Changing lifestyle behaviors with personalized feedback delivered via the Internet

Valorization

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Social Relevance

According to recent projections, as much as 52 million people will die of noncommunicable diseases, such as cardiovascular diseases, in 2030. Many of these deaths can be prevented by tackling the four risk factors common to noncommunicable diseases: tobacco use, harmful use of alcohol, unhealthy diet, and insufficient physical activity.

Currently, far too many people are not sufficiently physically active worldwide. Surveillance is necessary to detect whether the situation improves or worsens. We have shown that it is feasible to dispatch devices that can measure physical activity objectively, across several countries, and discussed why this should be done instead of continuing to rely on biased self-reports.

Obesity is also still a major global concern. Thus, finding long-lasting strategies to help individuals manage their weight and be sufficiently physically active is a huge challenge. In the Food4Me project, we set out to test whether personalized advice was more effective in changing unhealthy behaviors, such as unhealthy diet and low physical activity, than non-personalized health guidelines. We also wondered whether the intervention could be delivered via the Internet.

These questions are relevant for society for several reasons. Almost any adult with an interest in personalized nutrition was free to volunteer for the Food4Me study (with the exception of persons with very specific needs because of a medical condition or food allergy, who were excluded for safety reasons). Great interest was raised, more than 5,500 people starting the screening procedure and even more visiting the Food4Me website. Thus, the interest in personalized nutrition goes well beyond the scientific community.

Using the Internet is also very relevant because it is probably the only feasible way to deliver a tailored intervention at such a scale at reasonable costs. Nowadays, 78.5% of the population in the European Union uses the Internet, and it is the place where many people go to find information about health or help.

At the same time, researchers, but also private companies, have sought to use the rapid advances in genotyping of the last two decades to tailor health-related advice to the individual. However, this has raised a number of issues: whether we understand gene-lifestyle interactions well enough to derive recommendations based on genetic

make-up, whether gene-based advice is more effective in changing unhealthy behaviors than non-gene-based advice, whether collecting DNA information and providing such feedback is ethical, and so forth. The discussion of our findings contributes to answering these questions.

Internet proved a good medium for the delivery of our intervention and most individuals who started the trial completed it. However, we also found that individualized feedback was not always enough to motivate people to engage in healthier behaviors. Although people were interested in monitoring their physical activity themselves, detailed feedback in real time will be necessary for more compliance. In terms of effectiveness of gene-based advice, large, good-quality randomized controlled trials were needed to inform the scientific community, as well as companies selling genetic tests. Our findings argue against using genetic test results to tailor advice on physical activity and body weight. In addition, as discussed in this thesis, we are in favor of tampering the enthusiasm for precision medicine and would encourage measures that more directly serve the prevention of noncommunicable diseases, i.e. can be implemented now. Personalized advice can be an effective strategy to help individuals to make healthy changes, and Internet can be an appropriate platform for support, if additional features (e.g. online coaches) are put into place next to an interactive website and online tailored feedback. Tailoring the advice is necessary but gene-based advice does not seem justified.

Target groups

Low physical activity, as well as overweight and obesity are major risk factors for noncommunicable diseases, such as type 2 diabetes, cardiovascular diseases, and some cancers. Our results can help raise awareness that it is important to monitor oneself and consciously look for ways to make sustainable changes. Hence, this thesis can be of interest to any individuals at risk. It may also interest those curious about having their DNA sequenced and the accuracy of health advice based on such genetic tests. It will hopefully also interest the private companies that are promoting those tests, and make them reflect on their practices and how these can be improved.

We have identified a number of gaps in the literature. Thus, the discussions in this thesis may inform researchers on future steps, as well as engineers who ought to develop better ways to measure dietary intake and physical activity energy expenditure. We have concluded that we believe in choice architecture to promote healthier behaviors but that regulation is necessary, especially to limit unhealthy nudges. In that respect, our results are also addressed to governments. They can make a tremendous difference, if they respond readily to maintain that people are responsible for their own

health, while also taking public health actions that change default choices to make it easier for people to stay healthy.

Activities

All research described in this thesis stems from a close collaboration between eight European universities or research centers and also involved industrial partners. This successful collaboration is a good example of interdisciplinary research and how it can lead to a large-scale pan-European intervention. Research can only have an impact if it is shared within the scientific community and without, in order to kindle relevant future research, raise awareness and support from the society, and push policy makers to get involved. To this end, the results described in this thesis have been communicated in multiple ways. Results have been written in original research articles, which have been published or submitted in high-impact peer-reviewed journals in the field of medicine, obesity, or mobile health. These articles are or will be open access, available online to anyone (scientist or not) with an interest in the topic. Furthermore, a white paper has been written (which includes part of the findings from this thesis) for the attention of the European Commission. Results have also been presented at several local, national and international conferences. In addition, regular updates are posted on the Food4Me website.

