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The Pocketable Electronic Devices in Radiation Oncology (PEDRO) Project: How the Use of Tools in Medical Decision Making is Changing?

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Abstract

Purpose: To analyze the impact of mobile electronic devices (MEDs) and apps in the daily clinical activity of young radiation or clinical oncologists in 5 Western European countries (Italy, Germany, Spain, Portugal, and Denmark). **Methods:** A web-based questionnaire was sent to 462 young ($\leq$40 years) members of the national radiation or clinical oncology associations of the countries involved in the study. The 15 items investigated diffusion of MEDs (smartphones and/or tablets), their impact on daily clinical activity, and the differences perceived by participants along time. **Results:** A total of 386 (83.5%) of the 462 correctly filled questionnaires were statistically evaluated. Up to 65% of respondents declared to use an electronic device during their clinical activity. Conversely, 72% considered low to moderate impact of smartphones/tables on their daily practice. The daily use significantly increased from 2009 to 2012: users reporting a use $\geq$6 times/d raised from 5% to 39.9%. Professional needs fulfillment was declared by less than 68% of respondents and compliance to apps indications by 66%. Significant differences were seen among the countries, in particular concerning the feeling of usefulness of MEDs in the daily clinical life. The perception of the need of a

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comprehensive Web site containing a variety of applications (apps) for clinical use significantly differed among countries in 2009, while it was comparable in 2012. **Conclusions:** This survey showed a large diffusion of MEDs in young professionals working in radiation oncology. Looking at these data, it is important to verify the consistency of information found within apps, in order to avoid potential errors eventually detrimental for patients. "Quality assurance" criteria should be specifically developed for medical apps and a comprehensive Web site gathering all reliable applications and tools might be useful for daily clinical practice.

Keywords
mobile electronic devices, app, smartphone, tablet, radiotherapy

Abbreviations
AIRO, Italian Association of Radiation Oncology; MED, mobile electronic device; PCS, Pearson chi-square; PEDRO, Pocketable Electronic Devices in Radiation Oncology

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Introduction

The field of clinical oncology rapidly evolved over the last decades and several technological, medical, and biological innovations changed the daily practice of clinical oncologists.[1-3] Thus, a continuous effort to optimize medical education and update skills and knowledge is strongly demanded. National and international congresses represent a helpful possibility, but they are often time and resource consuming. Moreover, some important geographical and logistic issues potentially limit a widespread participation, in particular for young professionals. Nevertheless, it is a rather frequent situation for physicians to examinate patients having a previous informative background regarding their health conditions and disease, obtained from ''official'' or ''unofficial'' cancer-related Web sites.[4-6] In recent years, tablets and smartphones became widely diffused worldwide, potentially overcoming the limits of a slow internet connection or the impossibility to easily access a personal computer to obtain medical information. These mobile electronic devices (MEDs) and their available different tools represent a very interesting way to overcome the aforementioned limitations. Indeed, they could be promptly consulted during the daily clinical activity. Moreover, several dedicated softwares (apps) are available online and could be easily downloaded and installed, usually for free: thus, MEDs became accessible sources of information and education for radiation oncologists. Given this technological and social background, those MEDs are now an important tool in the daily clinical practice of radiation oncologists. It is worth noting that some differences in the diffusion and utilization of MEDs could be influenced by the ''technological level'' of a country and the ''technological habits'' of the physicians. One of the major aims of the Italian Association of Radiation Oncology (AIRO)—Young Members Working Group (AIRO Giovani) is the conduction of studies and activities investigating different issues related to young members of the society.[7-13] The Pocketable Electronic Devices in Radiation Oncology (PEDRO) project is an international, web-based survey investigating the impact of MEDs on the clinical practice of young radiation oncologists. As a first step, we previously reported on exclusive Italian data.[11] Thereafter, we performed a comparative analysis with the data of other European young national radiotherapy societies involved in the project (Spain, Portugal, Denmark, and Germany). The aim of this study is to report definitive results of the PEDRO survey.

Material and Methods

A self-produced 15-item-based, nonvalidated, questionnaire was designed by a specific task force of AIRO Giovani. The questionnaire was subsequently evaluated by 2 external reviewers and modified according to their suggestions in terms of content, face validity, wording, and flow. Finally, 3 questions allowed open text answers and 11 questions presented multiple choice items. The survey was entirely conducted during 2013. Questions number 6 to 9 and 15 (referred to the years 2009 and 2012) should be intended as a report of participants' perception regarding their habits in using MEDs during their clinical activity in the cited years. Representatives from the young sections of 5 European scientific societies devoted to radiation oncology were contacted and asked to diffuse the survey, namely, AIRO, German Society for Radiotherapy and Oncology, The Danish Association of Young Oncologists, Spanish Association of Radiotherapy and Oncology, and Portuguese Society of Radiotherapy and Oncology. Their databases were consulted in order to target young members (<40 years; both young specialist and residents). A total of 462 young professionals were identified and reached via e-mail for participation to the PEDRO International project (anonymity of the survey was addressed in the presentation letter). The survey was conducted online, using the Internet-based Survey-Monkey platform (www.surveymonkey.com), and completion took about 10 minutes. The survey was active from September to December 2013. Twice a month, an e-mail reminder was send to all the so-identified participants. The completed

Table 1. Features of the Population.

	Italy	Germany	Denmark	Spain	Portugal
Sample, N	158	89	61	52	26
Age, years					
Average	33.9	33.0	32.1	34.7	31.5
Min	26.9	25.0	26.0	28.0	27.0
Max	40.0	39.0	39.0	41.0	41.0
Specialists, N (%)	108 (68.35)	42 (47.2)	8 (13)	43 (83)	15 (57.7)
Age, years					
Average	35.6	35.5	37.9	35.3	33.7
Min	30.0	30.0	36.0	29.0	30.0
Max	40.0	39.0	39.0	41.0	41.0
Residents, N (%)	50 (31.65)	47 (52.8)	53 (87)	9 (17)	11 (42.3)
Age, years					
Average	30.5	30.8	31.2	32.1	28.5
Min	26.0	25.0	26.0	28.0	27.0
Max	40.0	36.0	38.0	40.0	31.0

Abbreviations: max, maximum; min, minimum.

questionnaires were collected and anonymously analyzed during February and March 2014.

