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Nutrition apps: Quality and limitations

An explorative investigation on the basis of selected apps

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Abstract

There is a large selection of nutrition applications (apps) which are used for self-tracking and as instructional tools for a healthy diet. These apps offer a great variety of functions ranging from keeping food diaries to providing concrete nutritional recommendations. To date, there are very few recognized and standardized criteria for evaluating nutrition apps. In addition, there is usually a lack of transparency about data protection and sources of information. The apps examined in this work were limited in terms of defined functions and quality of information. A comparison of energy content and nutritional values of foods with the information of a nutrition software based on the information provided by the German Food Database *(Bundeslebensmittelschlüssel, BLS)* revealed that individual values deviated by as much as 50%. Nevertheless, the tested apps can provide the user with orientation regarding the energy and macronutrient content of different foods.

Keywords: mobile application (app), self-tracking, weight management, nutrition communication, data protection

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Background

Modern nutrition communication

According to statistics from 2015, 63% of people over the age of 14 in Germany use a smart phone, and that number is rising [1]. This goes hand in hand with an increasing selection of mobile applications (apps) that provide health information [2]. There is a growing number of health apps, particularly nutrition apps, which are reaching more and more people with a new kind of nutrition communication. Across the globe, the app stores iTunes (Apple) and Google Play offer roughly 4 million apps, of which about 3% address the topic of "health and fitness" [3]. Nutrition apps can be categorized as "health and fitness" apps or as "medical" apps in terms of their content. Apps such as EateryApp, MyMeal-Mate, MyFitnessPal, and FatSecret sound promising, and with functions like "calorie counting" and keeping food diaries, they can be used as supportive tools in nutritional therapy. There are, however, relevant limitations, such as the inclusion of unverified information and open questions regarding data protection.

In Germany, there are currently very few standardized criteria for the evaluation and certification of apps. Therefore the credibility of many nutrition apps in terms of, for instance, missing information about data sources and providers, must be critically examined. A study published by the Bertelsmann foundation describes the app market as being intransparent and considers the market development to be highly supply-oriented rather than needs-oriented [4]. Nevertheless, the use of apps, particularly in the context of food and nutrition, is extremely popular, since they are quick and easy to use and ubiquitarily available. Many apps are available free of charge, which makes them even more attractive.

Open questions regarding data protection

Data protection presents a major challenge to users as well as manufacturers. In Germany, protection of privacy and personal data is governed by the Federal Data Protec-

tion Act *(Bundesdatenschutzgesetz*, BDSG*)*. Telemedicine and electronic health (e-health) applications are additionally subject to the Telemedia Act (*Telemediengesetz*, TMG) and the Law on Secure Digital Communication and Applications in Public Health (*E-Health-Gesetz*). According to § 13 Section 1 of the TMG, the app manufacturer is obligated to inform users of the type, scope, and purpose of collection and use of personal data during the app installation. This so-called privacy statement within apps is often incomplete, difficult to understand, or altogether non-existent, so users often consent to use of their data without being properly educated. For example, "HealthOn", an information and evaluation platform for health apps, showed that only every fifth app contains a privacy statement [5]. The technical inspection authority *TÜV Rheinland* has found that in approximately 40% of apps used in Germany, private user data is released without the user's knowledge or authorization [6].
The app data protection check called Check Your App (→ www.checkyourapp.de) by *TÜV Rheinland* is an initial step toward more practical data protection, such as in the handling of personal data. During a checking process requested by the app developer, apps are tested for "transparency and appropriateness regarding data collection, storage, processing, and transfer to third parties" [7]. It should be noted that to date, *TÜV Rheinland* has only tested one single nutrition app, and that the organization is communicating the data protection check as a marketing instrument and presenting data protection as a possible competitive advantage [8].

Assessment and evaluation

Though there are no standardized criteria for the assessment and evaluation of nutrition apps, users and developers can find orientation in the form of information and evaluation platforms that help to create more (data) transparency bilaterally.

The Federal Institute for Drugs and Medical Devices *(Bundesinstitut für Arzneimittel und Medizinprodukte, BfArM)* has published a "Guidance on Medical Apps", which allows developers of apps to determine whether their application is considered a medical product and thus subject to the Medical Devices Act (*Medizinproduktegesetzes*, MPG) or whether it is considered a wellness application [9].

