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Improving employee health; lessons from an RCT

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Abstract: Work site healthy lifestyle interventions hold promise for improving health and employability. As part of a larger employer vitality program and a work site randomised controlled trial (RCT, n = 59 intervention arm) to assess cardiac risk impacts, we conducted a design analysis on a hybrid eHealth solution. The control condition was six weeks waiting list and then start of the hybrid eHealth support (n = 57). Our analysis supports three conclusions. First, the hybrid eHealth intervention did significantly improve physical risk factor variables after six weeks. Motivation and measurement alone (waiting list) did not. Second, theory on timing of health support for patients appeared generalisable to employees: it did help to offer support at a moment of high motivation, instead of later. Hence, offering employees active health support directly after physical measurements (health check-ups) is more effective for improving health and self-management than the common practice of focusing on the employee check-up itself. Third, a design analysis was conducted to help improve ICT-enabled health interventions. This resulted in several recommendations and improved user adoption.

Keywords: randomised controlled trial; RCT; work site health; eHealth; productivity; engagement; ownership; health check; healthy lifestyle intervention.

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1 Introduction

The speed and changes of modern work life place serious demands on worker health, resilience and work-life balance. Moreover, given our ageing work force and future financial challenges, upholding health and productivity form a major societal challenge all across Europe.

Currently, the majority of the 60+ citizens in the potential work force in the Netherlands are not employed (CBS, 2012). This is partly due to health and vitality concerns. For males, the 60–65 age group consumes the largest healthcare budget, mainly due to cardiovascular disease (Slobbe et al., 2011). Given our ageing population and rising healthcare costs, the need grows for a population which stays healthy and employable longer.

Moreover, increasing employee ownership for health and recovery management is important, see previous work on ‘corporate athletes’ (Loehr and Schwarz, 2001). Worker engagement is crucially important (Bakker et al., 2011) and personal energy management (Schwartz and McCarthy, 2007). Nowadays, job content and job security are not always

very stable, hence health and resilience are very important. At work and for the issue of work life balance.

The context of this study is provided by an employee vitality program. Since 2010, the Human Resource (HR) Department of Delft University of Technology has piloted an extensive eSupported lifestyle program, the Health Coach Program, which combines coach sessions with electronic dashboarding and self-management. The HR department and company physicians mainly aim at the following part of the employee population: those with increased cardio-metabolic risk (inclusion of > 50 participants/year), with increased absenteeism (inclusion of > 50 participants/year) plus a minority admission (inclusion of < 30 participants/year) with various health issues or interests.

In this HR setting, promising health and productivity results have been measured on a pre-/post-intervention basis (Simons et al., 2013, 2014b). For example, for the n = 115 employees that started the Health Coach Program in 2013, there were average biometric improvements after 12 months: weight –3%, cholesterol –5%, LDL cholesterol –7%, blood sugar –6% (Tweede Kamer, 2014). Besides, 70% of them were feeling more fit. Regarding productivity, the initial report said three weeks productivity gain (Tweede Kamer, 2014). However, when including all data, the average result was four weeks gain per person, about equally due to reduced absenteeism and reduced sickness presenteeism.

Regarding the biometric risk factor effects, these are easiest to measure on a short-term basis. In 2014, an randomised controlled trial (RCT) has been conducted, in order to further assess efficacy of the eSupported lifestyle program (Verweij et al., 2011). The primary research question is: are physical risk factors impacted by the intervention?

This RCT study design does not aim at the entire employee population. Rather, it aims at the employee subset, which meets the eligibility criteria for cardio-metabolic risk, ability to participate and motivation. The primary study outcomes are total cholesterol and LDL cholesterol, aimed at cardio-metabolic risk.

Besides, there are longer term outcomes. There is an HR interest in exploring impacts on productivity related measures like work engagement (UWES-9, Bakker et al., 2011; Schaufeli et al., 2006) or presenteeism and absenteeism (Iverson et al., 2010). The results after three months are presented and discussed in this paper.

This paper does address another important issue: efficacy of the service mix deployed in the eSupported lifestyle intervention. Hence, we also conduct a design analysis based on an evaluation framework of requirements for ICT-enabled healthy lifestyle interventions.