Statistical Analysis

In order to provide a glimpse into eventual differences occurring during time in terms of frequency of daily use and utility perception of MEDs, a subgroup analysis was performed according to the year considered (2009 and 2012). Two approaches were employed. A transversal approach investigating eventual differences occurring among different scientific society members during 2009 and during 2012, either on the whole sample with "society" as a variable (5 variables overall) and on a specific sample for each society compared to AIRO data set as reference (2 variables). A longitudinal approach investigating eventual differences occurring within the members of the same society between 2009 and 2012 was also performed. Pearson chi-square (PCS) tests for independence (1 or 4 degree of freedom at significance level $\alpha = .05$ for 2 or 5 variable analyses, respectively) were performed using cross-tabulations for items 6 and 9 and for items 14 and 15 (see Table 1 for the items). The level of statistical significance for PCS was set to $\geq$3.84 and $\geq$9.49 for 1 and 4 degrees of freedom analyses, respectively. The investigation evaluated whether the dichotomous variable society (for year 2009 and 2012, respectively) and "year" (2009 vs 2012) might be associated with the frequency distributions of the analyzed events considered as categorical variables in our sample (high vs low use level: 6-10/11-15/$\geq$16 vs 0-1/2-5; high vs low level of utility perception: yes/probably yes vs no/probably not). The events we considered were mutually exclusive and had a total probability of 1. A test of goodness of fit was performed (assessing whether the observed frequency distribution differed from a theoretical distribution). The open text answers were also analyzed and classified following a categorical affinity approach. Descriptive and quantitative statistical analyses were performed with SPSS Statistics Software version 19.0 (IBM, Armonk, New York).

Results

Descriptive Statistics

A total of 386 (83.5%) of the 462 questionnaires were completely filled in and consequently taken into account for the present analysis; those partially completed were automatically disregarded by the electronic platform, thus avoiding selection bias. The number of respondents strongly varied according to country from 158 for Italy to 26 for Portugal (reflecting differences in the total number of young radiation oncologists in the participant countries). The distribution between residents and specialists was quite similar for Germany and Portugal, in favor of specialists for Spain and Italy and in favor of residents for Denmark. Overall mean age of the participants was 32.8 years. Mean age ranged from 31.5 (Portugal) to 35.6 (Germany) (see Table 1 for details).

Data About MEDs Diffusion in the Daily Clinical Practice

The overall reported use of MEDs (tablet and/or smartphone) among the considered countries was 65.1%. In Italy, almost 58% of respondents declared to use a tablet in daily clinical activity, while up to 17% used both a tablet and a smartphone (Figure 1A). For Germany, 36% reported to use a smartphone (10.1% both a smartphone and a tablet; Figure 2A). For Denmark, 52.5% used a smartphone (Figure 3A). For Spain, up to 50% declared to use a smartphone (Figure 4A), while for Portugal, 46.2% used a smartphone, 11.5% a tablet, and 19.2% both (Figure 5A). Main apps by category employed during daily clinical activity included cancer staging and treatment (Italy, Germany, Spain, and Portugal), apps for bibliographic researches (Italy, Denmark, Spain, and Portugal), radiobiological (all the considered countries), and general medicine apps (Germany and Denmark; Figures 6D and 7). Main apps employed by type included guidelines, radiobiological calculators, citation databases, and drug vademecum (Figures 6B and 8). Interestingly, main apps that respondents would desire to be created and shared online included oncological guidelines, contouring tools, radiotherapy guidelines, and apps allowing for external access to the informatics hospital system (Figure 6E).

Data About Perceived MED Usefulness in the Daily Clinical Practice

The real impact of these devices during routine activity is still considered low–moderate for Italy (82.2%), Germany (87.2%), Denmark (91.8%), Spain, and Portugal (65.4%; Figures 1B, ;2B, ;3B, ;4B, and ;5B). Despite the frequent use of electronic devices, the fulfillment of professional needs and requirements is never or occasionally achieved for 85.5% of respondents for Italy (Figure 1C), 76.4% for Germany (Figure 2C), and 73.8% for Denmark (Figure 3C). Spain and Portugal had a frequent or

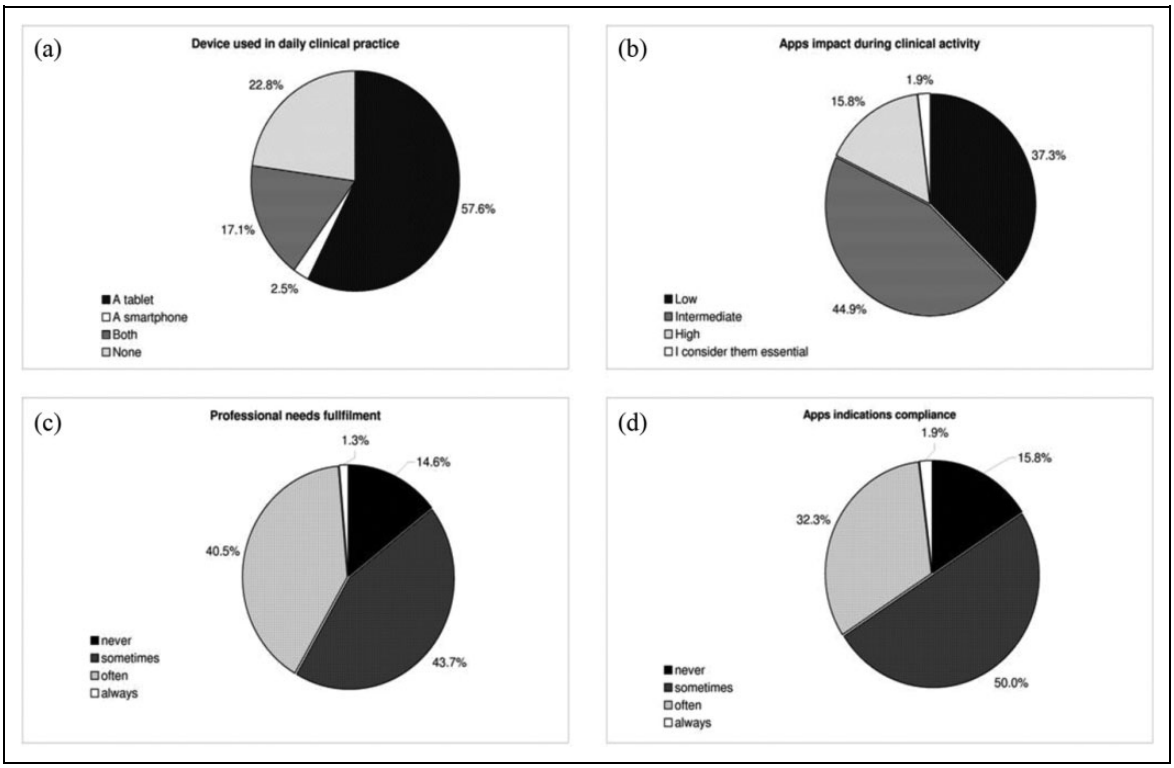

Figure 1. Impact of apps by country—Italy.

