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COMPARISON OF A WEB-BASED DIETARY ASSESSMENT TOOL WITH SOFTWARE FOR THE EVALUATION OF DIETARY RECORDS

PRIMERJAVA SPLETNE APLIKACIJE IN RAČUNALNIŠKEGA PROGRAMA ZA OVREDNOTENJE PREHRANSKIH DNEVNIKOV

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ABSTRACT

Keywords:
web-based dietary assessment tools, dietary records, comparison, pregnant women

Background. Dietary assessment in clinical practice is performed by means of computer support, either in the form of a web-based tool or software. The aim of the paper is to present the results of the comparison of a Slovenian web-based tool with German software for the evaluation of four-day weighted paper-and-pencil-based dietary records (paper-DRs) in pregnant women.

Methods. A volunteer group of pregnant women (n=63) completed paper-DRs. These records were entered by an experienced research dietitian into a web-based application (Open Platform for Clinical Nutrition, OPEN, http://opkp.si/en, Ljubljana, Slovenia) and software application (Prodi 5.7 Expert plus, Nutri-Science, Stuttgart, Germany, 2011). The results for calculated energy intake, as well as 45 macro- and micronutrient intakes, were statistically compared by using the non-parametric Spearman's rank correlation coefficient. The cut-off for Spearman's rho was set at >0.600.

Results. 12 nutritional parameters (energy, carbohydrates, fat, protein, water, potassium, calcium, phosphorus, dietary fiber, vitamin C, folic acid, and stearic acid) were in high correlation (>0.800), 18 in moderate (0.600-0.799), 11 in weak correlation (0.400-0.599), while 5 (arachidonic acid, niacin, alpha-linolenic acid, fluoride, total sugars) did not show any statistical correlation.

Conclusion. Comparison of the results of the evaluation of dietary records using a web-based dietary assessment tool with those using software shows that there is a high correlation for energy and macronutrient content.

IZVLEČEK

Ključne besede:
spletne aplikacije za ovrednotenje prehranskih dnevnikov, prehranski dnevniki, primerjava, nosečnice

Izhodišča. *V klinični praksi za ovrednotenje prehranskih dnevnikov običajno uporabljamo računalniško podporo, bodisi v obliki računalniškega programa ali spletne aplikacije. Namen članka je predstaviti rezultate primerjave nemškega računalniškega programa in slovenske spletne aplikacije za ovrednotenje prehranskega vnosa na osnovi metode štiridnevnega papirnega tehtanega prehranskega dnevnika (papirni PD), ki so ga vodile nosečnice.*

Metode. *Skupina nosečnic prostovoljk (n=63) je vodila papirni PD. Izkušeni klinični dietetik je vnesel dnevnike v spletno aplikacijo (Odprta platforma za klinično prehrano, OPKP, http://opkp.si, Ljubljana, Slovenija) in računalniški program (Prodi 5.7 Exper Plus, Nutri-Science, Stuttgart, Germany, 2011). Rezultate za izračunani energijski vnos ter vnos 45 makro- in mikrohranil s pomočjo aplikacije in programa smo statistično primerjali z neparametričnim Spearmanovim koeficientom (>0,600).*

Rezultati. *Visoko korelacijo (>0,800) med metodama smo ugotovili za 12 hranil (energija, ogljikovi hidrati, skupne maščobe, beljakovine, voda, kalij, kalcij, fosfor, skupna prehranska vlaknina, vitamin C, folna kislina in stearinska kislina), zmerno (0,600-0,799) za 18 hranil, šibko (0,400-0,599) za 11 hranil, medtem ko za 5 hranil ni bilo korelacije (arahidonska kislina, niacin, alfa-linolenska kislina, fluor, skupni sladkorji).*

Zaključki. *Rezultati ovrednotenja prehranskih dnevnikov s spletno aplikacijo in računalniškim programom so v visoki korelaciji za energijsko vrednost in vsebnost makrohranil.*

