Research Paper : Growth and Development

Meta-analytic Study of Gender Differences in Motor Performance and Their Annual Changes among Japanese Preschool-aged Children

Takahiro Ikeda[*,] and Osamu Aoyagi[***]**

[*]Department of Early Childhood Education and Care, Saga Junior College
3-18-15 Kamizono, Saga 840-0806 Japan
ikeda@saga-jc.ac.jp
[**]Graduate School of Health and Sport Science, Fukuoka University
8-19-1 Nanakuma, Jyonanku Fukuoka 814-0180 Japan
[***]Faculty of Health and Sport Science, Fukuoka University
8-19-1 Nanakuma, Jyonanku Fukuoka 814-0180 Japan
[Received April 11, 2008 ; Accepted June 24, 2008]

The aim of the present study was to investigate the gender differences in motor performance, movement patterns, movement skills, and physical fitness and their annual changes among Japanese children. To examine gender differences, a meta-analysis was conducted. A total of 1830 effect sizes were calculated using children's motor abilities reported in 100 published articles. Based on these effect sizes, 44 test items were conducted on a yearly basis. The integrated effect sizes were also calculated for movement patterns, movement skills, and physical fitness each year. Only 22 of 44 test items showed any gender difference. Based on the annual change in gender differences for each item, the following three patterns were observed: "test items that improve with growth among male children", "test items that remain constant over time among female children" and "test items with no specific gender difference". In gender differences and their annual changes for movement patterns, movement skills, and physical fitness, it was found that male children's manipulation, walking, and throwing exceeds those of female children; however, excel in locomotion, manipulation with a ball, muscular endurance, and balance. The items in which male children surpassed female children appeared at higher ages and increased with growth. Furthermore, items in which female children excelled emerged at lower ages and disappeared with growth. These differences are considered to be the result of the precocious development of female children in comparison with male children. However, the items in which male children surpassed female children are thought to be considerably influenced by motor experiences.

Keywords: Effect Size, Meta Analysis, Movement Pattern, Test Item of Motor Ability

[School Health Vol.4, 24-39, 2008]

1. Introduction

Numerous studies regarding motor ability in preschool-aged children in Japan have been reported since Matsui, et al., (1955) and Matsuda (1961). Aoyagi (1987) reviewed numerous studies on the motor ability of preschool-aged children from both Japan and overseas and pointed out the difficulty in applying adult measurement methods to preschool-aged children, the availability of the performance tests, discriminative gender differences existing in each movement pattern and motor ability element, and the existence of motor coordination in peculiar movement patterns. Also Murase & Demura (2005) reviewed numerous studies in Japan with a focus on two academic journals, "Japan Journal of Physical Education, Health and Sports Science" and "Japan Journal of Physical Fitness and Sports Medicine", and provided clarification of motor ability structure, measurement, and evaluation methods in preschool-aged children. In particular, they pointed out the availability of longitudinal studies and objective investigations on ageing changes and gender differences.

In general, nervous system growth is significant in preschool-aged childhood; therefore, in physical strength, motor coordination is said to be significant compared with muscle strength and power (Malina & Bouchard, 1991). In addition, androgen secretion, which is said to have an effect on muscle strength in adults, does not show gender difference in this age (Matsuura, 1982). For this reason, in preschool-aged children, the interest and ability in movement for both males and females are highly analogous; therefore, male children and female children can be grouped together for physical education at this stage (Gallahue & Donnelly, 2003).

However, male children are superior to female children in the ball throw (Demura,1993; Katsube, 1979; Takeuchi & Tateishi, 1993; Tamiaki & Akimaru, 2003; Ueda, 1986), and female children are superior to male child in ball bouncing (Aoyagi, 2006; Takeuchi & Tateishi, 1993). These and other gender differences in performance have been reported. For example, male children are superior to female child in the 20-m and 25-m run (Aoyagi, 2006; Otaki, 1978; Tamiaki & Akimaru, 2003; Yoshizawa, 2002); female children are superior to male children up to four years of age and from five years of age, this advantage becomes inverted (Kobayashi, 1987); and female children are superior to male child up to four and a half years of age, with male children gaining superiority over female children after five and a half years of age (Katsube, 1979). In addition to these reports, a variety of other reports are available on items related to gender differences and annual changes. Moreover, in terms of movement skills and physical fitness, a number of reports on the characteristics of the gender differences for similar test items show similar results. For example, Sugihara, et al., (2004) reported that there were no differences in the movement of jumping. However, Miyaji, et al., (1970) found female children to be superior to male children, and Kawahara, et al., (1981) reported that male children were superior to female children. Moreover, Inoue (1968) examined development in regard to gender difference and reported that while no differences were observed up to four years of age, such differences could be found from six years of age. Nakamura & Matsuura (1979), however, reported gender differences from four years of age.

