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Corresponding Author: Mrs. Riitta Pyky,

Corresponding Author's Institution: Oulu Deaconess Institute

First Author: Riitta Pyky

Order of Authors: Riitta Pyky; Heli Koivumaa-Honkanen; Anna-Maiju Leinonen; Riikka Ahola; Noora Hirvonen; Heidi Enwald; Tim Luoto; Eija Ferreira; Tiina M Ikäheimo; Sirkka Keinänen-Kiukaanniemi; Matti Mäntysaari; Timo Jämsä; Raija Korpelainen

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Results: Life satisfaction improved in the intervention ($p<0.001$) and control group ($p=0.01$). Life satisfaction was most likely to improve among men with low baseline satisfaction (OR 13.8; 95% CI 3.7 - 51.8) and mood-related exercise motive (2.5 (1.1 - 5.6)). There were no statistically significant changes in self-rated health, but those who reported poor health at baseline (OR 9.6; 95% CI 3.7 - 24.9) and improved self-rated fitness during the trial (4.2 (1.5 - 11.9)) were more likely to gain improvements in self-rated health.

Conclusion: The mobile intervention was most beneficial for men with low life satisfaction and poor self-rated health at baseline.

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# Effect of tailored, mobile intervention on life satisfaction and self-rated health in young men: A population-based, randomized controlled trial (MOPO study)

Riitta Pyky[1,2,3,4], Heli Koivumaa-Honkanen[5,6,7], Anna-Maiju Leinonen[1,3,8], Riikka Ahola[3,4], Noora Hirvonen[4,9], Heidi Enwald[4,9], Tim Luoto[10], Eija Ferreira[11], Tiina M. Ikäheimo[4,12], Sirkka Keinänen-Kiukaanniemi[2,4,13], Matti Mäntysaari[14], Timo Jämsä[3,4,15], Raija Korpelainen[1,2,4]

Author Note

[1]Department of Sports and Exercise Medicine, Oulu Deaconess Institute, Oulu, Finland;

[2]Center for Life Course Health Research, Faculty of Medicine, University of Oulu, Oulu, Finland;

[3]Research Unit of Medical Imaging, Physics and Technology, Faculty of Medicine, University of Oulu, Oulu, Finland;

[4]Medical Research Center Oulu, Oulu University Hospital and University of Oulu, Oulu, Finland;

[5]Department of Psychiatry, Institute of Clinical Medicine, University of Eastern Finland, Kuopio, Finland;

[6]Department of Child Psychiatry, Institute of Clinical Medicine, University of Oulu, Oulu, Finland;

[7]Departments of Psychiatry: Kuopio University Hospital (KUH), Kuopio, Finland, South-Savonia Hospital District, Mikkeli, Finland; North Karelia Central Hospital, Joensuu, Finland;

SOSTERI, Savonlinna, Finland; SOTE, Iisalmi, Finland; Lapland Hospital District, Rovaniemi, Finland;

[8]Infotech Oulu, University of Oulu, Oulu, Finland;

[9]Information and Communication Studies, Faculty of Humanities, University of Oulu, Oulu, Finland

[10]Cultural Anthropology, Faculty of Humanities, University of Oulu, Oulu, Finland

[11]Biomimetics and Intelligent Systems Group, Faculty of Information Technology and Electrical Engineering, University of Oulu, Oulu, Finland

[12]Center for Environmental and Respiratory Health Research, University of Oulu, Oulu, Finland;

[13]Unit of Primary Health Care, Oulu University Hospital, Oulu, Finland;

[14]Centre for Military Medicine, The Finnish Defence Forces, Helsinki, Finland;

[15]Department of Diagnostic Radiology, Oulu University Hospital, Oulu, Finland

Correspondence concerning this article should be addressed to Riitta Pyky, Oulu Deaconess Institute, Department of Sports and Exercise Medicine, Albertinkatu 18A, P. O. Box 365, 90100 Oulu, Finland. Email: riitta.pyky@odl.fi.

## Abstract

Background: Online behavior-change programs may increase physical activity in adolescents, but their effects on subjective health and wellbeing are not well known.

Purpose: We investigated the effects of a mobile intervention on life satisfaction and self-rated health among young men.

Methods: In this population-based study, 496 men (17.8y, SD 0.6y) participated in a 6-month trial. They were randomized into an intervention (n=250) and a control group (n=246). Only the intervention group had access to a tailored mobile service. Life satisfaction and self-rated health were inquired about at baseline and at the end of the trial.

Results: Life satisfaction improved in the intervention ($p<0.001$) and control group ($p=0.01$). Life satisfaction was most likely to improve among men with low baseline satisfaction (OR 13.8; 95% CI 3.7 – 51.8) and mood-related exercise motive (2.5 (1.1 – 5.6)). There were no statistically significant changes in self-rated health, but those who reported poor health at baseline (OR 9.6; 95% CI 3.7 – 24.9) and improved self-rated fitness during the trial (4.2 (1.5 – 11.9)) were more likely to gain improvements in self-rated health.

Conclusion: The mobile intervention was most beneficial for men with low life satisfaction and poor self-rated health at baseline.

*Trial registration*: This randomized controlled trial is registered to the clinical trials register NCT01376986.