2 Theory

The large majority of work site health programs have very limited health effects on the longer term (Verweij et al., 2011). As more extensively discussed elsewhere, it is crucially important to connect to intrinsic health motivations (Simons and Hampe, 2010a, 2010b), reap fast results (Simons and Hampe, 2010a), create positive feedback, for example, via using modern technologies (Simons and Hampe, 2010b), create a persuasive ‘service-scape’ combining face-to-face and electronic coaching in order to maximise impact (Simons et al., 2013, 2014a, 2014b). Next, it is important to create maximum health impacts, using state of the art healthy lifestyle intervention guidelines, for example

from the lifestyle expert group of Harvard University (Willett, 2004; Willett and Ludwig, 2011).

In work contexts, time is sparse. Health support should be efficient and still have sufficient attention value and added value (Bruck et al., 2012, Simons et al., 2015b). Electronic tools accessible via smartphone, mail and/or web, potentially offer a number of advantages: they use a personal device that is available any time any place, they are efficient and can use idle time that is otherwise lost, and they are suited for just in time learning (Bruck et al., 2012).

If we look at the design challenge of persuasive technology (Fogg, 2002, 2009) for health, it was theorised and tested elsewhere that this challenge is not just located in the ICT design, but also in the design of the overall service scape, including health effects and coach relationship (Simons et al., 2014a, 2014b). It should generate positive, mutually reinforcing service experiences across communication channels and activate long-term health motivation and – behaviours, in order to deliver long-term results. This is reflected in the following design evaluation framework for health improvement ICT solutions (Simons et al., 2014b), see Figure 1. It helps evaluate the impact of ICT-enabled interventions on health effectiveness, coaching performance and ICT value adding.

Figure 1 Basic requirements when designing ICT-supported healthy lifestyle interventions

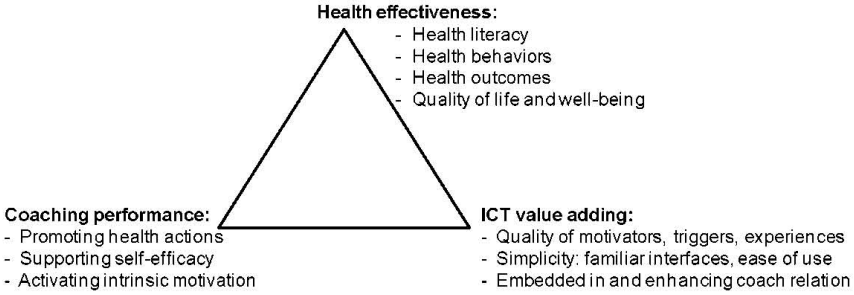

Figure 1 addresses three evaluation domains. First, health effectiveness not only includes health outcomes, but also health literacy ('as a user I know how to best serve my health'), health behaviours and health well-being (meaning health related quality of life (Ware and Gandek, 1998) and the Seligman (2012) dimensions of well-being related to health). Preferably, health interventions have broader and deeper impacts rather than narrow ones, since the former will improve health well-being more significantly. Experiencing larger health well-being impacts forms an important intrinsic motivator for health behaviours in the longer term. Second, coaching performance not only includes promoting health actions [improving health readiness by moving from awareness to intentions to behaviours as in the HAPA and i-change models (Schwarzer et al., 2010; Wiedemann et al., 2011)], but also activating intrinsic motivations, and supporting users in their self-efficacy (their day-to-day attempts and successes to turn their health behaviour experiments into health wellness experiences). Third, ICT value adding includes (Fogg, 2002, 2009): value adding via high quality triggers, motivators and service experiences [which often involves using a mix of channels, each for their strengths – Demark-Wahnefried et al. (2007), De Vries et al. (2008), Sperling et al. (2009), Simons (2006)], simplicity [which means using ICT interfaces that are mainstream for the user group and being very attentive to ease of use – many initiatives underperform due to usability

barriers, see Jimison et al. (2008)] and finally: embedding applications in an overall health provider or coach relationship (so that the meaning is enhanced of the coach relationship as well as the meaning of the data). For example, the foundations of coaching include 'building rapport or relationship', using different levels of listening based on empathy and intuition, see Starr (2008). This is best done by a person. Whereas data capturing, processing and feedback to users is preferably automated (Simons and Hampe, 2010b).

