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Original Article

A Cluster Randomized Controlled Trial on the Effects of Technology-aided Testing and Feedback on Physical Activity and Biological Age Among Employees in a Medium-sized Enterprise

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ABSTRACT

Background: It has been suggested that engaging technology can empower individuals to be more proactive about their health and reduce their health risks. The aim of the present intervention was to study the effects of technology-aided testing and feedback on physical activity and biological age of employees in a middle-sized enterprise.

Methods: In all, 121 employees (mean age 42 ± 10 years) participated in the 12-month three-arm cluster randomized trial. The fitness measurement process (Body Age) determined the participants' biological age in years. Physical activity was measured with the International Physical Activity Questionnaire Short Form.

Results: Physical activity did not change during the intervention. Biological age (better fitness) improved in all groups statistically significantly ($p < 0.001$), but with no interaction effects. The mean changes (years) in the groups were −2.20 for the controls, −2.83 for the group receiving their biological age and feedback, and −2.31 for the group receiving their biological age, feedback, and a training computer.

Conclusion: Technology-aided testing with feedback does not seem to change the amount of physical activity but may enhance physical fitness measured by biological age.

1. Introduction

Employer-sponsored wellness programs have achieved significant improvements in cardiovascular risk factors [1], such as weight management and waist circumference [2,3]. Participation in well-structured worksite wellness programs may increase health and life satisfaction for employees, and they appear to help employees develop and maintain healthy behaviors [4–7]. Participation in workplace physical activity programs can also be associated with improvements in the mental component of health-related quality of life, although the physical activity level remains the same [8]. However, fewer small businesses adopt workplace health promotion programs compared with large businesses [9].

While participation in worksite wellness programs may increase employees' health and life satisfaction, technology-aided methods are expected to increase encouragement and motivate changes in health behavior better than, for example, the traditional testing of physical capacity [10]. Workplace health promotion interventions may improve physical activity and dietary behavior, and encourage a healthy weight, but there is no evidence of increased efficacy associated with specific intervention types [11]. Previous studies are inconclusive, and some have suggested that the effectiveness of interventions in physical activity and productivity-related outcomes in occupational settings could be poor [12,13]. Thus, it has also been suggested that engaging technology can empower individuals to be more proactive about their health and reduce their health risks [14].

Our study concentrated on studying the effects of technology-aided methods and measurements of physical activity using the Body Age method. Body Age is a fitness assessment method and a product concept developed in the late 1980s. Body Age applies a person's demographics, health status, lifestyle questionnaires, and

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fitness assessments. Reliable and repeatable assessments are made possible by hardware provided by the Body Age System, herein referred to as the test system (Polar Electro Inc., Kempele, Finland). The fitness assessment results are characterized by a Body Age score, which defines the person's biological age (in years). The software of the test system generates an assessment report automatically [15].

Heterogeneity of the age-related physiological changes is shown by the "biological age," which determines the rate of aging experienced by each individual. Biological age is defined as the functional capability of a human, and the selected biomarkers encompass various complex physiopathological factors related to intrinsic and extrinsic physiological and functional aging. It can be measured, for example, by functional capacity tests, blood tests, and skin, retinal, and strength tests [16]. The biological age index is commonly constructed from a number of the most reliable biomarkers of aging [17]. Compared with individual biomarkers, the index has been shown to be a reliable biomarker of mortality, and a cognitive and physical performance prognostic factor. The correlation is not demonstrated only with individual biomarkers [17]. To our knowledge, the applicability of Body Age to occupational health services has not been studied previously.

The purpose of the present study was to determine the effects of technology-aided testing and feedback given (Body Age score) on physical activity and biological age during a 12-month follow-up period in a cluster randomized controlled study in a medium-sized enterprise.

