Muscle-Strength-Ratios in Para-Badminton

- with special consideration of the Trunk Muscles

Hanno Felder[1 2] , Franziska Geise[1]

[1] Olympic Training Center (Saarbruecken / Germany)
[2] World Badminton Federation (Kuala Lumpur / Malaysia)

Body strength (bilaterally and unilaterally / upper and lower body) and endurance, speed, anaerobic power and trunk muscle function have been pointed out as important factors to be successful in Badminton - and in Para-Badminton.

→ Regarding trunk muscle function, improving trunk strength and trunk endurance would allow Badminton practitioners to increase their ability to generate and maintain force throughout a match (Ellenbecker, 1991).

Beside the upper and lower limb strength, the core strength has a prominent impact on the Para-Badminton performance:

→ Core stability is an important component maximizing efficient athletic function . . . . "The core is important to provide local strength and balance and to decrease back injury".

→ Strength and trunk instability due to impairments, disabilities and handicaps can have adverse effects on posture, function and movement (Kibler, Press & Sciascia, (2006).

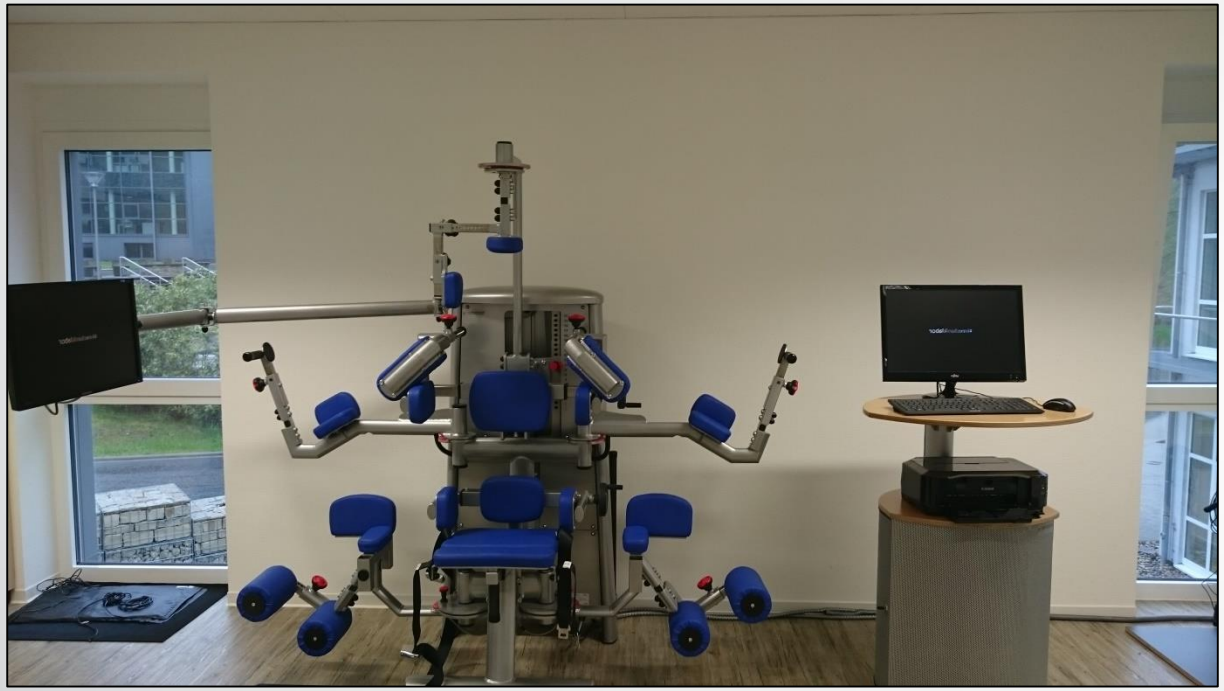
Classification		Typical examples of impairments
Wheelchair	WH 1	Spinal injury causing impairment to upper limbs/trunk; Scoliosis; Multiple Sclerosis
	WH 2	Spinal injury causing impairment to lower limb/trunk; Spina Bifida; above knee amputation necessitating need for wheelchair
Standing	SL3	Single above knee amputation; double below knee amputation; Cerebral palsy
	SL4	Single below knee amputation; Cerebral palsy; hip dysplasia; lengh difference (of minimum 70 mm)
Standing upper limb	SU5	Upper limb amputation; upper limb impairment – eg. Brachial plexus inury
Short Stature	SS	Short stature/dwarf condition eg. Achondaplasia

