IFA
Institut für Arbeitsschutz der
Deutschen Gesetzlichen Unfallversicherung

# IFA projects on prevention of physical inactivity at VDU-workplaces

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# Introduction

Work-related physical inactivity, e. g. at office VDU workplaces, is a growing problem.

Possible negative consequences of physical inactivity:

- muskuloskeletal disorders (Carter and Banister, 1994; Todd et al., 2007)
- reduced muscular strength and endurance (Vanderborne et al. 1998)
- reduced cardiovascular fitness (Perhonen et. al. 2001, Watenpaugh et al. 2000)
- metabolic syndrom (Blanc et al. 2000)
- increased risk of developing chronic diseases (Straker and Mathiassen, 2009)

Currently there are approx.18 Mio. office workplaces in Germany.

# Conclusions of the European Council on nutrition and physical activity (2014/C 213/01)

The European Council notes with concern

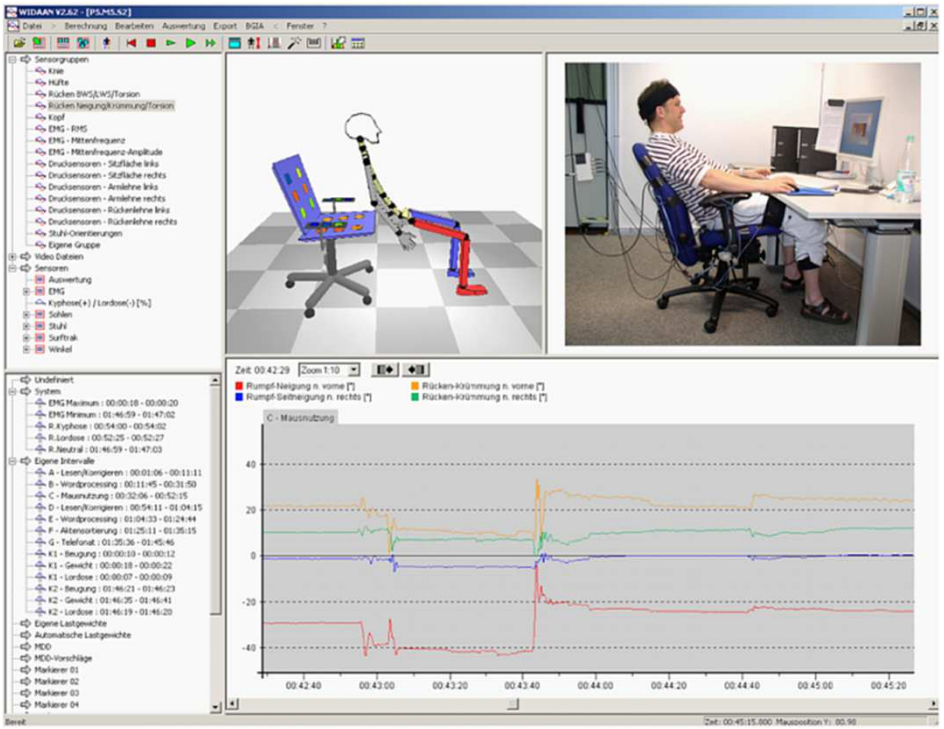
- …„ that obesity and its morbid consequences have been described as having reached epidemic proportions, as more than half of the adult population in the EU is overweight or obese according to the BMI classification of WHO and that the high level of overweight and obesity in children and adolescents is of particular concern …”

and invites the member states to

- “… support initiatives to promote health in the workplace, aiming at facilitating healthy eating habits and integrating physical activity into every day working life…”

# IFA studies on physical activity promotion in offices

- development of measuring systems for physical activity assessment „CUELA activity“ (2002 – ongoing)
- comparative ergonomic study on specific dynamic office chairs (2005 – 2008)
- pilot intervention study on physical activity promotion in offices (2009 – 2012)
- laboratory study on dynamic office work stations (2012 – 2014)



