condition that is a result of defects in insulin secretion, insulin action, or both. According ADA (2015), the share of carbohydrates should be carefully monitored for diabetic patients. Typical symptoms of hyperglycaemia are polydipsia, polyuria, weight loss, as well as blurred vision (ADA, 2015; Rydén et al., 2013). Energy intake should be proportional to energy expenditure in order to maintain a desirable body weight. It is recommended that such diet contain 25–35 g of fibre/day. Fat intake should be 35% or less of total calories, and total protein intake 12–20% of total calories or about 0.8 g/kg/day (Rahelić et al., 2016). Chronic pancreatitis is an inflammatory disease of the pancreas characterized by progressive changes in exocrine and endocrine function (Verhaegh et al., 2013). Structural damage and insufficient activity of the pancreas has an influence on the metabolism of the patient and its ability for proper digestion and absorption of nutrients, which leads to malnutrition (Verhaegh et al., 2013; Duggan et al., 2014; Rasmussen et al., 2013).

Diagnosis of CP is based on the results of tests of pancreatic function and imaging analysis, which includes computed tomography, magnetic resonance imaging and endoscopic ultrasonography (Forsmark, 2013). CP patients may develop a deficiency in vitamins A, D, E and K due to increased requirements, increased losses and fat malabsorption. Deficiencies in zinc, calcium, magnesium, folic acid and vitamin B_{12} have also been reported. Pancreatic diet consists of 25–30% from fat, 15–20% from protein (1.0–1.5 g/kg body weight/day) and 55–60% from carbohydrate in a daily amount of calorie intake and it should be divided in few small meals. The diet for CP patients should include small amounts of dietary fibre, because fibre can absorb enzymes and postpone the absorption of nutrients (Rasmussen et al., 2013; Hackert

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et al., 2014).

To provide comprehensive information about the amount of various nutrients found in foods, it is necessary to use Food composition databases (FCDBs). Data of food composition for a menu or diet identify nutrient contents. This content is compared with the recommendations allowing the nutrition monitoring in order to avoid any health risk of the healthy individual or a patient (Probst and Mamet, 2016). Reliable data of food composition are needed in the estimation of nutrient intake (s) by food consumption (Haytowitz and Pehrsson, 2018). Food consumption analysis is the basis of any quantitative study of human nutrition or a diet therapy (Lupiañez-Barbero et al., 2018; Haytowitz and Pehrsson, 2018). As well as other countries, Croatia also has developed their own FCDB in order to estimate nutrient intake from food, improve the nutritional status and to reduce the risk of chronic disease of their population (Haytowitz and Pehrsson, 2018; Sivakumaran et al., 2018; Kaić-Rak and Antonić, 1990). Widely used analysis used as a means of comparing a gold standard method of measurement with a new method of measurement particularly in the discipline of medicine is the Bland–Altman analysis (Bland and Altman, 1999). The difference in measurement values between the two methods and the mean measurement values can be seen from the plots from the Bland–Altman analysis and they are used to determine if the difference is independent of the mean. However, to date there has been limited publications on the application of the Bland–Altman analysis in examining similarities or differences of FCDBs despite its use in other clinical areas (Głabska et al., 2016).

The aim of this study was to analyse the energy and nutrient offers for menus, in two seasons (Spring/Summer and Autumn/Winter) of pancreatic and diabetic diets, and to define their compliance to the DRI recommendations (Official Gazette, 2011; DRI, 2005) and the Standard of hospital nutrition (Official Gazette, 2015). Four different FCDBs were used in the energy and nutritional analysis, the outcomes were compared using Bland-Altman charts, which were also used for the first time in the comparison of results of energy, and nutritional analysis of diets intended for patients with diabetes and chronic pancreatitis. For them, critical intake of a certain nutrient (carbohydrates for DD and fats for CP) may adversely affect the general health of the patient.

2. Methods

2.1. Menu analysis

Diet therapy is an important factor in treatment of different conditions during hospital treatment. In Clinical Hospital Dubrava (CHD) are offered 50 different diets adjusted to patient's state of illness, the most commonly prescribed diets are pancreatic and diabetic diet (for more than 50% of patients). The Hospital offers daily approximately 800 daily menus. Menus intended for different diets were analysed. We used the recipes of a specific diet (DD or CP) and their food ingredients to calculate the food composition of a meal and daily menu using four different FCDBs. Analysis of the menus offered in the pancreatic (CP) and diabetic diet (DD) was conducted for seven consecutive days in 2 seasons (Spring/Summer and Autumn/Winter).

