



Can Smartphones Promote Cancer Prevention Behaviours in Healthy Young Adults? A Prospective Study

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Abstract

Cancer prevention should start as early as possible. Young adults would benefit largely from the use of a smartphone app aiming at promoting cancer prevention behaviours. The aims of the study described in this paper are to (1) examine the user participation and engagement with a cancer prevention app in real-life settings and (2) assess changes in the users' cancer prevention behaviours. A cancer prevention smartphone app called Happy was developed and released to the general population. Data from registered app users' ($N = 3326$) demographics and baseline cancer prevention behaviours was analysed. App engagement was measured and all behaviour data logged through the app was analysed to assess the effectiveness of the app in the promotion of cancer prevention behaviours. User demographics and baseline behaviour assessment show that the app reached its intended target population: young adults that generally do not comply with cancer prevention guidelines. Logged behavioural data showed an increased frequency in several cancer prevention behaviours and a significant increase in the overall putative cancer prevention level ($p < 0.001$). However, user engagement with the app was limited and might condition the long-term impact of such changes. Happy reached its intended population and seems to be an effective tool to promote cancer prevention. Further research is needed to fully assess its long-term persuasive potential.

Keywords Cancer prevention · Behaviour change · Smartphones · Mobile applications

Introduction

The Importance of Cancer Prevention in Young Adults

Estimates predict that the number of cancer cases will continue to rise affecting more than 26 million by the year 2030 [1]. Smoking, drinking alcohol, physical inactivity, inadequate

sun exposure and a poor diet are among the factors that can seriously increase the risk of cancer. In fact, it is estimated that more than half of all cancers are due to unhealthy lifestyle choices [2]. Thus, any intervention aiming to change these behaviours should start as early as possible, since the cancer risk increases with the longer exposure to risk factors [3]. Research has shown the reduced awareness of young adults about cancer risk factors [4, 5] and that an increase in knowledge can have a positive impact on the frequency of cancer prevention behaviours [6]. Thus, it seems imperative to disseminate cancer prevention information among young adults. Taking into consideration that young people are early adopters of digital technologies, it is surprising that researchers have identified an absence of health interventions delivered by smartphone targeted to young populations [7]. It seems that we are overlooking a major opportunity to reach this priority population on a broad range of health behaviour issues.

Smartphones as Cancer Prevention Tools

People generally have favourable attitudes towards healthy behaviours but often lack the skills needed to maintain it as a consistent part of their daily routine [8]. Smartphones, due to

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their portability, connectivity and capabilities, can be very helpful tools in this hard task. Smartphones are personal devices that accompany individuals throughout the day and hence are in a unique position to influence users' behaviours. They can leverage on the "principle of kairos", offering health suggestions at the most opportune moments [9]. It is known that timely message reception can lead to attitude change and then to behaviour change. If receivers are able and motivated, they will process the message and act upon it. The message will persuade if it is well reasoned, data based and logical; if not, it will fail [10]. Using the "principle of kairos", one can enhance the persuasiveness of the message, increasing the probability of success.

Pandey and colleagues [11] analysed 77 cancer-related apps and concluded that currently available smartphone apps lack scientifically supported data. The authors stated that only one fourth of all apps were developed by healthcare agencies. There is a need to ensure that valid and relevant information reaches the consumers. The majority of cancer-related apps analysed are focused on general information about the disease, recent research advances and support for healthcare professionals and patients. Despite its importance, cancer prevention was not mentioned as the main theme of any application. Coughlin and colleagues [12] did an exploratory literature review and concluded that there is not a sufficient amount of well-designed studies to establish the cancer prevention capabilities of smartphone apps. They also called for the need to develop culturally appropriate, tailored health messages to promote cancer knowledge and awareness. Cancer-related apps are likely useful and provide a low-cost way to disseminate cancer prevention information to the general population and to particular at-risk populations [13]. However, we currently do not have reliable studies and strong evidence to support this assertion.

This paper describes the impact evaluation of a cancer prevention mobile app, made available to the general population in real-life settings. The aims of this exploratory study are to (1) examine the user participation and engagement with the app in real-life settings and (2) assess changes in the users' cancer prevention behaviours.

Methods

Smartphone App Description

Happy (Health Awareness and Prevention Personalized for You) is a cancer prevention smartphone app that aims to persuade users to change their behaviour, making healthier choices, thus reducing their personal risk of cancer (please refer to Online Resource 1 for screenshots of the app).

