Effectiveness of a mobile app delivering real-time tailored sun safety advice in a randomized trial

David Buller,[1] Marianne Berwick,[2] Kathleen Lantz,[3] Ilima Kane,[1] Mary Buller,[1] and James Shane[1]

1. Klein Buendel, Inc., Golden, CO, USA
2. University of New Mexico, Albuquerque, NM, USA
3. University of Colorado and National Oceanic and Atmospheric Administration, Boulder, CO, USA

Abstract. Mobile apps on smart phones have been created to communicate the UV Index and provide sun safety advice in several countries. We developed a mobile app that combines time and location from the phone and hourly UV Index forecasts from the U.S. weather service, displays current UV Index, risk of sunburn, and estimated vitamin D, and recommends sun protection, adjusted for users' skin type and protection practices (e.g., clothing, sunscreen SPF, use of shade). In a randomized controlled trial with a nationwide U.S. sample (n=604), adults assigned the mobile app reported elevated self-efficacy for sun protection (+0.16, p=0.022), greater use of shade (+7%, p=0.034), and less use of sunscreen (-6%, p=0.048) at posttest compared to controls. The mobile app's effect was moderated by income, tan desirability, and urban location, and influenced by amount of use. The mobile app may be effective because it can proactively and repeatedly provide sun safety advice in the moment, when and where it is most needed.

Introduction

Adults are using smart phones and tablet computers to run mobile apps and access the Internet, including for health information (Fox, 2011). Mobile interventions have the potential to improve health. They can collect user data, manage time and location dependences, and access remote databases. They may enhance engagement by proactively, unobtrusively, and repeatedly reaching out to users, requesting attention, creating urgency to respond, and delivering advice in real-time, 24/7, anywhere. This should elevate the ecological validity of the intervention by tailoring advice to users "in-the-moment," and creating social support (Abroms, Padmanabhan, and Evans, 2012; Riley, Rivera, Atienza, Nilsen, Allison, Mermelstein, 2011; Fjeldsoe, Miller, Marshall, 2012).

In this project, we tested a mobile application ("app") that provided sun safety advice. It was hypothesized that the mobile app would increase sun protection practices and decrease sunburn.

Solar Cell mobile application

The *Solar Cell* mobile "app" was available for Android smart phones.[39] It delivered personalized sun protection advice based on: a) 5-day hour-by-hour UV Index forecasts from the U.S. National Oceanic and Atmospheric Administration for each 0.5º latitude-longitude grid in North America, b) time and location from the smart phone, and c) personal information from the user (i.e., skin phenotype, height, weight, age, whether in the sun, in the shade, or indoors, use of sunscreen and clothing and use of sun-sensitive medications). Using algorithms based on published literature, the mobile app provided the

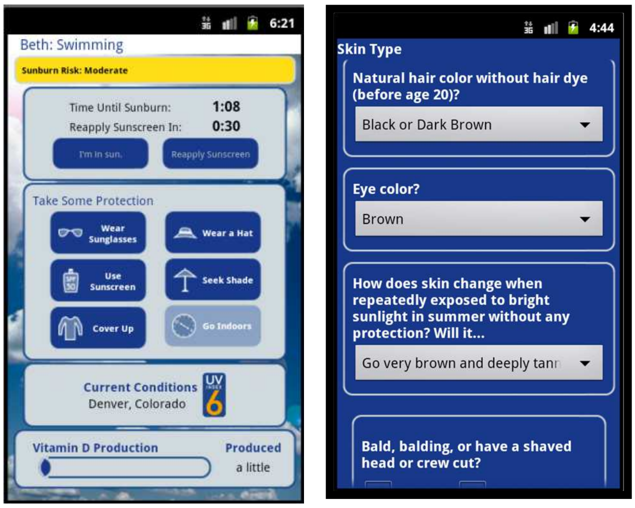

Figure 1: Feedback screen in the *Solar Cell* app (left panel) and example of user input screen (right panel).

following advice: a) risk of sunburn (time until sunburn and level of risk [low, moderate, extreme]) adjusted for skin phenotype, sunscreen, and shade, b) time until reapplication of sunscreen, c) recommended sun protection practices (sunglasses, sunscreen, hats, protective clothing, shade, and go indoors), d) forecasted UV Index, and e) estimated amount of vitamin D produced by the skin. Visual and audible alerts signaled when users needed to reapply sunscreen, recommended daily dose of vitamin D was achieved, and sunburn risk was extreme.

Sample, trial design and measures

Adults (n=604) were recruited from the Knowledge Panel (a panel representative of the U.S. population) from July 10-23, 2012. Eligibility criteria were being non-Hispanic or Hispanic white, 18 years of age or older, and a U.S. resident, and owning an Android smart phone. Participants consented, completed the baseline survey, and were enrolled in a randomized pretest-posttest controlled design. Those assigned to the treatment group received instructions to download and use the *Solar Cell* mobile app (n=399 treatment; n=395 control; no statistically significant differences between groups, p>0.05). At seven weeks, participants were sent a reminder to use the mobile app. Ten weeks after the recruitment period began, all participants were re-contacted for posttesting, which concluded on October 3. A few participants failed to indicate they had completed the pretest but were eligible and randomized, so they were posttested in December. The posttest was completed by 454 participants (75%; n=222 treatment; n=232 controls; completers were older and home owners than non-completers, p<0.05). Time in the midday sun (10 am to 4 pm), sun protection practices (percent of days), and sunburn prevalence in the past 3 months were assessed.