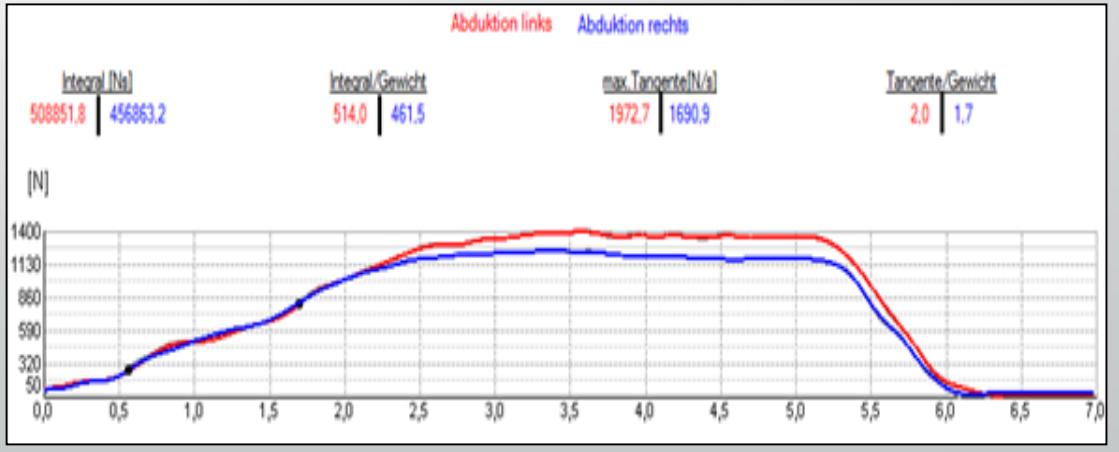
Following questions (especially for the trunk) should be answered in this study:

- What are the maximum isometric strength values of the German Para-Badminton national team ?
- What are the strength ratios between the dominant and non-dominant body side as well as between the agonists and antagonists ?

Participants	Class	Sex	Age	Weight (kg)	Height (cm)	Years of practice
1	WH1	male	36	80	182	7
2	WH1	female	46	85	169	16
3	WH1	female	26	68	170	9
4	WH2	male	55	90	188	9
5	WH2	male	28	73	181	8
6	WH2	male	29	84	181	9
7	SL3	male	41	83	186	32
8	SL3	male	42	83	186	33
9	SL4	male	21	55	174	6
10	SL4	male	26	88	190	1
11	SL4	male	21	98	184	3
12	SL4	male	23	88	174	11
13	SL4	female	46	106	170	9
14	SL4	male	48	80	180	30
15	SL4	male	17	65	181	5
16	SL4	male	22	54	173	6
17	SL4	male	18	88	181	6
18	SL4	female	47	98	170	9
19	SL4	male	22	88	184	14
20	SU5	male	27	83	180	11
21	SU5	male	36	90	179	7
22	SU5	male	57	82	180	15
			33,4±12,5	81,4±13	179,2±6,2	11,7±8,8

Subjects characteristic data




Abduktion links
Abduktion rechts
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456863.2
Integral/Gewicht
514.0
461.5
max.Tangente[N/s]
1972.7
1690.9
Tangente/Gewicht
2.0
1.7
[N]
1400
1130
860
590
320
50
0,0
0,5
1,0
1,5
2,0
2,5
3,0
3,5
4,0
4,5
5,0
5,5
6,0
6,5
7,0

Methods

The following tests were implemented:

