

A CROSS-SECTIONAL STUDY OF GENDER DIFFERENCES IN PULLING STRENGTH OF TOW FOR JAPANESE ELEMENTARY SCHOOL CHILDREN

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The aim of this study was to obtain the data of gender differences of pulling strength during experimentally executed TOW for Japanese elementary school children. In mean back strength, gender difference was small from 1st grade to 4th grade, but on 5th and 6th grade, gender difference became large. In mean pulling strength, gender difference was large in 5th and 6th grade. But no tendency was found from 1st grade to 4th grade. In male children, sum of pulling strength increases substantially when the grade changes from 4th to 5th. But pulling strength tended to grow constantly. On the other hand, in female children, sum of pulling strength increases substantially when the grade changes from 2nd to 3rd. And from 4th to 6th, sum of back strength and rope tension were very close to each other. Results suggested that though male children get grow for muscles, female children get motor function more than male children.

KEY WORDS: gender difference, tug of war, elementary school

INTRODUCTION: Pulling at a rope has been performed ritually all over the world. Today, it is enjoyed as a sport called tug-of-war; TOW. The appeal of TOW is to cooperate with any other teammates to aim for win. Although TOW is commonly sport for us, 'pulling for maximal effort and step backward', 'hold for maximal effort against opponents pull' and 'step forward unable to hold' in TOW are complicated movements and not usual.

TOW is constructed for three types of phase; Drop phase, Hold phase, and Drive phase (Masahiro et al, 2005). Drop phase is from start to run out the slack. Hold phase is hold against opponent or step forward unable to hold. Drive phase is step backward. From previous studies the agonists in Hold phase are backside muscles, and in Drive phase are abdominal muscle and backside muscles (Shigeki et al, 1988).

In TOW, power and endurance of muscles is very important. Before 10 years old no gender difference in development of muscles is found out, but after 10 years old males start to grow more than females. Furthermore, in 10 years old, the muscle development rate normalized by peak is 35%. On the other hand, developments of motor function is dependent on motor learning; growing muscles and neural system, usually experience. Starting to learn walking forward is 3 years old, running forward is 7 years old, walking and running backward is 11 years old (Saki et al, 2005). That is to say elementary school children have been in developmental stage.

In most previous studies, athletes, adults, and students at collage had performed and had been measured. On the other hand, there are few studies for elementary school children. So, the purpose of this study was to obtain the data of gender differences of pulling strength during experimentally executed TOW for Japanese elementary school children.

METHODS:

Subjects of this study were healthy elementary school children. 8 male and 8 female children in each grade participated (male: $8 \times 6 = 48$, female: $8 \times 6 = 48$). Table1 shows the physical characteristics of subjects. In a preliminary session, subjects were measured for back strength and pulling strength. Both parameters were measured by load cell (TCLP-2000KA, Tokyo Sokki Kenkyujo, Co., LTD Japan).

Table 1: Physical characteristic

grade	gender	height(cm)	weight(N)	age(years)
1	male	122.5±4.4	233.4 ± 33.3	7.2±0.3
	female	119.0±2.6	217.7 ± 26.5	6.7±0.4
2	male	127.1±2.0	257.9 ± 18.6	8.0±0.3
	female	123.1±5.8	245.2 ± 45.1	7.7±0.1
3	male	130.4±6.5	271.7 ± 42.2	9.0±0.3
	female	126.3±3.8	241.3 ± 23.5	8.6±0.3
4	male	135.0±4.8	306.0 ± 46.1	9.9±0.2
	female	138.3±7.9	340.3 ± 104.0	9.6±0.3
5	male	140.3±3.8	348.1 ± 66.7	11.1±0.3
	female	143.1±6.7	324.6 ± 62.8	10.9±0.3
6	male	154.8±3.1	472.7 ± 108.9	11.5±0.6
	female	145.4±7.5	355.0 ± 37.3	11.6±0.4

The subjects performed 1 trial for each parameter. The 1 trial was 5 seconds and designed for Figure1 and Figure2. Those parameters were defined as average in 5 seconds. And as test session, the 8 students in each grade were split into 2 groups (group A: n=4, group B: N=4) and performed mini game (4:4) to be measured the rope tension. The sum of back strengths in each group were equalized as possible based on preliminary session. The mini game was set for 30 seconds and performed 3~5 games for each pairing (Figure3). This difference was caused by the fatigue of subjects. The rope tension was defined as average in all trials.