In addition, the privately organized information and evaluation platform for health and medical apps HealthOn (→ www.healthon.de) provides checklists and independent test reports to give app developers and users some orientation regarding the trustworthiness (e.g. usefulness and soundness) of health-related app concepts and content [10]. The so-called "HON Code of Conduct" is based on the criteria of the "Health On the Net (HON) Foundation", which accredits health-related and medical information published on web sites by means of an "HONcode" [10]. The "HONcode" is the oldest and most frequently used ethical code of conduct accepted globally as an accreditation system [11]. Since 2011, HealthOn has pursued an approach of voluntary commitment by app providers and has been testing health apps since that time [10].

The information and evaluation platform "AppCheck" (→ www.appcheck.de) established by the Center for Telematics and Telemedicine (*Zentrum für Telematik und Telemedizin GmbH*, ZTG) currently evaluates health-related apps dealing with diabetes mellitus, asthma, dementia, and coronary heart disease regarding qualitative aspects like usability, data security, and transparency [12, 13]. At the time of this research, the online data base listed 69 health apps [14].

Apart from the above, the "Good Practice Health Information" (*Gute Praxis Gesundheitsinformation*, GPGI) criteria of the German Network for Evidence-based Medicine (*Deutsches Netzwerk Evidenzbasierte Medizin* e. V.) bear mentioning, which also define quality requirements (comprehensibility, transparency, and content) for health-related patient information [15].

The Advisory Council for Consumer Affairs *(Sachverständigenrat für Verbraucherfragen)* has taken a stance on the issue of the digital world and health and indicates two prerequisites to be necessary for realizing the potential of digitalization in the health sector: "Transparency and reliable (evidence-based) consumer information and support of consumers' competence in everyday life" [16]. The authors provide the following three recommendations:
- Provision and clear labelling of reliable and transparent health information by means of e- and m-health (electronic und mobile health)
- support of competence
- taking data protection seriously

Since the market offers an unmanageable number of apps that grows every day through new offers and updates, it is virtually impossible for independent institutes to test these apps quickly and systematically according to defined standardized criteria [17]. A future self-obligation system for app manufacturers for more transparency and data protection is under discussion as an alternative.
On the positive side, in Germany the research topic of "digital health" is receiving more and more support by the Federal Ministry of Education and Research (*Bundesministerium für Bildung und Forschung*, BMBF) in the form of public service announ-

Digression: Effects of apps on body weight

Very limited data is available regarding the effectiveness of apps for weight management. Few studies have been able to show that the use of apps as support tools can lead to increased weight reduction. In a commercial weight-loss programme (Weight Watchers®), an interactive online tool and an app were offered in addition to personal meetings. Participants could choose these tools freely. The use of all three components led to the greatest weight loss after 6 months [23]. Naimark et al. compared an app-based intervention with a control group without app in a randomized controlled study. After 14 weeks, the drop-out rate in the control group was higher than that of the intervention group. The members of the intervention group had lost an average of 1.44 kg of body weight; the control group lost 0.13 kg. In addition, the intervention group displayed positive effects on parameters like nutrition knowledge and physical activity [24].

The effect of the commercially available app Noom Coach on body weight was examined retrospectively in users with overweight and obesity (n = 35,921). Of the app users, 77.9% reported having reduced their body weight while using the app (median women: 267 days; median men: 264 days) [25].

A pilot study (n = 127) compared the effectiveness of an app (smart phone), an online tool (internet), and printed media (paper version) for weight reduction. The smart phone group showed the lowest drop-out rate and highest level of adherence. After 6 months, the average weight loss ("intention to treat") in the smart phone group was 4.6 kg, in the paper group it was 2.9 kg, and the internet group lost 1.3 kg [22].

A US American study with 365 participants recently revealed that the use of an interactive app could not improve weight loss over a two-year period. In this randomized clinical study, three groups were compared (interactive app, personal coaching supported by app, control group). At no point in time did the app group perform better than the control group [26]. In a 12-week pilot project (n = 51), the results of the control and intervention groups did not differ in terms of weight reduction, increase of physical activity, increased consumption of vegetables, and decreased consumption of sugary drinks. Both the control group and the intervention group received printed training material. The intervention group also received four text messages (SMS) and four e-mails per week and had access to apps and internet forums [27].

The work group around Turner-McGrievy compared three groups (n = 96, food diary, web site, app) in terms of energy consumption, changes in eating behavior, and body mass index (BMI). The three groups did not differ significantly regarding these end points. After 6 months, only significantly ($p = 0.01$) lower energy consumption could be detected in the app users compared to the users of the food diary (1,437 ± 188 kcal/day vs. 2,049 ± 175 kcal/day) [28].

