

# Dynamic Plantar Pressure Distribution in Multiple Sclerosis Patients with Different Neurological Status



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## Background and aim

Multiple sclerosis (MS) is the most common demyelinating disease of the central nervous system.

As compared to normals, the MS patients exhibit [1]:

- 35% reduction in velocity
- 25% decrease in stride length
- 22% decrease in cadence
- 23% increase in step width

MS frequently causes gait difficulties related to several factors [2].

- Weakness (can cause such problems as toe drag, foot drop etc.)
- Spasticity (affects about 60% MS patients)
- Loss of balance (results in a swaying and a "drunken" type of gait known as ataxia)
- Sensory deficit

The identification of the relative contributions of spasticity, ataxia and other problems is an important part of the assessment of the MS patient.

The aim of this study was to determine the correlation between pressure distribution parameters and impairments in pyramidal and cerebellar systems.

## Subjects and methods

81 patients (26m/55f), age 37±10 years, diagnosed with relapsing-remitting MS according to McDonald's criteria (EDSS 2.2 ±1.2).

Clinical assessment included complete neurological examination.

The Kurtzke Expanded Disability Scale (EDSS) quantifies disability in 8 functional systems (FS): pyramidal, cerebellar, brainstem, sensory, bowel and bladder, visual, cerebral and other.

EDSS steps 1.0 to 4.5 refer to MS patients who are fully ambulatory, EDSS steps 5.0 to 9.5 are defined by the impairment to ambulation.

## PFS and CFS

### PFS:

- 0-no pathology
- 1-pathology without motive impairments
- 2-minimal gait impairments
- 3-slight or moderate paraparesis or hemiparesis
- 4- significant paraparesis or hemiparesis

### CFS:

- 0-no pathology
- 1-pathologic symptoms without coordinator impairments
- 2- slight ataxia
- 3-moderate body ataxia or ataxia in extremities
- 4-significant ataxia in all extremities