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1 INTRODUCTION

Dietary records are an important tool for estimating food and nutrient intakes in different groups of the population. In addition to dietary records, there are other methods of dietary assessment (food frequency questionnaires, 24-hour recall method), but paper dietary recording (paper-DR) has proven to be the best and most accurate way of evaluating food and nutrient intake (1-5). In the dietary record approach, each respondent must describe the foods and amounts consumed, including the name of the food (brand name, if possible), preparation methods, recipes for food mixtures and portion sizes consumed over a certain period of time (6-7). The amounts consumed can be measured either by using a scale or estimated by household measures or models, pictures or without visual aids (8). Ideally, the recording is done at the time of eating in order to avoid reliance on memory. A recording period of more than seven consecutive days is usually unsatisfactory, because of respondent fatigue or non-compliance (8). The duration most often used in the literature is three or four days of dietary recording (two or three weekdays and one weekend day), which has previously given acceptable and reliable data, and caused relatively low dropout (9-10).

There is an increase in computer support tools (such as as software, web-based applications or mobile applications) available for both the general population and nutritional experts, which have received an increasing attention for large-scale population nutrition research (7, 11-17). The goal of computer support for the general population is to facilitate and simplify recording, as well as to be able to access the results quickly. Computer support tools allow end-users to enter food intake and receive feedback relating to energy and nutrient intake. The collected dietary data can be processed and calculated in place, or exported by a research dietitian for data analysis. Despite the availability of novel tools, the usual method of self-monitoring continues to be the paper-DR, which is time consuming, tedious and inconvenient for study volunteers, as well as for the research dietitians (11, 18).

We aimed to compare matching results of four-day paper-DRs kept by 63 pregnant women (hereinafter referred as volunteers), entered by an experienced research dietitian into the web-based application Open Platform for Clinical Nutrition (OPEN; hereinafter referred as web-DR) and the software Prodi 5.7 Expert plus, Nutri-Science, Stuttgart, Germany, 2011 (Prodi; hereinafter referred as SW-DR). Our objective was to examine whether web-DR and SW-DR yield similar results of energy and nutritional intake estimates for 45 macro- and micronutrients.

2 METHODS

2.1 Study Design

This pilot study is a part of the Slovenian research project entitled ‘The role of human milk in development of a breast fed child’s intestinal microbiota’ or ‘My-Milk,’ in short, which has been described elsewhere (available at: www.moje-mleko.si/en) (19). Briefly, the ‘My-Milk’ study aims to elucidate the role of microbiota and the fatty acid composition of mother’s milk in the development of intestinal microbiota and the overall health status of a newborn infant.

Within this pilot study, we aimed to determine whether web-DR is equivalent to SW-DR, which would substantially reduce logistical and cost burdens in clinical practice, since the web-DR could be recorded directly by the volunteer/user/patient and only checked by a dietitian.
Volunteers were included in the study if they were healthy and willing to participate by keeping a paper-DR at home throughout four consecutive days, including one weekend day (from Sunday to Wednesday), because of the protocol of ‘My-Milk’ study.

They were recruited from January until May 2011, at the Gynecological Clinic, University Medical Centre Ljubljana, while attending the ‘School for Parents.’ The volunteers came mainly from Ljubljana (the capital of Slovenia) and its surrounding areas. The study protocol was approved by the Ethics Committee of the Medical Faculty, University of Ljubljana, Slovenia (No. 32/07/2010), and is registered at ClinicalTrials.gov (NCT01548313).

The volunteers received 15 minutes of oral instruction from a research dietitian, as well as written instructions on how to keep a paper-DR. We provided them with a kitchen scale, with 1 g resolution (CTC, Clatronic® International GmbH), and asked them not to make any dietary changes during the trial. We recorded the basic anthropometrical measurements (age, week of pregnancy, body height and pre-pregnancy body mass for each volunteer) and basic socio-demographic data (level of education and employment status). Body mass was measured with a certified medical scale to the nearest 0.1 kg and body height to the nearest 0.5 cm (Seca digital scale 769, Germany). The volunteers’ data were coded and all information was kept confidential.

2.2 Study Population

By the end of May 2011, 65 volunteers had been approached for study recruitment; two of them withdrew from the study because of lack of interest. In total, 63 volunteers completed the paper-DR. Their average age was 30.4 (±4.0) years, they were in the 30.7th (±4) week of pregnancy and had a pre-pregnancy body mass index of 25.3 (±3.6) kg/m2. The majority of the volunteers were better educated (postgraduate: 13 (21%); tertiary: 42

(67%); secondary: 8 (13%), primary: 0 (0%)), and all were employed.