To date, the studies have hardly been convincing with respect to positive effects of apps on body weight. However, the studies used older, less flexible apps that have little in common with the apps available today.

cements; since summer 2015, for instance, four competence clusters on nutrition research have been established which deal among other things with the issues of "modern nutrition communication". Furthermore, the Federal Ministry of Health has supported the project "*Chancen und Risiken von Gesundheits-Apps* (CHARISMHA)" (opportunities and risks of health apps), the results of which were published in April 2016 [18].

Benefits of nutrition apps

There are few studies that have evaluated the effectiveness of nutrition apps for influencing eating habits. Many scientific papers deal merely with categorizing or describing the app content or analyzing user behavior [18, 19]. It has been shown that user's adherence is not continuous. Though apps are often installed, they are not actively used over a longer period of time. Helander et al. were able to confirm this in a retrospective cohort study. Only 2.6% of persons who had downloaded the Eatery app could be identified as active users, with the term "active" being defined as describing users who used the app for at least one week and uploaded ten meal photos (= main function of the app) [20]. A pilot study revealed that in keeping food records, there is no difference in the documentation rate between text entry and image uploading of meals when both entry options are available via an app [21]. By contrast, another study was able to prove that using an app, compared to using a home page or print material, increases the documentation rate [22]. See ◆ Box "Digression: Effects of apps on body weight".

Problems with searching nutrition apps

A systematic search of nutrition apps available in app stores is virtually impossible due to the limited search options and lack of clear categorization. In addition, the information on apps that is provided in app stores is not very meaningful; there are "limited indicators of information sources used, available evidence, etc." [17].

Common points of criticism of nutrition apps are their poor quality of information and a lack of information about e.g. conflicts of interest of the provider. In addition to the apps offered by nutrition information services (e.g. app of the former "*aid infodienst Ernährung, Landwirtschaft, Verbraucherschutz* e. V.": "*Was ich esse*" (What I eat) and health insurers (e.g. AOK, app: "*Bewusst einkaufen*" [Sensible food shopping]), apps are mostly offered by persons and institutions with no related expertise but often with a commercial interest. A systematic software-based analysis of the current world market for weight management apps showed that while these apps are highly popular, they do not convey any scientifically sound content. Aside from the lack of professional expertise, sometimes starting right from the development process, the authors emphasize the necessity for clinical studies regarding the evaluation of health apps [29]. According to Albrecht et al., nutrition apps are predominantly aimed at laypersons, which is why very few users critically examine the content conveyed by the apps [17].

Methodology

Random sampling of nutrition apps

During the second quarter of 2015, a random sample of 100 nutrition apps was selected from Google Play Store using search terms such as "nutrition", "nutrition weight loss", "weight reduction", "food diary", "healthy nutrition", and "food intolerance". The random selection of German language apps was taken using the app store description. The selected apps were then grouped according to various contents and functions, which were in turn assigned to the three functions "information", "feedback", and "exchange". About half of the apps provided only one single function, while the other half offered a combination of different functions. Among apps with one function, 91% offered the "information" function.
After further selection steps, three apps that primarily convey nutrition information in the form of energy and nutrient statistics, are in German, are free of charge, and had a high installation rate were selected as examples for this paper: "*Kalorienrechner free*" (Calorie Calculator, App 1), "*Kalorientabellen*" (Calorie Tables, App 2), "fddb Scanner" (App 3) (◆ Table 1). The test device was a smart phone (Samsung, model "Galaxy S3 Mini") with Android operating system. The three apps were tested as examples regarding the information on kilocalories (kcal) and daily energy expenditure. The app information was compared with the information provided by the nutrition software OptiDiet PLUS (Version 5.1.2.046) and with the reference values for nutritional recommendations published by the German Nutrition Society (*Deutsche Gesellschaft für Ernährung* e. V., DGE). If the apps did not show the processing stage of the foods (raw, fresh, cooked, boiled, etc.) it was assumed that the values referred to raw foods. In addition, unprocessed foods (natural products) were given preference. Whenever possible, foods without any manufacturer information were chosen for calculation.