Happy uses the Fogg Behavior Model [14] as a theoretical framework, focusing on the persuasive power of triggers, and is

based on the principle of tailoring. It also uses several strategies based on different behaviour change techniques such as barrier identification, prompting, social support, social comparison and behaviour modelling [15]. When users access Happy for the first time, they are required to answer a behaviour assessment questionnaire. The assessed behaviours include diet, physical activity, weight, alcohol and tobacco consumption, ultraviolet (UV) radiation exposure, vaccination, screenings and self-exams. The data collected allows the definition of the user profile and determines a putative level of cancer prevention, called HappyScore (HSc) in the context of the app. HSc is calculated using weighted values for different behavioural factors, derived from scientific evidence [16–19]. The resulting score ranges between 0 and 150: the highest the displayed number, the better the overall behaviour in terms of cancer prevention. HSc is represented on the landing page, allowing users to self-monitor their behaviour in a glanceable way.

Behaviour assessment during app use was done through Ecological Momentary Assessment [20]. Each day, 30 min before self-reported bedtime, users were prompted to answer one behaviour question, randomly assigned from the whole behaviour assessment questionnaire. Users could also log behaviours by tapping the button "+" on the app's landing page. Daily behaviour assessments were used to recalculate the users' HSc and change the user profile over time, allowing message tailoring to occur concurrently to behaviour changes. At any given moment, users could assess their behaviour by exploring the statistics section of the app.

Happy sends one tailored short message per day within the self-reported waking hours of the user via push notification. A total of 1120 messages were created. Messages follow the European Code Against Cancer guidelines [2] and target specific behaviours, providing educational information, reminders, motivators and facilitators. The short messages are tailored to the users' profile and take into account users' context (location, time of day, week and month, weather conditions), leveraging on the "principle of kairos" [9].

In order to take advantage of existing online social interactions, Happy was integrated with Facebook, the most widely used social networking system [21]. When users access the social section and opt-in, they can see all their "Facebook friends" that are using the app sorted by HSc in a "scoreboard". The app also allows social interaction to occur between users via messaging.

Finally, Happy also suggests healthy challenges. The challenges are optional and users can enrol them at their own will. They are designed to give small achievable goals to boost users' motivation and help them reach desired behaviours. Each successfully completed challenge has a score and adds to the user score. When they reach certain milestones, they unlock rewards in the form of badges. These badges can be used for comparison purposes with other users in the social section.

The app was developed to run on Android OS and iOS, the two most commonly used smartphone platforms.

Data Acquisition

The smartphone app was made available in Portugal in September 2016, and prospective participants downloaded the free app from the Apple App Store and Google Play Store between September 2016 and April 2017. All data collected through the app between September 2016 and April 2017 was analysed. All participants provided informed consent through the smartphone and gave permission for sharing telephone data with the researchers. This study was approved by the University of Aveiro's (Portugal) Ethics Committee.

Outcome Measures

Participation, Demographics and Baseline Behaviour Assessment

The number of app downloads and number of registered users were recorded. Date of birth and gender were assessed when users registered in the app. Users later received a survey via email allowing the collection of the achieved level of education. Registered users were then required to answer a baseline behaviour assessment. The assessed behaviours include diet, physical activity, weight, alcohol and tobacco consumption, UV radiation exposure, vaccination, screenings and self-exams.

User Engagement

Engagement with the app was defined as the duration and frequency of involvement with the app. Three measures of engagement were used: (1) the duration of app use, calculated as the number of calendar days from the first to the last time behavioural data was logged; (2) the total number of days behavioural data was recorded in the app and uploaded to the system server; and (3) number of completed healthy challenges. The combination of the first two measures informs on how “intensely” the app was used by users. For instance, users could have logged data in two different occasions during a 20-day period (low level of interaction) or logged data every day in a 15-day period (high level of interaction).

Behavioural Data

HSc was used as a putative indicator of behavioural changes. Evolution of HSc (resulting from behavioural data logged in the app) between September 2016 and April 2017 was analysed. Given that prospective participants downloaded and used the app anytime during this period, there were users with very different time frames of participation. To reach a minimum of users for adequate statistical analysis, we

considered the evolution of HSc (behavioural logged data) on a 4-month time frame (first 4 months for users with longer time usage). All collected data was computed and monthly averages were calculated. Differences between initial and subsequent HSc values were computed for all users to show trends in cancer prevention behaviours.