*Keywords*: subjective wellbeing, health promotion, eHealth, tailoring, gamification, computer

## 1 Introduction

Physical inactivity has been suggested to be possibly the most important factor compromising health [1]. Worldwide, 80% of adolescents do not meet the current recommendations for adequate daily physical activity of at least 60 minutes [2, 3]. Based on objective physical activity measurement, only 17% of the Finnish 13 to 15 year olds met the recommendations and especially in young Finnish men physical activity decreases more with age compared to other countries [4]. Physical inactivity in youth may affect health and morbidity across the whole lifespan [5].

Life dissatisfaction is strongly linked with poor physical and mental health (including depression and risk of suicide) [6-9]. In a large sample of North American students, 11% reported poor life satisfaction (LS), with 7% indicating very poor satisfaction [6]. Physical activity level and willingness to be physically active are closely linked with self-rated health (SRH) and life satisfaction [6, 10, 11] and they have been shown to predict longevity [7, 9, 12, 13]. Among adolescents, lesser time spent on sedentary activities has been related to good self-rated health [11]. In several previous studies, a change in physical activity has been shown to be bidirectionally related to change in subjective wellbeing [14-17].

Both physical and mental health promotion of the young is one of the top long-term priorities in the Western world. One possible way to improve self-rated health and life satisfaction in young men could be through the promotion of physical activity, but only a few randomized controlled trials aiming to increase physical activity among healthy young men have reported the effects of the intervention on life satisfaction and self-rated health [18].

Instead of traditional health promotion strategies, such as individual and group face-to-face counseling, Internet-based approaches, social aspects and having fun may be important in promoting health and physical activity among young people [19]. Especially, adolescents presenting

unhealthy behaviors have been interested in Internet-based health promotion [20]. Various studies have also shown that web-based tailored intervention may be a promising method to promote health behaviors of adolescents and young adults [21-25], but more knowledge is needed on the influence of digital physical activity promotion on self-rated health or overall wellbeing.

Thus, effective preventive interventions for the health and wellbeing of young men at risk for unhealthy behaviors are needed. This population-based, randomized controlled study aimed to reveal whether a mobile physical activity intervention with tailored contents can improve subjective health and life satisfaction among young men. We hypothesized that the mobile intervention improves self-rated health and LS especially among young men with unhealthy behaviors.

## 2 Material and methods

The present study is based on a comprehensive population-based study (MOPO) that aims to promote health and physical activity and to prevent social marginalization among young, conscription-aged Finnish men [26]. This randomized controlled trial is registered to the clinical trials register NCT01376986. Military service or civic duty is compulsory for all male citizens in Finland, and Finnish Defense Forces organizes conscription every year. The entire age cohort of 18 year old men attends the conscription except those whose physical or mental health or psychological capacities do not allow independent living. Thus, the conscription provides a large, population-based representative sample of young men. This randomized controlled trial was conducted before young men entered to military service or civil duty.

### 2.1 Design

The study design is a parallel group, six-month randomized controlled trial (RCT). The participants were allocated (allocation ratio 1:1) into an intervention or a control group. The main

outcome measures were changes from baseline in life satisfaction and self-rated health, and secondary outcomes were changes in self-reported PA and sitting.

### 2.2 Study population and Procedures

All men who attended the conscription for military service in the Oulu area of Finland in September 2013 (N = 1,265) were invited to fill out a questionnaire including health, wellbeing and lifestyle questions and to participate in physiological measurements. A total of 1,035 (81.8%) men completed the questionnaire, and 811 (64.1%) men participated in the measurements. All men attending the measurements were invited to participate in the 6-month RCT, and 496 (61 %) of them agreed to (Figure 1). The mean age of the participants was 17.8 (SD 0.6) years.

The participants were randomized into an intervention (n = 250) and a control (n = 246) group. Randomization was performed after recruitment and conducted by an assistant who was neither involved in the trial nor in the data collection and analysis. A list of computer-generated random numbers in blocks of 10 was used. Each participant received the next random assignment sequentially in the list. Both the measurements and the questionnaires were repeated at the end of the trial in March 2014. The study included face-to-face contact only twice: in the beginning and at the end of the trial while conducting the questionnaire and the physiological measurements. Figure 1 shows the trial flow. A total of 182 (72.8 %) participants in the intervention group and 163 (66.2 %) in the control group completed the study. Two participants from the control group entered the military service in January 2014 and wanted to withdraw from the study because of that. Three participants from the intervention group discontinued the study: one did not want to attend the final measurements, one moved to another location and one did not give a reason for the discontinuation.

From the control group, 81 participants did not fill out the final questionnaire and 65 from the intervention group. Altogether, 151 (30.4 %) study participants were lost to follow-up (Figure 1.).