Profile of the sample

Participants were aged 18 to 80 (M=38.9 years; 68% 18-44) and were well educated (40% had a college degree). The sample was equally divided on gender (48% female) and 30% had been diagnosed with skin cancer. The average household size was 3.1; 63% had incomes of $50,000 or more; and 69% were married. Finally, 10% were Hispanic whites and 24% had high-risk skin phenotypes (scores of 4 or 5 on the index). The treatment group had fewer heads of household (-7%, p<0.05) than the control group.

Effect of experimental group assignment

Participants assigned to *Solar Cell* and completing the posttest reported they used shade a higher percent of time (+7%, p=0.03) but sunscreen a lower percent of the time (-6%, p=0.04) when outdoors at posttest than controls. Group assignment did not affect other sun safety practices, sunburn prevalence, or time spent outdoors in the midday sun (p>0.05). Preference for a sun tan moderated group differences. Participants with stronger preferences for a tan assigned to *Solar Cell* reported using protective clothing more often than controls (p=0.03). Individuals assigned to *Solar Cell* report greater confidence they could avoid getting sunburned than controls (+0.16, p=0.02); this effect was greater among less affluent adults (p=0.01). All differences were not evident in analyses performed imputing missing posttest values.

Use of *Solar Cell* mobile app

Of the 305 people assigned to *Solar Cell*, only 125 (41%) used it and obtained sun safety advice (i.e., had the feedback screen displayed at least once; 76% 1 to 5 times, 16% 6 to 10 times, and 8%, ≥11 times). Those who used *Solar Cell* spent a larger percentage of days keeping their time in the sun to a minimum and estimated they spent fewer hours in the midday sun (but not fewer days) than non-users (-36.6 hours, p=0.02). Users also reported a larger percentage of time practicing all sun protection behaviors than non-users (+6%, p=0.04). Use had favorable effects on sun protection among non-employed individuals (higher use of wide-brimmed hats; p<0.01), those in large households (more frequent use of shade; p<0.01), and females (fewer hours spent in midday sun; p=0.03).

Discussion

The *Solar Cell* mobile app appeared to promote sun protection, especially when it was used. Shade use can substantially cut UV exposure but needs to be present. Reduced use of sunscreen may be favorable since it is often used inadequately (Buller, Andersen, Walkosz, Scott, Maloy, Cutter, Dignan, 2012). Of the moderators, the positive impact of *Solar Cell* on sun protection by adults preferring a suntan is noteworthy, as this group may be intentionally exposing their skin to UV. Also, *Solar Cell* may correct over-confidence among more affluent users that sun protection is easy. Adults in larger families may be more motivated to follow *Solar Cell*'s advice to protect their children.

Use of *Solar Cell* was lower than expected and use was highest in the early days of the study. This pattern of use has been observed with other technology interventions. Low use may occur if adults found *Solar Cell* less valuable, lost interest or learned to follow its advice and no longer needed the mobile app. Increased use of *Solar Cell* was related to spending less time in the midday sun and more frequent sun protection, so strategies to elevate app use are needed. Finally, the mobile app did not increase individual's sun exposure.

Strengths of the trial included the large nationwide sample and prospective randomized design. The self-report measures and lack of mobile app use by some participants were limitations.

References

Abroms, L., Padmanabhan, P., Evans, W. 2012. Mobile phones for health communication to promote behavior change. In: Noar S, Harrington N, editors. E-Health Applications: Promising Strategies for Behavior Change, 1st ed, pp. 147-166. New York, NY: Routledge.

Buller, D.B., Andersen, P.A., Walkosz, B.J., Scott, M.D., Maloy, J.A., Cutter, G.R., Dignan, M.D. 2012. Compliance with sunscreen advice in a survey of adults engaged in outdoor winter recreation at high-elevation ski areas. Journal of the American Academy of Dermatology 66(1):63-70.

Fjeldsoe, B., Miller, Y., Marshall, A. 2012. Text messaging interventions for chronic disease management and health promotion. In: Noar S, Harrington N, editors. E-Health Applications: Promising Strategies for Behavior Change, 1st ed, pp. 167-186. New York, NY: Routledge.

Fox, S. The social life of health information, 2011. Pew Internet & American Life Project Web site. http://www.pewinternet.org/Reports/2009/8-The-Social-Life-of-Health-Information.aspx. Updated May 12, 2011. Accessed January 14, 2013.

Riley, W., Rivera, D., Atienza, A., Nilsen, W., Allison, S., Mermelstein, R. 2011. Health behavior models in the age of mobile interventions: are our theories up to the task? Translational Behavioral Medicine 1(1):53-71.