Food selection

◆ Table 2 shows the energy content of 13 foods that were chosen as examples of each food group from apps 1, 2, and 3 compared to the nutritional value reference (OptiDiet PLUS). Foods were chosen for which all three apps provided information. The common food item "banana", for

App	Technical details	Description
***Kalorienrechner free* (App 1)**[a] provider: Benjamin Lochmann New Media GmbH Virchowstraße 20B D-90409 Nürnberg	version/size: 2.7/6.4 M system requirements: android version ≥ 2.3.3 update: 14.01.2015	goal: weight reduction downloads: 500,000–1,000,000
***Kalorientabellen* (App 2)** provider: Gergely Rakoczi Gußhausstrasse 28–30 A-1040 Wien	version/size: 1.1/853 K system requirements: android version ≥ 2.1 update: 14.01.2012	goal: healthy diet downloads: 100,000–500,000
***fddb Scanner* (App 3)** provider: Nicolai Spohrer NSp Dienstleistungen Auf der Wacht 11 D-74867 Neunkirchen	version/size: 1.4.6/1.3 M system requirements: android version ≥ 2.1 update: 13.05.2013	goal: weight reduction downloads: 100,000–500,000

Tab. 1: **Technical details and data of sample apps** (Source: *Google Play Store*)
[a] Free of charge at the time of inquiry
K = kilobyte; M = megabyte

instance, could not be included because it was not included in all apps.

Results

App 1

App 1 consists of the three menu items "Calories in foods", "Calories burned during activities", and "Personal calorie statistic". Under "Calories in foods", the user can access 21 different food groups: alcoholic beverages, bread spread, fast food, instant meals, fish, meat, baked goods, poultry, vegetables, grain products, beverages, dairy products, muesli, nuts, fruit, mushrooms, sauces, snacks, sweets, sausages, oils & fats. The individual foods can be accessed either directly in the food groups or via a search field. The food category "fruit" is symbolized by a banana, although the food "banana" itself is not listed in the app. The category "oils & fats" shows energy values of "herbed butter", but not of "pure" butter. Further searching revealed that this app lists "butter" under the food group "bread spreads". Such content-related and structural deficits make gathering information more difficult.

The comparison of energy contents in App 1 with the reference (◆ Table 2) revealed an average discrepancy of 8.4%. The greatest discrepancy was calculated at 19.9% for the food "*Leberkäse*" (a processed sausage meat).

In addition to accessing nutritional values, users can enter information on their gender and body weight in a range from 50–200 kg in 5 kg intervals. The amount of food consumed (millilitre [mL], gram [g], piece) can be added to the "Personal calorie statistic" via the function "Add to today's total". It was noticeable that every food has to be listed with a minimal amount of 50 mL or g or half a piece. The user must, for example, enter a minimum consumption of 50 g of butter, even though the actual consumption may have been much lower. Under "Calories burned during activities", the energy consumption in kcal per minute (min) of physical activity can be calculated. The energy consumption can also be added to "today's total".

The imprint was available only on the developer's web page, not in the app itself or in Google Play Store. No information about the developers' qualifications could be found. The source for the nutritional value information was not cited. Also, no information about the use, transfer, and storage of data could be found. In App 1, the user is presented with health-related information, but it is not pointed out that the app cannot replace professional nutrition counselling. There were no indications of possible commercial motives of the provider.

App 2

App 2 offers the user 11 different food groups (vegetables, fruit, meat etc., egg, milk etc., grain, nuts, fast food, sweets, drinks, sushi) with sub-groups, in which the energy content of 100 g of the various foods can be viewed. One remarkable aspect is that sushi forms its own food group. In addition, the categories "TOP 10" and "FLOP 10" each list foods with especially low

(e.g. cucumber) or especially high (e.g. olive oil) energy content.
As with app 1, the search for particular foods was impeded by structural and content-related deficiencies. This app does not offer a search function, i.e. users have to find out for themselves which category a food is assigned to. This turns out to be difficult, as some foods are grouped under somewhat non-typical headings (*"Amerikaner"* [sugar-frosted cake] under "fast food" and *"Sahnetorte"* [cream-filled cake] under "grain"). Also, the app does not contain "rapeseed oil" but does contain "beef tallow".
The category "FLOP 10" should also be viewed with reservation. It lists very high-energy (> 550 kcal/100 g) foods such as "chocolate-nut-spread" or "potato crisps", but various oils are also grouped under the "FLOP 10". This suggests – regardless of the amount consumed – that vegetable oils should be avoided because of their high energy content.