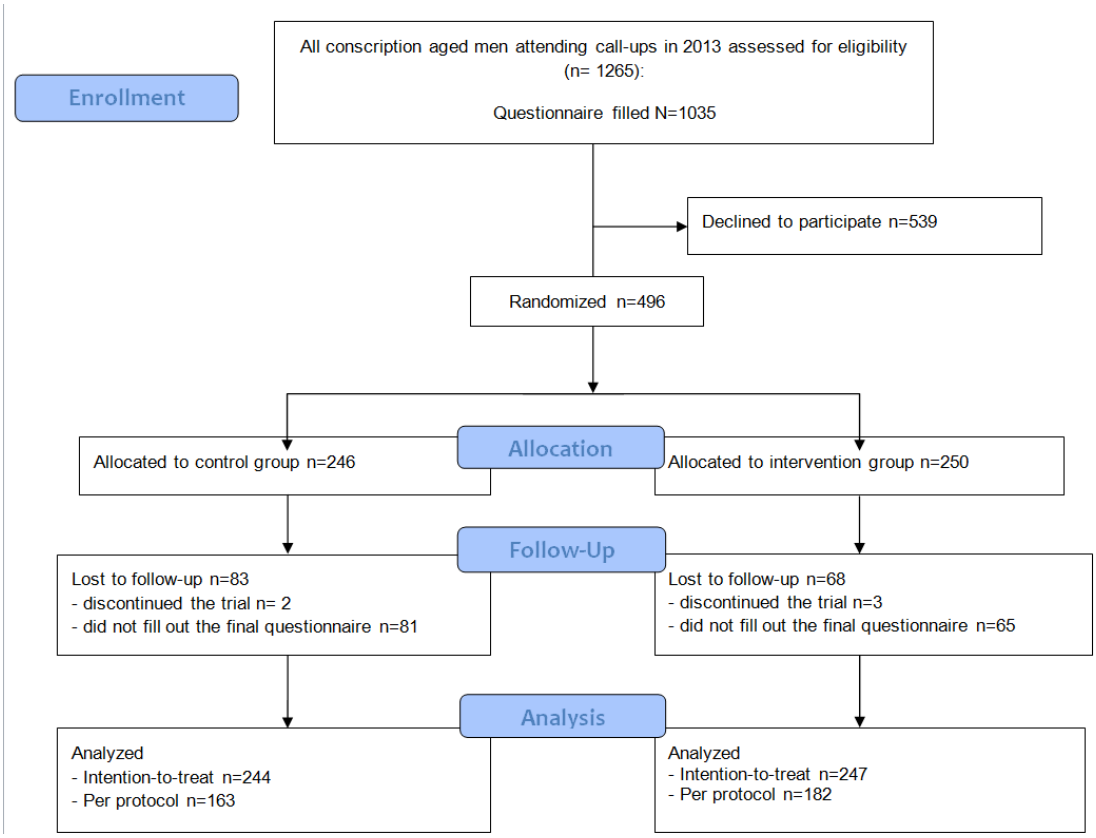


Figure 1. The CONSORT flow diagram of participants in the population based six-month randomized controlled trial.

### 2.3 Intervention

In the beginning of the study, wrist-worn physical activity monitors (Polar Active, Polar Electro Ltd., Finland) were given to the participants in both groups. After the blind, first-week activity data collection, the monitors displayed the accumulated daily moderate-to-vigorous physical activity time for the intervention group but only the time of day in the control group during the trial. The participants in both groups were asked to wear the activity monitor during all waking hours and were advised to upload their activity data from the monitors to a database at least once

every three weeks. Participants in both groups were sent a text message reminder every three weeks to upload the physical activity data. All the participants who uploaded the data were included in a lottery for two movie tickets once a month. After the baseline week, the intervention group was given access to a novel mobile service (MOPOrtal) [27] developed in the MOPO study (see description below). The aim of the MOPOrtal was to motivate participants physically, mentally and socially. In addition, the participants in the intervention group received tailored feedback according to their personal physical activity through the MOPOrtal. Participants in the control group did not have access to the service and were not given any feedback on their physical activity level. The timeline of the study in the intervention and control groups is presented in Figure 2.