2.3 Methodology of the Comparative Study

We asked the volunteers to record the intake of all foods, drinks and food supplements consumed over four consecutive days; from Sunday to Wednesday.

The sum values of recording for all four days together for web-DR (n=63) and SW-DR (n=63) were compared for energy and 45 macro- and micronutrients (hereinafter referred to as 46 parameters) (Table 1).

We selected the list of observed nutrients on the basis of the previous study comparing nutrient intake of Slovenian adolescents (20) and, additionally, on the basis of nutrients that are of special interest in the 'My-Milk' study (i.e., fatty acids: linoleic acid, arachidonic acid, alpha-linolenic acid, eicosapentaenoic acid and docosahexaenoic acid) (19). For dishes specified in the diaries, we used Slovenian traditional recipes and frequently used recipes to identify the ingredients.

2.3.1 Paper-DR

The paper-DR had five pages, including one page of instructions with an example of one daily dietary record. Detailed information regarding the: a) time of consumption, b) quantities in grams/milliliters or, exceptionally, also in household measures (such as cup, tablespoon, teaspoon, cup of coffee, slice of bread, etc.), c) foods with brand names when appropriate, and the type of preparation were requested. The paper-DRs were checked when received by the experienced research dietitian.

The research dietitian entered the paper-DR into the web-DR and SW-DR and checked the entries twice.

2.3.2 Web-DR (OPEN)

OPEN is the first Slovenian web-based tool for assessment of dietary intake, as well as for diet planning, and it has been described in more detail elsewhere (21-22). Briefly, it consists of data from Slovenian (23-24), European (25) and, to a limited extent, also American (26) food composition tables. To support its use in different countries and languages, OPEN allows translation of the user interface into any language, as well as the use of any food composition dataset that complies with Food data structure and format standard (BS EN 16104:2012). To calculate food composition data for traditional and frequently consumed Slovenian dishes, OPEN applied a recipe-calculation procedure, originally recommended by INFOODS (27) and recognized by EuroFIR (28). In order to prove the efficiency and correctness of the recipe-calculation procedure applied within OPEN, the energy and nutrient contents of composite samples of daily meals (each sampled four times) were compared by using both analytical and calculation techniques (29, 30). The data included for each food item from paper-DRs were: the amount consumed, the date and time of consumption. After a meal had been entered by the research dietitian, OPEN stored the information.

2.3.3 SW-DR (Prodi)

Prodi is German software for nutritional counseling and nutritional therapy available in German and English language. It supports meal planning and calculation, as well as documentation of the consultancy. Foods and their ingredients are readily available, calculated and compared.

In this pilot study, we used Prodi 5.7 Expert plus Nutri-Science, Stuttgart, Germany, 2011, which contains the database of approximately 14,800 foods from the Bundeslebensmittelschlüssel 3.01 (BLS 3.01) database, Fachmann-Kraut-Nährwerttabellen (FKN, Stuttgart, 2005) database, and industrial products and dietetic foods.

2.4 Statistical Analysis

We applied the Shapiro-Wilk normality test to determine whether or not the dataset was modeled with a normal distribution. The dataset of observed parameters did not have a normal distribution, so non-parametric Spearman's rho coefficients were used to measure the correlation of results of nutrient intake calculated by OPEN and Prodi. We defined acceptable correlation as being 0.600 or more. Statistical analyses were performed using the statistical software SPSS ver. 21 (SPSS Inc, Chicago, IL, 2012).

3 RESULTS

Our data show that there was no systematic error in entering. For all 126 DRs (63 in web-DR and 63 in SW-DR), we first calculated the average, SD and median values. We then calculated Spearman's rho correlation coefficients for 46 parameters to check the correlation between web-DR and SW-DR.

In the Table 1 the average and median daily nutrition content for 46 nutritional parameters from paper-DRs (n=63) entered into web-DR and SW-DR. Figure 1 shows the Spearman's rho correlation coefficients for 46 nutritional parameters. The Spearman's correlation coefficient for parameters ranged from -0.05 for total sugars to 0.95 for water.