On average, the energy content listed in App 2 differed from the reference values by 23.1%. The lowest discrepancy was 4.1% (low-fat yoghurt), the maximum discrepancy was 66.7% (cucumber), with this last food generally being very low in energy (◆ Table 2), so the discrepancy should not be overemphasized. Three foods showed a discrepancy of more than 50% (◆ Table 2). Under "Info", the user is provided with information about the app developer (name, internet page) and about the source of the content, but this is not a classic imprint. There is no information about the use, transfer, and storage of data or commercial interests. There is, however, a disclaimer stating that the developer does not accept liability for the completeness, quality, and correctness of the content.
In App 2, the user is presented with health-related information without a notation that the app cannot replace professional nutrition counselling. The listed developer web site could not be accessed at the time of this analysis due to site maintenance.

App 3

In contrast to app 1 and app 2, which are divided into food groups, app 3 does not present food categories for selection. The user searches for foods via a search field, which then provides a results list with no more than ten results. In addition to energy content, the app lists macronutrients contained in the food. A comparative analysis of the energy content listed in app 3 with the nutritional value calculation software used as a reference yielded an average discrepancy of 8.6% (◆ Table 2). Four of the foods ("natural product egg, from chicken"; "average value *Leberkäse*"; "natural product cucumber, fresh"; "fillet of pork, butcher") showed no discrepancy. For the food items "apple", "cauliflower", "cod", and "French fries", the values listed in the app diverged from the reference by more than 10%. The maximum discrepancy of 30.6% was found for "low-fat yoghurt". Comparing the discrepancies in macro-nutrients with the discrepancies in energy content, it was noted that for some foods (e.g. cauliflower) the macro-nutrient calculation in the app matched the reference data base, but the energy content differed, and vice versa (*"Leberkäse"* and "egg"). For most foods, the discrepancy regarding macro-nutrients between app and reference was less than 10%. In app 3, the amount of food consumed can be entered via a self-defined portion or pre-set portion sizes. The amount of food consumed can then be added to a day or a meal category (e.g. breakfast). The function "food diary" displays the total consumption. Prerequisite for the calculation of the user's daily energy requirement is a user profile, which can only be set up via an entry mask of the home page (→ fddb.info/). The body weight can be entered into the app via a separate function "weight (diet report)".
In addition to monitor nutrition, app 3 can also be used to record exercise behavior. In the function "Activities" (e.g. jogging), sports with different activity levels can be selected along with a duration and the user's body weight.
After setting up a profile on the web site, the program requires information about the user's gender, birth date, height and weight, and activity level (e.g. light, medium, intense), and the regular sports activities (no sports, once/several times per week, high-performance sports) to calculate the user's "daily energy expenditure". According to the app, a man (30 years of age, 70 kg, 170 cm) has a daily energy expenditure of 2,218 kcal. The formula used to calculate the energy expenditure is not listed. Compared to this, the calculation formula of the DGE yields a total daily energy expenditure of 2,705 kcal at a physical activity level (PAL) of 1.6 for the same sample person. Using a formula by Mifflin and Stjeor (1990), the sample person has a total daily energy expenditure of 2,588 kcal [30]. The app information thus differed from the reference values used by 487 kcal (22%) or 370 kcal (17%), respectively.

App 3 does not have an imprint, but it does refer to the web site (→ fddb.info/), where an imprint is published. A written inquiry to *fddb Internetportale GmbH* regarding the sources of the food data revealed that the nutrition information is taken in part "from the manufacturer information on the product packaging" and in part, e.g. for "natural products like fruit, vegetables, herbs, etc." from the "*Bundeslebensmittelschlüssel* or information provided by the producers/distributors".
Further search revealed no information about the use, transfer, and

