

EVALUATION OF DYNAMIC OFFICE WORKSTATIONS



The treadmill workstation (WALK) and a screenshot of the 3D visualisation of motion capture system (Xsens)

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Sedentary work entails health risks. Besides increasing the leisure time physical activity, prevention efforts at the office workplace itself are needed. Dynamic workstations, at which (computer) tasks can be combined with physical activity, might reduce the risks. This project evaluates three dynamic workstations with regard to their potential health benefits, effects on work performance, usability, comfort, and acceptance.

HEALTH RISKS OF SEDENTARY WORK

Sedentary work, i.e. work that is characterized by long periods of uninterrupted sitting, is associated with premature death in general, type II diabetes and obesity. These health risks have a dose-response relationship with sitting time; more hours of sitting lead to higher risks. For instance, each 2 hours per day increase in sitting at work was associated with a 5% increase in risk of obesity and a 7% increase in risk of type II diabetes. Persons who reported to be 'sitting almost all of the time' had a 1.5 higher chance to be dead 12 years after the start of a prospective study than persons who reported to be 'sitting almost none of the time'. The health risks are also independent of the amount of physical activity a person has when he or she is not sitting. This means that persons with sedentary jobs who are engaged in sports still have a higher health risk than persons with non-sedentary jobs, like construction workers, who are also engaged in sports.

Daily physical inactivity is a health risk for low back pain. Prolonged sitting causes an increase of the intradiscal load and a sustained stretch of passive lumbar structures in combination with poor back muscle activity. Although epidemiological reviews provide conflicting evidence for the association between physical inactivity and low back pain, researchers agree that prolonged sitting is considered a risk factor for developing low back pain.

'TYPING AND READING PERFORMANCE IS NOT AFFECTED BY THE ELLIPTICAL TRAINER AND THE BICYCLE'

DYNAMIC WORKSTATIONS

Dynamic (or active) workstations are workstations where (computer) tasks can be combined with physical activity like walking, stepping, cycling or an elliptical leg movement while sitting. Given the dose-response relationship between sedentary time and health risks, and in view of the long hours spent behind a computer every day, the potential health benefits of combining physical activity with computer work seem to be great. Moreover, dynamic workstations have the ability to tackle the problem of sedentary work at its source: the workplace.

METHODS OF EVALUATION

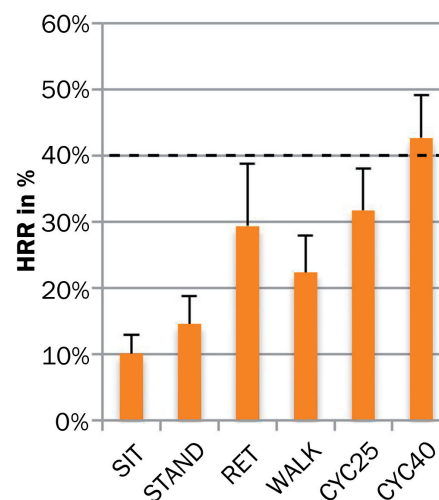
In this study, we investigated the effects of three dynamic workstations: a recumbent elliptical trainer (LifeBalance Station from Rightangle) (RET), a treadmill (Life Span) (WALK), and a bicycle ergometer (Tunturi E60) combined with a height adjustable desk. A regular sitting desk (SIT) and standing desk (STAND) were used as a reference workstation. The bicycle workstation was tested at two intensities (CYC25 and CYC40), leading to six experimental conditions. Four standardized office tasks were performed by 15 subjects (7 male, 8 female) for 30 minutes per workstation. Subjects varied in age (29, SD=12 years) and in Body Mass Index (BMI) (22.3, SD=2.1 kg/m²). Typically, subjects exercised more than two times a week at a moderate intensity, for an average of 50 minutes. The experiments were conducted in an office-like laboratory environment. Subjects performed the four tasks in a different order at each workstation and completed the experiment in one day. This study evaluated the effects of the different workstation conditions on work performance, trunk rotation, comfort and discomfort, and user experience.

LEVELS OF PHYSICAL ACTIVITY

The movement intensities used were: 2.5 km/h on the treadmill; 40 revolutions per minute (17 Watt) on the recumbent elliptical trainer; typically 60 revolutions per minute at 25% and 40% heart rate reserve (HRR) on the bicycle ergometer, corresponding to 56 (SD=21) and 85 (SD=28) Watt respectively. The relationship between HRR and cycling intensity in Watts was individually determined with a submaximal Åstrand-test. A heart rate belt (Polar) was used to measure the heart rate.

It is assumed that in order to prevent cardiovascular diseases and type II diabetes, the exercise intensity, described in %HRR, should be 40% or higher. The highest cycling intensity (CYC40) was the only workstation condition that accomplished this intensity (see graph below). All other dynamic workstation conditions are non-sedentary, and therefore contribute to NEAT (Non-Exercise Activity Thermogenesis).

Average Heart Rate Reserve (HRR)



Exercise intensity of the different workstations displayed as HRR. The dotted line indicates the health promoting exercise intensity (40% HRR).