# Ergonomic study on specific dynamic office chairs*

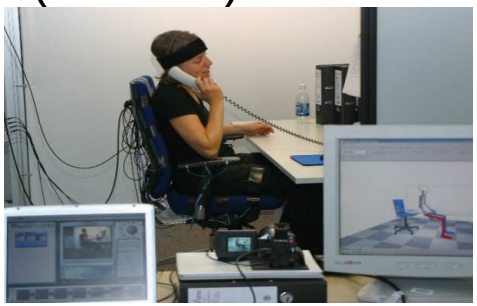
| A | B | C | E | D |
|---|---|---|---|---|
|  |  |  |  |  |
| Electric motor under seat pan: rotation of 0,8° to left and right, frequency: 5 $min^{-1}$ | Suspension system of the seat pan: stimulation of movement in horizontal plane | Seat pan fixed to a pendulum; possibility of moving freely in all directions | 3D moveable joint, seat pan can move freely in all directions | Reference chair, standard office chair with synchro system |
| 1250 $ | 1050 $ | 900 $ | 800 $ | 575 $ |

*Ellegast R., Kraft K., Groenesteijn L., Krause F., Berger H., Vink P., 2012. Comparison of four specific dynamic office chairs with a conventional office chair: Impact upon muscle activation, physical activity and posture. Applied Ergonomics 43:297-307.

# study design

## lab study

- laboratory office workplace
- 10 subjects (office workers)
- measurements of muscular activity (EMG), body postures and joint angles, physical activity intensity, chair utilization
- Survey on comfort, subjective perceived disorders and workloads
- 5 standardized office tasks (100 min)



## field study

- study in 4 companies
- 40 subjects , incl.12 measurement subjects (office workers)
- measurements of body postures and joint angles, physical activity intensity, chair utilization
- Survey on comfort, subjective perceived disorders and workloads
- everyday office work (2 h)

# Conclusions (office chair study)

- For all chairs relatively low muscular activations and physical activity intensities were measured.
- The **comparison of specific dynamic chairs A, B, C, E and the reference chair D** showed
  - no significant differences concerning muscular activation (m. erector spinae, m. trapezius)
  - no significant differences concerning joint/body angles
  - few significant differences concerning physical activity intensity (95th percentiles PAI values L1/Th3 (chair A) and head (chair C))
  - several significant differences concerning chair parameters (chairs B, C, E vs. D)
- On the contrary the performed tasks strongly affected the measured muscle activation, postures and kinematics. Dynamic tasks, e. g. sorting files, differ significantly to static tasks, e.g. mouse tasks.
- Subjective ratings of the chairs showed many variabilities and ind. preferences.

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# Pilot intervention study on physical activity promotion in offices*