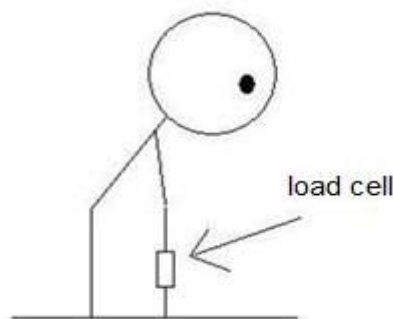


Figure1: Back strength trial

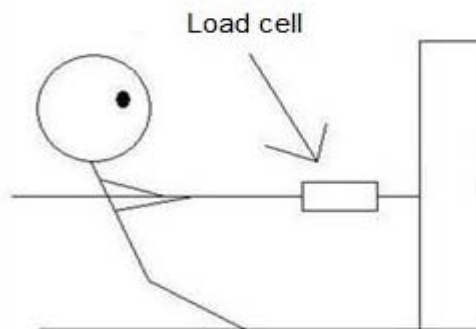


Figure2: Pulling strength trial

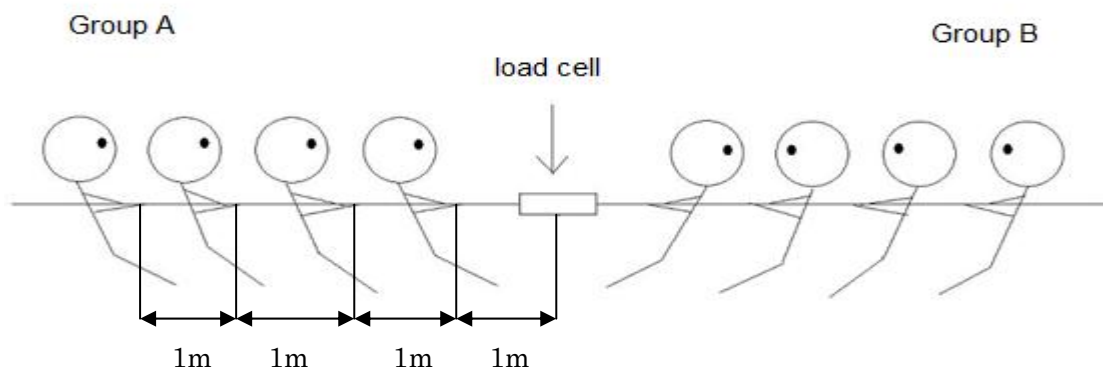


Figure3: Mini game

RESULTS:

Table 2 shows the measurements in preliminary session. In mean back strength, gender difference was only small from 1st grade to 4th grade, but on 5th and 6th grade, gender difference became large. In mean pulling strength, gender difference was large on 5th and 6th grade. But no tendency was found from 1st grade to 4th grade.

Table2: Mean back strength and pulling strength (±SD)

grade	gender	Back strength (N)	Pulling strength (N)
1	male	119.6 ± 47.0	176.4 ± 41.2
	female	101.9 ± 20.6	131.3 ± 21.6
2	male	186.2 ± 53.9	193.1 ± 30.4
	female	180.3 ± 59.8	149.9 ± 31.4
3	male	214.6 ± 76.4	183.3 ± 43.1
	female	260.7 ± 43.1	203.8 ± 12.7
4	male	255.8 ± 26.5	184.2 ± 36.3
	female	234.2 ± 72.5	192.1 ± 49.0
5	male	345.9 ± 87.2	254.8 ± 58.8
	female	248.9 ± 30.4	209.7 ± 34.3
6	male	390.0 ± 63.7	296.9 ± 43.1
	female	293.0 ± 66.6	229.3 ± 33.3

The developments of rope tension and sum of pulling strength were shown for Figure 4 and Figure 5. Sum of pulling strength in those figures was defined as intermediate value between group A's and group B's. In male children, sum of pulling strength got grows largely when the grade changes from 4th to 5th. But pulling strength was tended to grow constantly. On the other hand, in female children, sum of pulling strength got increases substantially when the grade changes from 2nd to 3rd. And from 4th to 6th, sum of back strength and rope tension were very close to each other.

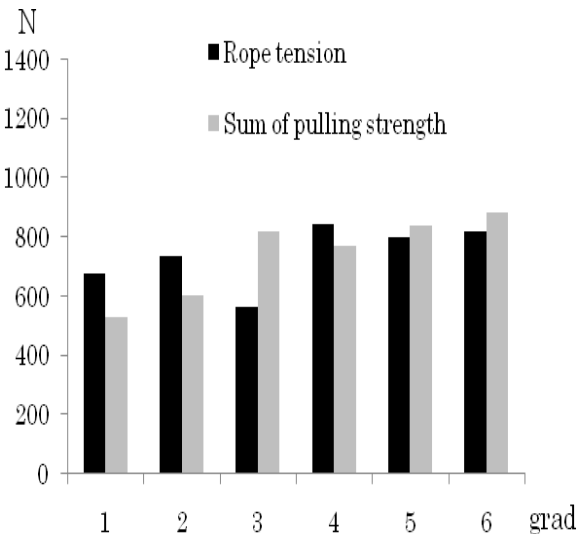


Figure 4: The developments of rope tension and sum of pulling strength in male children

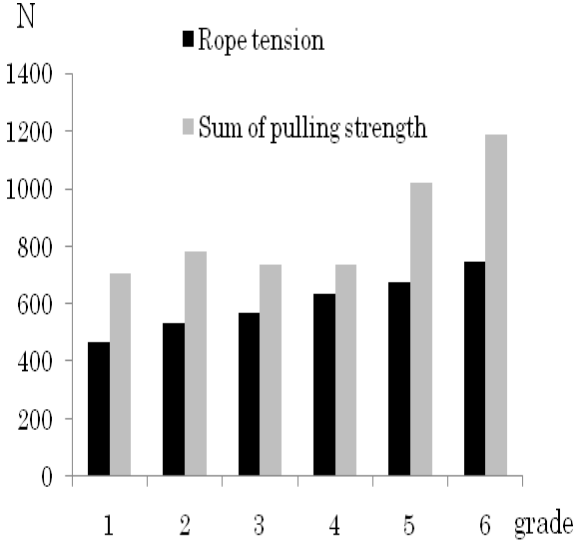


Figure 5: The developments of rope tension and sum of pulling strength in female children

DI. ROPE TENSION AND PULLING STRENGTH

The difference between rope tension and sum of pulling strength in male children was larger than female's. Because of this tendency, it remains possible that female children take advantage of muscle power to perform any complicated movements more than males. Thus, it is suggested that though male children develop for muscles, female children develop motor function more than male children.

Through this study, the data of pulling strength during experimentally executed TOW for Japanese elementary school children has been obtained and gender differences in tendency of developments of muscle and motor function have been shown.

In further investigation, it needs to increase the number of subjects and find out the statistical significance. On the other hand, it is very important to address not only a cross-sectional study like this but a longitudinal study to certify the muscles and motor function developing.

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