Some food ingredients couldn't be found in all FCDBs and in such case the mentioned ingredient(s) is removed from the calculation in all FCDBs (e.g. vanilla sugar, flax seeds and spices, such as bay leaves, oregano, rosemary and cumin). Analysis included the information about the content of energy, proteins, total fats, carbohydrates, 7 minerals (sodium, calcium, magnesium, phosphorus, iron, zinc and copper) and five vitamins (B1, B2, B3, B6 and vitamin C). The offers were analysed using following four FCDBs: Croatian FCDB (Kaić-Rak and Antonić, 1990), Danish FCDB, FDB7.01 (DTU, 2009), USDA FCDB, rel.19 (USDA, 2006) & the FCDB used in the CHD. The analyses were conducted for two seasons (Spring/Summer & Autumn/Winter). Each menu consisted of three meals; breakfast, lunch and dinner. FCDB used in CHD is based on the data from *Tables of the composition of food and beverages* (Kaić-Rak and Antonić, 1990): the Croatian FCDB that is complemented with items from different sources, during the years 2007 and 2008. It is consisted of 716 items and 29 energy-nutritive components. Croatian FCDB contains 582 items and 33 energy-nutritive components. USDA FCDB (USDA, 2006) contains 7234 items and 33 energy-nutritive components and it was released in 2006. Danish FCDB from 2009 contains 1049 items and 112 energy-nutritive components however; some of the nutritional values are not listed for each item. USDA FCDB contains 7234 items and 33 energy-nutritive components and it was released in 2006.

2.2. Statistical analysis

The data matrix for each diet consisted of seven daily menus. To compare values of the 7-day menus, descriptive statistics (mean value, standard deviation, minimum and maximum value, and coefficient of variation) was used.

To identify all correlations per diet (42 meals per diet) for observe nutritive information (16 of them), a data matrix of 2688 data was built. Such data matrix was used in the principal component analysis to identify possible similarities and/or differences (Gajdoš Kljusurić et al., 2016).

Number of the observed relationships of different FCDBs, in the food composition, is calculated using a combination without repetition:

$$K_n^r = \binom{n}{r} = \frac{n!}{r!\,(n-r)!} \tag{1}$$

Where n presents the number of used FCDBs ($n = 4$) and r is the number of observed FCDBs in one relation ($r = 2$). So, six combinations of FCDB pars were observed (presented in Tables 3 and 4).

The agreement of the results of the food composition obtained by use of different FCDBs was recalculated by use of the Bland-Altman index (Yiou et al., 2016). For this index is calculated the limit of agreement value (LOA) as the sum of the mean absolute difference of the observed food component calculated by use of an exact FCDBs, and the standard deviation of the absolute difference of the observed food component, calculated intake magnified by 1.96.

3. Results

Food ingredients and their content listed in recipes, were used for calculating and evaluating the food composition of pancreatic and diabetic diets. The average energy and nutrient content of the weekly diabetic and pancreatic menus were calculated using data from four FCDBs. Those results are presented in Tables 1 and 2.

The assessment of agreement of energy/nutrient intake is set for the Bland-Altman index on maximum of 5% for 95% of individuals are observed to be beyond the limits of agreement (Bland and Altman, 1999; Yiou et al., 2016). Analyses of the average weekly menu of diabetic diet (Table 1) per both seasons, point out a good agreement with the recommendations (DRI, 2005; Official Gazette, 2015) for the amounts of energy, protein, fats and carbohydrates. This agreement is valid for all macronutrients calculated with different FCDBs with the exception of the amount of protein that was slightly over the recommendation (104.6 g/day) when calculated with the USDA FCDB for different seasons. The amount of sodium was mainly in accordance with recommendation in all FCDBs during the both seasons. But sodium content was noticed being lower than it is recommended for diabetic diets regardless the season, when CHD FCDB is used, as well as in the Autumn/Winter season using the Danish FCDB. The amount of calcium in the menus was adequate in both seasons according to the USDA and CHD FCDB. However, calcium contents obtained using Croatia and Danish FCDB were below daily recommended intake. Analysis of magnesium levels in the diabetic menus showed that only calculations by use of USDA FCDB in the season Spring/Summer were in accordance with recommendations. All values for potassium were higher than recommended, regardless of the season and which FCDB has been used.

Table 1
The average food composition of 7-day diabetic diet menus offers and daily recommendations.