Own nomenclature	Nomenclature reference	Coding [BLS]	kcal [BLS]	Nomenclature App 1[a]	kcal App 1	%	Nomenclature App 2
apple	apple	F110000	61	apple	54	11.5	apple
Amerikaner	*Amerikaner* from sponge mixture	D750100	318	*Amerikaner*	318	0.0	*Amerikaner*
cauliflower raw	cauliflower	G311100	23	cauliflower	27	17.4	cauliflower
cola-beverage	cola beverages (caffeinated)	N330000	47	coca cola-cola[b]	44	6.4	cola-beverages
egg	hen's egg	E110000	137	hen's egg whole	158	15.3	hen's egg
low-fat yoghurt	yoghurt 1.5% Fat	M141200	49	yoghurt low-fat 1.5%	47	4.1	yoghurt, semi-skim
cod	cod raw	T204100	78	fish cut cod	77	1.3	cod filet
Leberkäse	*Leberkäse*	W256100	292	*Leberkäse*	350	19.9	*Leberkäse*, fried
olive oil	olive oil	Q120000	885	olive oil, cold pressed	900	1.7	olive oil
French fries	French fries (standard recipe)	X654112	329	French fries	270	17.9	French fries
whole grain rye bread	whole grain bread rye	B121000	198	whole grain rye bread	193	2.5	whole grain rye bread
salad cucumber	cucumber	G520000	12	cucumber, raw	13	8.3	cucumber
pork fillet	pork fillet	U510000	107	pork fillet	104	2.8	pork fillet

Tab. 2: **Energy content of selected foods in app 1, 2 and 3 compared to the reference (OptiDiet PLUS) for 100 g of the sample food**
% = discrepancy in % = app value:reference value; BLS = German Food Database (Bundeslebensmittelschlüssel version 3.01); g = gram; kcal = kilocalories
[a] free at time of survey, [b] company product

storage of data. Though the user is presented with health-related information, the app does not inform the user that this type of information cannot replace professional nutrition counselling. There is no indication of financial interests on the provider's part. In addition to sources for the nutritional values, fddb also provides a written statement on the currentness of app functions: the app "*fddb Scanner*" was developed by an external developer; the free app "*fddb Extender*" has extended functionalities and content and is updated regularly.

Discussion

The examination of the test apps and comparison of the information with reference data revealed deficits in particular with regard to content, user-friendliness (e.g. lack of a search function), and data transparency.

Due to the unmanageable number of apps available, no standardized inclusion or exclusion criteria were defined for the app samples. The nutrition app research, as in CHARISMHA study, was not conducted systematically, but in a structured and exploratory manner [18]. For this reason the sample is not representative. Only three apps were examined in detail, which does not allow any conclusions to be drawn about the overall market for nutrition apps.

The authors of the CHARISMHA study summarize that the multitude of apps being offered is confusing, which is further exacerbated by a lack of transparency and can cause users to feel disoriented [18]. Another paper by Albrecht et al. analyzing weight control apps showed that systematic app search currently does yield specific search results because of limited search options and unclear categorization [17]. International research groups came to similar conclusions. In an overview by Breton et al., all of the 204 apps examined were rated inadequate regarding evidence-based information [31].

In this paper, the initial sample size of 100 apps was reduced to three sample apps according to defined criteria. In order to receive a reflection of the currently available range of apps, the apps were included in the evaluation regardless of their

kcal App 2	%	Nomenclature App 3	kcal App 3	%
49	19.7	various apples	52	14.8
303	4.7	bakery *Amerikaner*	308	3.1
16	30.4	natural product cauliflower, fresh	28	21.7
45	4.3	coca-cola, classic[b]	42	10.6
160	16.8	natural product egg, from chicken	137	0.0
51	4.1	Milbona low-fat yoghurt mild 1.5%, natural[b]	64	30.6
70	10.3	fresh cod	90	15.4
460	≥ 50	average value *Leberkäse*	292	0.0
930	5.1	natural product olive oil	851	3.8
350	6.4	average value French fries, deep fried	291	11.6
227	14.6	bakery whole grain rye bread	193	2.5
4	≥ 50	natural product salad cucumber, fresh	12	0.0
171	≥ 50	butcher pork fillet	107	0.0

release date or latest update. This is why the app *"fddb Scanner"* was tested instead of the current extended version *"fddb Extender"*. In interpreting the results, it should be considered that technology has taken great strides in recent years and current apps have more diverse functions. Whether content has improved in the new app generation and whether the information is now evidence-based is the subject of current research. In the sampled apps, the number of foods was very limited and the search for foods was made more difficult by arbitrary assignment to food groups. Imprecise information on energy content and consumption amounts that could not be individually set could lead to misinterpretations. Malfunctions and misinformation resulting from such malfunctions are considered to be potential risks of health apps, which is why such apps should be used with caution [18]. This is also why it would be desirable to involve nutrition experts as early as during the development stage.