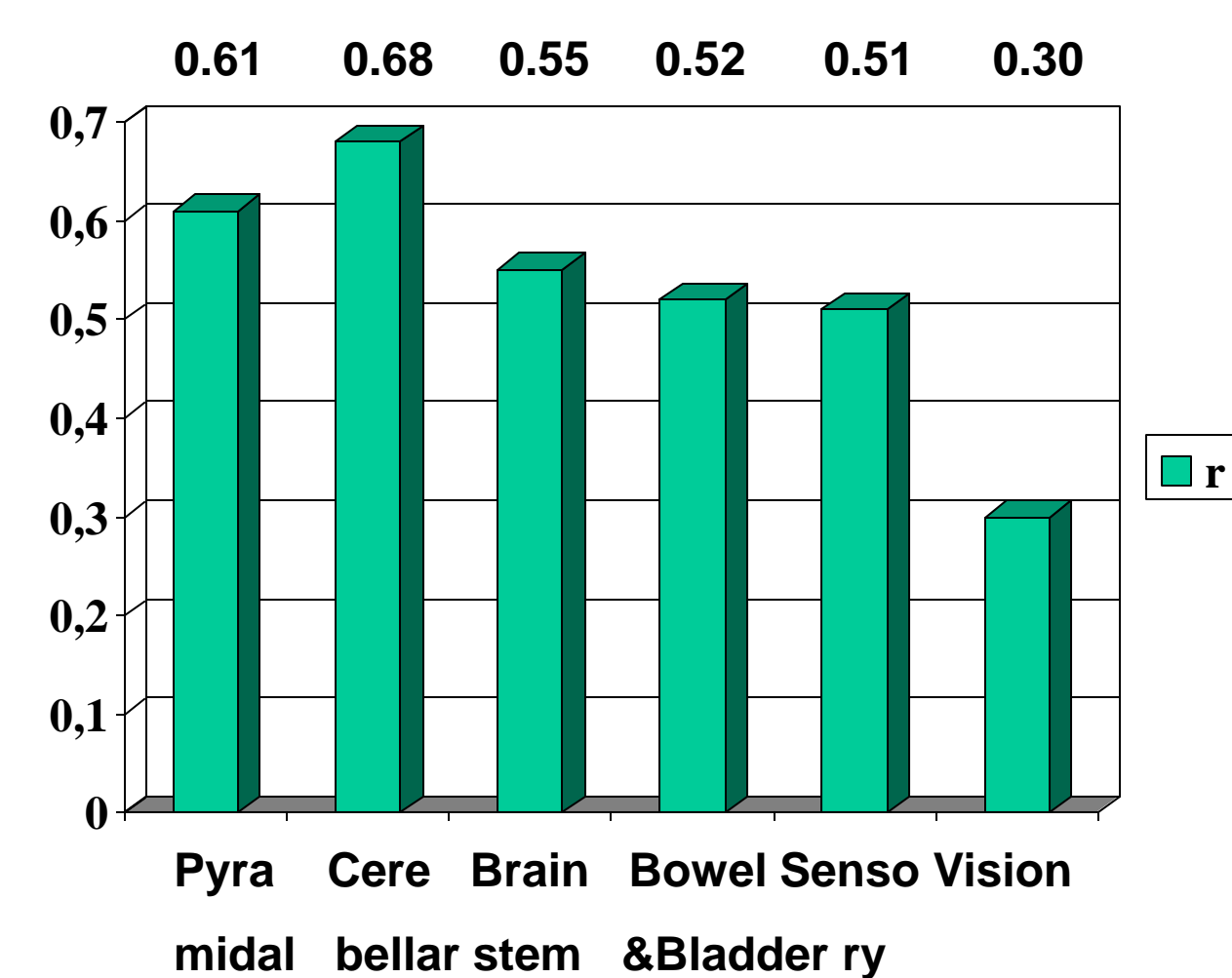
## PDM and data analysis

Five dynamic records of each foot were carried out with first step procedure using emed-at 25 system (novel, Germany).

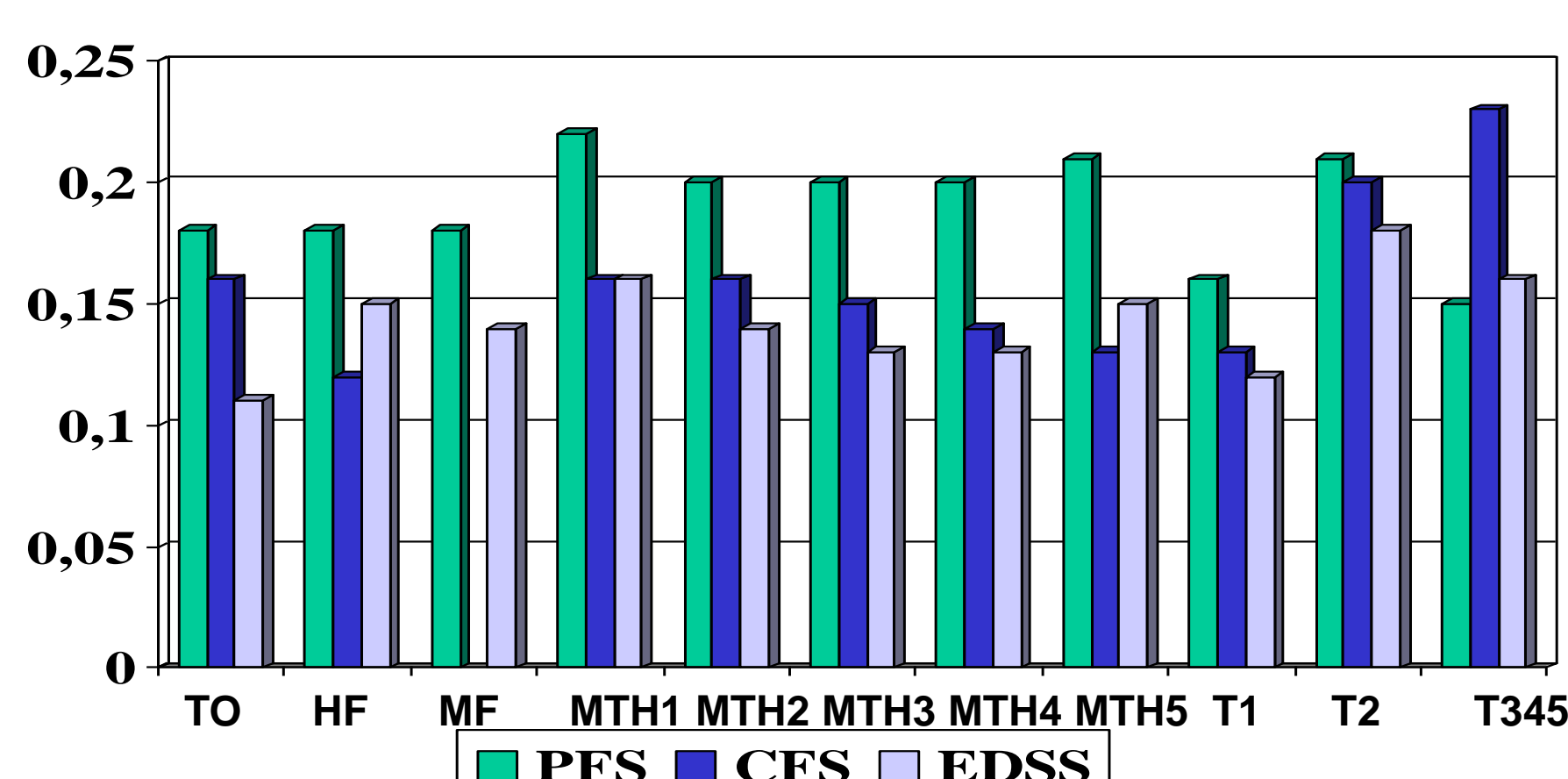
Peak and mean pressure, maximum force, pressure- and force-time integrals, contact time under 10 anatomic areas were calculated with novel software.