Innovation

The work described in this thesis is part of the Food4Me Study, which is the largest randomized controlled trial on personalized nutrition and lifestyle to date. It answers an identified need to know more about the effect of genetic-based advice on nutrition and lifestyle (physical activity, body weight). Personalized nutrition, as well as precision medicine, is in the spot light and it is necessary to carefully assess whether they represent an immediate future, or one farther away. Our study was innovative; it was designed to emulate an Internet-based personalized service, and therefore all contact between researchers and subjects was via the Internet or the postal services. This study was the first to use gene-based advice to try to increase physical activity levels. To our knowledge, we were also the first to monitor physical activity with accelerometers for 6 months, using a system, which allowed us to see participants' physical activity levels directly upon data upload on their computer.

The Food4Me Study was part of a larger EU project, which aimed to explore all elements of personalized nutrition using a multi-disciplinary approach. Food4Me recognized that without a detailed understanding of consumer attitudes to personalized

nutrition, any foresight in this field would fall well short of ideal. Thus a significant part of the work-program was devoted to probing the opinions of EU consumers. Allied to an understanding of consumer attitudes to personalized nutrition is the need to understand the viability of any personalized nutrition enterprise whether driven by either social or private entrepreneurship. Across a series of workshops with stakeholders from across a wide range of interested sectors, a number of scenarios were developed which will help shape our thinking of the viable alternatives for the creation of a sustainable personalized nutrition offering. This work-package on business models drew on the findings of the consumer research group in developing its final set of scenarios. Personalized nutrition is largely driven by technology, with regards to what can be measured to best characterize health status and nutritional needs. The efficiency of assessment and delivery of personalized nutrition advice is also technology-dependent. For this reason, exploring the technologies needed in personalized nutrition was a central focus of the project, with a specific work-package dedicated to the theme. The researchers involved set up a Global Network and online knowledge base to establish the most relevant genes in relation to dietary interactions for health outcomes. In addition, the work-package has developed algorithms for the delivery of personalized nutrition advice and has pioneered novel methods for assessing health parameters using very small blood-spot samples. In the USA, personalized nutrition, specifically personalized nutrition based on genomic data, has come under the scrutiny of regulatory authorities from time to time. In addition, fears are frequently expressed at personalized genomic data becoming available to third parties such as health insurance companies. Thus Food4Me established an ethics and legal work-package devoted entirely to this topic. Several ethical issues have been raised and explored via workshops and scientific publications.

Schedule and implementation

In this thesis, we have shown that disclosure of genetic information was not effective in motivating people to increase their physical activity or reduce their body weight. The research team currently investigates whether this absence of effect is also true for other lifestyle aspects, such as changes in diet. The research team is also looking at whether the disclosure of a low-risk genetic test result leads to poorer outcome changes in terms of dietary components. It was not very clear for physical activity and body weight changes.

More research is also needed to identify the features that are necessary to the success of a tailored eHealth intervention. A number of components were judge essential (e.g. online coaches), but other studies need to confirm this. Assessing physical activity

levels using accelerometers was successful in our pan-European study, and we hope it will encourage any new large-scale trial assessing physical activity to do the same instead of only relying on self-reports.

Another aspect, in which the research team is currently not involved but hopefully will in the future, is the development of better, more objective, methods to measure dietary intake. Dietary intake data are mostly collected using self-report instruments, such as food frequency questionnaires, food records (or diaries) and 24-hour dietary recalls but there is a large body of evidence showing that self-reported dietary intake is poorly related to actual energy or nutrient consumption. Alternatives to self-report instruments for dietary assessment include nutritional biomarkers, but they do not reflect total energy intake and are cumbersome and expensive. The intake-balance method involves measuring changes in energy expenditure as well as changes in body energy stores, but is also demanding and costly. Other technologies are being developed for self-tracking dietary intake, including devices that count bites and measure chewing and swallowing but they give no information on which foods are consumed. Probably the most promising are food recognition systems. They are still in their infancy, but are promising and more researchers ought to get involved in that area.

Finally we believe in choice architecture, i.e. the careful design of the environments in which people make choices, and that a top priority should be to study how this can promote healthier behaviors. This cannot happen without close collaboration with responsive governments because regulation is necessary, especially to limit unhealthy nudges. A government that responds readily can maintain that people are responsible for their own health while also taking appropriate public health actions to make healthy choices, the default choices.