Statistical Analysis

Descriptive statistics and exploratory data analysis were performed. Comparisons of HSc data collected in the app were done using repeated measures ANOVA test. All statistical analysis was done using IBM SPSS Statistics, version 22.

Results

Participation, Demographics and Baseline Behaviour Assessment

From launch to the time of study closure (September 2016 to April 2017), Happy was downloaded 4691 times (data derived from iTunes Connect and Google Play Developer Console). However, only 3326 (70.9%) users registered in the app and completed the baseline behaviour assessment. Likewise, only 599 (18.0%) users provided data concerning the achieved level of education. Table 1 summarises the users' sociodemographic data along with the self-reported baseline behaviour.

Engagement with the App

Overall, the app was used between 1 and 237 days (mean 30.8 days, SD 51.9) with 8.2% of users (273 out of 3326) participating at least in one challenge. Users logged behavioural data 7.6 days (range 1–193 days), on average, with only 23.4% (779 out of 3326) of users logging data 10 times or more. With increasing length of app usage, the number of behavioural data logged and challenges done per week decreased (Table 2). For example, users that utilised the app between 2 and 3 months (61–91 days) logged, on average, 1.3 times a week, whereas users with between 1 and 2 weeks (8–14 days) of app use logged 3.3 times a week, on average.

Behavioural Data

Analysis of HSc calculated upon logged behavioural data showed an average 4 point increase (Fig. 1).

A repeated measures ANOVA analysis supports this observation. Mauchly's test indicated that the assumption of sphericity had been violated, $\chi^2(5) = 188.82, p < 0.001$; therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\epsilon = 0.607$). The results show that there was significant effect on HSc over the time, $F(1.82, 291.52) =$

Table 1 Sociodemographic characteristics and self-reported baseline behaviours of 3326 app users

		<i>n</i> (%)
Sociodemographic characteristics		
Gender, <i>n</i> (%)	Female	1988 (59.8)
	Male	1338 (40.2)
Age, mean (SD)		32.7 (11.1)
Level of education* (<i>n</i> = 599), <i>n</i> (%)	Secondary education	115 (19.2)
	Higher education	484 (80.8)
Self-reported behaviour (baseline)		
Level of physical activity, <i>n</i> (%)	High	475 (14.3)
	Moderate	509 (15.3)
	Low	783 (23.5)
	No response	1559 (46.9)
Fruit and vegetables (daily average), <i>n</i> (%)	≥ 5 servings	1127 (33.9)
	3 to 4 servings	932 (28.0)
	1 to 2 servings	776 (23.3)
	None	62 (1.9)
Tobacco consumption, <i>n</i> (%)	No response	429 (12.9)
	> 10 cigarettes	156 (4.7)
	1 to 10 cigarettes	376 (11.3)
	Nonsmoker	2794 (84.0)
Motivation to quit smoking* (<i>n</i> = 532), <i>n</i> (%)	High	18 (0.5)
	Moderate	93 (2.8)
	Low	421 (12.7)
Alcohol consumption (daily average), <i>n</i> (%)	> 2 drinks	138 (4.1)
	1 to 2 drinks	866 (26.1)
	None	76 (2.3)
	No response	2246 (67.5)
Body mass index (BMI), <i>n</i> (%)	Obese	203 (6.1)
	Overweight	582 (17.5)
	Normal weight	1834 (55.1)
	Underweight	274 (8.2)
	No response	433 (13.0)
Sunburn in the previous year, <i>n</i> (%)	Yes	631 (19.0)
	No	2400 (72.2)
	No response	295 (8.9)
Performed skin self-exam, <i>n</i> (%)	Yes	876 (26.3)
	No	1832 (55.1)
	No response	618 (18.6)
Received pap smear* (<i>n</i> = 1988), <i>n</i> (%)	Yes	1093 (55.0)
	No	511 (25.7)
	No response	384 (19.3)
Performed breast self-exam* (<i>n</i> = 1988), <i>n</i> (%)	Yes	945 (47.5)
	No	696 (35.0)
	No response	347 (17.4)
Performed testicular self-exam* (<i>n</i> = 1388), <i>n</i> (%)	Yes	355 (25.6)
	No	689 (49.6)
	No response	344 (24.8)
HPV vaccination* (<i>n</i> = 1988), <i>n</i> (%)	Yes	918 (46.2)
	No	573 (28.8)
	Don't know	317 (15.9)
	No response	180 (9.1)
HBV vaccination, <i>n</i> (%)	Yes	1967 (59.1)
	No	360 (10.8)
	Don't know	681 (20.5)
	No response	318 (9.6)

*Items with *n* different from total (3326)

9.52, $p < 0.001$. These results suggest that HSc has positively changed over time.