Pearson's correlation coefficient ( $p < 0.01$ ) was used for assessment the correlation between pressure distribution parameters and pyramidal and cerebellar functions scores (PFS and CFS).

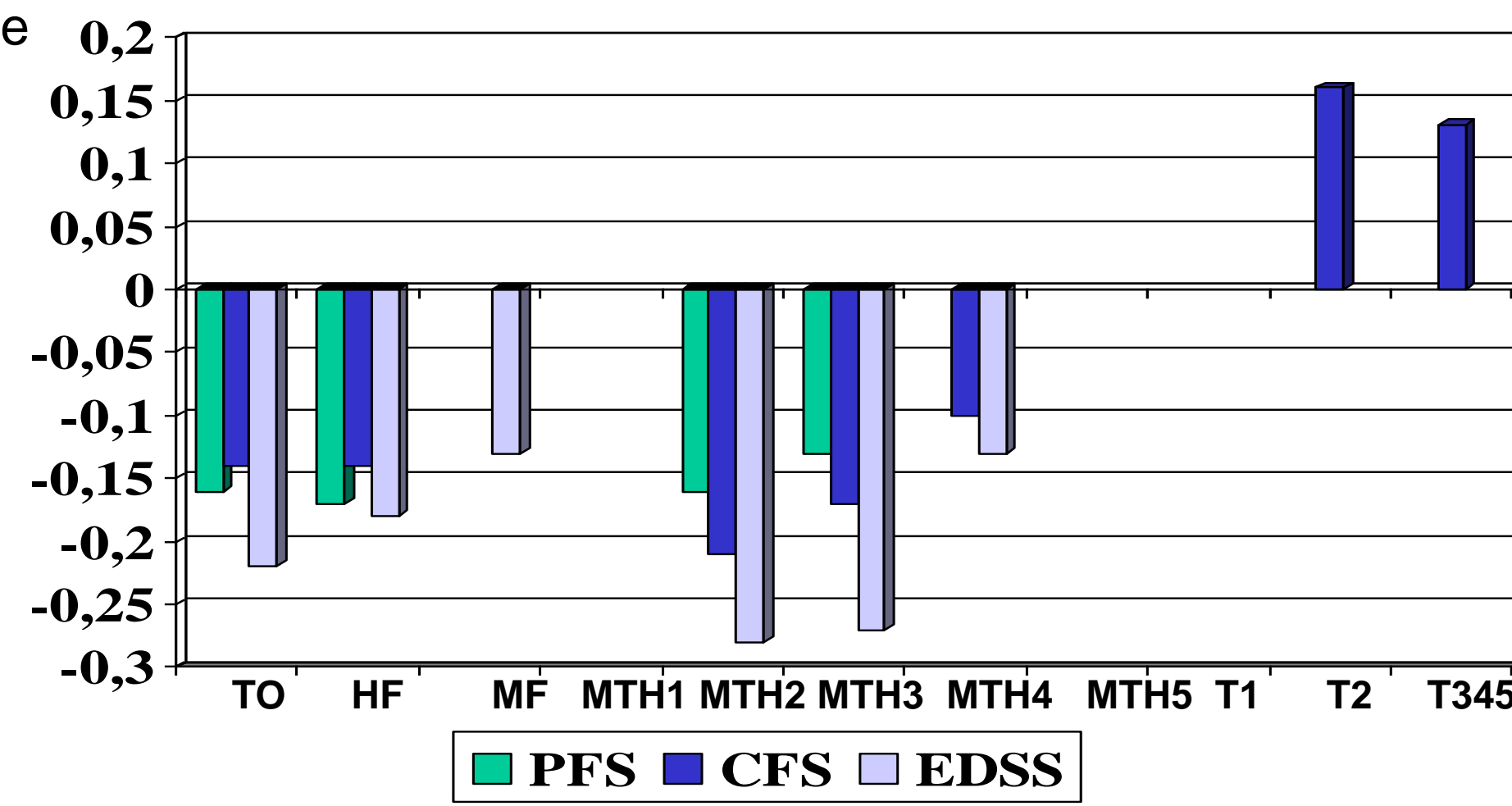
## r(EDSS and FSS)