Component	Season Spring/Summer								Season Autumn/Winter								Recommended	
	CHD$_{FCDB}$		CRO$_{FCDB}$		USDA$_{FCDB}$		Danish$_{FCDB}$		CHD$_{FCDB}$		CRO$_{FCDB}$		USDA$_{FCDB}$		Danish$_{FCDB}$			
	x	SD	x	SD	x	SD	x	SD	x	SD	x	SD	x	SD	x	SD	Min[#]	Max[#]
Energy (kJ)[#]	7168	530	7427	742	7848[a]	521	7480	593	7301	271	7558	330	7600	1048	7589	330	4200	11340
Protein (g)[#]	88.4	6	91	8	105[a]	12	95	10	89	5	90	7	99[a]	15	93	6	25	101
Total fat (g)[#]	68	8	72	17	66	10	62	10	68	6	75	6	66	9	64	5	22	90
Carbohydrates (g) [#]	2156	17	200	12	222	10	224	15	220	14	200	13	213	36	228	12	125	405
Sodium (mg)[$]	1474	351	1788	538	2076[a,b]	391	1643[b]	284	1397	380	1728	6567	1803[b]	567	1484[b]	474	1500[$]	2300[$]
Calcium (mg) [*]	857	150	751	165	937[a]	190	756	173	831	118	705	170	820	78	704	169	800[*]	1500[*]
Magnesium (mg) [*]	323	50	2623a[a]	60	395[a]	95	323	63	306	37	237	38	360[a]	34	285	31	375[*]	700[*]
Phosphorus (mg) [*]	1487	179	1503	218	1591	174	1508	140	1508	117	1494	65	1491	214	1469	71	700[*]	1400[*]
Iron (mg) [*]	15.1	2.9	16.8	3.2	15.9[b]	5.0	13.8	3.1	13.9	1.8	15.1	2.3	12.5[b]	1.0	12.7	3.8	14[*]	30[*]
Zinc (mg) [*]	10.2	2.4	6.2[a]	1.4	15.1[a]	1.8	12.0	1.8	9.9	2.6	5.4	1.1	14.9[a]	2.0	11.8	3.3	10[*]	15[*]
Copper (mg) [*]	0.9	0.2	1.0	0.2	1.3	0.1	1.2	0.2	0.9	0.2	1.0	0.2	1.2	0.1	1.1	0.1	1[*]	3[*]
Vitamin B_1 (mg) [*]	1.3	0.3	1.5	0.2	1.5	0.3	1.5	0.5	1.3	0.2	1.4	0.3	1.4	0.4	1.5	0.5	1.1[*]	4,0[*]
Vitamin B_2 (mg) [*]	1.8	0.1	1.8	0.2	2.2	0.4	1.8	0.2	1.7	0.2	1.6	0.3	1.9	0.3	1.7	0.4	1.4[*]	4,0[*]
Vitamin B_3 (mg) [*]	19.9	2.9	23.2	3.3	24.4	4.5	24.0	5.3	19.1	2.9	21.9	2.9	21.9	4.3	23.8[a]	2.7	16[*]	35[*]
Vitamin B_6 (mg) [*]	1.9	0.4	2.0	0.2	2.9	0.4	2.6	0.3	1.8	0.4	1.9	0.2	2.8[a]	0.3	2.6	0.2	1.4[*]	6,0[*]
Vitamin C (mg) [*]	186	40	221	44	147	44	23	32	203	52	244[a]	60	161	30	256[a]	60	80[*]	500[*]

CHD = Clinical Hospital Dubrava FCDB.
[#] = Decision on Standards of Hospital patients (2015) *Official Gazette 59/15*.
[$] = DRI (2005): Water, Potassium, Sodium, Chloride, and Sulfate. Food and Nutrition Board, Institute of Medicine, National Academies.
[*] = Ordinance on dietary supplements (2011) *Official Gazette* 46/11.
[a] = differences in the same season using different FCDs [b] = seasonal differences (same FCD).

The amount of iron was lower than recommended in the season Autumn/Winter when FCDB as CHD, USDA and Danish FCDB were used. The amount of zinc was lower than recommended in both seasons when Croatian FCDB was used, as well as in the season Autumn/Winter using the CHD FCDB. The amount of Copper was mainly in accordance with recommendations, although it values were lower in both seasons when the FCDB of the CHD was used. According to the analysis of diabetic diet, content of vitamins were in accordance with the recommendations in both seasons, regardless which FCDB was used. The amount of vitamin C is higher than recommended but under the recommended upper level (Table 1).

The results obtained by analysing the calculation of the average weekly menu of pancreatic diet (Table 2) show that the amount of energy was in accordance with the recommendations, except the calculations by use of the USDA FCDB in the Spring/Summer season menus ($\approx$2% deviation). According to the data, the amount of proteins was within the recommendations only in menus evaluated by FCDB CHD, while the protein content calculated with other FCDBs departed from 3.5 to 18%. The amount of fats was in accordance with the recommendations, as well as amount of carbohydrates, except the amount of carbohydrates calculated by use of Croatian FCDB for the season Autumn/Winter (slightly lower than it is recommended, 0.5%.

Table 2
The average food composition of 7-day pancreatic diet menus offers and daily recommendations.