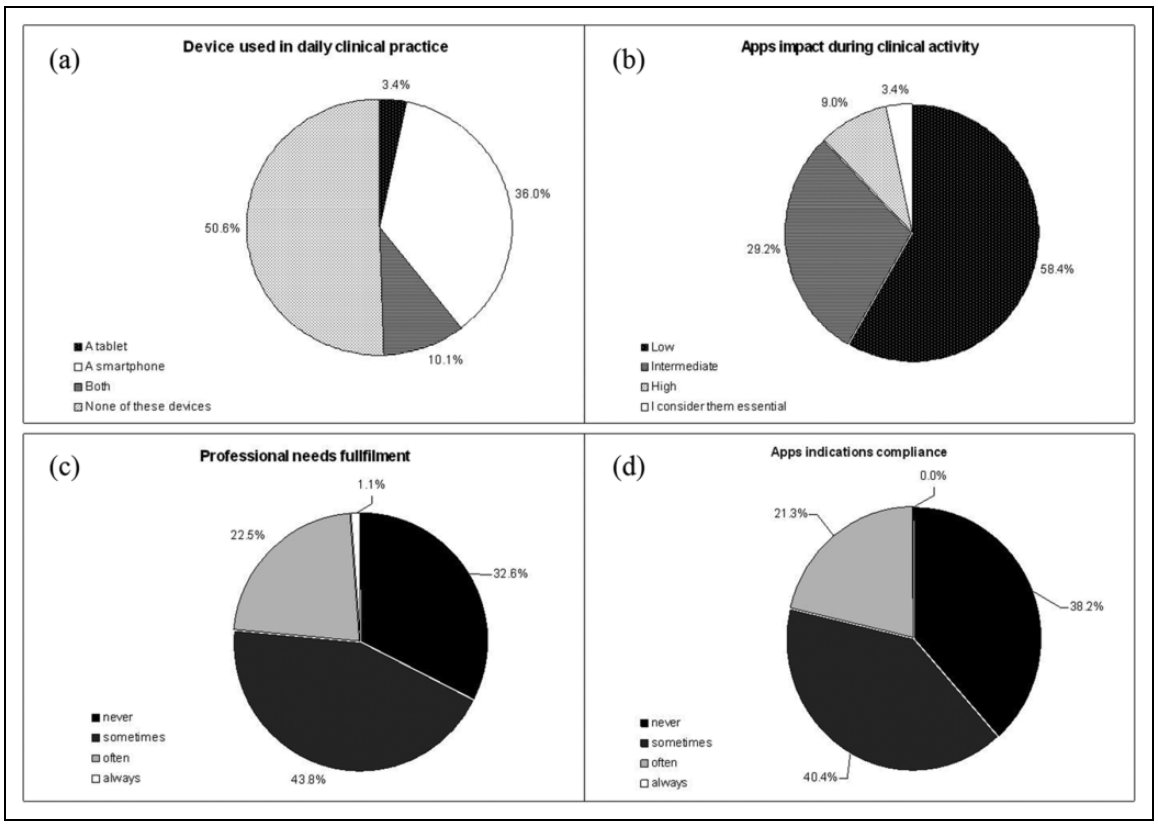

Figure 2. Impact of apps by country—Germany.

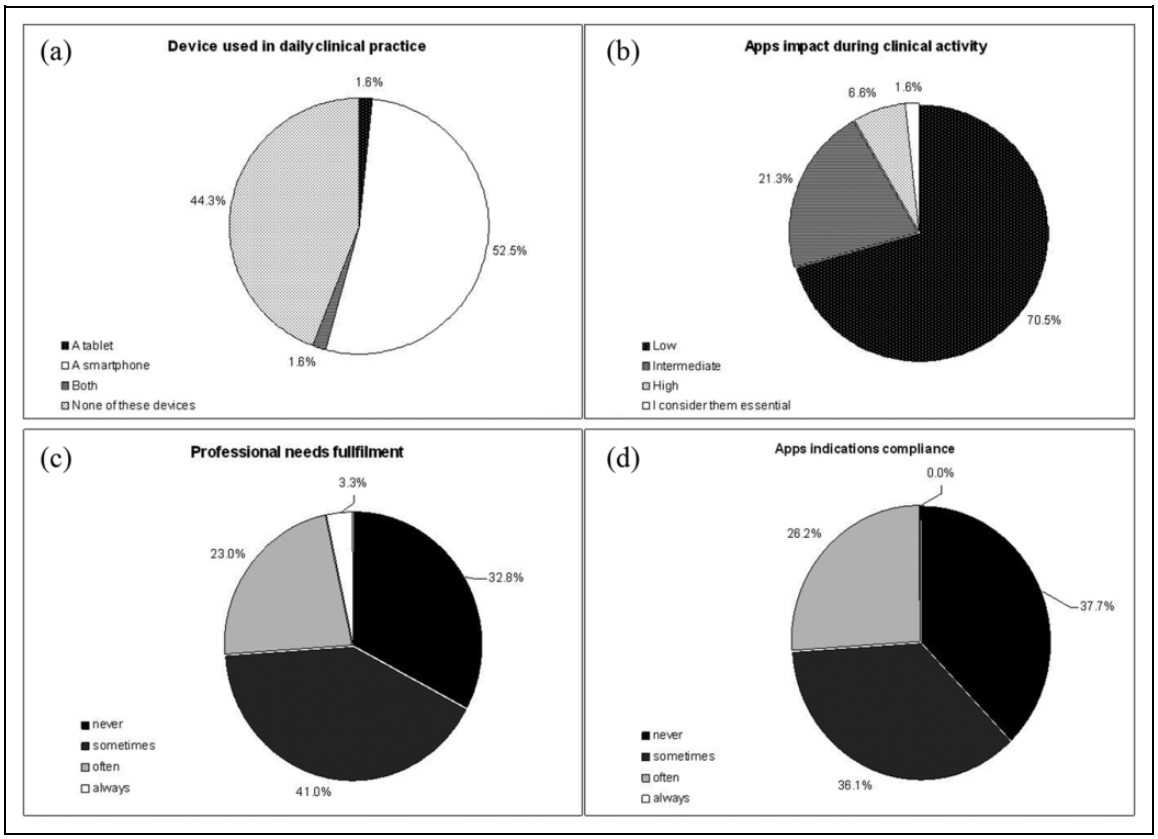

Figure 3. Impact of apps by country—Denmark.