## Randomised controlled intervention study (n=25)

### Intervention group (IG)

**n=13** (4♀, 9♂)
**Age** 40,7 (±10,2) yrs. **BMI** 26,3 (±3,2) kg/m$^2$

*12-week intervention period with various activity promotion measures*

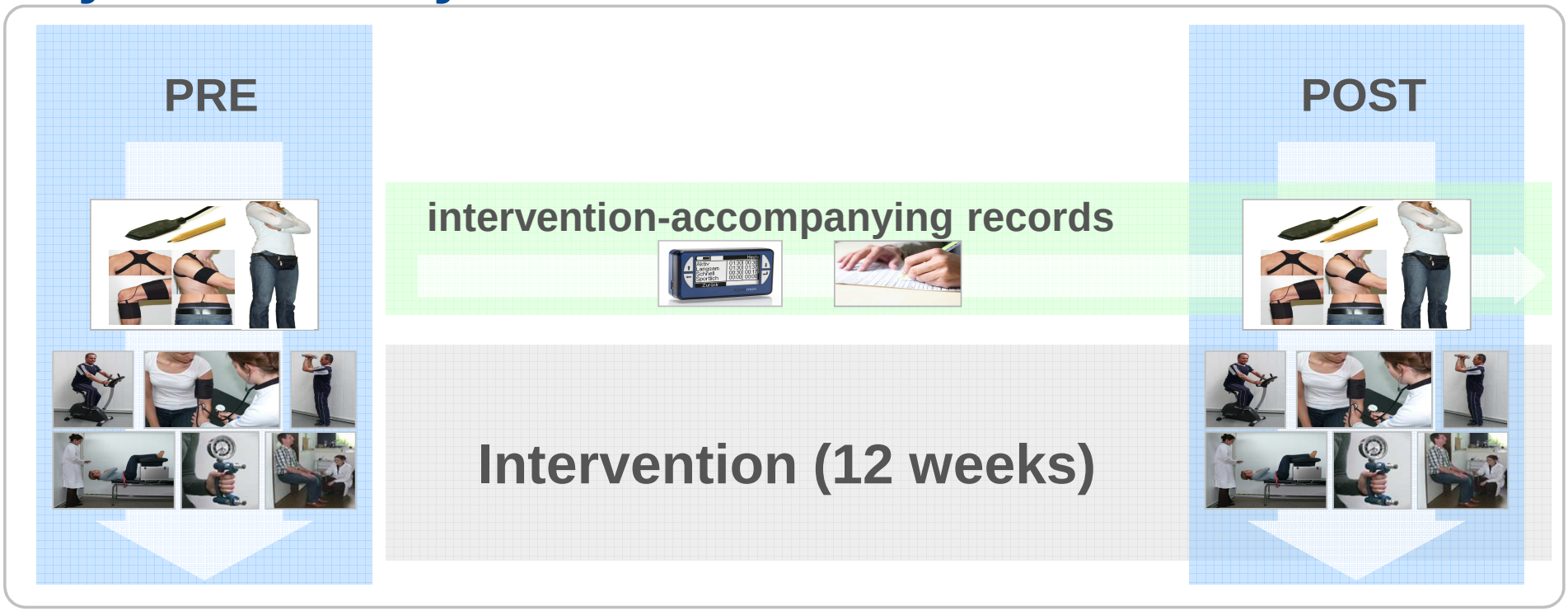
### Control group (CG)

**n=12** (4♀, 8♂)
**Age** 42,1 (±13,2) yrs.
**BMI** 26,0 (±3,2) kg/m2

*No intervention*

*Ellegast R., Weber B., and Mahlberg R., 2012. Method inventory for assessment of physical activity at VDU workplaces. Work No. 41, 2355-2359.