Component	Season Spring/Summer								Season Autumn/Winter								Recommended	
	CHD$_{FCDB}$		CRO$_{FCDB}$		USDA$_{FCDB}$		Danish$_{FCDB}$		CHD$_{FCDB}$		CRO$_{FCDB}$		USDA$_{FCDB}$		Danish$_{FCDB}$			
	x	SD	x	SD	x	SD	x	SD	x	SD	x	SD	x	SD	x	SD	Min[#]	Max[#]
Energy (kJ)	8478	1063	8902	1132	9387[a]	1113	9006	945	8229	492	8689	715	9232[a]	505	8756	576	8400	9240
Protein (g)	84[a]	4	94	10	99	16	90	10	84	4	93	11	103	22	90	14	53	87
Total fat (g)	47[a]	20	52	22	59	19	54	16	48	9	55	12	62[a]	8	56	7	35	64
Carbohydrates (g)	332	26	331	26	338	23	336	24	314	22	310	24	319	20	317	20	315	375
																	RDA	**UL**
Sodium (mg)	1913	272	2271	635	2265	437	1759[a]	428,9	1808	427	2043	674	2084	497	1649[a]	383	1500[$]	2300[$]
Calcium (mg)	679	218	671[b]	203	863[a]	282	729	299.7	571	142	512[b]	157	753[a]	140	570	177	800[*]	1500[*]
Magnesium (mg)	241	43	195	56	347[a]	89	276	31.4	231	72	180	86	351[a]	131	273	50	375[*]	700[*]
Phosphorus (mg)	1294	131	1330	117	1401	124	1384	158.2	1248	116	1254	209	1339	254	1278	178	700[*]	1400[*]
Iron (mg)	12.2	1.9	13.8	1.8	16.3	2.8	11.8	2.0	12.6	1.7	14.1	1.8	17.0	3.9	12.2	2.6	14[*]	30[*]
Zinc (mg)	7.6	2.0	4.2[a]	1.1	12.4[a]	3.6	10.5	3.1	7.4	2.4	3.8[a]	1.8	11.9	2.7	10.3	2.6	10[*]	15[*]
Copper (mg)	0.9	0.3	0.8	0.2	1.5	0.1	1.0	0.2	0.9	0.3	0.8	0.3	1.5	0.2	1.0	0.1	1[*]	3[*]
Vitamin B_1 (mg)	1.1	0.1	1.1	0.1	1.7	0.3	1.2	0.2	1.0	0.2	1.0	0.2	1.7	0.3	1.1	0.2	1.1[*]	4,0[*]
Vitamin B_2 (mg)	1.3	0.2	1.3	0.2	20	0.3	1.6	0.4	1.2	0.2	1.1	0.4	1.9	0.4	1.4	0.4	1.4[*]	4,0[*]
Vitamin B_3 (mg)	16.6[a]	4.3	19.0	5.8	26.2	7.3	21.8	9.1	18.7	2.2	21.0	3.3	28.6[a]	7.0	23.8	4.9	16[*]	35[*]
Vitamin B_6 (mg)	1.4[a]	0.3	1.4[a]	0.4	2.5	0.4	2.2	0.6	1.4[a]	0.3	1.4[a]	0.4	2.6	0.4	2.2	0.4	1.4[*]	6,0[*]
Vitamin C (mg)	104[a]	8	125	18	135	20	190[a]	13	100	22	116	26	128	28	186[a]	35	80[*]	500[*]

CHD = Clinical Hospital Dubrava FCDB; RDA = Recommended Dietary Allowance; UL = Upper Intake Level.
[#] = Decision on Standards of Hospital patients (2015) *Official Gazette 59/15*.
[$] = DRI (2005): Water, Potassium, Sodium, Chloride, and Sulfate. Food and Nutrition Board, Institute of Medicine, National Academies.
[*] = Ordinance on dietary supplements (2011) *Official Gazette* 46/11.
[a] = differences in the same season using different FCDs [b] = seasonal differences (same FCD).

According to the results of the food composition analysis using all four FCDBs and in both seasons, the amount of sodium was in accordance with the recommendations, while the amount of calcium was lower than recommended in all FCDBs and seasons except in USDA FCDB in the Spring/Summer season. All values for magnesium were lower than recommended (−48% to −7.5%), while potassium levels were in accordance with the recommendations, except in USDA FCDB in Spring/Summer season where it was slightly over the recommended amount. Analysis of the amount of iron indicates that the recommended daily allowance met only in USDA FCDB, in both seasons, and in Croatian FCDB, in the Autumn/Winter season. Analyses of the Zinc and Copper contents showed that the amount of both minerals is beneath the recommendations when CHD and Croatian FCDBs in both seasons were used. Contents of all vitamins in pancreatic diet were mainly in accordance with the recommendations, except the lower amount of vitamin B_1 in the Autumn/Winter season when CHD FCDB was used, as well as the lower amount of vitamin B_2 for the same FCDBs in both seasons. But all the claims of deviations form the recommendations must be observed in the light of the novel research of methods used to evaluate the adequacy of nutrient intakes (Román-Viñas et al., 2009; Chiurazzi et al., 2017) specifying 10–15% as acceptable coefficient of variability.