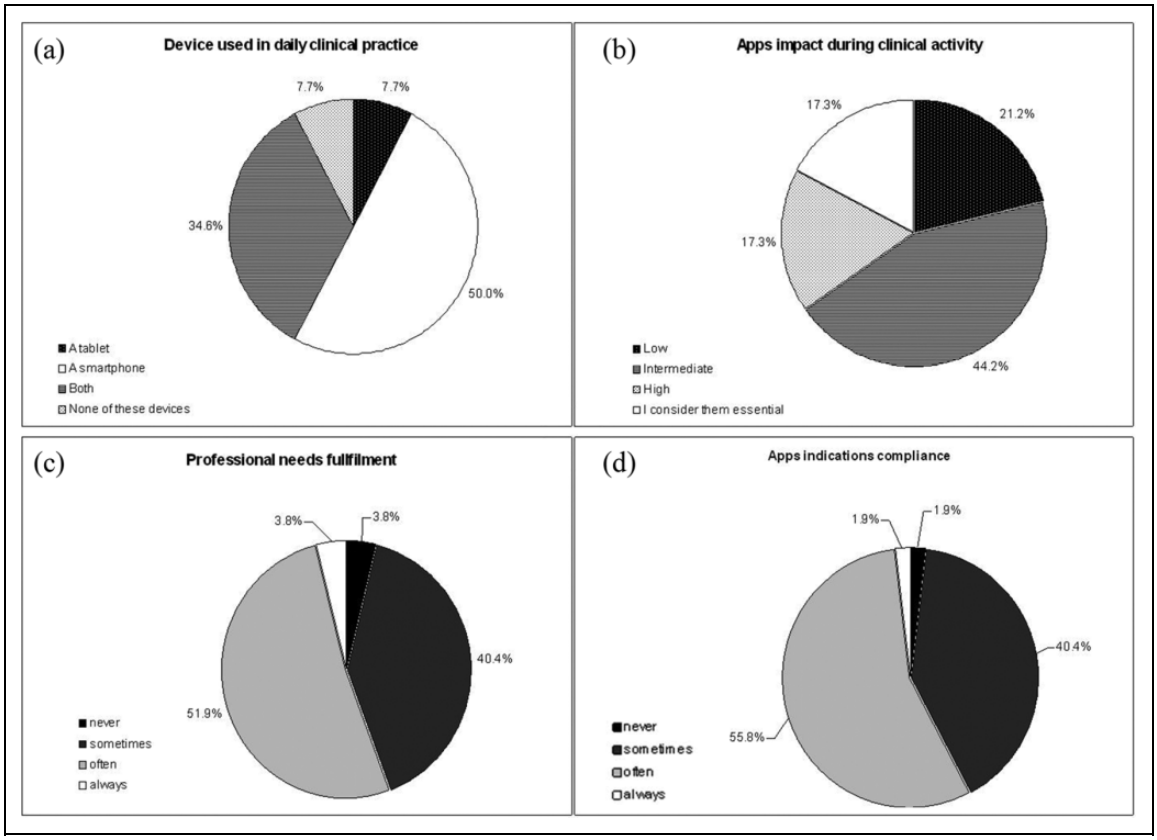

Figure 4. Impact of apps by country—Spain.

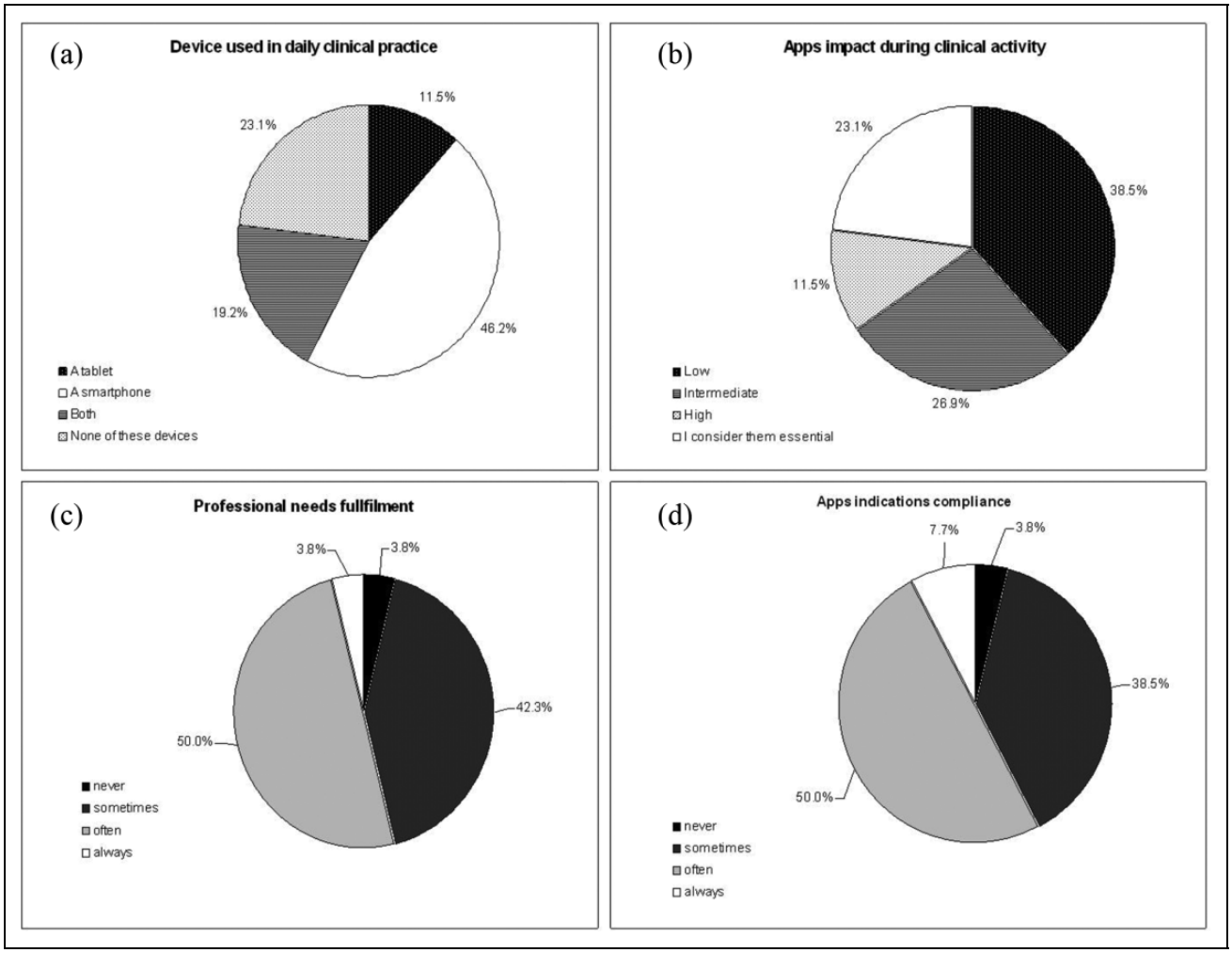

Figure 5. Impact of apps by country—Portugal.

constant fulfillment for 55.7% and 53.8% of respondents (Figures 4C and 5C). Compliance to the indications obtained from apps is declared by 34.2% of participants for Italy (Figure 1D), 21.4% for Germany (Figure 2D), and 26.2% for Denmark (Figure 3D). Conversely, these results rose up to 57.7% for Spain (Figure 4D) and Portugal (Figure 5D).

Data About the Time Trend of MED Utilization in the Daily Clinical Practice

The daily use of electronic devices/apps was significantly different among the different countries on an overall basis both in 2009 (PCS = 10.859) and 2012 (PCS = 31.299). The magnitude of this difference was found higher in 2012. Having Italy as a reference, statistically significant differences in terms of the daily use were found in 2009 for Germany (PCS = 7.780) and Denmark (PCS = 4.786) with less utilization in Germany and Denmark. In 2012 (still with Italy as comparison), significant differences were found with Spain (PCS = 8.772), which had superior use, Germany (PCS = 5.793), and Denmark (PCS = 6.692), which continued to use MEDs less frequently.