Discussion

Main Results

The goals of this study were to examine the user participation and engagement with a cancer prevention mobile app called

Happy in real-life settings and assess behaviour changes towards cancer prevention.

During the observation period (September 2016 to April 2017), the app was downloaded 4691 times. A total of 3326 users registered in the app and, thus, provided demographic information. Users were predominantly female (59.8%), graduated (80.8%), and with a mean age of 32.7 (SD = 11.1). The baseline behaviour assessment revealed that the majority of users did not comply with cancer prevention guidelines. About two thirds (33.9%) ate less than five portions of fruit and vegetables a day, and only 14.3% had the recommended

Table 2 Mean engagement parameters for different enrolment lengths. All users that logged behavioural data were included (*n* = 3140)

Length of app usage	<i>n</i>	Days of app usage Mean (SD)	Behavioural data logged (days)		Challenges	
			Mean (SD)	Mean/week (SD) ^a	Mean (SD)	Mean/week (SD) ^b
≤ 1 week (1–7 days)	1611	2.4 (1.8)	1.9 (1.2)	6.2 (1.4)	1.4 (1.3)	2.6 (2.8)
1–2 weeks (8–14 days)	283	10.6 (2.0)	5.0 (2.6)	3.3 (1.6)	1.9 (1.2)	1.4 (0.8)
2–3 weeks (15–21 days)	195	17.8 (2.0)	5.8 (3.8)	2.3 (1.4)	2.9 (3.2)	1.2 (1.3)
3–4 weeks (22–29 days)	156	25.5 (2.4)	8.8 (5.7)	2.4 (1.5)	2.2 (1.9)	0.6 (0.5)
1–2 months (30–60 days)	338	42.2 (9.1)	10.4 (8.4)	1.8 (1.4)	3.9 (4.2)	0.7 (0.8)
2–3 months (61–91 days)	169	75.9 (9.1)	14.5 (13.4)	1.3 (1.2)	2.9 (2.5)	0.3 (0.2)
3–4 months (92–122 days)	104	105.6 (9.7)	17.7 (18.3)	1.2 (1.2)	3.5 (5.4)	0.2 (0.4)
4–5 months (123–152 days)	98	137.6 (7.9)	27.1 (32.0)	1.4 (1.6)	5.3 (6.0)	0.3 (0.3)
5–6 months (153–182 days)	68	168.5 (9.2)	26.0 (25.5)	1.1 (1.1)	8.7 (12.6)	0.4 (0.5)
6–7 months (183–212 days)	65	200.3 (8.9)	35.1 (38.1)	1.2 (1.3)	3.2 (4.2)	0.1 (0.1)
7–8 months (213–237 days)	53	226.1 (7.3)	49.3 (53.5)	1.5 (1.6)	7.9 (12.5)	0.2 (0.4)