The principal component analysis is used to evaluate positive and negative correlations between observed food composition evaluated with different FCDBs (Fig. 1). The Biplot presentation showed qualitative separation based on different diets (group diabetic diet (DD) and chronical pancreatic diet (CP)).

Tables 3 and 4 present the biases and deviation values (D%) calculated during the modelling of Bland-Altman index. The results of analysed diets are presented as average values regardless of the season for patients on DD and CP diet.

4. Discussion

Total data matrix was build up by 42 daily menus per diet (21 meals per one season) where each meal contributed with 16 information regarding the energy and nutritional content in it.

Application of FCDB is a useful tool for analysis and comparison of the nutritional composition of daily menus. The food analysis provides data about energy and nutrient composition of diet menu offers giving us an insight in the compliance with the recommendations. This study identified statistical differences between FCDBs due to their mutual variations. Croatian FCDB has some limitations – this database contains small number of items and the available data refer just too raw food. The same deficiency showed the FCDB used in the CHD because this is just the extended version of the Croatian FCDB. In comparison with other FCDB used in this survey, Croatian FCDB & FCDB CHD have the smallest amount of information concerning the composition of foods (Kaić-Rak and Antonić, 1990). In these FCDBs miss values for some minerals (manganese, selenium) and vitamins (D, K, B_5, B_9, B_{12}) presented in other two FCDBs. But from Tables 1 and 2 is evident that in the case of diabetic diet analysis, deviate only 14% of the observed food components (Table 1), mainly when the USDA FCDB was applied (61%). However, the deviations in pancreatic diet evaluation are slightly higher, 19.5%. However, only 36% of the difference caused by the use of the USDA FCDB (Table 3), while 64% of total differences are caused when the Croatian FCDBs are used (CRO and CHD). Information given in the FCDB are subjected to a series of limitations, such as factors influencing the composition of the food due to its biological nature (e.g. an agricultural area and stability of nutrients in food), analytical techniques, methods of manufacturing and processing, as well as the use of factors and other mathematical calculations in order to determine nutritional value (degradation during the storage, high temperatures influences) (Haytowitz and Pehrsson, 2018). The differences in the amount of vitamin C calculated by use of different FCDBs (as presented in Tables 1 and 2) can be explained by using different analytical methods as well as different methods of sample preparation in composing certain FCDBs (Uusitalo et al., 2011; McCullough et al., 1999).

To investigate which FCDB is more similar to which one, we applied principal component analysis (PCA) to investigate potential grouping and to try to relate it with information about the food composition of the examined diets (Fig. 1). Different menu intake based on different geographical regions (Gajdoš Kljusurić et al., 2016) showed successful

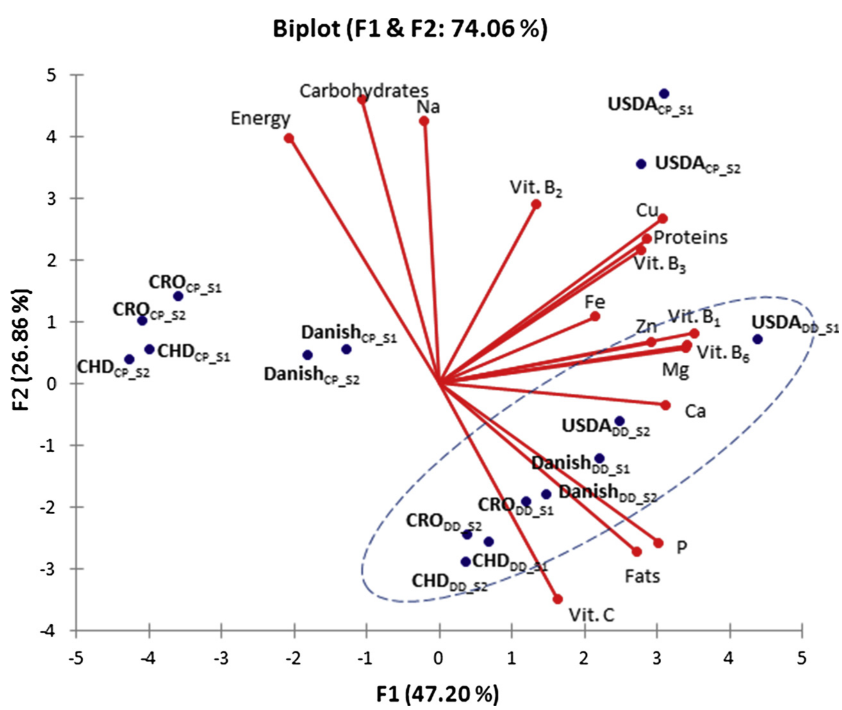

Fig. 1. Principal Component Analysis of the evaluated energy and nutrient contents in two seasons (Spring/Summer, S1; Autumn/Winter, S2) of hospital meals for diabetic DD) and pancreatic (CP) diets by use of 4 different FCDBs (Croatian, CRO; Clinical Hospital Dubrava, CHD; USDA; Danish).