# Physical activity assessment



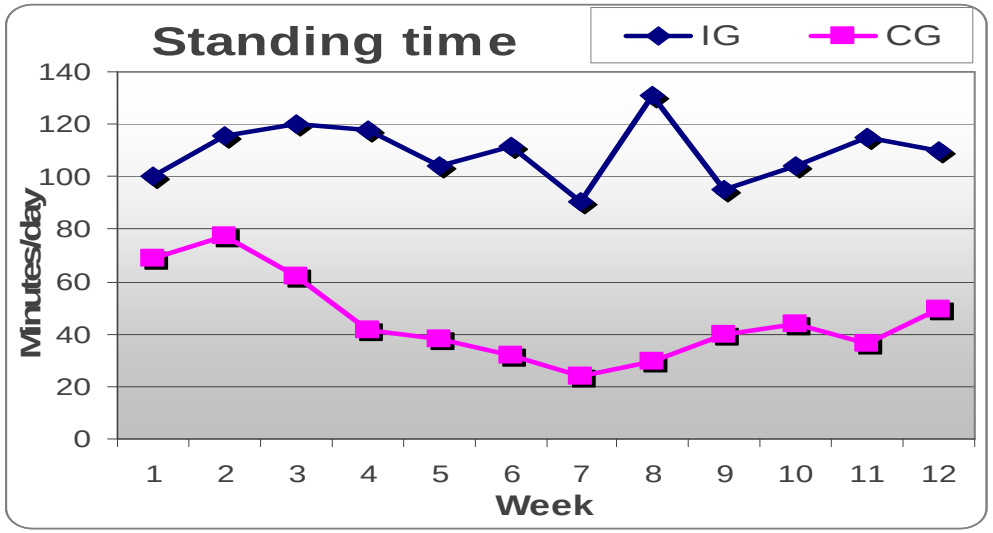

**Statistics**

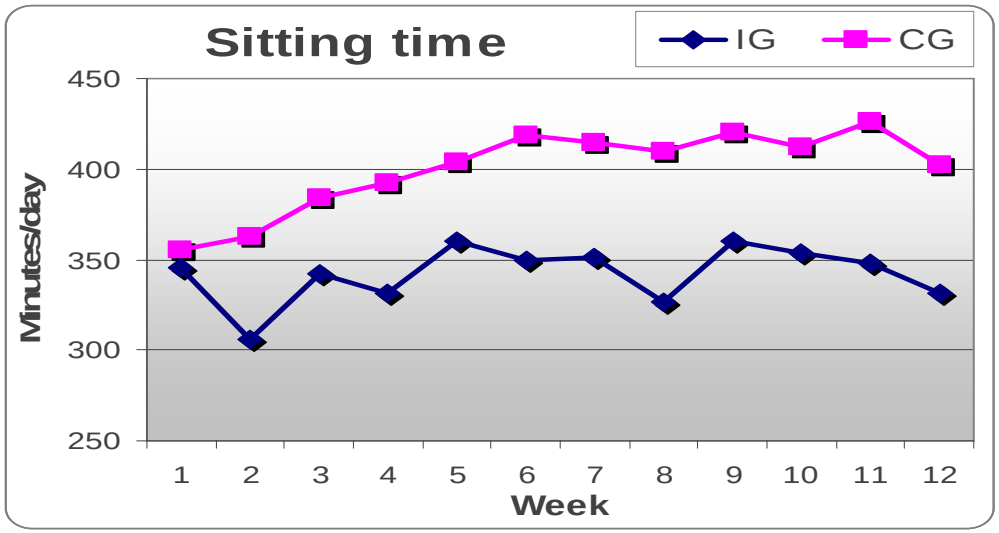
- Pre-post differences by two-way ANOVAs
- Day-to-day data by Wilcoxon signed-rank tests