Table 1. Averages and medians of daily nutrient content for all parameters calculated from 63 four-day paper-based dietary records (paper-DR) entered into web-based dietary records (web-DR) and software-based dietary records (SW-DR).

	Average(SD)		Median	
	web-DR	**SW-DR**	**web-DR**	**SW-DR**
Energy [kcal]	2017.21(386.53)	1994.89(363.02)	2094.13	2025.50
[kJ]	8350.63(1618.03)	8350.63(1519.58)	8766.00	8478.75
Carbohydrates [g]	263.14(56.91)	243.59(49.47)	270.79	241.75
Total sugar [g]	114.77(32.45)	0.61(2.70)	111.95	0.00
Starch [g]	78.35(30.79)	116.00(30.35)	79.76	117.50
Dietary fiber [g]	23.64(8.07)	28.15(9.39)	22.63	27.80
Fats [g]	71.50(18.30)	74.20(19.23)	68.97	74.25
SFA* [g]	25.38(6.94)	25.72(8.43)	24.92	25.25
Myristic acid [g]	2.92(1.11)	3.30(1.09)	2.80	3.33
Palmitic acid [g]	12.62(3.40)	13.14(3.67)	12.28	13.10
Stearic acid [g]	5.65(1.69)	6.05(2.09)	5.62	5.80
MUFA** [g]	18.72(5.36)	22.99(7.88)	18.05	21.75
Oleic acid [g]	13.35(4.89)	21.75(6.88)	12.57	21.13
PUFA*** [g]	11.26(3.24)	12.84(5.90)	10.45	11.40
Linoleic acid [g]	10.72(3.37)	11.40(5.53)	10.09	9.15
Alpha-Linolenic acid [g]	1.48(0.63)	1.06(0.34)	1.27	1.00
Arachidonic acid [g]	0.10(0.06)	0.17(0.16)	0.08	0.10
Eicosapentaenoic acid [g]	0.04(0.07)	0.05(0.08)	0.01	0.00
Docosahexaenoic acid [g]	0.13(0.26)	0.17(0.16)	0.03	0.10
Cholesterol [mg]	253.41(102.34)	254.68(103.62)	230.08	231.50
Proteins [g]	78.64(16.90)	79.02(17.95)	78.30	79.10
Water [g]	2928.89(1355.09)	2758.93(872.28)	2707.06	2808.50
Alcohol [g]	0.57(1.09)	0.64(1.17)	0.06	0.15
Vitamins:				
Biotin [μg]	35.97(11.15)	52.08(20.42)	34.76	49.75
Folic acid [μg]	388.64(106.78)	298.59(109.33)	377.37	277.25
Niacin [μg]	30698.05(8505.74)	27343.77(7964.66)	30861.95	26568.50
Pantothenic acid [mg]	6.13(2.04)	5.94(2.09)	5.68	5.40
Vitamin A [mg]	0.76(1.34)	0.41(0.20)	0.52	0.36
Riboflavin [mg]	1.91(0.48)	1.65(0.49)	1.91	1.62
Thiamine [mg]	1.47(0.38)	1.36(0.53)	1.42	1.22
Vitamin B_{12} [μg]	3.90(1.26)	5.23(2.08)	3.87	4.83
Vitamin B_6 [mg]	1.89(0.48)	1.81(0.48)	1.86	1.82
Vitamin C [mg]	173.69(93.75)	189.07(74.99)	156.09	171.25
Vitamin D [μg]	2.58(2.64)	2.50(3.07)	1.73	1.75
Vitamin E [mg]	11.96(4.18)	15.10(6.01)	11.00	14.68
Minerals:				
Calcium [mg]	1106.75(508.97)	1084.81(320.02)	1042.99	1088.25
Magnesium [mg]	571.99(1100.57)	386.16(102.35)	363.15	376.50
Phosphorus [mg]	1349.86(305.69)	1475.62(352.82)	1334.92	1437.00

