CHANGES OF FORCE AND SPEED CHARACTERISTICS IN MALES AND FEMALES EIGHT TO FIFTY YEARS OLD

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The purpose of this study was to determine changes of force and speed characteristics in male and female subjects from eight to 50 years old. Four hundred and eighteen sedentary subjects grouped by age from eight to 50 years old were tested for several force and speed indicators. One-way ANOVA revealed that the majority (four out of six) of force and speed characteristics showed significant increases in subjects up to 30 years of age and subsequent significant decreases. The remaining two indicators showed continuous decline throughout the tested lifespan. It is suggested that these results may be used as a criterion which may assist in promoting physical activity and sport beyond the age of 30 years.

KEY WORDS: physical conditioning, force, speed, physical activity, age

INTRODUCTION AND PURPOSE: The determination of physical conditioning and, in particular, the strength and speed of the neuromuscular contraction, has been the subject of previous research (Heltinger, 1961; Bührle 1985; Schmiedbleicher. 1994). The research, however, is fragmented and does not include a cross sectional age range of the population. Thus, the purpose of this study was to determine changes in selected force and speed characteristics in male and female subjects eight to 50 years old.

METHODS: Four hundred and eighteen sedentary, male and female subjects participated in the study. They were divided by age into ten groups as shown in Table 1.

Table 1 Subject **Characteristics (n=418;** Males **($_M$)=210;** Females **($_F$)=208)**

Group	Age	Composition
Group 1 (G_1)	8-10	n=40, 20_M 20_F
Group 2 (G_2)	11-13	n=40, 20_M 20_F
Group 3 (G_3)	14-17	n=43, 23_M 20_F
Group 4 (G_4)	18-20	n=43, 20_M 23_F
Group 5 (G_5)	21-25	n=45, 20_M 25_F
Group 6 (G_6)	26-30	n=42, 22_M 20_F
Group 7 (G_7)	31-35	n=40, 20_M 20_F
Group 8 (G_8)	36-40	n=45, 25_M 20_F
Group 9 (G_9)	41-45	n=40, 20_M 20_F
Group 10 (G_{10})	46-50	n=40, 20_M 20_F

Subjects were tested for: a) maximum knee joint extension (isometric) strength (F_{max})—pressing against a dynamometer with the knee joint at 90 degrees, b) vertical jump from a static (SJ) squat position—starting with the knee joint at 90 degrees, c) dropped vertical jump (DJ)—dropping from 10, 20, and 30 cm, and d) maximum pedaling speed with zero resistance (PS_{max}). Two, 1-D dynamometers were utilized to measure F_{max}, SJ, and DJ. Force data were collected at a sampling rate of 1000 Hz. The measurement error was ±5N. Based on previous research (Kramer et al. 1994, Papadopoulos et al. 1997, Schmidbleicher, 1992; 1994; Young, 1993), the following variables were chosen for analysis: a) PS_{max}, indicative of both strength and speed of the neuromuscular contraction, b) F_{max}, as an

absolute strength indicator, c) F_{100}, maximum force achieved during the first 100 msec of F_{max}, as an indicator of muscle power, d) F_{nor}, as a relative strength indicator, e) F_{100}/F_{max}, as an indicator of both strength and power, 9 MRA (muscle reaction ability), as a measure of the ability of muscle to quickly and forcefully contract after it has been stretched. Variables and their derivation are presented below:

Variable	Measure (or indication) of	Derivation
PS_{max} (Km/h)	speed and strength	measured
F_{max} (N)	(absolute) strength	measured
F_{100} (N)	(absolute) power	measured
F_{nor}	(relative) strength	F_{max}/weight
F_{100}/F_{max} (%)	power	$(F_{100}/F_{max})100$
MRA (%)	muscle reaction ability	$((DJ_{max}-SJ_{max})/SJ)100$

One-way ANOVA was used for statistical analysis.

RESULTS: Results are presented in Tables 2-7. Numerical values for G_1, G_{10} and maximum are bolded to highlight trends. Table 2 presents the ranges in maximum pedaling speed with zero resistance (PS_{max}) across all groups. As it is shown, for both genders combined, PS_{max} significantly ($p<.05$) increased by 34.19 % up to age 30 (from 53.05 to 71.19 Kmlh) and then significantly ($p<.05$) decreased by 23.25 % by age 50 (from 71.19 to 54.64 Km/h). When gender is considered, the increases appeared to be similar in both genders (35.25 and 32 % for males and females, respectively), whereas the decreases were more drastic in males than in females (18.5 and 12.56 % for males and females, respectively).

Table 2 Range **for** PS_{max} (Kmlh)

Gender	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8	G_9	G_{10}
Both	53.05	59.20	63.35	69.42	68.07	71.19	63.71	67.18	59.81	54.6
Males	59.1	67.39	71.45	79.93	76.11	76.38	71.8	69.43	63.11	61.4
Fem.	47.0	49.80	55.25	61.77	62.04	58.88	56.36	54.25	54.32	54.3

Table 3 presents the ranges in maximum force achieved during the first 100 msec (F_{100}) of F_{max}, across all groups. Again, when both genders were combined, the results show that F_{100} significantly ($p<.05$) increased by 168.12 % up to age 30 (from 298 to 799 N) and then significantly ($p<.05$) decreased by 23.04 % by age 50 (from 799 to 615 N). When gender is considered, both increases and decreases were greater in males (increases of 199.06 and 136.7 % and decreases of 32.92 and 17.88 % for males and females, respectively).