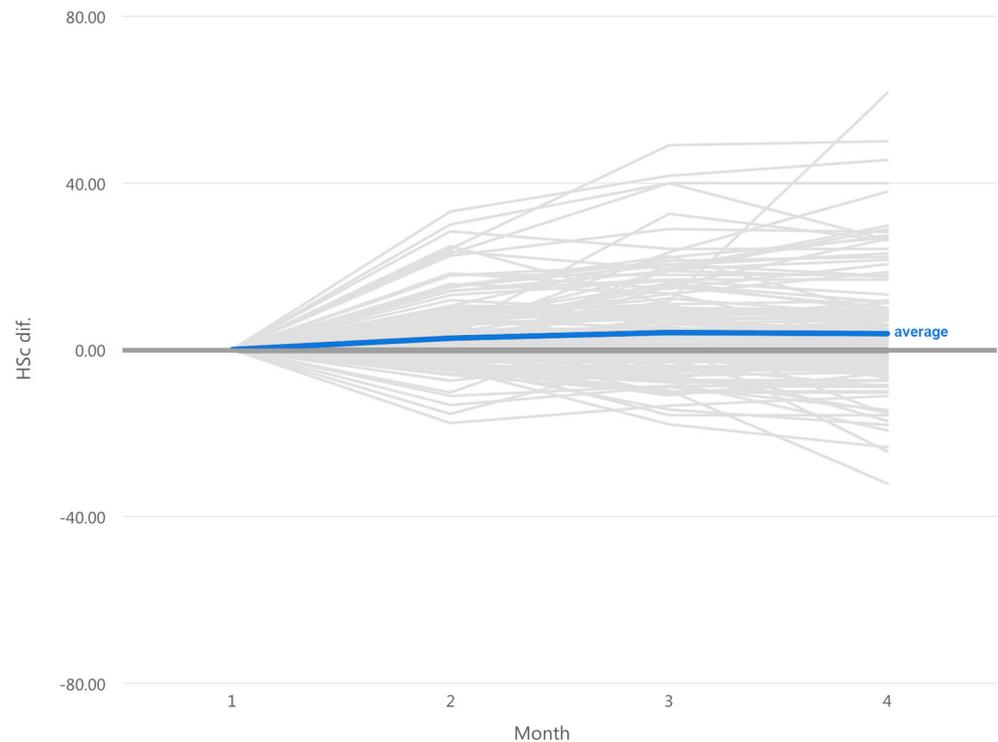
^a Calculated by (number of behaviour logs / number of days of app usage) × 7

^b Calculated by (number of completed challenges / number of days of app usage) × 7

level of physical activity. A quarter of users (23.6%) were overweight; 16.0% presented themselves as smokers and

30.2% declared alcohol consumption. A fifth of all users (19.0%) had at least one sunburn in the past year and more

Fig. 1 Changes in users’ HSc during the first 4 months of app use (*n* = 161). Each grey line represents a different user. The blue line depicts the average HSc difference for the whole group of users



than half (55.1%) never performed a skin self-exam, undermining the possibility of preventing the most common form of cancer (nonmelanoma skin cancer) [1]. Among female users, about half (45.0 and 53.8%) did not comply with cervix cancer prevention guidelines (Pap smear and HPV vaccination), despite being a common form of cancer in women [1]. Likewise, almost half of all male users (49.6%) had never performed a testicular self-exam, a simple and quick way to detect the most frequent cancer in young men in Western populations [22]. This confirms previous observations concerning this population's lack of cancer awareness [4, 5]. We can thus assert that this app reached the target population: young adults that currently do not comply with cancer prevention guidelines. It is also worth noting that, among users that smoked, the motivation to quit was, overall, low (cf. Table 1). It is reasonable to think that these users would never download a quit-smoking app. However, by downloading this app, they were exposed to health messages motivating them to quit smoking, providing a good opportunity for them to change this harmful behaviour. This underlines the importance of multiple behaviour interventions as opposed to single behaviour interventions.

The present study reported low levels of app engagement, with only 23.4% (779 out of 3326) of users logging data 10 times or more. On average, the app was used for 30.8 days and only 8.2% users participated in healthy challenges. Results also showed that the longer the users logged data, the less frequently they engaged with the app each week. This has been reported in previous studies and seems to be a side effect of using health-related apps in real-life settings [23]. This phenomenon has been called the “Law of attrition” and is one of the fundamental methodological challenges in the evaluation of health-related applications [24]. Unlike drug trials, where the intervention is “prescribed” to patients, in studies involving health information technology, usage is at the discretion of the participant and he/she can easily discontinue usage. In longitudinal studies such as the one described, where the intervention is neither mandatory nor critical for the participants' health, frequently trial participants will be lost reducing the intervention group to a small number of participants. Several factors have been proposed that might influence nonusage and dropout attrition in mobile health interventions such as inappropriate information (leading to unrealistic expectations), ease of enrolment and drop out, usability and interface issues, lack of personal contact, workload and time required, competing interests, among others [24].

Happy was designed for long-term use, since it relied on small changes to occur cumulatively over a long period of time. In this sense, we can assume that the app was not able to engage users for a long period of time, conditioning its long-term effectiveness. This time range should be taken into consideration when designing future health-related apps: 30-day interventions should be more adequate to optimise

resources and results. Despite this limitation, study results show that Happy might be an effective way to promote cancer prevention. Behavioural data logged by users showed an increase in some protective behaviours and a decrease in risky behaviours. The average HSc, representing the overall cancer prevention level, improved by 4 points during a 4-month period. Results are suggestive of the persuasive potential of Happy to increase cancer prevention behaviours in frequent users. However, given the attrition limitations experienced in this study, more research is needed to effectively assess this effect on cancer prevention behaviours on longer time frames in real-life settings.