	Average(SD)		Median	
	web-DR	SW-DR	web-DR	SW-DR
Potassium [mg]	3349.91(783.74)	3557.52(922.98)	3294.96	3418.00
Sodium [mg]	3130.55(2416.03)	2343.81(872.59)	2474.43	2178.25
Chloride [mg]	4934.61(3759.24)	3951.81(1386.93)	4074.61	3595.75
Trace elements:				
Iron [mg]	14.06(3.79)	14.28(3.71)	14.07	13.98
Copper [µg]	1684.52(440.59)	2472.60(595.37)	1721.94	2546.25
Fluoride [µg]	297.19(255.45)	906.85(341.91)	241.35	857.50
Iodine [µg]	132.65(117.95)	171.22(62.78)	98.48	161.00
Manganese [µg]	5194.11(3363.54)	4738.35(1730.32)	4348.27	4438.50
Zinc [mg]	9.64(2.34)	12.31(2.88)	9.96	12.25

* Sum of saturated fatty acids
** Sum of monounsaturated fatty acids
*** Sum of polyunsaturated fatty acids

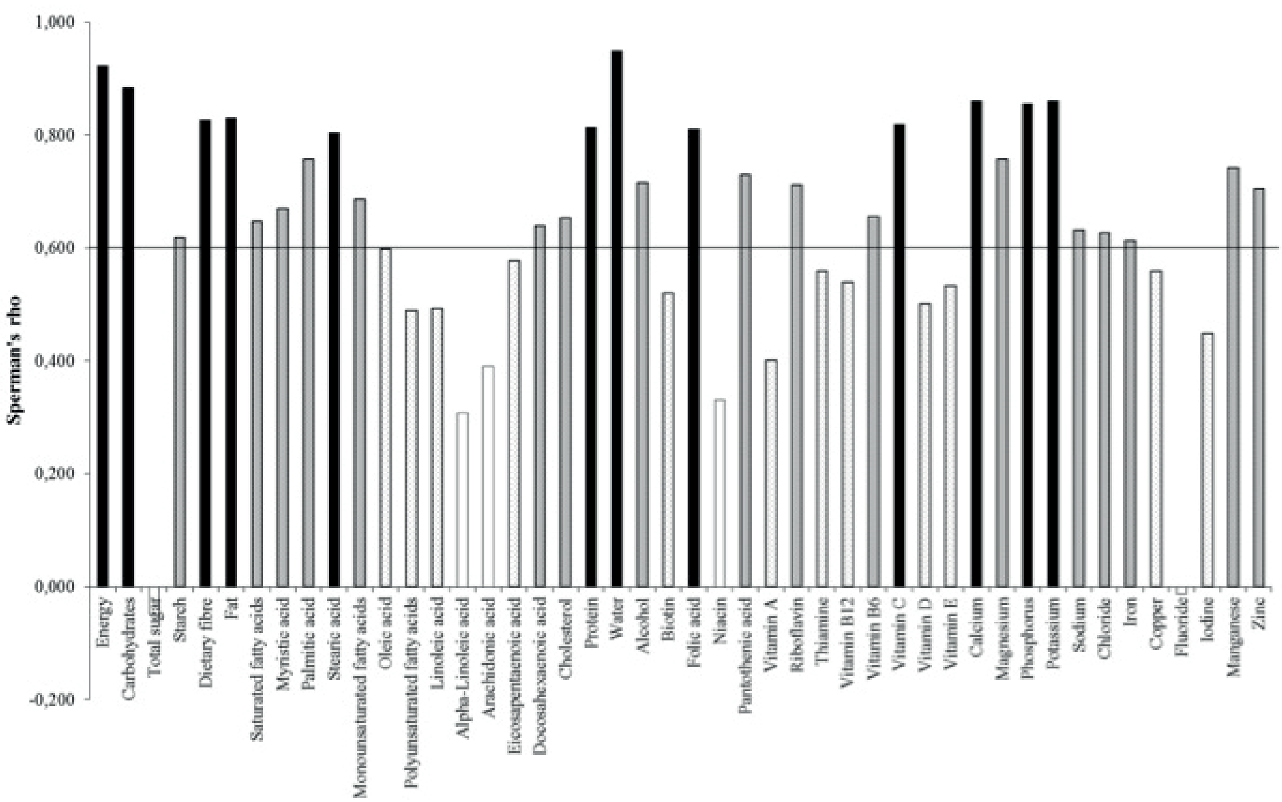

Figure 1. Spearman's rho correlation coefficients for 46 parameters calculated from 63 four-day dietary records recorded by 63 volunteers and entered into web- and software-based dietary records by a dietitian (cut-off for Spearman's rho as strongly positive correlation was set at >0.800 (black columns), as medium significant at 0.600-0.799 (grey columns), as weak at 0.400-0.599 (spotted columns) and no correlation (white columns)). Spearman's rho coefficients for all studied correlations are significant at the 0.05 level.