Regarding the variations in utilization between 2009 and 2012 within the same country, it was found that in Italy the proportion of physicians with a high daily use significantly increased from 5% to 39.9% (PCS = 17.726). In 2012, up to 12.7% of Italian respondents used apps more than 10 times/d (Figure 6A). Germany showed a significant increase from 5.6% to 24.7% (PCS = 12.618), with 9% reporting to use apps >10 times/d. Also Denmark presented a significant increase from 6.5% to 21.3% (PCS = 5.536), with 4.9% of respondents reporting to use apps >10 times/d. Spain had a statistically significant increase from 13.4% to 63.5% (PCS = 27.463), with 30.8% reporting to use apps >10 times/d, while Portugal raised up from 15.3% to 53.8% (PCS = 8.497), reporting to use apps >10 times/d (Figure 9A-D).

The Issue of a Web Site Collecting the Available Apps: The Perception of the Participants

The perception of the need for a comprehensive Web site containing a variety of apps for clinical use significantly differed among countries in 2009 (PCS = 16.331), while it was

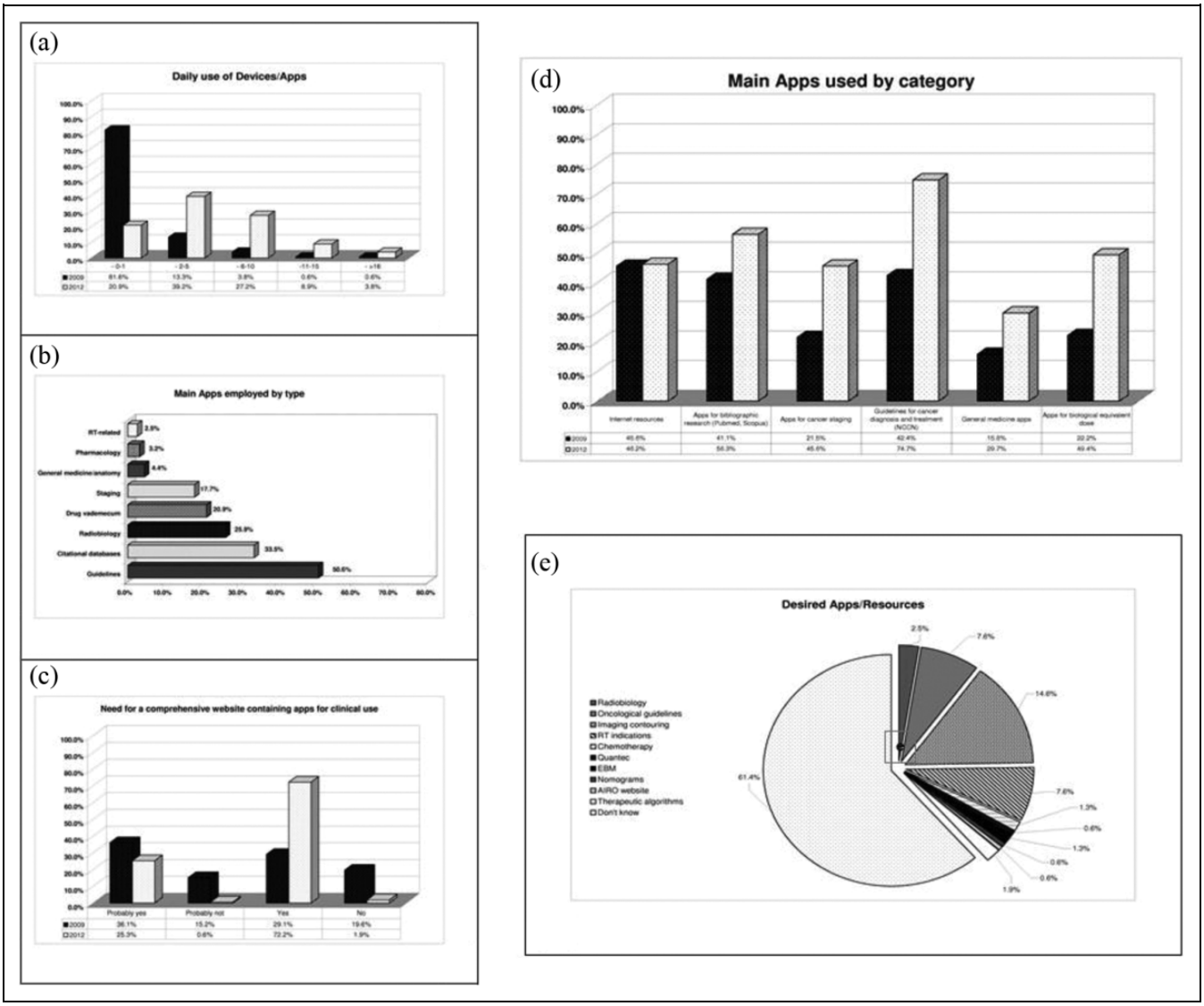

Figure 6. Habits in apps utilization—Italy (reference data).

comparable in 2012 (PCS = 4.237; no statistically significant difference). With Italy as a reference, in 2009, the only significant difference was found with Spain (PCS = 13.193), which had an inferior perception of the utility of such kind of Web site. In 2012, no difference could be found among Italy and other countries. Regarding the differences in the perception of the need for a comprehensive Web site between 2009 and 2012 within the same country, Italy and Germany had highly significant increases (PCS = 54.205 and 41.978, respectively), with up to 97.5% and 96.6% of respondents desiring it in 2012 (Figures 6C and 8A). Spain (PCS = 27.463), Portugal (PCS = 8.497), and Denmark (PCS = 5.536) showed lower, but still significant increase with 100% of physicians desiring it in 2012 (Figure 8B-D). In general, the need for a comprehensive Web site gathering together all reliable apps and tools was found to be highly demanded in all countries in recent years (Figures 8 and 10).

Discussion

To the best of our knowledge, the PEDRO project is the first study aiming at the analysis of the diffusion and impact of MEDs among young radiation oncologists in Western Europe. The high response rate of 83.5% renders these data a quite realistic picture of the young radiation oncologist's current perception on the role, diffusion, and impact of these devices during daily clinical practice. In our opinion, several characteristics of the present study should be underlined. The survey was anonymously filled in online, and the incompletely filled in questionnaires were automatically rejected by the platform, avoiding selection bias. The statistical method, which was used, allows an ''intracountry'' analysis (showing eventual differences between 2009 and 2012) but also an ''intercountries'' analysis (showing differences between the participating countries). Finally, nonrespondents characteristics were collected