# Results: activity logs

**Intervention group (IG) was significantly more active than control group (CG)**

- IG spent more time standing and less time sitting

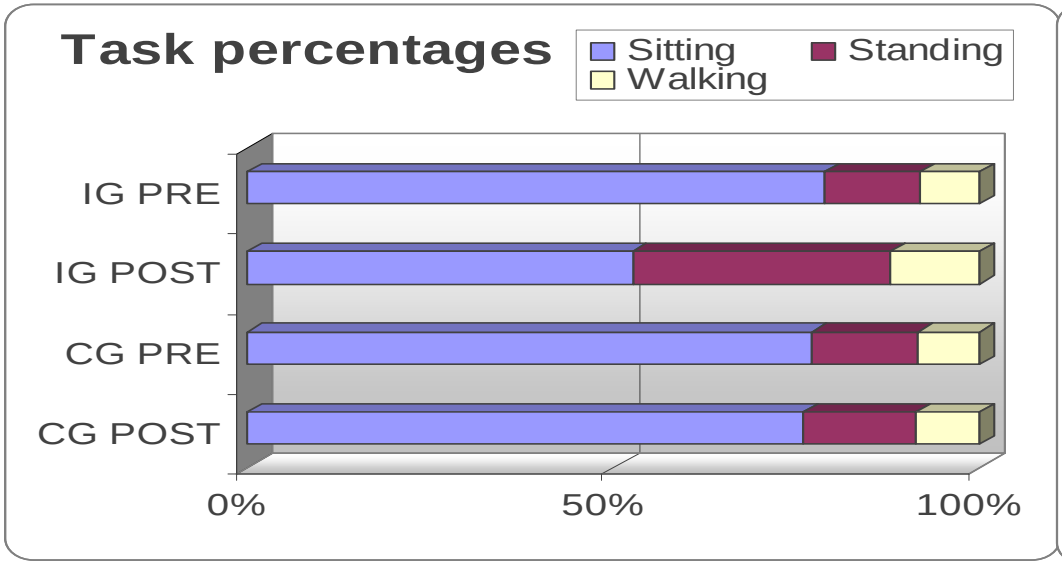


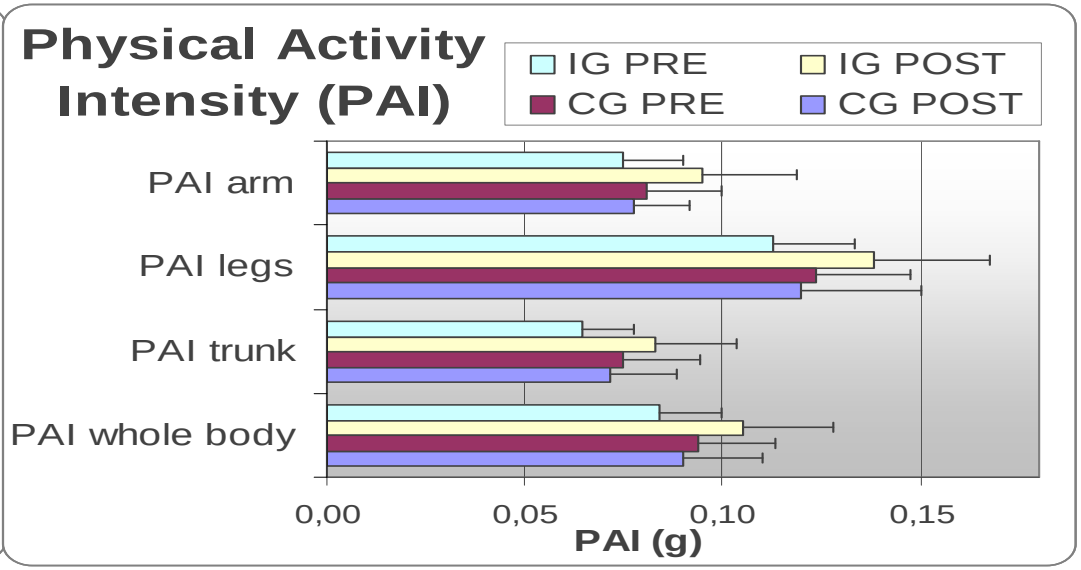



# Results: CUELA activity expert system

**Intervention group (IG) was significantly more active than control group (CG)**

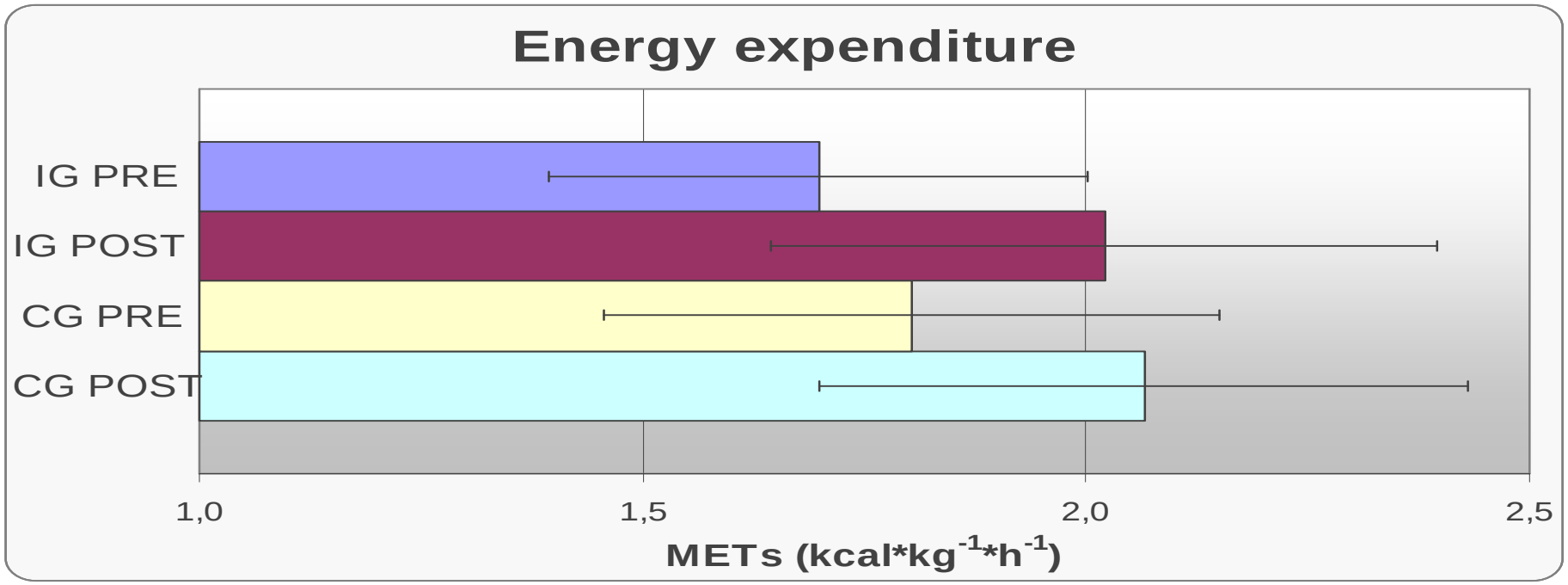
- Reduction of sitting and increase of standing and walking;
  Higher physical activity intensity (PAI) of all body regions