Specifically for work settings, a few elements from Figure 1 deserve special attention. First, regarding health effectiveness and the requirement of supporting quality of life and well-being, work and work-life balance have a large impact (Steenbeek et al., 2010). These are and should be important themes in work site health coaching. And also, the interactions with work engagement are important (Bakker et al., 2011). Second, regarding coaching performance and the requirement of promoting health actions, this includes:

a Raising the awareness question 'In which ways does my context hamper or promote health actions?

b Promoting actions to start influencing that work context (Schaufeli et al., 2006).

Third and fourth: both 'intrinsic motivation' and 'self-efficacy' are closely linked to resilience (Seligman, 2012) and work engagement (Bakker et al., 2011) and regularly do require work related coaching in a worker health context.

3 Methods and study design

Our study consists of an RCT within a larger employer vitality program. Participants were recruited in 2014, on a voluntary basis, from the employee base of the Delft University of Technology. Slightly more participants entered the program than required on the basis of the power calculations for minimal sample size.

After a 0-measurement of vitality and control variables and when meeting inclusion criteria, participants were randomly assigned to either a direct start of the lifestyle intervention (n = 59), or to a waiting list with a start after a six weeks: the control group (n = 57). Hence, the control group consisted of participants who were re-measured six weeks later and then entered into the hybrid eHealth program.

The study protocol was approved by the medical ethics committee of Leiden University Medical Centre. The first measurements and randomisation started in January, there were ten start groups during the year and the final (waiting list control) group started their eHealth support program on November 27th 2014. On January 13th 2015 they were the final group for which the six weeks post-start physical measurements were conducted. At the time of writing, the 12 months results were not complete yet. However, the three months results were.

Physical inclusion criteria were chosen on the basis of medical literature. The other in-/exclusion criteria were mainly concerned with feasibility and practicality: can someone fully participate in the program and is there enough motivation? Eligibility following these criteria is checked by the company physicians, who know many of the employees. Besides, there are self-assessment questions in the 0-measurement for the prospective participants, regarding the degree of motivation and ability to participate.

The inclusion criteria are:

- cardiovascular disease (including previous diagnoses, hypertension (>= 140/90) or hypercholesteremia (cholesterol >= 6.0 or LDL >= 3.4), and/or diabetes-2 (including prediabetes risk: HbA1C >= 6.0) and/or being overweight (BMI >= 25)
- physically, mentally and socially capable of participating in an intensive lifestyle program.

Exclusion criteria are:

- serious comorbidity or treatment side effects that hamper participation
- psychiatric problems
- risk factor measurement outcomes which require immediate medication changes
- not enough motivation to participate (score < 3 'average' on a five-point scale).

In this employee sub-population with cardio-metabolic risk, standard deviation for total cholesterol and LDL cholesterol is about 0.9 mmol/l. Hence, power calculations indicated that if the true difference in the experimental and control means is 0.5 mmol/l, we needed to study at least 52 experimental subjects and 52 control subjects to be able to reject the null hypothesis that the population means of the experimental and control groups are equal with probability (power) 0.8. The type I error probability associated with this test of the null hypothesis is 0.05.

Besides describing short-term physical effects, a qualitative service design analysis is conducted in the results section, using Figure 1 requirements framework from theory regarding the design of ICT-supported healthy lifestyle interventions.

4 Results

In this section, we combine three months results from the RCT measurements with a design analysis based on the framework of Figure 1 (from the theory section).

Table 1 shows the differences between the waiting list (control) condition and the direct start (intervention) condition and Table 2 shows the differences in biometric values after six weeks. This is the moment at which the waiting list groups have not received any coaching yet. By contrast, the direct start groups have received their first six weeks of extensive health (e)coaching by then. Due to missing values, in the biometric value analysis two participants are discarded from the control arm and three from the intervention arm of Table 2.