4 DISCUSSION

To the best of our knowledge, this is the first study to compare two self-administered methods (web-DR versus SW-DR) completed by the same persons and entered into both applications by the same research dietitian. We have already compared the assessment of dietary intake using paper-DR as the gold standard (1) versus the novel web-DR completed by the same volunteers (31). There was no difference between total matching of paper-DR versus web-DR. The next step was to compare the two most frequently used dietary record softwares in clinical practice in Slovenia; OPKP (Web-DR) and Prodi (SW-DR).

Average ranges (median) are not different between the two methods (Table 1). The basic parameters in nutrition assessment (i.e., energy, carbohydrates, proteins, fat and water) were highly correlated between the methods (>0.800) (Figure 1). As expected, some of the parameters, such as arachidonic acid, niacin, alpha-linolenic acid, fluoride and total sugars, did not correlate. In our opinion, the reason for the discrepancy with arachidonic acid, niacin and alpha-linolenic acid was mainly a lack of compositional data for branded food items. Namely, foods rich in these nutrients are meat and meat products, fish and fish products, eggs and egg products, nuts and nut products, and grain-based products. In OPEN, the Slovenian food composition data for meat, fish and their products were used. Since meat of Slovenian origin accounts for the largest share of meat consumed in this country, a comparison of compositional data on Slovenian meat with data from the literature was made, showing a wide variation, particularly for the total fat content, fatty acid composition and cholesterol content (24).

In the case of fluoride and total sugars, the differences were due to different food composition databases (mainly there is no data for total sugar in Prodi). The lack of correlation could also be due to human error but this is less likely, because all paper-DRs were entered into the web-DR and SW-DR by the same research dietitian and they were checked twice.

Values for total saturated, monounsaturated, and polyunsaturated fatty acids may include individual fatty acids not reported; therefore, the sum of their values may exceed the sum of the individual fatty acids. In rare cases, the sum of the individual fatty acids may exceed the sum of the values given for the total saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA). These differences are generally caused by rounding and should be relatively small.

Various instruments are used nowadays to assess nutrient intake and food consumption, each with advantages and disadvantages (16). However, it makes more sense to use a DR that is supported by devices that are integrated into the daily lives of people (computer, tablet, smartphone, etc.), as has already been described in the literature (14, 18, 32, 33).

Our study also had some other limitations. Firstly, not participants themselves, but the research dietitian entered the paper-DR into the web-DR and SW-DR. It would be interesting to analyze the matching of dietary assessment with both methods, conducted by the same volunteers.

Secondly, when the exact food was not available in the OPEN food composition database, the closest substitute was used (the research dietetic sometimes selected a different substitute in OPKP to that chosen in Prodi).

Thirdly, some technical limitations with web-DR were observed/reported, such as a slower internet connection speed, which can decrease the user-friendliness of OPEN; users, consequently, had to wait longer than expected for the food list to appear on the screen. In the Probst and Tapsell study (34), it was reported that spelling errors and errors in the identification of specific foods can also cause problems, especially with self-administered web-based dietary records, but not in SW-DR. There was the same problem in our case, especially in relation to some local traditional foods that have different names for the same items across Slovenia (e.g., lard), or some newly adopted international words (e.g., pizza, ketchup).

5 CONCLUSION

Our study shows that web-DR (OPEN) provides dietary intake data information of equal or superior quality to that of SW-DR (Prodi), mainly because it is based on Slovenian food composition data, which are integrated in OPEN. The use of advanced technology in DR recording has shown and continues to show great promise. We have shown that either one of the nutritional dietary record softwares can be used in clinical practice.

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CONFLICTS OF INTEREST

The authors declare that no conflicts of interest exist.

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ETHICAL APPROVAL

The study protocol was approved by the Slovene National Medical Ethics Committee (No. 32/07/2010).

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