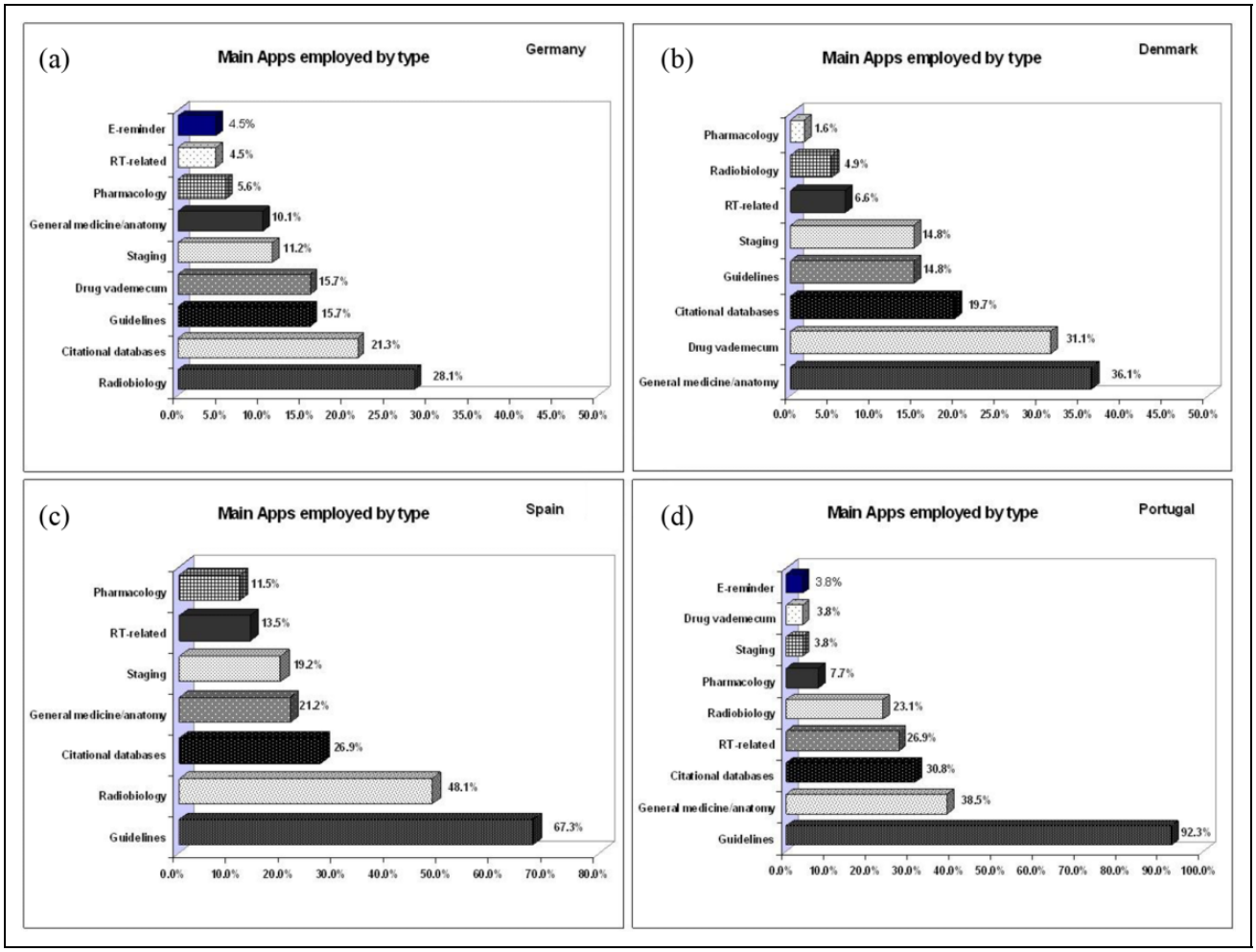

Figure 7. Most used apps by country.[2]

and found similar to those of attending patients (data not shown). Our results suggest a rather important impact of MEDs in the daily clinical practice of respondents: Overall, 65% of physicians declared to use a smartphone and/or a tablet during their clinical activity, even if this use was much lower in Germany compared to other countries (49.4%). One of the most relevant results of the PEDRO survey regards the perceived impact of MEDs in the routine activity. Indeed, more than 80% of Italian, German, and Danish participants consider it as low–moderate. This means that young radiation oncologists frequently use the apps, but they do not consider them essential or at least have a critical approach toward their integration within the clinical decision-making process. Easy access to a quick and friendly application may lead to a frequent consultation during working activities; conversely, the application of the suggestion and recommendation implies a trustful process that takes into account the reliability of the electronic tool. Thus, there may be only a partial correspondence between consultation and practical repercussion rates. This finding is divergent to the constant use increase detected in all countries over time (2009-2012). Conversely, Spanish and Portuguese participants showed a major impact of MEDs, as one-third of them consider them as essential. Moreover, most of respondents reported a low level of satisfaction toward the congruity of indications provided by the employed apps, as the fulfillment of professional needs and requirements was never or occasionally achieved for 73.8% to 85.5% of respondents in Italy, Germany, and Denmark (Figures 1C, 2C, and 3C). Consistent with previous findings, Spanish and Portuguese physicians showed a completely different trend, reporting frequent or constant fulfillment for more than 50% of respondents (Figures 4C and 5C). Some hypotheses may be supposed: residents (44% of participants) are probably still incompletely autonomous in the clinical decision making, and the presence of an institutional duty of a decisional filter performed by a tutorial figure could mitigate the influence of MEDs. However, the explanation for the ''frequent referral/low real utilization'' dichotomy for the Italian subgroup could not be applied to the Spanish group, which was principally constituted by young specialists. For specialists (56% of respondents), this diverging profile could be explained with the clinical experience and professional maturity leading to a critical interpretation of suggestions derived from apps and MEDs. Looking at the trend of utilization over time, it shows an overall ''high daily use''