Table 1 Comparison: waiting list vs. direct start condition

Waiting list (control) participants (n = 57):	*Direct start (intervention) participants (n = 59):*
Descriptive:	*Descriptive: [as waiting list, plus directly]:*
• Motivated volunteers	• Intake and personal action plan
• Taken ownership by applying for study	• Start workshop (full day) + coach sessions
• Physical measurements raised awareness	• Health behaviour logging
• Majority self-searched for measurement interpretation and started health actions	• Coach progress logs in dashboard
	• Heath quiz + weekly start tips

The descriptive elements indicate that the waiting list participants do have incentives to start health improvements after initial measurements, even though they are on the waiting list. They were motivated to start health improvement, that had actively stepped forward and enlisted themselves for the study (a process involving significant obligatory paper work) and they had received the results of their physical examination. After the six weeks waiting period we had intakes with these participants, where the majority indicated that had tried to interpret the results (usually with internet search) and started attempts at healthier behaviours.

Table 2 Change in biometric values after six weeks (baseline data available with authors)

	Control arm change (n=55)	*Intervention arm change (n = 56)*	*Difference*	*p-value*
Total cholesterol (mmol/l; mean (SD))	–.007 (0.61)	–0.34 (2.46)	–0.27	*0.03*
LDL-cholesterol (mmol/l; mean (SD))	–.010 (0.63)	–0.35 (0.69)	–0.25	*0.04*
HDL-cholesterol (mmol/l; mean (SD))	0.03 (0.14)	–0.02 (0.19)	–0.05	0.12
Weight (kg; mean (SD))	–0.19 (1.5)	–1.29 (0.59)	–1.09	*0.01*
Systolic blood pressure (mmHg; mean)	–1.05 (12.31)	–3.25 (13.0)	–2.20	0.36
Diastolic blood pressure (mmHg; mean)	–.022 (8.13)	–2.98 (7.24)	–2.76	0.06
Glucose (mmol/l; mean (SD))	0.10 (0.34)	0.12 (0.78)	0.02	0.85
HbA1c (%; mean (SD))	–0.08 (0.23)	–0.09 (0.23)	–0.01	0.83

The biometric differences of Table 2 indicate that the intervention (direct start) participants had significantly larger improvements in total cholesterol, LDL cholesterol, weight and near-significant larger improvements in diastolic blood pressure than the control (waiting list) participants. For reference: the nearly 10% improvement in LDL cholesterol means a nearly 40% reduced heart attack risk per year, among other health benefits (Danaei et al., 2009).

These results answer the primary research question of the RCT with a yes: The main physical health risk factors are positively impacted by the intervention. And these effects are larger than the effects of selecting motivated volunteers, conducting physical measurements, asking their commitment or explaining them the rationale of the healthy living intervention in the (legally required) participant information.

Table 3 shows that there is a disadvantage to being in the waiting list group, given the results three months after start of the coaching. Whereas the results of the direct start participants are very similar to the results in previous years, those of the waiting list participants three months into their health support program are not. This effect is relatively broad and the results are less positive for: LDL cholesterol (–0.16 mmol/), weeks of work availability per year (Iverson et al., 2010), work engagement (Utrecht Work Engagement Scale, Schaufeli et al., 2006), physical and mental health, as measured with the RAND SF-8 survey, and satisfaction after three months. Still, satisfaction is not really low (similar to previous years) and recommendation is high (grade 8.4 out of 10).

Table 3 Comparison: waiting list vs. direct start three months post-intervention start (grades: 1–10)

Waiting list (control) participants (n = 55):	*Direct start (intervention) participants (n = 51):*
Survey measurements:	*Survey measurements:*
• Work availability: –1.4 weeks/year per person (from 38.0 weeks/year to 36.6 weeks/year)	• Work availability: + 3.8 weeks/year per person (from 38.1 weeks/year to 41.9 weeks/year)
• Work engagement:+0% (UWES 4.59 to 4.59)	• Work engagement: +5% (UWES 4.35 to 4.54)
• Physical health: +3.6 (RAND 66.0 to 69.6)	• Physical health: +8.6 (RAND 67.6 to 76.2)
• Mental health: +5.1 (RAND 67.6 to 72.7)	• Mental health: +6.8 (RAND 68.4 to 75.2)
• Avg. satisfaction start week = *8.0* (n = 54)	• Avg. satisfaction start week = *8.2* (n = 55)
• Avg. satisfaction 3 months = *8.0* (n = 55)	• Avg. satisfaction 3 months = *8.6* (n = 48)
• Avg. recommendation 3 months = *8.4* (n = 55)	• Avg. recommendation 3 months = *8.5* (n = 48)

These differences do reflect the comments we heard during intakes and coach sessions: that several participants had lost part of their motivation or worked hard at the wrong things during the waiting list period. We return to this matter in the discussion section.