Table 3
Bland-Altman parameters evaluating differences in food composition of diabetic diets, using different FCDBs.

Observed component	CHD$_{FCDB}$ vs. CRO$_{FCDB}$		CHD$_{FCDB}$ vs. USDA$_{FCDB}$		CHD$_{FCDB}$ vs. Danish$_{FCDB}$		CRO$_{FCDB}$ vs. USDA$_{FCDB}$		CRO$_{FCDB}$ vs. Danish$_{FCDB}$		USDA$_{FCDB}$ vs. Danish$_{FCDB}$	
	bias	D (%)	bias	D (%)	bias	D (%)	bias	D (%)	bias	D (%)	bias	D (%)
Energy (kJ)	−258.1	−3.5	−489.4	−6.5	−300.2	−4.1	231.3	3.0	42.1	0.6	−189.3	−2.5
Protein (g)	−2.0	−2.2	−12.8	−13.5	−5.6	−6.1	10.8	11.3	3.6	3.9	−7.2	−7.4
Total fat (g)	−5.7	−8.1	1.4	2.2	4.2	6.4	−7.2	−10.3	−9.9	−14.5	−2.7	−4.2
Carbohydrates (g)	18.7	9.0	0.4	0.2	−8.5	−3.8	18.4	8.8	27.3	12.8	8.9	4.0
Sodium (mg)	−322.0	−20.2*	−503.6	−29.8*	−127.4	−8.5	181.6	9.8	−194.6	−11.7	−376.2	−21.5*
Calcium (mg)	116.7	14.8	−34.2	−4.0	114.6	14.6	150.9	18.8*	2.1	0.3	−148.8	−18.5*
Magnesium (mg)	64.2	22.7*	−63.2	−18.3*	10.4	3.4	127.4	40.6*	53.8	19.4*	−73.6	−21.6*
Phosphorus (mg)	−1.0	−0.1	−43.6	−2.9	8.8	0.6	42.6	2.8	−9.8	−0.7	−52.4	−3.5
Iron (mg)	−1.5	−9.6	0.3	2.2	1.3	9.2	−1.8	−11.7	−2.7	−18.8*	−1.0	−7.1
Zinc (mg)	4.2	53.4*	−5.0	−39.8*	−1.9	−17.1*	9.2	88.5*	6.1	69.0*	−3.1	−23.1*
Copper (mg)	−0.1	−12.0	−0.4	−35.3*	−0.2	−22.1*	0.3	23.6*	0.1	10.2	−0.2	−13.5
Vitamin B$_1$ (mg)	−0.1	−10.6	−0.2	−14.8	−0.2	−17.2*	0.1	4.2	0.1	6.7	0.0	2.5
Vitamin B$_2$ (mg)	0.0	2.1	−0.3	−17.9*	−0.1	−4.2	0.4	20.0*	0.1	6.2	−0.3	−13.8
Vitamin B$_3$ (mg)	−3.1	−14.5	−3.6	−17.1*	−4.4	−20.2*	0.6	2.6	1.3	5.8	0.7	3.2
Vitamin B$_6$ (mg)	−0.1	−5.8	−1.0	−41.4*	−0.7	−31.9*	0.9	35.8*	0.6	26.2*	−0.3	−9.9
Vitamin C (mg)	−38.2	−17.9*	40.4	23.2*	−51.8	−23.5*	−78.6	−40.7*	13.6	5.7	92.2	46.1*

D – deviation, ratio of the bias and the mean value, calculated for each Bland-Altman plot.
* Significant deviations (over 15%).