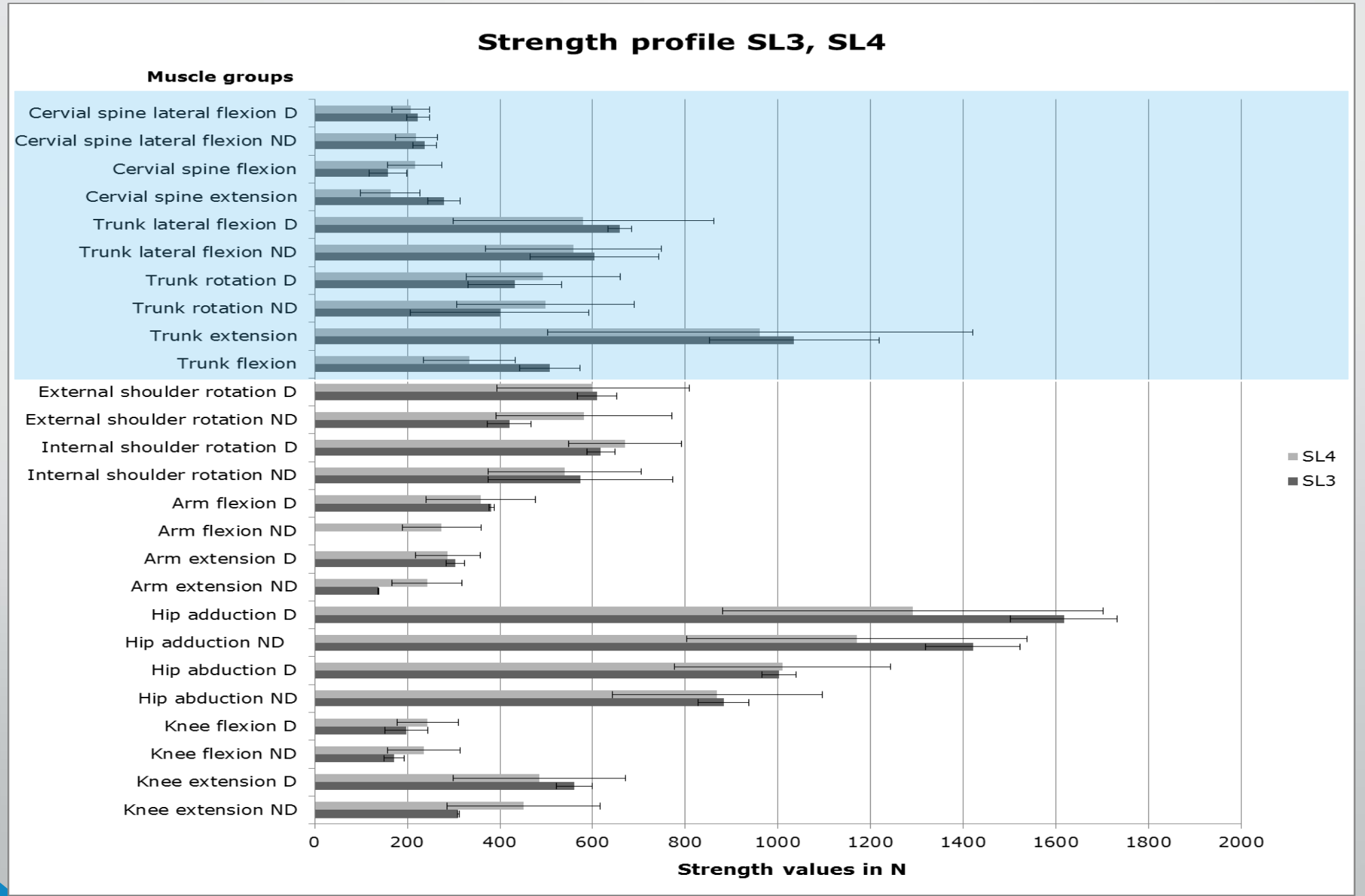
1. Knee flexion
2. Knee extension
3. Hip abduction
4. Hip adduction
5. Arm flexion
6. Arm extension
7. Internal shoulder rotation
8. External shoulder rotation
9. Trunk flexion
10. Trunk extension
11. Trunk lateral flexion
12. Trunk rotation
13. Cervical spine flexion
14. Cervical spine extension
15. Cervical spine lateral flexion