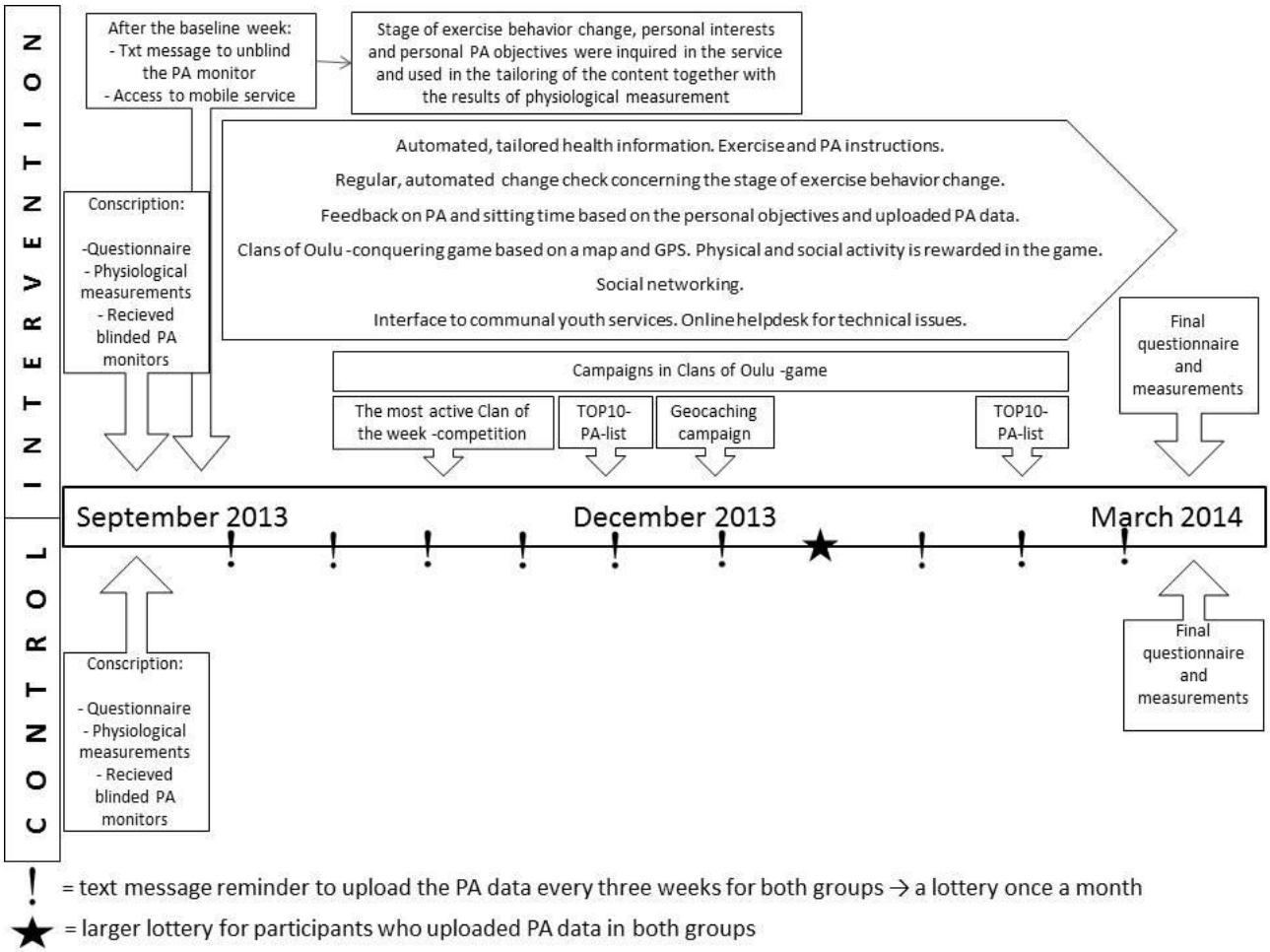


Figure 2. Timeline of the study and content of the trial in the intervention and control group

### 2.3.1 Mobile service

The MOPOrtal service [27] was set up together with the city of Oulu and enterprises of related expertise (including a game studio). The requirements for the service were defined in the multidisciplinary MOPO study in 2009–2012 (http://www.tuunaamopo.fi/sivu/fi/mopo-study_in_english/). They were based on cross-sectional studies assessing self-reported health and wellbeing, use of media and technology and measured the fitness of young men participating in the call-ups each year. In addition, 16–20-year old men from local school classes, voluntary courses and youth workshops organized by the city were engaged in the iterative design, development and testing of the service. Pilot interventions were carried out in 2011 and 2012 [28]. The MOPOrtal included the following:

1) Web-based interface to communal youth services
2) Personal objectives for physical activity and fitness improvement based on baseline measurements
3) Exercise and overall physical activity instructions and guidelines for aerobic- and muscle-fitness improvement, as well as weight management
4) Tailored, automated health information and feedback messages based on the transtheoretical model of behavior change [29]. The delivered health information was based on scientific evidence reviewed before the trial.
5) Clans of Oulu game, in which success was determined by the level of daily physical activity compared to sitting time monitored with a wrist-worn monitor. The Clans of Oulu game is a mixed-reality conquering game based on a map and real-life events in which activity of any kind (physical, social, etc.) was rewarded.
6) Social-networking possibilities. The user was able to share contents on the service's social applications, such as chat and a photo gallery.

### 2.3.2 Transtheoretical model as a basis of message tailoring

The tailoring of the automated health information and feedback messages was based on the Transtheoretical model of behavior change [36] which is one of the most popular behavior change models utilized in tailored health interventions [30]. This stage-based model integrates principles from different theories of behavior change and proposes that behavior change is a non-continuous process occurring through stages that reflect different mind-sets of people.

In the present intervention study the participants were divided into five groups according to their stage of exercise behavior change. The participants rated their stage of exercise-behavior change at the beginning and every month during the trial. Participants were also able to rate the stage more often if they felt it necessary. The stage of exercise-behavior change, according to the transtheoretical model [29], was assessed based on a modified scale from Cardinal, 1995 [31, 32]. The respondents were instructed to choose an alternative that best described their regular exercise behavior and intentions to exercise. Regular exercise was defined according to the Finnish national recommendations for 13–18 year olds [33] as at least 1.5 hours of daily physical activity, of which half should be performed at a vigorous intensity. The answer options were a) I exercise on a regular basis and have been doing so for longer than 6 months (maintenance), b) I exercise on a regular basis but I have only begun doing so within the past 6 months (action), c) I do not exercise, but I have been thinking about starting to exercise within the next month (preparation), d) I do not exercise, but I have been thinking about starting to exercise within the next 6 months (contemplation), and e) I do not exercise and do not plan to start exercising in the next 6 months (pre-contemplation).

The delivered messages included a welcoming message and brief messages along the intervention once a week through the mobile service. The messages were tailored to match the processes of change theorized as most appropriate at each stage [34]. Some modifications were

made to the design guide derived from the one designed by Nigg et al. [34]. Furthermore, based on research on feedback perceptions of young men in different stages of exercise behavior change [35], message tactics that include comparison, namely normative and ipsative strategies, were used only in the more advanced stages (action, maintenance). The stage-tailored messages were tested in a 3-month pilot intervention study in 2011 with a volunteer sample of young Finnish men (n=129) [36].