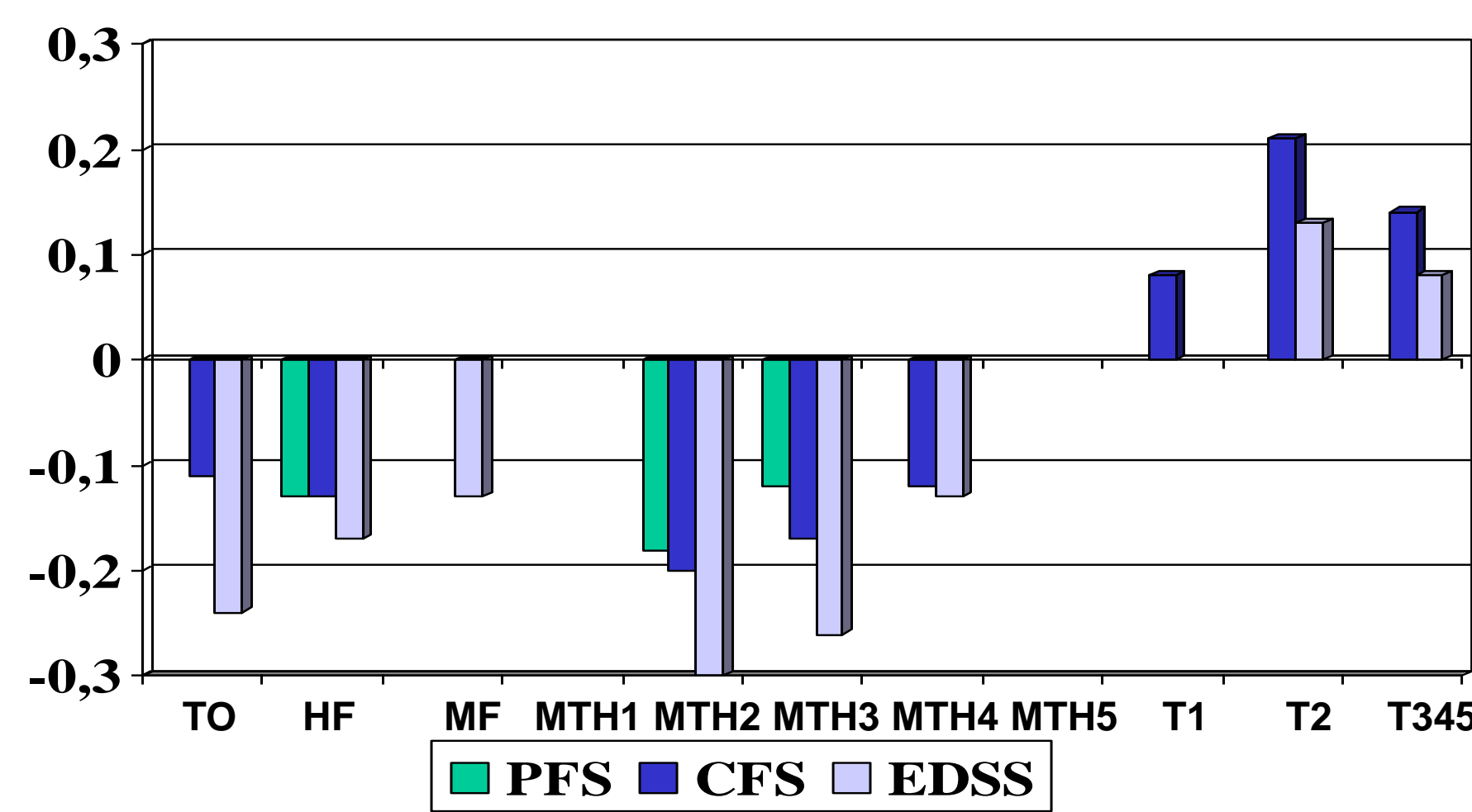
## r(contact time, ms, PFS, CFS, EDSS)