The energy and nutritional values in the apps were compared with the information of the nutrition software OptiDiet PLUS, which is based on the *Bundeslebensmittelschlüssel* (BLS, German Food Database) by the Max Rubner-Institute. Other energy and nutrition tables exist (e.g. [32] and [33]). Different discrepancies are expected for the energy and nutritional values of individual foods depending on the reference chosen. For example, the food item "egg" in the table *"Nährstoffe in Lebensmitteln"* (nutrients in foods) by Heseker [33] is listed as "hen's egg, raw, without shell" and designated as having an energy content of 155 kcal per 100 g edible portion. If the Heseker table would be used as a reference, the divergence percentage of the app value to the reference value would be lower. Since these differences occur in both directions depending on the reference, one might conclude that the calculated total energy balance is not significantly affected by the choice of reference table. Nevertheless, it is possible that the user could be provided with a false energy balance that could in the long term lead to undesired weight changes.

Outlook

In summary, because of divergence from reference values, the sample apps do not provide exact, reliable information for specific foods, but could provide a general orientation aid regarding the nutritional values of foods. Depending on the user's intention, these apps could be used as a support tool for self-monitoring despite their limitations. It has not been determined to what degree the use of an app can help users to achieve changes regarding their nutritional knowledge, eating habits, and body weight.
The results of this paper suggest that nutrition experts should be involved from the very early stages of app development. According to forecasts, apps will gain importance in years to come [34], which is why intense discourse about the challenges of digital nutrition communication, accompanied by systematic studies, is highly necessary.