### 2.4 Questionnaire

#### 2.4.1 Life satisfaction and self-rated health

Life satisfaction was assessed with a self-reported four-item scale measuring happiness, interest in life, feelings of loneliness and ease of living (score range 4–20; satisfied: 4–6; slightly dissatisfied: 7–11; dissatisfied: 12–20). This LS scale has shown to be closely related to many psychometric scales and to be able to predict several health outcomes among adults. [7, 9, 37, 38] As a measure of self-rated health, the participants rated their health as good, pretty good, average, pretty poor or poor [39]. Poor self-rated health evaluated with this scale has been reported to be a strong predictor of mortality.[40]

#### 2.4.2 Physical activity and sitting

Leisure-time physical activity was assessed with the question, “How much do you exercise or strain yourself physically in your leisure time?” [41]. Response options were 1) I read, watch TV and do light housework; 2) I walk, cycle or exercise otherwise at least 4 hours per week (excluding travel to work or school); 3) I exercise to maintain my physical condition by, for example, running, jogging, cross-country skiing, doing gymnastics, swimming, playing ball games or doing heavy gardening etc. at least two hours weekly; and 4) I take part in competitive sports or other heavy

sports several times a week. The first response option was categorized as having no leisure time physical activity. Motives and restrictions for physical activity were studied on a 2-point scale: "Is the improving mood important for your physical activity" or "Is the lack of interest or guidance restricting your physical activity" (yes/no). [42] Participants also rated their fitness compared to coeval as significantly lower, somewhat lower, similar, somewhat higher, or significantly higher [43]. Daily sitting time was assessed with the question, "How much do you sit on average per day (e.g., studying, working, driving, watching TV, reading or spending time on computer) in leisure time and how much at work separately?"[44].

The men were also enquired about their socioeconomic status, family income, perceived future and other lifestyle factors such as smoking and alcohol intake. Their weight and height were also measured.

**2.5 Statistical analysis**

The power calculation was based on an expected decrease of one-third of the proportion of dissatisfied or slightly dissatisfied (life satisfaction score 7–20) participants in the intervention group. Since the proportion of at least slightly dissatisfied men was estimated to be 65% (data from the 2012 call-ups) at baseline, their proportion should be 43% (i.e., 2/3 x 65%) after the trial. With a study power of 80% (beta = 0.2) and significance level of 5% (alpha = 0.05), the calculated sample size was 78 men in each group.

Equation: $[(65 \times (100-65) + 43 \times (100-43))/(65-43)^2] \times 7.9 = 77.14$

The primary analyses were performed on an intention-to-treat (ITT) approach. Linear mixed model with full maximum likelihood, compound symmetry and Bonferroni correction for the

continuous variables and McNemar test with multiple imputation for the categorical variables were used to analyze the statistical significance of the within-group change from baseline. Independent samples t-test for the continuous variables and Mann-Whitney U test for the categorical variables with multiple imputation (number of imputation 5) was used to compare the difference in the change from baseline between the intervention and control group. In addition to ITT analyses, we performed per protocol analyses within the men who attended the follow-up visit.

In order to estimate the predictors of the change, we defined improvement of life satisfaction as a decrease of life satisfaction continuous score by at least one point (higher score indicating lower life satisfaction). Transition from a lower category to an upper one was defined as improved self-rated health. Univariate analysis (Pearson chi-square and t-test) was used to examine the associations of the baseline characteristics and their change during the trial with the change in life satisfaction or self-rated health. To define the independent predictors of the change in self-rated health and life satisfaction, multivariable binary logistic regression analyses (enter method) including all variables associated with the outcomes in the univariate analysis without multicollinearity were performed in the intervention (N = 250) and in the combined group (int + cont = combined; N=496). Statistically insignificant variables were removed from the model one by one.

The results are presented as odds ratios (OR) with 95% confidence intervals (95% CI). Statistical significance was set at $p < 0.05$ but variables with p-values <0.10 in the univariate analysis were entered into a logistic regression so that no potentially predictive variables were excluded prematurely. The data were analyzed with PASW Statistics software (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). The study is reported according to the CONSORT statement and checklist (see Appendix 1).

## 3 Results

The study participants did not differ according to life satisfaction, self-rated health and leisure time physical activity, BMI, socioeconomic situation and alcohol intake from the men who refused to participate in the six-month randomized controlled trial but filled in the questionnaire and participated in the physical measurements. In addition, there were no differences in weight, height or BMI between the men who participated in either physical measurements, the questionnaire or the trial and the men who refused to participate. The response rate of the life satisfaction and self-rated health outcome measures was high, ranging between 91 and 97% for those who filled out the questionnaire. There were no baseline differences in leisure time physical activity, life satisfaction and self-rated health between the 151 men who did not attend the follow up measurements and those 345 who completed the study. However, the men who did not complete the study were more often unemployed ($p = 0.008$), had higher alcohol intake ($p < 0.001$), lower measured aerobic fitness ($p < 0.001$) and grip strength ($p = 0.043$) (data not shown).