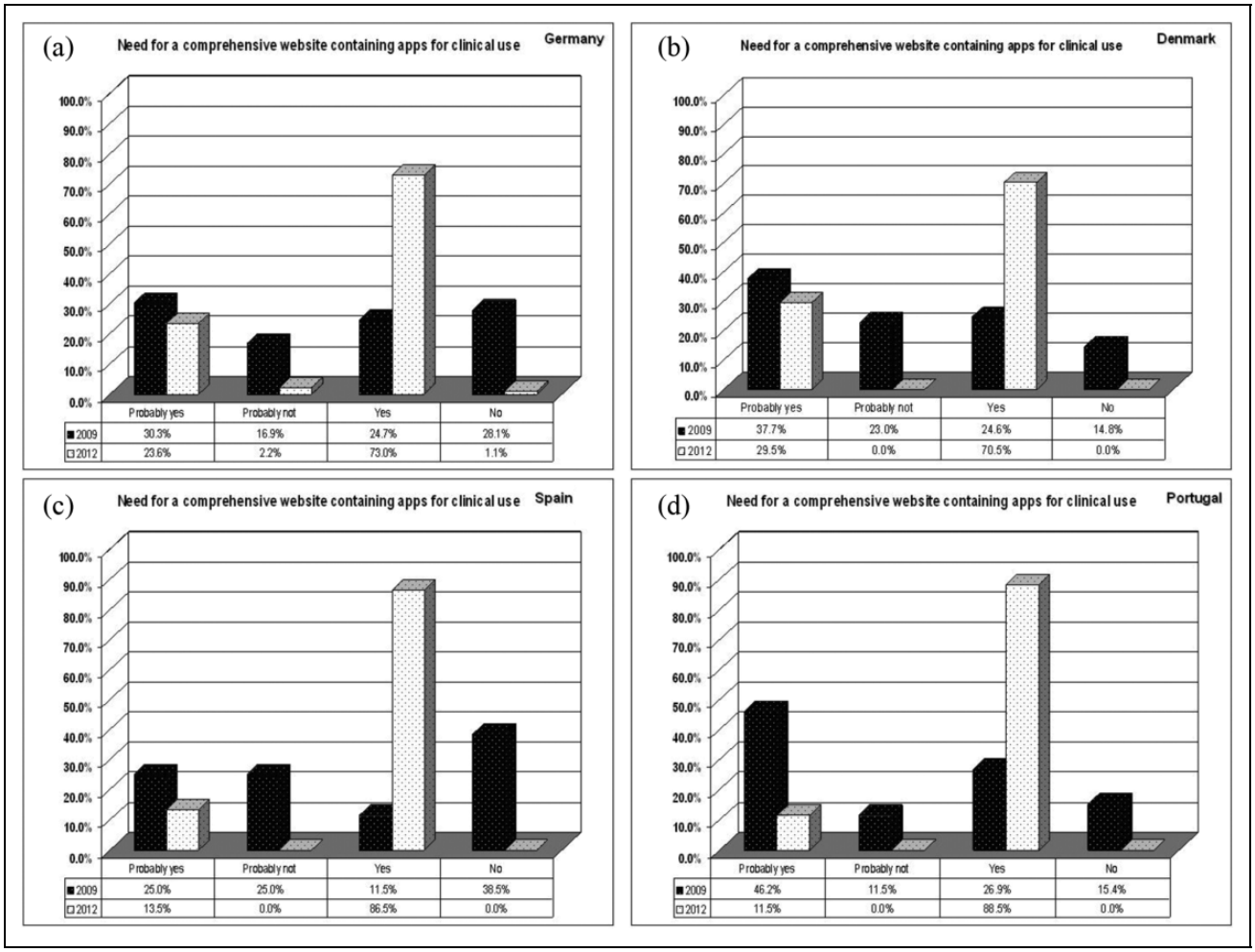

Figure 8. Perceived usefulness of a Web site containing apps for clinical and radiation oncology.

increase from 2009 to 2012. The daily impact of MEDs is quickly raising both in general population and in the professional life of physicians. It has been reported as increasing from 44% (2010) to 81% (2012) for smartphones and from 30% (2011) to over 72% (2013) for tablets, respectively.[14,15] Our study also confirms trends recently published within widespread and popular newspapers: an article in the *Wall Street Journal* showed that in 2011 up to 72% of all medical doctors in the United States own a smartphone and up to 95% of them do usually download apps.[16] In this context, the discipline of Radiation Oncology is much more influenced by the important evolving relationship between health care and technology, as clinical, technical, and computational aspects are clearly more interconnected. Thus, radiation oncologists could probably consider the role of MEDs very appealing, as they could be in their opinion a potential means to improve cancer care. The MEDs allow rapid access to the most updated information (apps, podcasts, reference texts, protocols, and recent research) and to the clinical guidelines endorsed by the most important radiation and clinical oncology societies. Moreover, several available apps strongly simplify the bedside use of medical equations (eg, Biologically effective dose (BED) calculation, scores, tumor staging, risk prediction, etc). We analyzed the use and diffusion of MED among young radiation oncologists, but it is worthwhile to note that a consistent literature has also been produced studying the potential impact of MED on educational processes of medical students and in the informational background of patients.[17-23] In this context, the importance of a correct knowledge of the clinical use of apps is strongly needed and should be underlined.[23-26] Indeed, the important potential advantages could be mitigated by some critical issues that must be strictly taken into account. Approaching MED and apps, the first question should be who are the providers and what is their reputation? One of the indices of the apps quality should be, in our opinion, the possibility to correctly and easily identify the name of the provider and the overall evaluation of the apps given in the user comments. O'Neill *et al*. analyzed 68 medical apps addressing issues related to colorectal cancer, assessing the levels of medical professional involvement in their design and content.[27] Only 29% of colorectal apps presented customer satisfaction ratings and only 32% declared medical professional involvement in their development or content. The authors concluded underlining the need for a better control and regulation of app content. Another recent study by Rodrigues