Table 4 Design evaluation on design requirements from Figure 1 (authors' opinions, five-point scale from – – to ++)

Health effectiveness	*Coaching performance*	*ICT value adding*
Health literacy:	*Promoting health actions:*	*Motivators, triggers, experience:*
++ Health quiz and start tips	+ Suggestions in health quiz	+ + Health quiz, start tips: (fun) experiences, triggers, hope, success experiences
– Waiting list effect: self-search confusions	– Waiting list: some started ineffective behaviour patterns	
Health behaviours:	*Supporting self-efficacy:*	*Simplicity:*
– Waiting list effect: some taking the wrong actions	+ Health quiz: improved portfolio of strategies (coping, avoiding pitfalls)	+/– Old behaviour logging was a burden (limited adoption); the new version was better
Health outcomes:	*Activating intrinsic motivation:*	*Fit with coach processes:*
– – Waiting list: poor short-term effects.	+ Start tips: 24 weeks motivators on all health topics.	+ Health quiz enhances coach insights and suggestions
Quality of life:	– – Waiting list effect: part of the start-motivation is gone.	+ The new behaviour logging enhances behaviour insights.
+ Participants sent thank you mails replying to the start tips		

Table 4 shows a qualitative design evaluation of effects observed by the authors during the 2014 RCT. On the one hand, several elements of eHealth support were added or changed, which led to improvements. On the other hand, there was a waiting list effect on

several of our design requirements from Figure 1, which hampered performance on the design requirements.

There were three forms of eHealth support added. Two at the start of 2014. First, a selection of 24 weekly start tips in the mail, to support growth in health awareness and competences. Second, a micro-learning Health Quiz starting one month after the initial workshop. An initial service design description in given in Simons et al. (2014a, 2015a). Next, we added gaming elements (points for trying, extra points for correct answers, speed points for fast responses, for completing a level and reaching daily targets) and team play (team scores and top score lists), plus further simplification of the user process (participants automatically receive daily, clickable e-mails to enable answering health questions; and weekly group progress statistics are mailed). A third improvement that was introduced at the end of 2014 was a simplified system for logging weekly health behaviours. So the final starting groups of 2014 benefitted from them and we could compare before-after differences.

In summary, in terms of design requirements, the largest hampering effects from the waiting list procedure were: on average a decay in motivation of participants, self-search for measurement interpretation abounded but led to confusion and to adoption of some poor quality health beliefs, plus several participants started in-effective or unhealthy behaviour patterns. Also, the waiting list led to lower health outcome improvements: not just after the first six weeks of waiting, but also after six weeks of hybrid eHealth support.

The largest contributions from the Health Quiz were: improved health literacy and providing a continuous stream of motivators, triggers and success experiences (this enhances self-efficacy and further learning). The largest contributions from the 24 weekly start tips in the mail were: continued motivation support and providing triggers. The largest contributions from the improved weekly behaviour logging interface that started late in the year, from Dec 2014, are threefold. First, lower thresholds to logging (participants indicate that the new logging software is more enjoyable). Second, when people log a week's behaviour, they enter about 50% more entries (exercise, mental balance, buddy contacts and foods/drinks). Third, participants look more closely at the progress graphs, which we contribute to freeing up extra mental processing capacity.

5 Discussion and conclusions

This preliminary analysis has several limitations. First, since the 12 months data are not available, we are focussing on short-term effects only. Second, the study design for the RCT was aimed at testing eHealth intervention effects on physical risk parameters after six weeks. The design analysis was a qualitative addition to that study design. Third, regarding external validity, these study results may only apply to motivated individuals, who volunteer for lifestyle training. Four, thanks to the fact that the control group also entered the program, but after six weeks waiting list, we expected a limited 'demotivation' effect of being randomised into a control group. Still, some demotivation was observed, but not quantified.