2. Materials and methods

2.1. Study sampling and design

This study was carried out among employees of a medium-sized enterprise in recycling. The circular economy company provides comprehensive environmental management services. The intervention project took place in its main site (Riihimäki, Finland) in the years 2008–2009. The company employed both blue and white collar workers, the majority working in manufacturing but a part also in administration. All employees ($n = 220$) were invited to participate in the physical activity intervention program. Both the occupational health nurse and the executive director informed all the employees beforehand, and everyone could sign up for the study. In addition, electronic information channels delivered general information about the study. In all 67% (149) of the employees registered for the study and were cluster randomized into three groups based on age, sex, and occupation (blue and white collar). The study was carried out through the occupational health service in the company and coordinated by an occupational health nurse. An ethics committee approval statement was obtained from the Lahti Region Hospital Ethics Committee. Written informed consent was obtained from the participants.

2.2. Participants

The inclusion criteria were readiness to participate in the study, age between 18 and 64 years, and the occupational physician in the company approving the self-reported medical history. The exclusion criteria were pregnancy, coronary artery disease, uncontrolled hypertension (blood pressure > 200/110 mmHg), and the use of a pacemaker. Contraindications for the study also included severe arrhythmias, myocardial infarction or bypass surgery in the last 6 months, angioplasty or thrombolytic therapy, valvular heart disease, or other problematic heart failures. Severe symptoms of stress, an unbalanced systemic disease, acute infection, and recent severe injury or surgery were also contraindications for the study.

Study participants' characteristics are shown in Table 1. During the 1st 3 months, 11 employees were made redundant for economic and production reasons, and they therefore dropped out of the study. The analysis includes employees with results from baseline as well as the 6-month and 12-month follow-ups ($n = 121$). There were almost no significant differences at baseline in background and outcome variables. All groups were similar except for the wall sit. Body Age was higher than chronological age in all groups at baseline.

2.3. Test system and procedure

The Body Age System is primarily targeted for use in fitness and health-related fitness environments to motivate individuals to be physically active for better health and fitness, and to improve their overall well-being.

The Body Age measurement process is used to form a biological age [15]. The measurement includes muscular strength, flexibility, aerobic fitness, and body composition by means of tests performed

Table 1
Demographic and clinical characteristics of the study participants by group

Variables	Group			*p*
	A $n = 42$	B $n = 43$	C $n = 36$	
Demographic variables				
No. of men, *n* (%)	34 (81)	35 (81)	27 (75)	0.67
Age (y), mean (SD)	42 (10)	43 (10)	40 (10)	0.33
Body mass index (kg/m^2), mean (SD)	27.2 (4.6)	26.8 (3.9)	26.3 (3.9)	0.63
Current smoker, *n* (%)	9 (21)	10 (23)	11 (31)	0.70
Clinical variables				
Blood pressure (mmHg)				
Systolic, mean (SD)	135 (11)	136 (9)	138 (12)	0.60
Diastolic, mean (SD)	93 (14)	93 (12)	91 (12)	0.59
Body age difference from chronological age (years), mean (SD)	4.23 (5.21)	2.59 (5.86)	2.52 (6.85)	0.24
Body age index (years), mean (SD)	46.1 (11.0)	45.9 (12.4)	42.6 (12.0)	0.31
Body fat, % (SD)	26.6 (9.1)	25.3 (7.0)	26.5 (9.1)	0.68
Biceps strength (kg), mean (SD)	41.7 (11.7)	44.3 (12.2)	41.0 (13.2)	0.39
Wall sit (s), mean (SD)	111 (52)	123 (61)	145 (64)	0.02*
Sit and reach (cm), mean (SD)	33.8 (8.5)	34.5 (8.1)	37.1 (9.2)	0.17
Crunch repetitions, mean (SD)	31.8 (15.4)	38.2 (15.9)	33.5 (17.8)	0.13
$VO2_{max}$ (mL/kg/min), mean (SD)	35.3 (7.1)	36.4 (8.8)	39.0 (10.1)	0.13

*Statistically significant according to the $p < 0.05$ level.
SD, standard deviation.

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