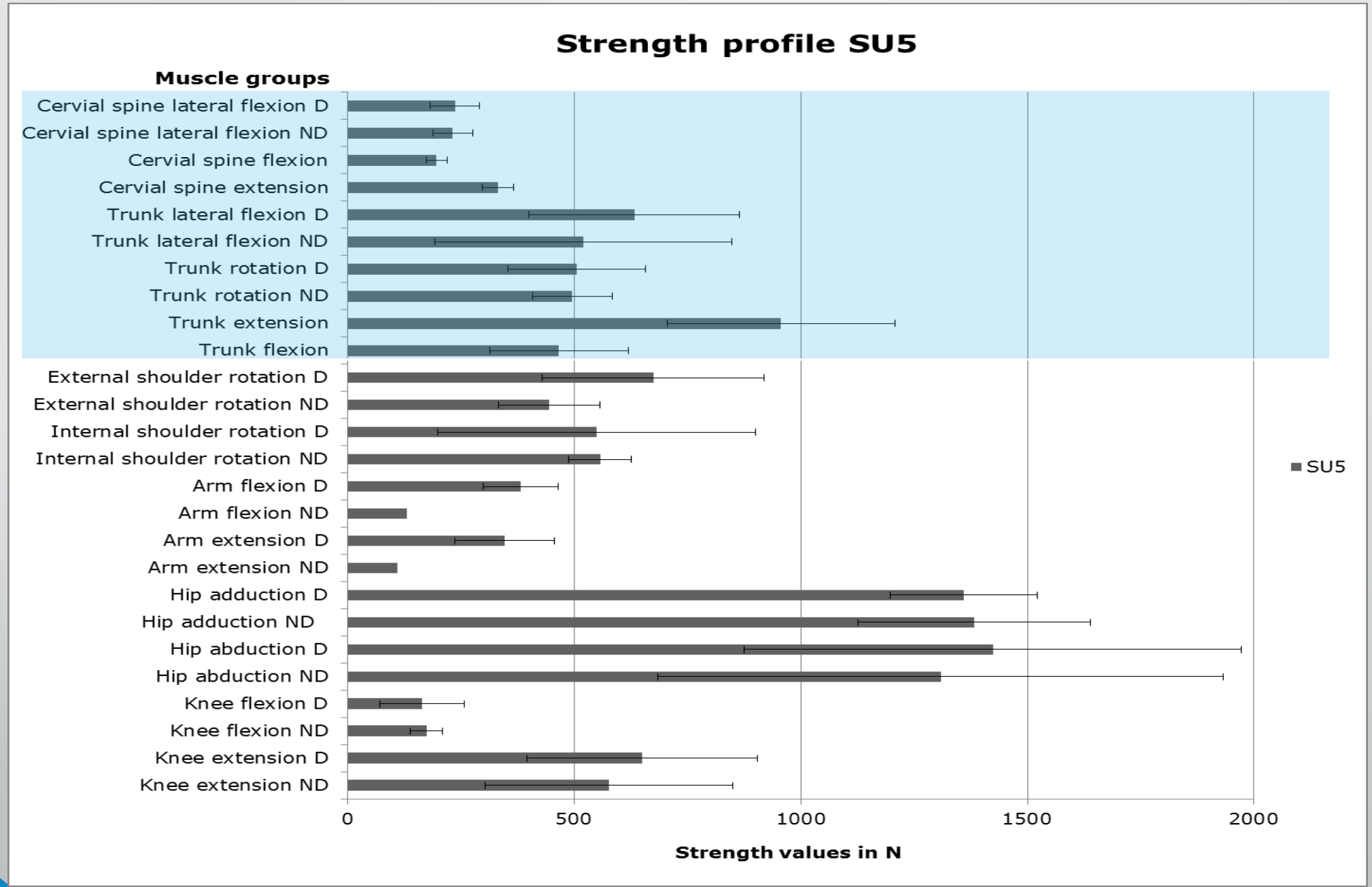
Trunk extension / flexion and rotation right / left