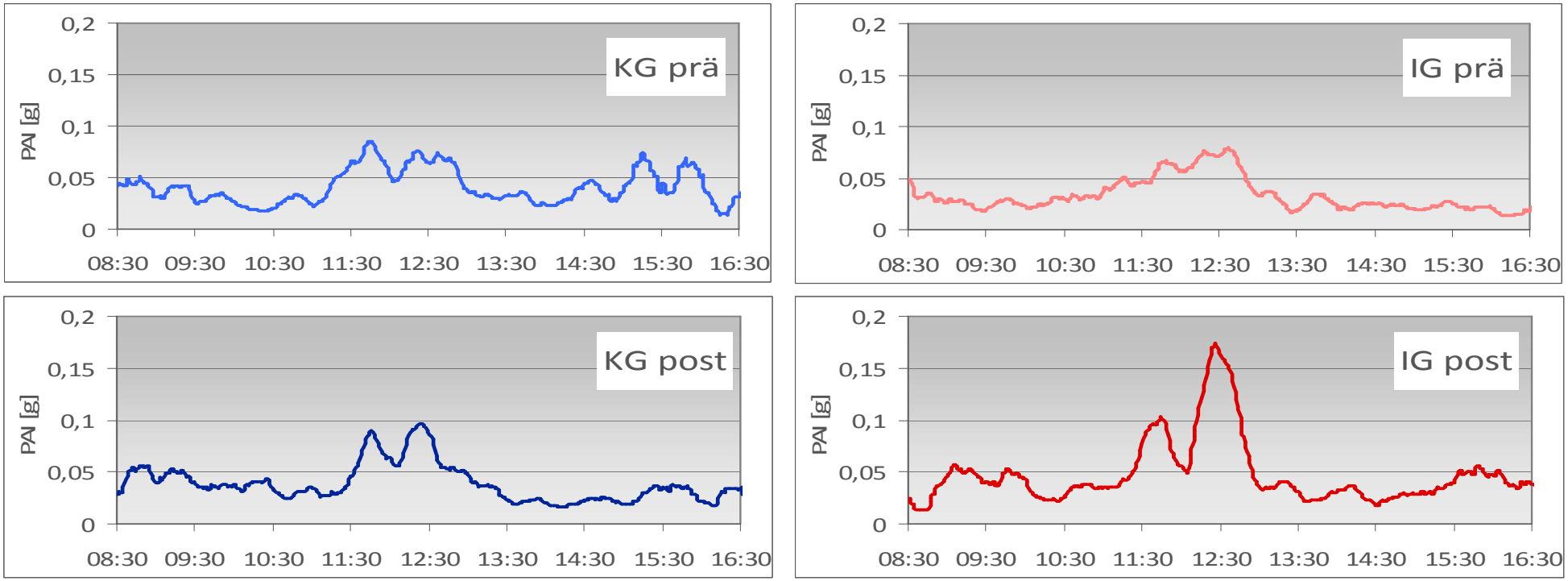
# Results: CUELA activity expert system

- No significant differences for energy expenditure.