Limitations

The main limitation in this study is associated with the nonusage attrition. Users logged behavioural data 7.6 days, on average, and engagement with the app decreased as they used it for a longer period. The reported low levels of app engagement undermine the generalisation of this study results and validate permanent behaviour changes.

Future Work

This study provided some evidence that a cancer prevention smartphone app might be effective. However, due to nonusage attrition, the results should be regarded with caution. An in-depth study of the factors underlying this phenomenon would be of great value, since user engagement with the cancer prevention app is essential for its success regarding the effectiveness of this solution in promoting cancer prevention behaviours. Further research is needed to fully assess the effectiveness of Happy. Namely, a randomised controlled study should be designed to assess the effects of using this cancer prevention app; the use of controlled settings would probably lower the nonusage attrition rate, since participants are likely to be more motivated and committed to this type of study because of the formal structure and selection processes involved [24].

Conclusions

The promotion of cancer prevention behaviours in healthy young adults can largely benefit from the use of smartphone apps. Happy, a smartphone app targeting cancer prevention behaviours, was developed and released to the general population aiming to reach young adults that generally do not comply with cancer prevention guidelines. The analysis of the user demographics and baseline assessment indicate that the app reached its target population. Study results provided some evidence that a cancer prevention smartphone app can be effective. However, user engagement with the app was shorter than expected and limits the conclusions of the study. Further

research is needed to fully assess the effectiveness of Happy, during a longer time range in real-life settings.

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Compliance with Ethical Standards

This study was approved by the University of Aveiro's (Portugal) Ethics Committee.