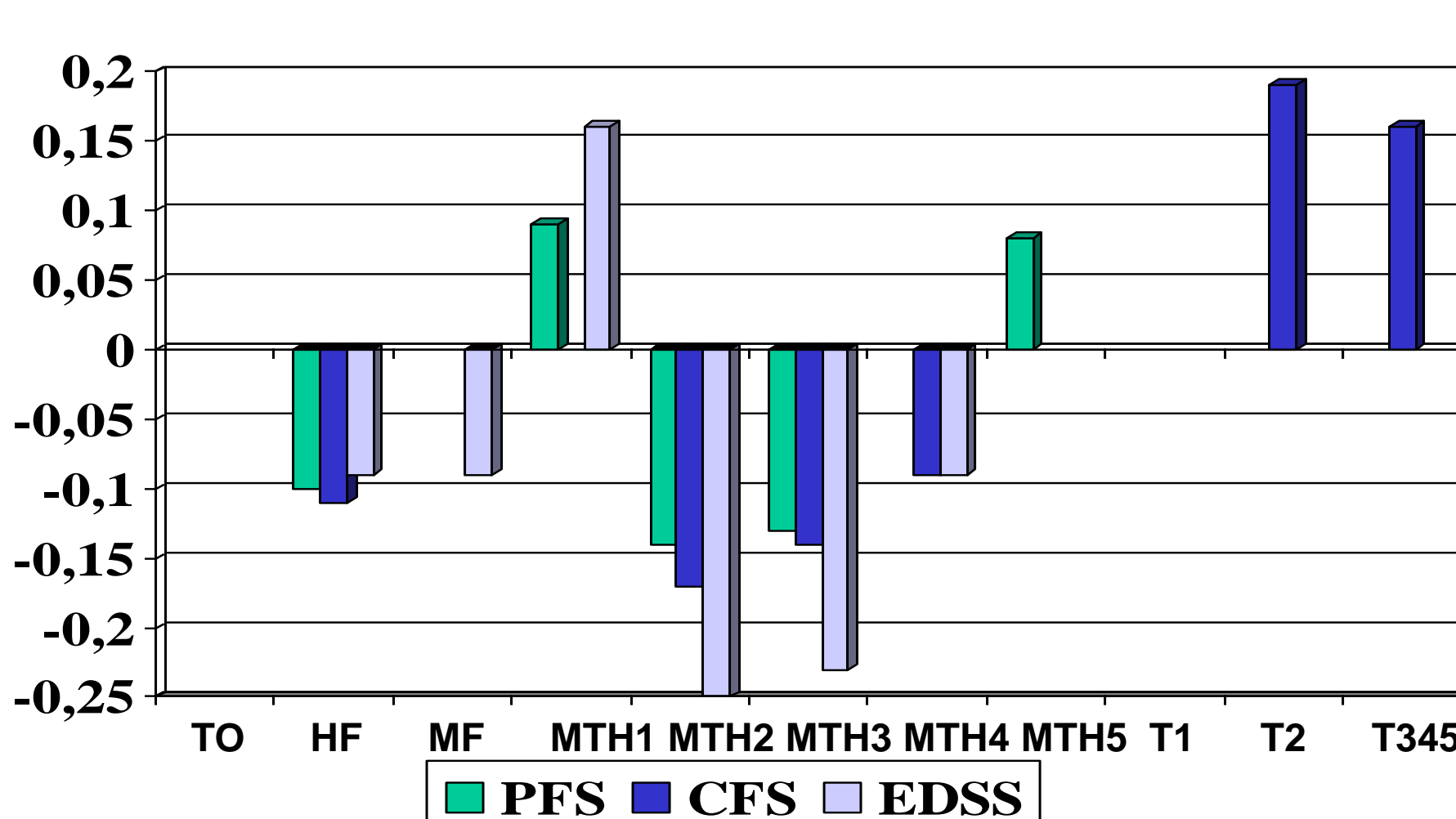
## r(mean pressure, kPa, PFS, CFS, EDSS)