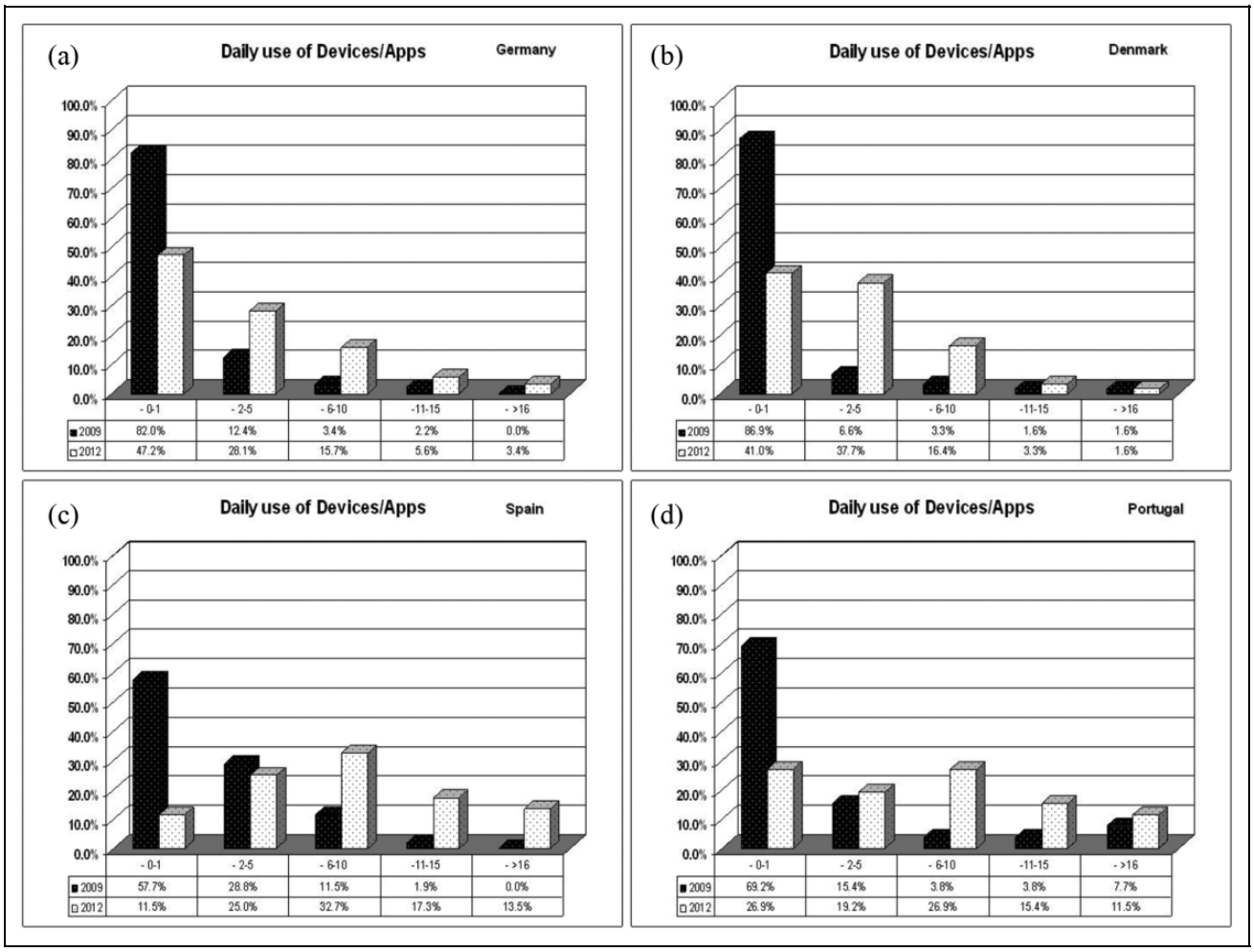

Figure 9. Daily use by country.

et al. analyzed 321 radiology-related smartphone applications.[28] Finally, despite their many potential benefits, the medical involvement in their contents and design was not always clearly identifiable. Finally, also these authors underlined the need for well-established measures to ensure apps accuracy. Van Velsen *et al*. originally underlined that one of the major limitations is the growing number of available apps: this overload makes it difficult for medical professionals (and citizens) to find the tools more appropriate to a given situation.[29] Moreover, the authors consider that information and features are fragmented over too many apps, thereby limiting their usefulness. Bender *et al*. reported in a recent review a lack of scientific data supporting the use of cancer-related apps scientifically supported data.[30] In their review, authors report that only 9.4% of the available apps are affiliated with a university or a medical institution. Finally, also these authors concluded that there is a need for a "white list" of scientifically recommended mobile health apps. We strongly share the positions of Van Velsen and Bender. In our opinion, it is time for a "joint venture" between the providers of medical information and the open source movement, aiming at a standardization of medical information formats and contents, preventing the risk of overload and improving the quality of the apps, and their impact on health care quality. We also support the creation of a Quality Assurance program, allowing also a clear definition of sources of information (eg, links to published, indexed articles, and/or to official Web sites). Last but not least, we would strongly underline that the specific clinical case and the personal clinical experience of the health care provider are much more important than information obtained by a MED, which should be considered as useful tools supporting, but not replacing clinical evaluations and knowledge. Indeed, clinical decision making should always remain an articulate and thoughtful process taking into account medical, technical, logistic, and human aspects. National and international scientific societies may play an important role in testing and verifying the correctness of the information provided by MED, endorsing, and certifying those considered valuable and reliable.

Conclusions

The PEDRO project confirmed the constantly increasing trend of utilization of clinical resources via smartphones and tablets. It is desirable to achieve a critical use of apps and mobile

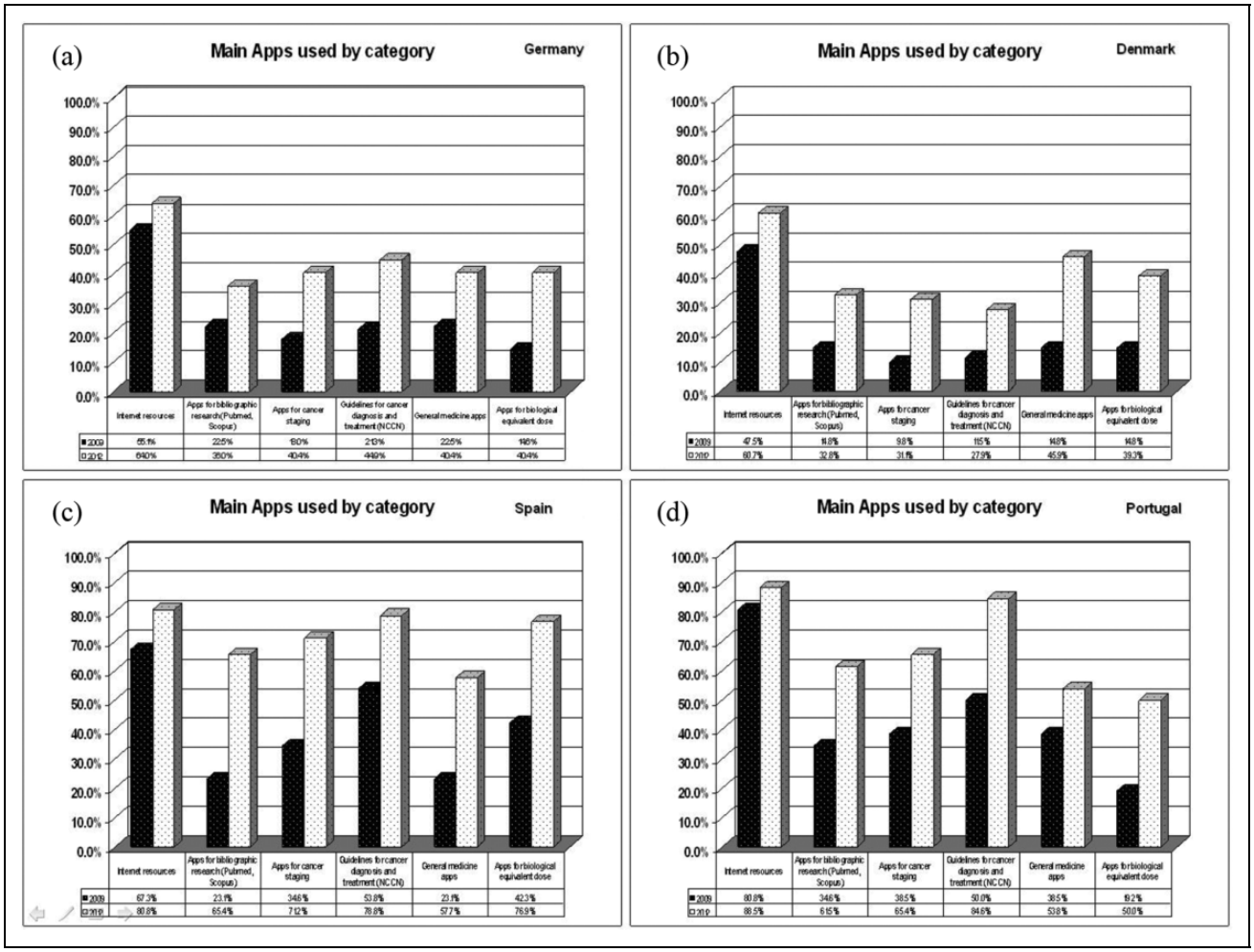

Figure 10. Most used apps by country.

technology to potentially optimize medical information and care processes. Security and reliability of apps remain important but actually unsolved issues, as well as the quality of the electronic resource, which should be checked before the adoption of the information obtained via MED in the clinical decision-making processes.

Declaration of Conflicting Interests

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