# Results: course of time, averaged daily activity

## physical activity intensity (PAI), daily course of time (mean values)



# Dynamic office workstations

Dynamic Workstations:

- recent additions to the commercial market
- limited research available on these workstations.

To be considered as feasible alternatives to current workstations, the following needs to be considered:

- the effects on posture and physiological parameters
- the influence on performance
- the subjective perception of the user
- the feasibility of these types of workstations in the work environment

# lab study on dynamic workstations

Investigate:

- the effect on performance for various basic office and computer-based tasks
- the contribution to physical activity, and the effect on posture and muscular activity
- the subjective perception of users

for two different dynamic workstations currently available on the commercial market in comparison to two conventional workstations.

**Treadmill Desk TR1200-DT (LifeSpan)**

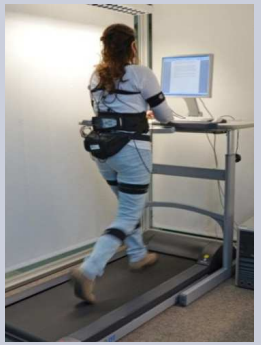
- Speed: 0,6 – 6,4 km/h (0,1 km/h increments)
- manual height adjustable desk

**LifeBalance Station (RightAngle)**

- 24 resistance levels
- RPM: approx. 20 - 60 (self selective)
- electrical height adjustable desk

# lab study on dynamic workstations

| | | Study protocol IFA |
|---|---|---|
| Test persons (office workers) | Number of test persons | 12 (6 female, 6 male) |
| | Mean age in years | 39 ± 11 |
| Workstations | Treadmill desk | 0,6 and 2,5 km/h |
| | Elliptical trainer (LBS) | Resistance 4 and 12 of 40 RPM (about 12 and 17 Watt) |
| | Conventional workstatic | Conventional sitting workplace<br>Conventional standing workplace |
| Office tasks | Standardized | Text processing, reading, telephone, and four different cognitive tasks (att short term memory) |
| Measurement of physiologic parameter | | • body angles, postures<br>• physical activity intensity (PAI)<br>• metabolic rate<br>• muscle activity<br>• heart rate |
| Evaluation of subjective perception | | • local perceived discomfort, perceiv perception of work performance<br>• acceptability |
| Measurement of work performance | | among other things, measurement of precision/error rate |