RESULTS

WORK PERFORMANCE

The speed and accuracy of four standardized office tasks were measured. Subjects typed a presented text, did 2 mouse agility tasks, read and corrected a text from the computer screen, and performed 4 cognitive function tests (attentional, perceptual, executive and memory). Performance measures of all conditions were compared with the seated workstation, as a reference condition. For the objective work performance, there was an equal performance for almost all conditions on reading, typing and cognitive tasks. Only while using the treadmill, subjects typed less characters than while using the seated workstation. For the mouse task, work performance decreased on all performance measures for all dynamic workstation conditions, and for the treadmill in particular. The work performance as perceived by subjects decreased significantly for all dynamic workstation conditions for all tasks. Reading was perceived as least affected and the mouse tasks as most affected.



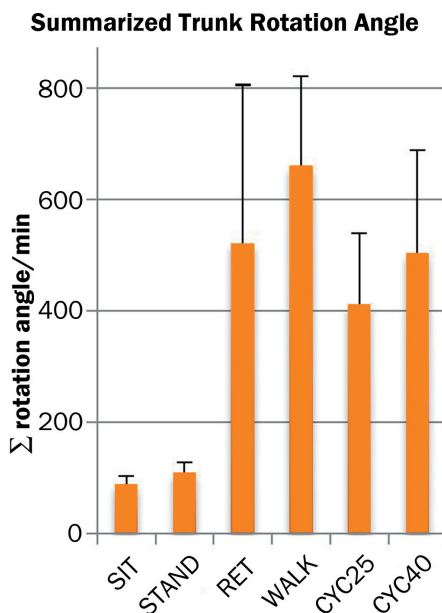
Schematic representation of trunk rotation: each maximum rotation angle between the shoulder and hip line contributes to the summarized trunk rotation angle.

TRUNK ROTATION

Seated work is very passive for the back. Employees with back pain may experience difficulties with long periods of uninterrupted sitting. Small passive rotations of the spine have been shown to increase spine length. Body postures and movements were measured with a motion capturing system (Xsens MVN full-body suit). Trunk rotation, defined as the rotation between the shoulder line and hip line (see figure), is regarded as an indicator of non-passive back behaviour. The trunk rotation for each dynamic workstation condition was higher than for the sitting and standing condition. Trunk rotation was comparable between the dynamic workstation conditions. The frequency of rotations was a result of the cycling and stepping frequency. The frequency was about 40 rotations per minute for treadmill and elliptical trainer and 60 rotations per minute for the bicycle ergometer conditions. The amplitude of the trunk rotations was higher for treadmill and elliptical trainer, about 6 degrees, and was 3-4 degrees for the bicycle ergometer conditions. It is assumed that these small rotations lead to an increased thickness of the intervertebral disc as a result of a higher swelling pressure. This could lead to less spinal shrinkage during the day.

COMFORT AND DISCOMFORT

Before and after each condition, the amount of discomfort was measured using the Local Perceived Discomfort method (LPD), in which subjects are asked to score their discomfort for each body part. The two bicycle conditions had a higher LPD score at the end of the test compared to sitting. This was due to the



Amount of trunk rotation expressed as summarized trunk rotation angle per minute.



The semi-recumbent elliptical trainer workstation (RET)

relatively high discomfort that most subjects experienced in the buttocks, caused by the saddle of the bicycle ergometer. Local perceived discomfort during working on treadmill and elliptical trainer did not increase compared to sitting. The results of the questionnaire on comfort show that subjects felt physically more tired after using the elliptical trainer and the bicycle workstation (both intensities) compared to sitting. They also felt less comfortable while working on treadmill, elliptical trainer, and bicycle workstation compared to sitting. The sitting and standing condition were rated more comfortable. Almost none of the subjects experienced back pain or joint pain due to the use of the dynamic workstations.

USER EXPERIENCE AND ACCEPTANCE

Subjects did not feel more, neither less, focused while using a dynamic workstation. Although subjects experienced some decrease in work performance and comfort, they also see benefits of working on a dynamic workstation. Typically 70-80% would like to use a dynamic workstation as an addition to their normal exercise routine and 20-40% would use a dynamic workstation as an alternative to their normal exercise routine. The usage of dynamic workstations in their current workplace was feasible according to about 50% of the subjects. If available in a dedicated setting for dynamic workstations, 80% of the subjects see themselves using a dynamic workstation at least once a week and 45% would use it more than once a week.

'80% WANTS TO USE A DYNAMIC WORKSTATION AT LEAST ONCE A WEEK'

CONCLUSIONS

Office workers can work on a dynamic workstation with equal performance on the most essential office tasks, high precision mouse tasks excluded. The perception of decreased performance might complicate the acceptance of a dynamic workstation, although most subjects indicate that they would use a dynamic workstation if available. Feasible exercise intensities on these dynamic workstations are not intense enough to fulfill the current guidelines on physical activity and health, except for the high (40% HRR) intensity on the bicycle workstation. However, all dynamic workstations may contribute to reduce the adverse health effects of sedentary behaviour and increase NEAT.



The bicycle ergometer workstation (CYC25 and CYC40)

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WORK AND EMPLOYMENT

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