relation with the intake of food with different content of total fats and fatty acids in boarding schools. Groping of calculated average values for the observed DD and CP diets showed a clear dietary separation based on diabetes and chronic pancreatitis. For diabetic diets, the majority of the average values, except the averages calculated by use of the USDA FCDB for the Spring/Summer season, grouped in the fourth quadrant, indicating their similarity and confirming good mutually arrangements (confirming also results shown in Table 1). In the first quadrant are also placed components as Ca, P, total fats and vitamin C. The same position (same quadrant) of the FCDBs/per seasons and the mentioned nutrients show that those nutrients are proportionally correlated to the diet, so *Ca* has the highest values when the USDA FCDB was used in the calculus. Relating the biplot results with those in Table 1, average values of Zinc calculated by use of the USDA FCDB differ regarding the season ($p = 0.001$). Average values of CP diets spread in the first two quadrants with a segregation of the calculus based on USDA FCDBs (positioned in the first quadrant) showing clear differences of the content of proteins (0.023), carbohydrates (0.019), energy ($p = 0.031$) and sodium ($p = 0.002$). McCullough et al. (1999) have compared four FCDBs in the DASH study, where results have shown variations that were different for most nutrients. One of the reasons for this deviation was the use of different analytical methods to determine the content of nutrients (McCullough et al., 1999). Chemical composition of nutrient in food is affected by factors such as climate and geographic area (Orešković et al., 2015; Uusitalo et al., 2011; McCullough et al., 1999), the use of fertilizers and the degree of ripeness of the fruit and vegetable (Nikkarinen and Mertanen, 2004; Rodriguez-Amaya et al., 2008). Therefore, these statistically significant differences between FCDBs were expected. Orešković et al. (2015), who have studied differences in vegan menus by use of different food composition databases, noted differences between Croatian, USDA and Danish FCDBs. The food composition calculus's differ when different FCDBs are used due to different number of food items, thermally processed food and the number of contained food components. The Croatian FCDB contained

Table 4
Bland-Altman parameters evaluating differences in food composition of pancreatic diets, using different FCDBs.

Observed component	CHD$_{FCDB}$ vs. CRO$_{FCDB}$		CHD$_{FCDB}$ vs. USDA$_{FCDB}$		CHD$_{FCDB}$ vs. Danish$_{FCDB}$		CRO$_{FCDB}$ vs. USDA$_{FCDB}$		CRO$_{FCDB}$ vs. Danish$_{FCDB}$		USDA$_{FCDB}$ vs. Danish$_{FCDB}$	
	bias	D (%)	bias	D (%)	bias	D (%)	bias	D (%)	bias	D (%)	bias	D (%)
Energy (kJ)	−442.1	−5.2	−956.1	−10.8	−527.9	−6.1	514.0	5.7	85.8	1.0	−428.2	−4.7
Protein (g)	−9.2	−10.4	−16.8	−18.1	−5.6	−6.4	7.5	7.8	−3.6	−4.0	−11.2	−11.7
Total fat (g)	−5.6	−11.1	−12.8	−23.8*	−7.4	−14.4	7.2	12.7	1.8	3.3	−5.4	−9.4
Carbohydrates (g)	2.7	0.9	−5.4	−1.7	−3.5	−1.1	8.2	2.5	6.2	1.9	−1.9	−0.6
Sodium (mg)	−296.7	−14.8	−314.4	−15.6*	156.1	8.8	17.7	0.8	−452.8	−23.5*	−470.5	−24.3*
Calcium (mg)	33.6	5.5	−182.8	−25.5*	−24.4	−3.8	216.4	30.9*	58.0	9.3	−158.4	−21.7*
Magnesium (mg)	48.4	22.8*	−113.0	−38.6*	−38.7	−15.1*	161.3	60.1*	87.0	37.7*	−74.3	−23.8*
Phosphorus (mg)	−20.7	−1.6	−98.7	−7.5	−60.1	−4.6	78.1	5.9	39.4	3.0	−38.7	−2.9
Iron (mg)	−1.6	−12.0	−4.3	−29.6*	0.3	2.8	2.7	17.8*	−1.9	−14.8	−4.6	−32.3*
Zinc (mg)	3.5	60.4*	−4.6	−47.3*	−2.9	−32.4*	8.1	100.5*	6.4	88.5*	−1.7	−15.4*
Copper (mg)	0.1	9.6	−0.6	−49.2*	−0.1	−9.0	0.7	58.2*	0.2	18.6*	−0.5	−40.7*
Vitamin B$_1$ (mg)	0.0	−3.6	−0.6	−46.9*	−0.1	−7.5	0.6	43.5*	0.0	3.9	−0.6	−39.7*
Vitamin B$_2$ (mg)	0.0	1.3	−0.8	−48.6*	−0.3	−20.6*	0.8	49.9*	0.3	21.9*	−0.5	−28.7*
Vitamin B$_3$ (mg)	−2.3	−12.3	−9.7	−43.3*	−5.2	−25.6*	7.4	31.4*	2.9	13.5	−4.6	−18.2*
Vitamin B$_6$ (mg)	−0.1	−3.7	−1.2	−59.6*	−0.8	−46.8*	1.1	56.2*	0.8	43.2*	−0.3	−13.8
Vitamin C (mg)	−18.3	−16.5*	−29.9	−25.6*	−86.0	−59.4*	11.6	9.2	67.7	44.0*	56.1	35.1*