References

- Torre LA, Bray F, Siegel RL, Ferlay J, Lortet-tieulent J, Jemal A (2015) Global Cancer Statistics, 2012. *CA Cancer J Clin* 65:87–108. <https://doi.org/10.3322/caac.21262>
- Schüz J, Espina C, Villain P, Herrero R, Leon ME, Minozzi S, Romieu I, Segnan N, Wardle J, Wiseman M, Belardelli F, Bettcher D, Cavalli F, Galea G, Lenoir G, Martin-Moreno JM, Nicula FA, Olsen JH, Patnick J, Primic-Zakelj M, Puska P, van Leeuwen FE, Wiestler O, Zatonski W, Guha N, Kralikova E, McNeill A, Peruga A, Anderson A, Berrino F, Boutron-Ruault MC, Cecchini M, Key TJ, Leitzmann M, Norat T, Powers HJ, Scoccianti C, Auvinen A, de Vries E, Erdmann F, Greinert R, Harrison J, Kesminiene A, McColl N, Friis S, Kogevinas M, Saracci R, Straif K, Vainio H, Almonte M, Anttila A, de Vuyst H, Dillner J, Franceschi S, Gonzalez P, Hall A, Park JY, Armaroli P, Atkin W, Dean PB, de Koning H, Dillner L, Kuijpers E, Lansdorp-Vogelaar I, Paci E, Regula J, Suonio E, Törnberg S, Wood LF, Gaudin N, Frie KG, Terrasse V, Winstanley K, Bellisario C, Biagioli E, Cinquini M, Gianola S, Gonzalez Lorenzo M, von Karsa L, Lignini T (2015) European code against cancer 4th edition: 12 ways to reduce your cancer risk. *Cancer Epidemiol* 39:S1–S10. <https://doi.org/10.1016/j.canep.2015.05.009>
- Colditz GA, Wei EK (2012) Preventability of cancer: the relative contributions of biologic and social and physical environmental determinants of cancer mortality. *Annu Rev Public Health* 33:137–156. <https://doi.org/10.1146/annurev-publhealth-031811-124627>
- Katz RC, Meyers K, Walls J (1995) Cancer awareness and self-examination practices in young men and women. *J Behav Med* 18:377–384. <https://doi.org/10.1007/BF01857661>
- Sherman SM, Lane EL (2014) Awareness of risk factors for breast, lung and cervical cancer in a UK student population. *J Cancer Educ* 30:1–4. <https://doi.org/10.1007/s13187-014-0770-3>
- Werk RS, Hill JC, Graber JA (2016) Impact of knowledge, self-efficacy, and perceived importance on steps taken toward cancer prevention among college men and women. *J Cancer Educ* 32:148–154. <https://doi.org/10.1007/s13187-016-0996-3>
- Fedele DA, Cushing CC, Fritz A, Amaro CM, Ortega A (2017) Mobile health interventions for improving health outcomes in youth. *JAMA Pediatr* 171:461–469. <https://doi.org/10.1001/jamapediatrics.2017.0042>
- Bauman A, Ainsworth BE, Sallis JF, Hagströmer M, Craig CL, Bull FC, Pratt M, Venugopal K, Chau J, Sjöström M, IPS Group (2011) The descriptive epidemiology of sitting: a 20-country comparison using the international physical activity questionnaire (IPAQ). *Am J Prev Med* 41:228–235. <https://doi.org/10.1016/j.amepre.2011.05.003>
- Fogg BJ (2007) Increasing persuasion through mobility. In: Fogg BJ, Eckles D (eds) *Mob. Persuas. 20 Perspect. Futur. Behav. Chang.* Stanford Captology Media, Stanford, pp 155–163
- Chatterjee S, Price A (2009) Healthy living with persuasive technologies: framework, issues, and challenges. *J Am Med Inform Assoc* 16:171–178. <https://doi.org/10.1197/jamia.M2859>
- Pandey A, Hasan S, Dubey D, Sarangi S (2013) Smartphone apps as a source of cancer information: changing trends in health information-seeking behavior. *J Cancer Educ* 28:138–142. <https://doi.org/10.1007/s13187-012-0446-9>
- Coughlin S, Thind H, Liu B, Champagne N, Jacobs M, Massey RI (2016) Mobile phone apps for preventing cancer through educational and behavioral interventions: state of the art and remaining challenges. *JMIR mHealth uHealth* 4:e69. <https://doi.org/10.2196/mhealth.5361>
- Bert F, Giacometti M, Gualano MR, Siliquini R (2014) Smartphones and health promotion: a review of the evidence. *J Med Syst* 38:9995. <https://doi.org/10.1007/s10916-013-9995-7>
- B.J. Fogg (2009) A behavior model for persuasive design. *Proc. 4th Int. Conf. Persuas. Technol. - Persuas. '09*. 1. doi: 10.1145/1541948.1541999
- Abraham C, Michie S (2008) A taxonomy of behavior change techniques used in interventions. *Health Psychol* 27:379–387. <https://doi.org/10.1037/0278-6133.27.3.379>
- Ott JJ, Ullrich A, Mascarenhas M, Stevens GA (2011) Global cancer incidence and mortality caused by behavior and infection. *J Public Health (Bangkok)* 33:223–233. <https://doi.org/10.1093/pubmed/fdq076>
- Parkin DM, Boyd L, Walker LC (2011) 16. The fraction of cancer attributable to lifestyle and environmental factors in the UK in 2010. *Br J Cancer* 105:S77–S81. <https://doi.org/10.1038/bjc.2011.489>
- Doll R, Peto R (1981) The causes of cancer: quantitative estimates of avoidable risks of cancer in the United States today. *J Natl Cancer Inst* 66:1191–1308 <http://www.ncbi.nlm.nih.gov/pubmed/7017215>
- Bjartveit K, Tverdal a (2005) Health consequences of smoking 1–4 cigarettes per day. *Tob Control* 14:315–320. <https://doi.org/10.1136/tc.2005.011932>
- Smyth J, Stone A (2003) Ecological momentary assessment research in behavioral medicine. *J Happiness Stud* 4:35–52. <http://link.springer.com/article/10.1023/A:1023657221954> (accessed May 30, 2014)
- Facebook statistics, (2015). <http://www.statisticbrain.com/facebook-statistics/> (accessed March 21, 2016)
- M. Van Hemelrijck, T. Shanmugalingam, A. Soultati, S. Chowdhury, S. Rudman (2013) Global incidence and outcome of testicular cancer. *Clin Epidemiol* 417. doi: 10.2147/CLEP.S34430
- McConnell MV, Shcherbina A, Pavlovic A, Homburger JR, Goldfeder RL, Waggot D et al (2016) Feasibility of obtaining measures of lifestyle from a smartphone app. *JAMA Cardiol* 346:793–801. <https://doi.org/10.1001/jamacardio.2016.4395>
- Eysenbach G (2005) The law of attrition. *JMIR* 7:1–9. <https://doi.org/10.2196/jmir.7.1.e11>