Still, on the positive side this study design did provide an opportunity to observe productivity effects (work engagement, absenteeism, presenteeism, health related quality

of life), waiting list effects and to conduct a design analysis in relation to a number of eSupport changes that were made.

5.1 Design lessons and implications for practice

Many employers offer (preventive) medical checkups, often without explicit follow up programs for health support. We have observed in the waiting list group, that a majority of people use the internet and/or family/friends for:

a interpretation

b possible health behaviour improvements.

Unfortunately, this regularly leads to confusion and/or ineffective behaviours. Which partly explains why the waiting list results in our study were minimal. Moreover, even just six weeks-ineffectiveness period was enough to reduce about half of the positive risk factor effects of our hybrid eHealth support after participants did start program, at least in the short-term (six weeks after start). This suggests that offering employees' active health support directly after measurements yields better results. We have to wait for the one-year results to determine the longer term risk factor impacts.

A second intervention design lesson also regards timing. In our 2014 RCT, we started our micro-learning Health Quiz plus weekly start tip mails only after one month, based on the rationale that the first intervention month is already packed with many support interactions (individual and group sessions, surveys, measurements, supporting materials) and we wanted to limit the work load. However, we observed that the start workshop is such a trigger for heightened motivation, health interests, health plans and a desire to learn more (see also the previous design lesson), that it seemed logical to start the Health Quiz and start tips mails directly. This was implemented in 2015 and the first (preliminary) results do point to faster micro-learning Health Quiz course progression.

Finally, logging health behaviours is very often perceived as a burden (Simons et al., 2012, 2013) even though it may improve health behaviour self-awareness and insights. During the second half of 2014 an improved interface was developed for logging weekly health behaviours (physical activity, mental energy, buddy system and diet). In January 2015, it went 'live' and several groups experienced the improvements in comparison to the old interface. The extra uptake (see Section 4 results) and increased 'mental space' for learning effects instead of logging efforts, do confirm the 'persuasive technology' theories of limiting burdens as much as possible and the eagerness of people to grow and develop (Fogg, 2002, 2009).

5.2 Implications for theory

The health support theory for patients that suggests to start health improvement at the peak of motivation (Stull et al., 2007) was confirmed in the sense that waiting list participants did not manage to catch up with the direct start participants in the short-term (three months after intervention start). They appear to have missed the opportunity to use their initial motivation. We have to wait for the long-term results to know if this difference disappears in the longer run.

Another interesting point is the question what increases intrinsic motivation and helps to exploit it. When there is a health crisis (cancer or other diagnosis) this raises

motivation and a majority of patients start implementing one or more health behaviour changes (Stull et al., 2007). This is a negative (and unplanned) event that raises the sense of urgency. However, the hybrid eHealth support program appears to offer a more positive and more planned increase in intrinsic motivation and self-efficacy (Bandura, 1997): that it pays rapid dividends to live more healthily. We believe this is an interesting area for further research of increasing health self-management competences (Simons et al., 2015a) via training and positive reinforcement, following the theories of positive psychology (Seligman, 2012) and 'automatic' healthy choices, perceptions, behaviours and self-assessments (Kahneman, 2011). This appears to create a positive spiral of: increased awareness, effective behaviour experiments, increased quality of life and health results, increased competence, increased motivation, eagerness to learn more, and so on.

5.3 Summary

In short, there are a few key findings from our study. First, the hybrid eHealth intervention did significantly improve physical risk factor variables after six weeks, and motivation and measurement alone (waiting list) do not. Second, the timing of the start does matter. Theory that suggests to start health improvement at the peak of motivation (Stull et al., 2007) was confirmed in the sense that waiting list participants did not manage to catch up with the direct start participants in the short-term (six weeks after intervention start). Third, this suggests that offering employees active health support directly after physical measurements (health check-ups) is more effective for improving health than the common practice of focusing on the employee check-up itself.

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