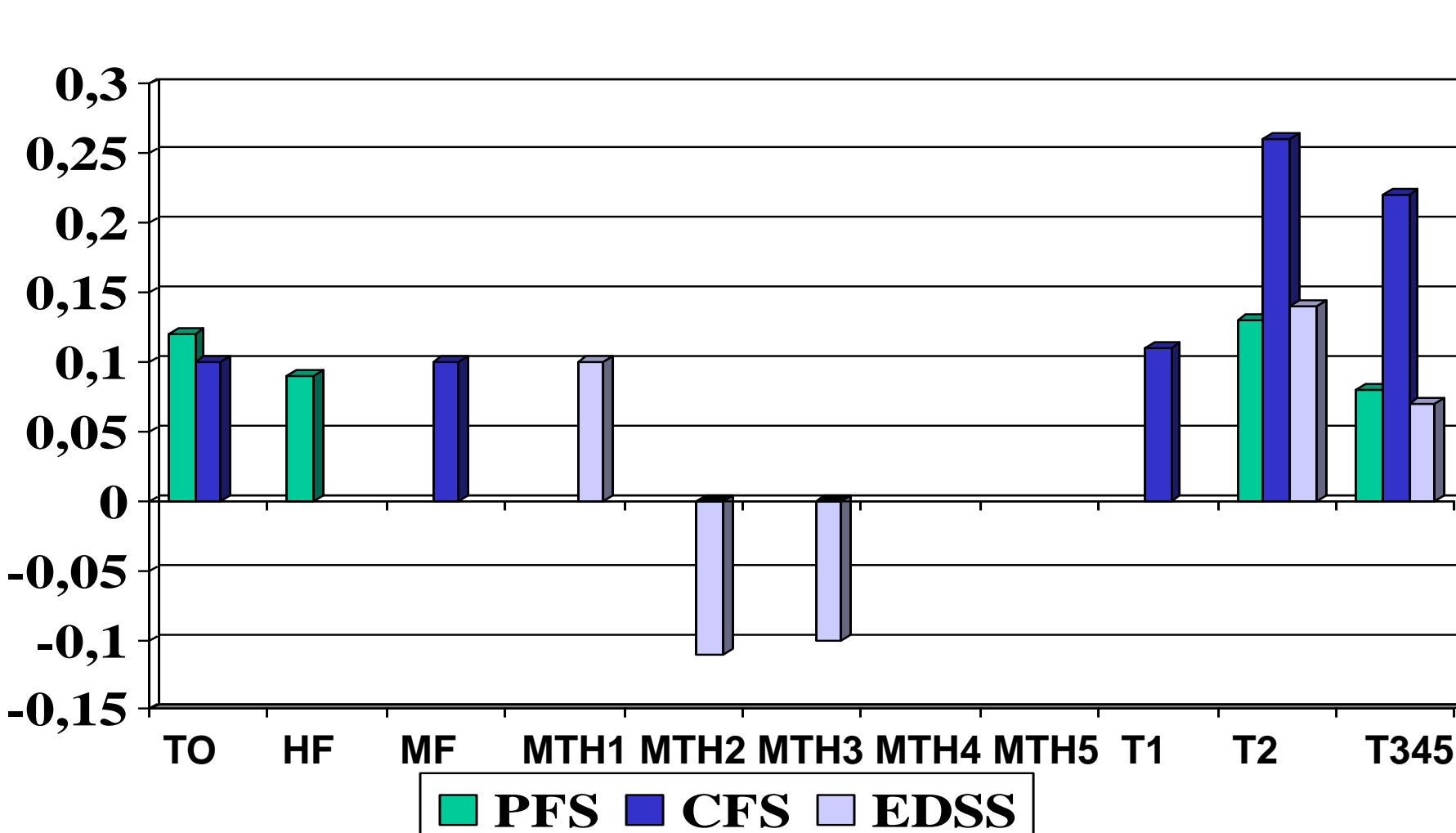
## r(maximum force, %BW, PFS, CFS, EDSS)



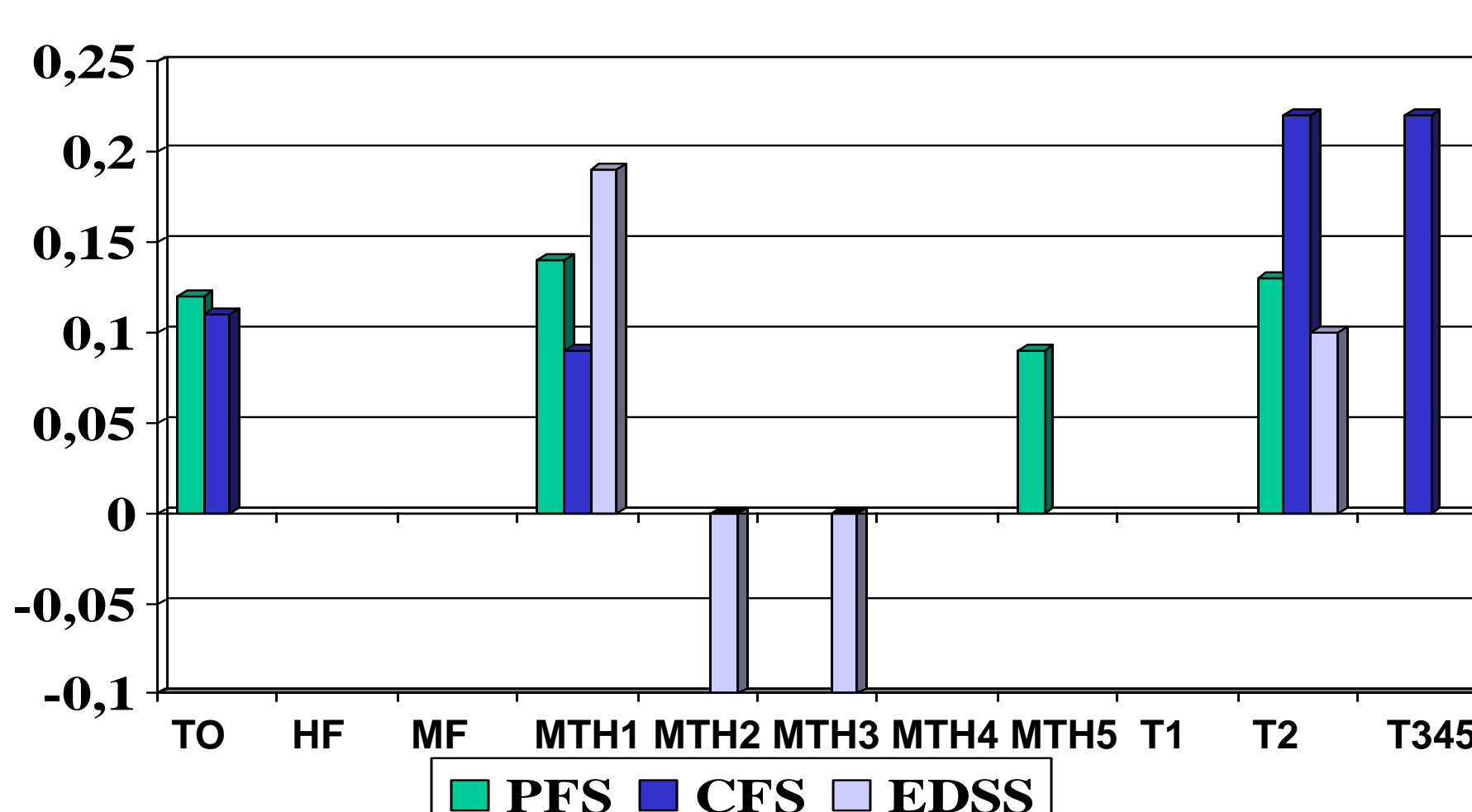
## r(peak pressure, kPa, PFS, CFS, EDSS)