In this way, preschool-aged childhood, when considering both motor ability test items and similar performance items, definition regarding gender differences is uncertain, and information varies. However, for items in which similar movement skills are performed, it is possible to analogize that similar gender differences are found. Also, when the nervous system is growing significantly, it is obviously expected that there will be changes in performance gender differences. In fact, it is also necessary to clarify the change in gender differences with ageing, such as from when gender differences are found or disappear.

Tomas & French (1985) are examining gender differences in motor ability from preschool-aged childhood to adolescence using meta analysis. Meta analysis integrates statistical means of multiple study results which have been obtained independently in identical research projects. This is a method that yields comprehensive and objective results in the examination of tasks (Mullen,1989; Shiba & Haebara,1990; Tomas & Nelson, 2001). For this reason, meta analysis is considered to be an effective way to examine performance gender differences in preschool-aged children.

In this study, we integrate studies on motor ability in preschool-aged children using meta analysis and examine performance gender differences seen in various test items along with tendencies of annual change. In addition, we aim to separate the test items and use the effective volume gained from each of the items. We will also examine the gender differences and annual changes in movement patterns, the movement skills and physical fitness.

2. Method

2.1. Data selection

The data used in meta analysis were obtained from documents related to published studies on preschool-aged children motor ability. The data search targeted reviews which quoted studies on preschool-aged children motor ability (Aoyagi, 1987; Ikeda & Aoyagi, 2006; Murase & Demura, 2005; Nakamura, et al., 1980; Nishijima, 2005). Further, we made use of Nii Scholarly and Academic Information Navigator (CiNii) at the National Institute of Informatics (Nii) with "preschool aged-children", "physical", "motor ability", "test" and "measurement" as keywords, targeting documents that were identified thereby. Among the targeting

documents, we selected those in which each age and sex showed average values and standard deviations as necessary information for meta analysis. Eventually, the number of the documents used for meta analysis was 100 articles, as shown in the appendix.

2.2. Test items and data processing

The test items used in this study were taken from the Tokyo University of Education Laboratory of Sport Psychology for first nationwide survey (Matsuda & Kondo, 1968) and the field test of motor coordination by the Research Center in Physical Education (Kurimoto, et al., 1981), all of which are considered good measures of motor ability in preschool-aged children. While different test item names are used according to the study, we selected them because they are considered identical in terms of content.

The targets of this study are preschool aged-children from two to six years of age. We recalculated the data which showed age divisions under one year in order to collect one year olds. Also, in the case that measurements were taken more than once in the same year, we calculated practical number, average value and standard deviation as total numbers. However, for studies that compare measurement values that were taken in different years, we processed the data as independent data for each year. Also, for studies that compare groups, we employed control groups. The total measurement sample was male children: 379,615 and female children: 356,260, for a total of 735,875 children for all age divisions and test items.

2.3. Calculation of effect size

The effect size (ES) that becomes the index of the gender differences is calculated by formula (1) (Hedge, 1981) and each age division by each test item.

$$ES = \frac{M_m - M_f}{SD} \quad \cdots\cdots\cdots\cdots\cdots (1)$$

(However, M_m: average value of the male children
M_f: average value of the female children

$$SD = \sqrt{\frac{(N_m - 1)\,SD_m^2 + (N_f - 1)\,SD_f^2}{N_m + N_f - 2}}$$

N_m: Number of male children
N_f: Number of female children)

(SD_m: Standard deviation for the male children
SD_f: Standard deviation for the female children)

However, the calculated ES is not an unbiased estimator. Therefore, in the case that the measured subjects (sample size) in each study was less, I calculated unbiased estimators (*ES**) by using formula (2).

$$ES_i^* = \left(1 - \frac{3}{4m - 1}\right) ES_i \quad \cdots\cdots\cdots\cdots\cdots (2)$$

(However, $m = N_m + N_f - 2$)

Furthermore, in integrating the effect size, the size of the measured subjects (sample size) in each study will be influenced. Therefore, we calculated the integrated effect size ($\overline{ES}$) by using formula (3) and we employed it as the final effect size in this study.

$$\overline{ES} = \frac{\sum_{i=1}^{k} d_i \Big/ Sest_i^{\,2}}{\sum_{i=1}^{k} 1 \Big/ Sest_i^{\,2}} \quad \cdots\cdots\cdots\cdots\cdots (3)$$

(However, k: data number
d_i: Effect Size (ES_i or ES_i^*)

$$Sest^2(ES) = \frac{N_m + N_f}{N_m N_f} + \frac{d_i^2}{N_m + N_f}$$)

Regarding the evaluation standards of the size of effect size, Cohen (1969), Tomas & French (1985) showed by absolute value that less than 0.20 equaled no difference, that more than 0.20 and less than 0.50 equaled a small difference, that more than 0.50 and less than 0.80 equaled a medium degree difference and that more than 0.80 equaled a large difference. In this study, I employed this standard to estimate the effect size. In addition, a positive ES (+) shows that male children are superior and that a negative (−) value indicates that female children are superior.