The intervention and control groups were similar in regard to baseline characteristics (Table 1). Over 92 % of the participants were students. Over one-fifth (n = 57, 23%) of the intervention group and nearly a fourth (n = 59, 24%) of the controls were overweight or obese. Majority of the participants rated their health as pretty good or good. At baseline, at least slight dissatisfaction (life satisfaction score 7–20) was reported by 153 (71.4%) of the men in the intervention group and 136 (61.3%) in the control group, but the difference was not statistically significant. (Table 1.)

Table 1. Baseline characteristics of the young men (n = 496) belonging either to the intervention or control group. Values are means (SD) unless otherwise stated.

| | Intervention group (n = 250) | Control group (n = 246) |
|---|---|---|
| Age, years | 17.9 (0.7) | 17.8 (0.6) |
| Student, n (%) | 218 (92.7) | 214 (92.2) |
| Height, cm | 177.9 (6.7) | 178.1 (6.0) |
| Weight, kg | 73.4 (15.0) | 72.9 (14.0) |
| BMI (kg/m2) categories | | |
| underweight (BMI < 18.5), n (%) | 16 (6.4) | 22 (9.0) |
| normal weight (BMI 18.5–24.9), n (%) | 178 (70.9) | 163 (66.8) |
| overweight (BMI ≥ 25.0), n (%) | 42 (16.7) | 41 (16.8) |
| obese (BMI ≥ 30.0), n (%) | 15 (6.0) | 18 (7.4) |
| Self-rated health pretty good or good, n (%) | 175 (79.5) | 181 (80.4) |
| Life satisfaction | | |
| satisfied (LS 4–6) , n (%) | 61 (28.5) | 86 (38.7) |
| slightly dissatisfied (LS 7–11), n (%) | 130 (60.7) | 111 (50.0) |
| dissatisfied (LS 12–20), n (%) | 23 (10.7) | 25 (11.3) |
| Life satisfaction[a], continuous score | 7.9 (2.8) | 7.5 (2.8) |
| No LTPA[b] other than light housework, n (%) | 33 (14.5) | 34 (14.7) |
| Self-reported daily sitting, h | 8.9 (3.7) | 9.4 (3.5) |
| Current smoker, n (%) | 45 (19.6) | 48 (21.3) |
| Alcohol intake (at least 6 servings ≥ once a week), n (%) | 43 (20.3) | 43 (19.2) |

[a]Life satisfaction as continuous variable: higher score indicating lower life satisfaction, scale 4 – 20.

[b]LTPA: leisure time physical activity

The results of the trial on health-related factors are presented in Table 2. Life satisfaction improved both in the intervention ($p < 0.001$) and the control ($p = 0.010$) group. There was no significant difference in the change between the groups. Neither were there statistically significant changes from baseline in the self-rated health, self-reported leisure time physical activity or sedentary time in either of the groups (Table 2). Mean weight increased significantly in both groups. When the data were analyzed on a per protocol basis, the results remained the same. A small difference was revealed in the change of daily moderate to vigorous physical activity between the groups over time in favor for the intervention group (*unpublished data*).

Table 2. Health-related characteristics at baseline and at six months. Values are mean (SE) unless otherwise stated.

| | Intervention group (n=250) | | | Control group (n=246) | | | Mean difference | |
|---|---|---|---|---|---|---|---|---|
| | Baseline | 6 months | p[a] | Baseline | 6 months | p[b] | (95 % CI) | p[c] |
| Weight, kg | 73.4 (0.9) | 74.9 (0.9) | <0.001 | 72.9 (0.9) | 74.5 (0.9) | <0.001 | 0.4 (-0.6-1.4) | 0.421 |
| BMI, kg/m2 | 23.2 (0.3) | 23.6 (0.3) | <0.001 | 23.0 (0.3) | 23.5 (0.3) | <0.001 | 0.1 (-0.2-0.4) | 0.497 |
| Life satisfaction score[d] | 7.9 (0.2) | 7.1 (0.2) | <0.001 | 7.5 (0.2) | 7.0 (0.2) | 0.010 | -0.5 (-1.3-0.3) | 0.215 |
| Self-reported daily sitting, h | 8.9 (0.3) | 9.2 (0.3) | 0.307 | 9.4 (0.3) | 8.8 (0.3) | 0.106 | 0.6 (-0.7-1.9) | 0.323 |
| Self-rated health pretty good or good (vs. average, pretty poor, poor); original data, N (%) | 175 (79.5) | 153 (84.1) | 0.383 | 181 (80.4) | 141 (86.0) | 1.000 | | 0.654 |
| Imputation number 1 | | | 0.078 | | | 0.248 | | 0.830 |
| Imputation number 2 | | | 0.458 | | | 0.458 | | 1.000 |
| Imputation number 3 | | | 0.417 | | | 0.360 | | 0.115 |
| Imputation number 4 | | | 0.100 | | | 0.031 | | 0.267 |
| Imputation number 5 | | | 0.248 | | | 0.700 | | 1.000 |
| Light housework but no other LTPA[e] ( vs. ≥ 4h LTPA weekly); original data, N (%) | 33 (14.5) | 22 (12.1) | 0.839 | 34 (14.7) | 25 (15.2) | 0.629 | | 0.434 |
| Imputation number 1 | | | 0.617 | | | 0.700 | | 0.483 |
| Imputation number 2 | | | 0.710 | | | 0.458 | | 0.461 |
| Imputation number 3 | | | 0.864 | | | 0.265 | | 0.653 |
| Imputation number 4 | | | 0.868 | | | 0.700 | | 0.461 |
| Imputation number 5 | | | 1.000 | | | 0.710 | | 0.476 |

[a,b] Linear mixed model with full maximum likelihood, compound symmetry and Bonferroni correction was used for the continuous variables and McNemar test with multiple imputation for the categorical variables for the change within intervention and control groups over the study period.