D – deviation, ratio of the bias and the mean value, calculated for each Bland-Altman plot.
* Significant deviations (over 15%); FCDB1: FCDB Hospital; FCDB2: Croatian FCDB; FCDB3: USDA FCDB; FCDB4: Danish FCDB.

the smallest number of items & lack of processed food information, while the Danish FCDB contained a small number of foods that was thermally processed. On the other hand, the USDA FCDB provides information about raw and a processed food (boiled, baked, and dried). In order to have comparable results Orešković et al. (2015) used data for food in raw state in all three FCDBs. But the question is whether this will be enough to identify potential differences as significant. Objective tool used to evaluate the agreement of two different methodologies and for evaluation of adequacy of nutrient intakes is the Bland-Altman analysis (Yiou et al., 2016). Average values of energy and each nutrient, calculated by use of each FCDB, were compared and evaluated with respect to the bias and the deviation (D%). For K_n^r combinations (Eq. 1) were presented the results for the diabetic diet (Table 3) and the chronical pancreatitis diets (Table 4). The main parameters, as bias and percentage of differences will give an answer on the main question: how big is the average discrepancy between evaluation of each observed parameter (energy and 15 nutrients). All deviations greater than 15% are marked by starvation (Tables 3 and 4). It is important to observe both, the bias and the deviation together. Large bias is an outcome for those parameters whose averages are large values (e.g. energy, content of sodium, calcium and magnesium). Big bias does not necessarily retract high deviations (see energy and protein content in Tables 3 and 4). The negative sign show that the calculated parameter is lower in the calculation (by use of the first FCDB vs. the second FCDB). Such parameter is the content of Sodium, which has a negative sign that indicates lower average values of Sodium in all FCDBs with an exception when Sodium is calculated using the CHD FCDB. The most important result in Table 3 is the content of carbohydrates because high bias and deviation would indicate that some of the FCDBs are problematic in calculating carbohydrates, and the restriction of carbohydrates is important in the diabetic diet (Rahelić et al., 2016). As we can see, content of energy and macronutrients is under the 15% of deviation with no critical point, indicating that all four FCDBs are acceptable in calculating and evaluating diabetic diets. Taking all deviations into account 35.5% data deviate and ½ of all observed nutrients in the observed relation CRO vs. USDA FCDB (in favour of the values calculated with the second FCDB).

However, the differences rise analysing the average values for the CP diet (Table 4). In average, 51.2% of all food composition deviations are over 15%. Those information would lead to the conclusions that the observed FCDB differ significantly and that it would be advisably to be careful which FCDB is used when CP diet menus are analysed. But the Bland–Altman method is applied to confirm so exclusive conclusion. Again, the differences in the amount of energy and the macronutrients are in the acceptable range, except the content of total fat calculated from the ratio of CHD and the USDA FCDB. The majority of micronutrient contents deviate more than 15%, what leads to the conclusion that the evaluation of CP diet is not as efficient as the evaluation of DD diet. Nevertheless, considering the content of macronutrients and energy – all FCDBs are equally reliable, and this fact substantiated by the use of Bland-Altman Analysis as well as the PCA. Results shown in this study presented statistically significant differences, due to inability of using the same ingredients or using ingredients that are most similar with their nutritive composition to initial ingredient. Orešković et al. (2015) have reported the same problem. The differences occurred because of various polices of countries and the food fortification with nutrients that have been proven to be insufficient in the daily diet in the population of the country (Burlingame et al., 2009).

5. Conclusion

Due to the mentioned factors, FCDBs may contain different content of energy and nutrients for the same food which was confirmed with this study. Although it could be concluded that use of four different FCDBs in the food composition calculations for DD and CP diet menus differ over the expected level (15%), the application of PCA and the Bland-Altman Index, denies such quote. PCA analysis and parameters as bias and ratio of deviation (D%) verified the fact that for the macronutrients were all FCDBs equally reliable. This is crucial and the most important fact, knowing that in the DD diet are the carbohydrates in focus and in the CP diet - the total fats, respectively.

It is important to emphasize that when choosing a FCDB, priority should be given to the FCDB made in the region of the country where it is used because in foreign FCDBs could appear foods that are enriched or modified (USDA, 2006). What should be also taken into consideration is the limited food choice in some FCDBs (e.g. Croatian FCDB) which are not applicable for evaluation and planning of specific diets like vegetarian or vegan diet (e.g. no tofu, soy fermented products, etc.). Application of the multivariate tool, principal component analysis showed good qualitative separation of the food components as well as the observed diets per season. The quantitative agreement was successfully established by use of the Bland-Altman index used to compare nutrient intakes.

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