| Conventional | Dynamic |
|---|---|
|  |  |
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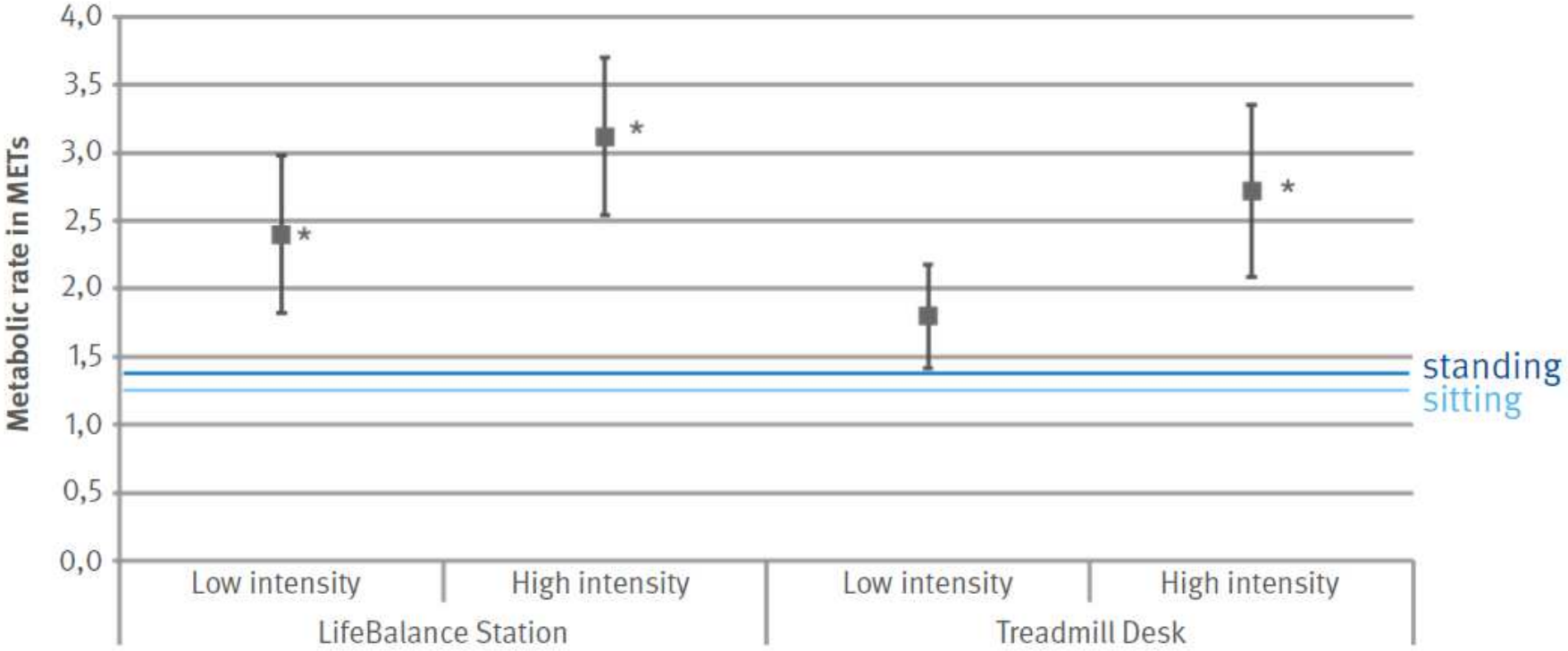
# Results: Physical Activity Intensity (PAI total)

| PAI total [%g] | Condition (p) | Sitting vs. | | | | | Standing vs. | | Task (p) | Condition x Task (p) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Standing | Recumbent Elliptic Trainer | | Walkstation | | Walkstation | | | |
| | | | Low Intensity | High Intensity | Low Intensity | High Intensity | Low Intensity | High Intensity | | |
| **50%ile** | **<0.001** | | * | * | * | * | * | * | **0.003** | **0.002** |
| **95%ile** | **<0.001** | | * | * | * | * | * | * | **0.002** | **0.056** |

# Results: Energy expenditure, comparison of workstations




*significant increases to conventional sitting

# Results: Task Performance

Table 2: Comparison of work performance for IFA and TNO (≈: no difference, • at least one dynamic workstation was significantly worse; x: no results for these parameter)

| Tasks | Parameter | Significance | |
|---|---|---|---|
| | | IFA | TNO |
| Reading | number of characters read | ≈ | ≈ |
| | number of identified errors | ≈ | ≈ |
| Typing | number of characters | ≈ | ≈ |
| | number of typing errors | ≈ | ≈ |
| Telephone | number of words | ≈ | X |
| | number of errors in speaking | ≈ | X |
| | subjective quality (MOS-Skala) | ≈ | X |
| Mouse dexterity | time of reaction | ≈ | • |
| | accuracy | • | • |
| Cognitive tasks | time of reaction | ≈ | ≈ |
| | accuracy | ≈ | ≈ |

# Conclusions (study on dynamic office workstations)

The comparison of dynamic workstations and conventional office workplaces resulted in

- few differences in measured postures (dynamic vs. conventional sitting and dynamic vs. conventional standing)
- significant increases of physical activity intensities (PAIs) and energy expenditure at the dynamic workstations (higher intensities).
- significant increased heart rates at the dynamic workstations (higher intensities).
- significant worse work performances only for mouse dexterity tasks (in comparison to conventional sitting workplace)
- subjective user ratings of worse work performance and comfort
- user feedback concerning ergonomic deficits of the tested dynamic workstations

➡ dynamic workstations may lead to an increase of physical activity, but user acceptance and ergonomic design still have to be improved

# Implementation of dynamic workstations/dynamic office concepts in companies and evaluation of acceptance, usage, practicability,…