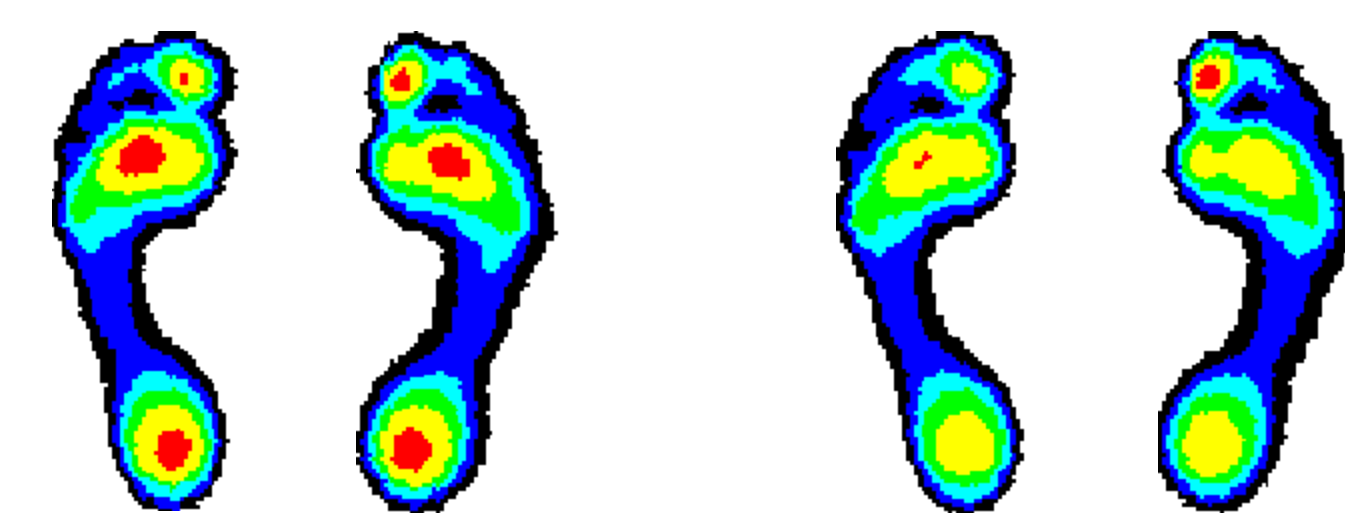
## r(force-time integral, %BW, PFS, CFS, EDSS)