[c] Independent samples t-test for the continuous variables and Mann-Whitney U test for the categorical variables was used for the difference in the change from baseline between the intervention and control group with multiple imputation. Pooled imputation is reported as a mean difference for the continuous variables. For the categorical variables, p-values describe the difference in the distribution of answers between the intervention and control groups at the end of trial.

[d] Life satisfaction as a continuous variable: higher score indicating lower life satisfaction

[e] LTPA: self-reported leisure-time physical activity

In the univariate analyses, baseline factors associated with improvement in life satisfaction over the trial were low family income ($p = 0.015$), slight life dissatisfaction or dissatisfaction ($p < 0.001$), average, pretty poor or poor baseline SRH ($p = 0.039$), improving mood as an important motive for exercise (0.026) and perceiving future as hopeless (0.016). Improvement in self-rated health was associated with the following baseline factors: low self-rated fitness ($p = 0.012$), poor self-rated health ($p = 0.018$), lack of interest ($p = 0.026$) and guidance ($p = 0.013$) restricting physical activity, low self-reported physical activity ($p = 0.006$), preparation, contemplation or pre-contemplation stages in exercise behavior change ($p < 0.001$) and hopelessness for future ($p = 0.042$). Changes in self-rated fitness and leisure time PA during the trial were also associated with improved self-rated health ($p = 0.026$, $p = 0.042$, respectively). (Table 3.)

Table 3. Univariate associations between baseline characteristics and improved self-rated health (SRH) and life satisfaction (LS) in the intervention group

| | Improved SRH (n = 30) | | Not improved SRH (n = 140) | | |
|---|---|---|---|---|---|
| Variable | No. | % | No. | % | P-value[a] |
| Self-rated fitness improved during the trial (vs. not) | 9 | 30 | 17 | 13 | 0.026 |
| Self-rated LTPA increased (vs. not) | 10 | 33 | 22 | 16 | 0.042 |
| Baseline self-rated fitness lower than peers (vs. similar or better) | 10 | 33 | 17 | 13 | 0.012 |
| Baseline SRH average, pretty good or good (vs. poor or pretty poor) | 27 | 90 | 138 | 99 | 0.018 |
| Lack of interest restricting PA (vs. no) | 11 | 38 | 25 | 18 | 0.026 |
| Lack of guidance restricting PA (vs. no) | 6 | 21 | 7 | 5 | 0.013 |
| Light housework but no other LTPA ( vs. ≥ 4h LTPA weekly) | 9 | 30 | 13 | 10 | 0.006 |
| Stage of exercise behavior change: preparation/contemplation/pre-contemplation (vs. maintenance/action) | 15 | 52 | 22 | 17 | < 0.001 |
| Perceived future hopeless or depressing (vs. hopeful) | 3 | 10 | 2 | 2 | 0.042 |
| | Improved LS (n = 74) | | Not improved LS (n = 91) | | |
| | No. | % | No. | % | P-value[a] |
| Low or pretty low family income (vs. high or pretty high) | 12 | 17 | 4 | 4 | 0.015 |
| Baseline SRH average, pretty good or good (vs. poor or pretty poor) | 4 | 5 | 0 | 0 | 0.039 |
| At least slightly dissatisfied (vs. satisfied) | 69 | 93 | 49 | 54 | < 0.001 |
| Improving mood important motive for exercise (vs. no) | 59 | 84 | 61 | 68 | 0.026 |
| Perceived future hopeless or depressing (vs. hopeful) | 5 | 7 | 0 | 0 | 0.016 |

[a] Pearson chi-square test. Fisher Exact Test was used if N≤ 5.

LTPA = leisure time physical activity

PA = physical activity

The binary logistic regression model was adjusted for all variables associated with improved life satisfaction or self-rated health in the univariate analyses. According to the multivariable analysis, baseline life dissatisfaction (OR 13.8; 95% CI 3.7 – 51.8) and mood enhancement as important motive for exercise (OR 2.5; 95% CI 1.1 – 5.6) were associated with improved satisfaction in the intervention group. Predictors of improved self-rated health during the trial were lower self-rated health at baseline compared to pretty good or good health (OR 9.6; 95% CI 3.7 – 24.9) and improvement of self-rated fitness during the trial (OR 4.2; 90% CI 1.5 – 11.9). (Table 4.) In the combined groups, the results remained the same except that mood enhancement as important motive for exercise was not related to improved life satisfaction.