Trunk lateral-flexion

Cervical spine lateral-flexion

Cervical spine extension-flexion


Strength profile SL3, SL4
Muscle groups
Cervial spine lateral flexion D
Cervial spine lateral flexion ND
Cervial spine flexion
Cervial spine extension
Trunk lateral flexion D
Trunk lateral flexion ND
Trunk rotation D
Trunk rotation ND
Trunk extension
Trunk flexion
External shoulder rotation D
External shoulder rotation ND
Internal shoulder rotation D
Internal shoulder rotation ND
Arm flexion D
Arm flexion ND
Arm extension D
Arm extension ND
Hip adduction D
Hip adduction ND
Hip abduction D
Hip abduction ND
Knee flexion D
Knee flexion ND
Knee extension D
Knee extension ND
SL4
SL3
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Strength values in N


Strength profile SU5
Muscle groups
Cervial spine lateral flexion D
Cervial spine lateral flexion ND
Cervial spine flexion
Cervial spine extension
Trunk lateral flexion D
Trunk lateral flexion ND
Trunk rotation D
Trunk rotation ND
Trunk extension
Trunk flexion
External shoulder rotation D
External shoulder rotation ND
Internal shoulder rotation D
Internal shoulder rotation ND
Arm flexion D
Arm flexion ND
Arm extension D
Arm extension ND
Hip adduction D
Hip adduction ND
Hip abduction D
Hip abduction ND
Knee flexion D
Knee flexion ND
Knee extension D
Knee extension ND
SU5
0
500
1000
1500
2000
Strength values in N

	Trunk flexion to extension	Trunk rotation D to ND	Trunk lateral flexion D to ND
	Strength ratios of the spine musculature		
WH1	0.63:1 ± 0.17	0.97:1 ± 0.38	1.11:1 ± 0.06
WH2	0.64:1 ± 0.41	1.08:1 ± 0.1	1.21:1 ± 0.21
SL3	0.50:1 ± 0.15	0.88:1 ± 0.87	1.12:1 ± 0.21
SL4	0.46:1 ± 0.32	1.01:1 ± 0.17	1.03:1 ± 0.39
SU5	0.49:1 ± 0.1	1.02:1 ± 0.19	1.39:1 ± 0.64

	Cervical spine flexion to extension	Cervical spine lateral flexion D to ND
	Strength ratios of the cervical spine musculature	
WH1	0.97:1 ± 0.4	1.35:1 ± 0.3
WH2	0.48:1 ± 0.03	1.33:1 ± 0.45
SL3	0.56:1 ± 0.08	0.94: 1 ± 0
SL4	0.83:1 ± 0.19	0.95:1 ± 0.09
SU5	0.59:1 ± 0.03	1.02:1 ± 0.12

Conclusion

- Trunk musculature plays a key role.
- Agonist-antagonist comparison showed high significant differences between the trunk flexion and trunk extension muscles.
- Significant difference in trunk rotation to the dominant side (especially between WH1 and SL4 athletes).
- High difference in strength performance within the groups, especially in trunk flexion and extension.

- Because of the present study, general strength values are now available for all para-badminton relevant muscles/muscle groups and serve as strength training orientation values and to prevent injuries following muscle imbalances.

➢ **Athletes should integrate trunk stabilization training in every strength training program with a special attention on trunk rotation and trunk flexion muscles.**

Follow up

- Estimation of the relationship of strength values to para-badminton performance as well as a follow up of this study with more participants to get more significant information to evaluate the training effects.

- A comparison between an assignment of strength values to injury contribution should be done.

Thank you very much

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