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References

1. *44 Millionen Deutsche nutzen ein Smartphone. URL: www.bitkom.org/Presse/Presseinformation/44-Millionen-Deutsche-nutzen-ein-Smartphone.html Zugriff 13.12.16*
2. *Prognose zur Anzahl der Smartphone-Nutzer weltweit von 2014 bis 2019 nach Region (in Millionen). URL: http://de.statista.com/statistik/daten/studie/489517/umfrage/prognose-zur-anzahl-der-smartphone-nutzer-weltweit-nach-region/ Zugriff 24.05.16*
3. *Health App-Dashboard. Apps weltweit: Google Play & iPhone. URL: https://www.healthon.de/de/health-app_dashboard Zugriff 05.10.16*
4. *Gesundheits-Apps. Bedeutender Hebel für Patient. Empowerment – Potenziale jedoch bislang kaum genutzt. URL: www.bertelsmann-stiftung.de/de/publikationen/publikation/did/spotlight-gesundheit-gesundheits-apps/ Zugriff 13.12.16*
5. *Eine „sichere" Gesundheits-App entwickeln: So geht das!. URL: www.healthon.de/de/2016/07/11/eine-%E2%80%9Esichere%E2%80%9C-gesundheits-app-entwickeln-so-geht-das Zugriff 05.10.16*
6. *Die TÜV Rheinland Datenschutzprüfung „Check your App". URL: www.checkyourapp.de/ Zugriff 05.10.16*
7. *Testverfahren: Einzigartiges App-Testverfahren von TÜV Rheinland. URL: www.checkyourapp.de/Testverfahren Zugriff 24.05.16*
8. *Check your App. Hintergrundwissen zur Sicherheit von Apps. URL: www.tuv.com/de/deutschland/gk/managementsysteme/informationstechnologie/check_your_app/check_your_app.html Zugriff 10.10.16*
9. *Orientierungshilfe Medical Apps. URL: www.bfarm.de/DE/Medizinprodukte/Abgrenzung/medical_apps/_node.html Zugriff 10.10.16*
10. *eHealth: HealthOn – Bessere Orientierung für die Nutzer von Health-Apps. URL: www.gesundheitsindustrie-bw.de/de/fachbeitrag/aktuell/healthon-bessere-orientierung-fuer-die-nutzer-von-health-apps/ Zugriff 10.10.16*
11. *Stiftung Health On the Net. Suchen Sie vertrauenswürdige Informationen über ihre Gesundheit? URL: www.hon.ch/HONcode/Patients/visitor_safeUse2_de.html Zugriff 10.10.16*
12. *Zentrum für Telematik und Telemedizin GmbH. Gesundheitsapps – neue Wege für die Versorgung. URL: www.ztg-nrw.de/2015/03/gesundheitsapps-neue-wege-fuer-die-versorgung Zugriff 24.05.16*
13. *Über App-Check. URL: www.appcheck.de/ueber-app-check Zugriff 14.12.16*
14. *Apps von A-Z: Apps. URL: www.appcheck.de/apps Zugriff 14.12.16*
15. *Der Weg zu guten Gesundheitsinformationen. URL: www.ebm-netzwerk.de/was-wir-tun/fachbereiche/patienteninformation/gpgi Zugriff 13.12.16*
16. *Digitale Welt und Gesundheit. eHealth und mHealth – Chancen und Risiken der Digitalisierung im Gesundheitsbereich. URL: www.bmjv.de/SharedDocs/Downloads/DE/Artikel/01192016_Digitale_Welt_und_Gesundheit.pdf;jsessionid=31C2649BC2712FD1CC75DD35DCC9C463.1_cid297?__blob=publicationFile&v=2 Zugriff 24.05.16*
17. *Albrecht UV, Engeli S, Jan U (2016) Mit Apps durch Dick und Dünn? Über das Suchen, Prüfen und Finden geeigneter Anwendungen. Adipositas – Ursachen, Folgeerkrankungen, Therapie 10: 43–50*
18. *Chancen und Risiken von Gesundheits-Apps (CHARISMHA). URL: www.digibib.tu-bs.de/?docid=00060000 Zugriff 13.12.16*
19. *Harricharan M, Gemen R, Celemin LF et al. (2015) Integrating mobile technology with routine dietetic practice: the case of myPace for weight management. Proc Nutr Soc 74: 125–129*
20. *Helander E, Kaipainen K, Korhonen I et al. (2014) Factors related to sustained use of a free mobile app for dietary self-monitoring with photography and peer feedback: retrospective cohort study. J Med Internet Res 16: 1–13*
21. *Aizawa K, Maeda K, Ogawa M et al. (2014) Comparative study of the routine daily usability of FoodLog: a smartphone-based food recording tool assisted by image retrieval. J Diabetes Sci Technol 8: 203–208*
22. *Carter MC, Burley VJ, Nykjaer C et al. (2013) Adherence to a smartphone application for weight loss compared to website and paper diary: pilot randomized controlled trial. J Med Internet Res 15: e32*
23. *Johnston CA, Rost S, Miller-Kovach K et al. (2013) A randomized controlled trial of a community-based behavioral counseling program. Am J Med 126: 19–24*
24. *Naimark JS, Madar Z, Shahar DR (2015) The impact of a web-based app (eBalance) in promoting healthy lifestyles: randomized controlled trial. J Med Internet Res 17: 1–14*
25. *Chin SO, Keum C, Woo J et al. (2016) Successful weight reduction and maintenance by using a smartphone application in those with overweight and obesity. Scientific Reports 6: 34563*
26. *Svetkey LP, Batch BC, Lin PH et al. (2015) Cell phone intervention for you (CITY): a randomized, controlled trial of behavioral weight loss intervention for young adults using mobile technology. Obesity 11: 2133–2141*
27. *Hebden L, Cook A, van der Ploeg HP et al. (2014) A mobile health intervention for weight management among young adults: a pilot randomised controlled trial. J Hum Nutr Diet 27: 322–332*
28. *Turner-McGrievy GM, Beets MW, Moore JB*

et al. (2013) Comparison of traditional versus mobile app self-monitoring of physical activity and dietary intake among overweight adults participating in an mHealth weight loss program. J Am Med Inform Assoc 20: 513–518

29. *Nikolaou CK, Lean ME (2016) Mobile applications for obesity and weight management: current market characteristics. Int J Obes 41: 200–202*
30. *Mifflin MD, St Jeor ST, Hill LA et al. (1990) A new predictive equation for resting energy expenditure in healthy individuals. Am J Clin Nutr 51: 241–247*
31. *Breton ER, Fuemmeler BF, Abroms LC (2011) Weight loss – there is an app for that! But does it adhere to evidence-informed practices? Transl Behav Med 1: 523–529*
32. *Souci SW, Fachmann W, Kraut H. Die Zusammensetzung der Lebensmittel, Nährwert-Tabellen. 8., rev. und erg. Aufl., Wissenschaftliche Verlagsgesellschaft Stuttgart, Stuttgart (2016)*
33. *Heseker B, Heseker H. Nährstoffe in Lebensmitteln: Die große Energie- und Nährwerttabelle. 4., akt. und erw. Aufl., Umschau Zeitschriftenverlag, Sulzbach im Taunus (2013)*
34. *medApps. URL: www.telemedallianz.de/at_apps.html Zugriff 13.12.16*

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