Table 4. The predictors of improved self-rated health (SRH) and life satisfaction (LS) (OR and 95% CI) after a six-months randomized controlled trial among young men in the intervention group (n = 250) according to multivariable logistic regression analyses.

| | Characteristic | Adjusted OR (95% CI) |
|---|---|---|
| Improved SRH | | |
| | Baseline SRH average, pretty poor or poor (vs. good/pretty good) | 9.6 (3.7 - 24.9) |
| | Improved self-rated fitness (vs. not improved) | 4.2 (1.5 - 11.9) |
| Improved LS | | |
| | At least slightly dissatisfied at baseline (vs. satisfied) | 13.8 (3.7 - 51.8) |
| | Enhancing mood important exercise motive at baseline (vs. not important) | 2.5 (1.1 - 5.6) |

## 4 Discussion

In this population-based, randomized controlled trial among young men, life satisfaction increased similarly both in the intervention and in the control subjects. The intervention was most successful within the men who were dissatisfied with their lives at baseline and who reported mood enhancement as important motive for exercise. There were no statistically significant changes in self-rated health in either group, but men who reported poorer health at baseline and succeeded to improve self-rated fitness during the trial were more likely to gain improvements in self-rated health. This suggests that the chosen trial regimen could be effective among the young men with low life satisfaction and need for health promotion.

Several studies have been conducted to promote physical activity through mobile or Internet-based interventions among young people [45, 46], but only few have reported the effects of the trial on subjective health and wellbeing. Especially population-based studies are lacking and trials which reported effects on psychological wellbeing have mainly been conducted among risk groups. In contrast to our study, a 10-week Internet-delivered intervention among college students with mental disorders did not have an impact on mental health outcomes [47]. In a study among adolescents at risk of Type 2 Diabetes, technology-based 12-month intervention affected the quality of life of girls, but had no effect in boys [48]. A 12-week web-based intervention [49] succeeded to increase health-related quality of life in overweight young people, but it did not have any effect on the control group unlike in the present study.

Previously, web-based interventions have been suggested to have at least short-term effect on physical activity in young people [45, 50]. In the study of Mailey et al. physical activity increased in both groups [47], but another study among young did not show any effect on physical activity or weight [48]. In a recent intervention [49] participant's fitness improved but BMI increased only among control subjects. In our study, weight increased regardless of the group

allocation but physical activity did not change. The contradictory findings may be due to the differences in the duration of trials. It may be easier to observe changes in shorter trials because of the enthusiasm of the participants in the beginning of the study. In addition, there also was face-to-face counseling in the studies of Mailey et al. and Riiser et al. while we used mainly mobile approach in our study.

In our study, life satisfaction improved in the control group. This may be due to anticipation of the follow-up measurements or simply the Hawthorne effect: Only participating and being considered in the study may have improved life satisfaction. The trial took place during a rainy autumn and cold winter, whereas the follow-up measurements were conducted in the spring. It has been previously reported that men with low education levels experience higher life satisfaction at the beginning of the year and decreasing over the course of the year [51]. In our study, the participants in the control group wore blinded activity monitors and received a reminder text message about the uploading the activity data to the database, which may have partly motivated them. The choice of which kind of control group was used may have influenced the results of the intervention study [52, 53]. In a review by Enwald and Huotari [52], the use of a no-information control group seemed to be linked to statistically significant between-group effects in measuring physical activity in tailored intervention studies.

Previously, low engagement in the interventions has complicated the evaluation of their effectiveness among young people [54, 55]. Furthermore, the quality of the design and protocol of the previous information and communication-technology-based interventions has been low, for example, due to the lack of a control group, which makes it difficult to draw conclusion about the effectiveness [46]. The advantage of our study was the population-based, randomized controlled design and large sample size. In addition, compliance within the study was reasonably high because

a majority of the participants (66% control; 73% intervention) attended the final measurement and logged in to the online service (59% intervention).

There are some limitations in this study. The follow-up measurements or upcoming military service may have activated the participating young men in both the intervention and control groups, and this may have confused the results. Moreover, 41% of the intervention subjects did not use the service. Age distribution is narrow in the study population, and all participants were male, which may limit the generalizability of the results.

### 4.1 Conclusion

Life satisfaction improved in this randomized controlled trial with tailored mobile intervention regardless of the group allocation. Within the intervention group, the service seemed to be most beneficial for those with low life satisfaction and poor self-rated health at baseline. The results can be used to target health promotion for young men at risk of low life satisfaction and poor self-rated health.

### 4.2 Authors' contributions

The corresponding author, RP, has been responsible for the practical arrangements of the data collection, data analysis and writing the first draft of the manuscript. HKH, AMJ, RA, NH, HE, TL, EF, TMI, MM, SKK, TJ and RK have provided contribution for the planning and implementation of the study, as well as for the planning and writing of the manuscript. TJ and RK have been the principal investigators and have obtained funding for the study. All authors have revised, read and accepted the final manuscript.

## 4.4 Compliance with Ethical Standards

### 4.4.1 Ethics, consent and permissions

The study was conducted according to the Declaration of Helsinki and was approved by the Ethical Committee of Northern Ostrobothnia Hospital District (ETTM123/2009). The subjects had the right to refuse to participate or withdraw from the study at any time without any effects on their future health care or military service. Written informed consent was obtained from all individual participants included in the study.

### 4.4.2 Conflict of interest

The authors declare that they have no competing interests, but RA is currently employed at Polar Electro Ltd.

## Appendix

1: CONSORT Checklist

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**Appendix 1 CONSORT Checklist**

**Click here to download Supplementary Material (for online Publication): Appendix_1_CONSORT_Checklist.doc**