## r(pressure-time integral, kPa\*s, PFS, CFS, EDSS)

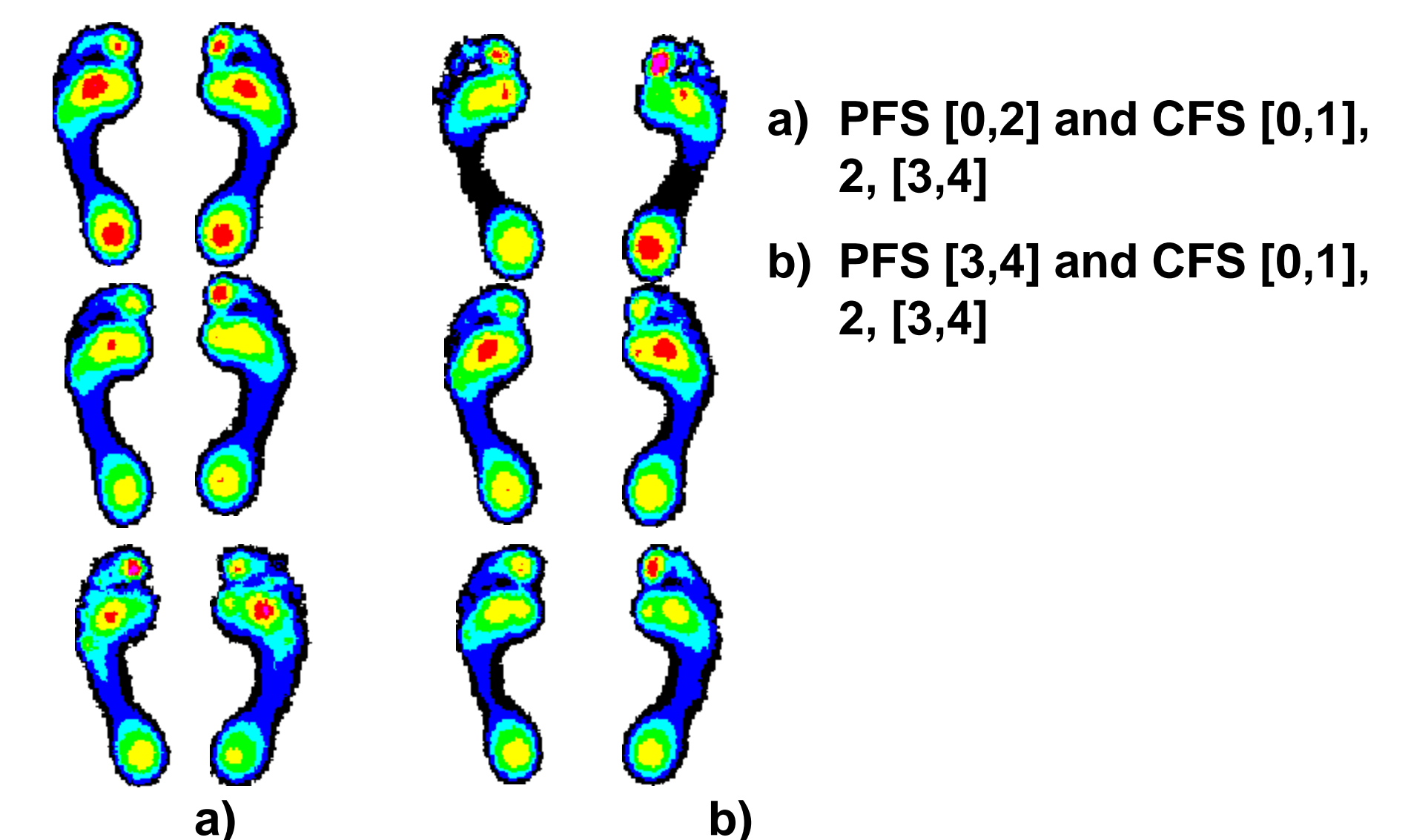


## Average MPP of MS patients with EDSS ≥ 1.5 and EDSS > 1.5



- Reduced loading of second and third metatarsal heads are caused with higher transverse arch of the forefoot with increase of spasticity [4]
- A higher load on first metatarsal head may be due to the role that first ray plays in bearing loading
- Lower lateral loading may be regarded as a protective mechanism of the patient to avoid an imbalance [4]

## Average MPP of MS patients with different PFS and CFS



## Conclusion

- ✓ Weak correlation between pressure parameters and neurological status assessments was found in fully ambulatory MS patients
- ✓ Increase of contact time is more correlated with impairments in pyramidal system
- ✓ Decrease of loading of second and third metatarsal heads is due to the impairments in both systems
- ✓ Decrease of loading of fourth metatarsal head with increase of loading of second-fifth toes correlates with impairments in cerebellar system

## Literature

1. A.E.Walker, J.H.Noseworthy, and K.R.Kaufman. Gait changes of patients with progressive multiple sclerosis. 23rd Annual Meeting of the ASB, University of Pittsburgh, 1999
2. The MS Information Sourcebook. National MS Society.
3. D.T.Shakespeare, J.Craig, M.Lloyd. Spasticity and Movement. Int MS J 2001; 7(3):93-9.
4. S Meyring, RR Diehl, TL Milani, EM Hennig, P Bettli. Dynamic plantar pressure distribution measurements in hemiparetic patients. Clinical Biomechanics 1997, 2(1): 60-5.