Table 3 Range **for** F_{100} (N)

Gender	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8	G_9	G_{10}
Both	298	378	588	612	663	799	784	766	635	615
Males	321	456	704	830	838	960	832	813	684	644
Fem.	267	284	450	508	538	578	632	590	537	519

For the most part, the same pattern seen in F_{100} was also found in F_{100}/F_{max} (Table 4). Specifically, F_{100}/F_{max} significantly increased by 52.57 % (from 34.77 to 53.05 %) up to age 30 for the combined group of males/females and then decreased by 28.01 % (from 53.05 to

38.19 %). Similarly, the increase was greater in males (59.2 and 57.22 % for males and females. respectively). The decreases were greater in females (28.86 and 31.05% for males and females, respectively).

Table 4 Range for F_{100}/F_{max} (%)

Gender	G_1	G_2	G_3	G4	G_5	G_6	G_7	G_8	G_9	G_{10}
Both	34.77	43.5	47.99	50.51	52.44	53.05	51.81	45.4	41.05	38.2
Males	35.93	42.84	47.69	51.71	52.99	57.2	54.35	46.07	43.05	40.7
Fem.	32.98	44.3	48.55	49.63	51.85	48.82	48.48	44.35	39.05	35.8

Results in Table 5 show significant ($p<.05$) increases and subsequent decreases in maximum knee joint isometric strength (F_{max}) across subjects as a whole and across each gender. Those changes were more pronounced in males than in females (increases of 80.38 and 28.47 % and decreases of 15.35 and 11.66 % for males and females, respectively). For both genders combined, it was found that the initial F_{max} significantly ($p<.05$) increased by 57.88 % (from 857 to 1353 N) . The decrease was significant but more moderate (13.97 %, from 1353 to 1164 N).

Table 5 Range for F_{max} (N)

Gender	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8	G_9	G_{10}
Both	857	957	1226	1211	1263	1353	1293	1258	1199	1164
Males	892	1065	1476	1556	1582	1609	1605	1470	1375	1362
Fem.	808	827	927	1023	1038	986	975	937	934	917

Table 6 shows the effect of body weight on relative strength (F_{max}). Relative strength showed significant ($p<.05$) decline across all subjects as a whole (from 2.24 to 1.63 time body weight, a 27.23 % decrease) and across both genders. The decline in relative strength appeared to be greater in females (28.44%) vs. males (24.79 %).

Table 6 Range for F_{nor} (%)

Gender	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8	G_9	G_{10}
Both	2.24	1.92	1.92	1.95	1.89	1.76	1.73	1.73	1.66	1.63
Males	2.34	2.06	2.07	2.12	2.05	2.03	2.01	2.01	1.86	1.76
Fem.	2.11	1.61	1.58	1.74	1.72	1.64	1.57	1.51	1.51	1.51

Muscle reaction ability (MRA), as measured by $((DJ_{max}-SJ_{max})/SJ)100$, was found to (progressively) decline significantly ($p<.05$) across all subjects and genders (Table 7). The decline was 88.82 % (from 18.06 to 2.02%) for males and females taken together, 85.71 % for males, and 91.67 % for the female subjects.

Table 7 Range for MRA (%)

Gender	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8	G_9	G_{10}
Both	18.06	17.3	14.81	12.4	8.24	6.11	5.5	5.9	3.5	2.02
Males	16.80	15.7	13.16	11.9	8.04	6.44	5.7	6.1	3.8	2.40
Fem.	19.12	19.26	16.39	12.8	8.34	5.88	5.4	5.1	3.3	1.60

CONCLUSION: The changes in selective force and speed characteristics in four hundred and eighteen male and female subjects from eight to 50 years old showed that the majority of these characteristics peak at approximately 30 years of age and decline thereafter. Some of the investigated variables, most notably the ability of muscle to quickly and forcefully contract after it has been stretched, declined more than others and the decline may be attributed to the lifestyle of most of today's population, which, in general, does not promote physical activity. It is suggested that these results may be used as a criterion to assist in promoting physical activity.

REFERENCES:

Bührle, M. (1985). Grundlagen des Maximal- und Schnellkrafttrainings (Hrsg.: Bührle, M.), Schorndorf 1985.

Hettinger, T. (1961). Dei Leistungsfahigkeit des Menschen und deren Messung. Munch. Med. Wschr. 103: 1860.

Grosser, M., Starischka, S. (1981). *Konditionstests*, Theorie und Praxis aller Sportarten. blv sportwissen, 27-63, 64-72.

Kramer, W.J., Newton, R.U. (1994). Training for improved vertical jump. In: *GSSI*, Sports Science Exchange, 7(6), 53.

Papadopoulos, C., Salonikidis, K., Schmidbleicher, D. (1997). Diagnose und Auswerung den motorischen Fahigkeiten Kraft und Schnelligkeit bei Kindern im Alter zwischen 10 bis 15 Jahren. *Leistungssport*, 6, 26-30.

Schmidbleicher, D. (1992). Training for power events. In: Komil, P.V. (Ed.): Strength and Power in Sport. Boston, 381-305.

Schmidbleicher, D. (1994). Entwicklung der Kraft und der Schnelligkeit. In: Bauer, J. et al. (Hrsg.): Motorische Entwicklung. Ein Handbuch. Beiträge zur Lehre und Forschung im Sport, Schorndorf, Band. 106, 129-150.

Young, W.B. (1993). Training for speed/strength: Heavy versus light loads. National Strength and Conditioning Association Journal,-15, 34-42.