2.4. Test of homogeneity

When integrated, we tested homogeneity. The test assumption for the k sample effect size ES_i (i = 1, 2, ···, k) takes its common population parameter from the parent population sample "$H_0 : ES_1 = ES_2 = \cdots = ES_k$," and the alternate hypothesis is that at least one effect size ES_i is different from the others. In this test, in the case that the sample from each study is large, it is applied as sample statistic χ^2_o and followed by χ^2 distribution based on the assumption of H_0 (Shiba & Haebara, 1990).

Table 1 Literature, sample sizes, mean, standard deviation, integrated standard deviation and effect sizes (*ES**) in "Crawling"

Author (published year)	Age	Boys			Girls			Integrated standard deviation	*ES**
		N	M	SD	N	M	SD		
Aoyagi (2005)	3	7	14.30	6.69	9	19.91	5.27	5.92	0.896
	4	118	11.74	3.01	117	14.55	3.16	3.09	0.908
	5	218	9.71	2.32	227	11.45	2.29	2.31	0.753
	6	160	8.52	1.95	132	9.94	1.79	1.88	0.755
Ebashi (1972)	3	29	19.19	8.58	22	21.57	7.32	8.06	0.291
	4	126	10.70	3.39	136	13.87	5.49	4.60	0.687
	5	296	8.39	3.42	260	10.33	2.84	3.16	0.613
	6	199	7.35	1.77	175	8.80	2.09	1.93	0.751
Katsuki & Takahashi (1989)	4	52	8.20	3.10	38	9.40	2.70	2.94	0.405
	5	34	6.30	1.20	44	7.50	1.30	1.26	0.945
Miyake (1984)	3	16	10.13	2.85	18	12.37	4.37	3.74	0.586
	4	37	7.85	2.12	41	8.74	1.38	1.77	0.498
	5	32	5.42	1.26	33	7.12	1.53	1.40	1.197
Miyake & Tokuda (1982)	3	3	10.73	2.25	8	10.36	2.27	2.26	-0.150
	4	20	9.67	2.92	17	7.47	1.53	2.39	-0.902
	5	26	6.59	1.24	26	6.25	1.15	1.20	-0.280

Note) The units are seconds in Mean and Standard deviation.

$$\chi_o^2 = \sum_{i\text{-}1}^{k} \frac{(ES_i - \overline{ES})^2}{Sest^2} \quad \cdots\cdots\cdots\cdots\cdots\cdots (4)$$

In these study results (ES_i), in the case that one result was separate from the entire estimate value ($\overline{ES}$), χ^2_o becomes large. And the value exceeds χ^2 on the distribution which is the degree of freedom $k-1$ with probability α, the assumption is rejected. In this study, I used formula (4), and integrated based on the condition that *ESi* would not reject its assumption by 1 % standard.

3. Result and discussion

3.1. Calculation of effect size and test

3.1.1. Effect size (*ES**) that was calculated from 100 articles

The test items that appeared in the 100 articles and the ages that could be targeted for the measurement varied in the documents; however, we confirmed that 94 items were common for the range of two to six years of age. Then, on to these 94 items, we calculated the effect size using formulas (1) and (2) for each of the 100 articles at one year age divisions. **Table 1** shows the crawling test as an example out of the 94 items from the documents in which they appeared, sex, sample number for each age, average value, standard deviation, integrated standard deviation and effect size (*ES**). Crawling is a test item that measures the time required to proceed a constant distance in a high crawling position. It is used in 5 out of the 100 articles targeted in this study. In the *ES** calculated from Aoyagi (2005) (**Appendix No.5**), it was seen that in gender differences in the age division of three to six years, the male children were superior by a large or medium degree. In addition, Ebashi (1972) (**Appendix No.9**) also showed gender differences, with male children being superior, though to a small and medium degree. On the other hand, Miyake & Tokuda (1982) (**Appendix No.62**) reported that for the three- to five-year-olds that they had observed, gender differences were apparent with female children being superior in all age divisions.

As described above, the *ES** which we obtained from the crawling item was seen in five documents and 16 items for three- to six-year-olds in four age divisions. The result of repeat examination of the remaining 93 items revealed the total *ES** to be 1830. The calculated occurrence rate of the complete *ES** and its percentage are shown in **Figure 1**. An *ES** of greater than 0.2 indicated a gender difference favoring male children in 658 cases or 36.0%, and an *ES** of less than -0.2 indicated a gender difference favoring female children in 619 cases or 33.8%. Therefore, the *ES** that did not show gender differences was 553 cases or 30.2%.

3.1.2. Test of homogeneity for integrating effect size

In order to integrate the *ES** which was calculated from the 100 articles, we performed a test of homogeneity using formula (4). However, items with only one *ES** in one age division were eliminated as test targets, and an integrated effect size ($\overline{ES*}$) calculation was not performed. Not only certain age

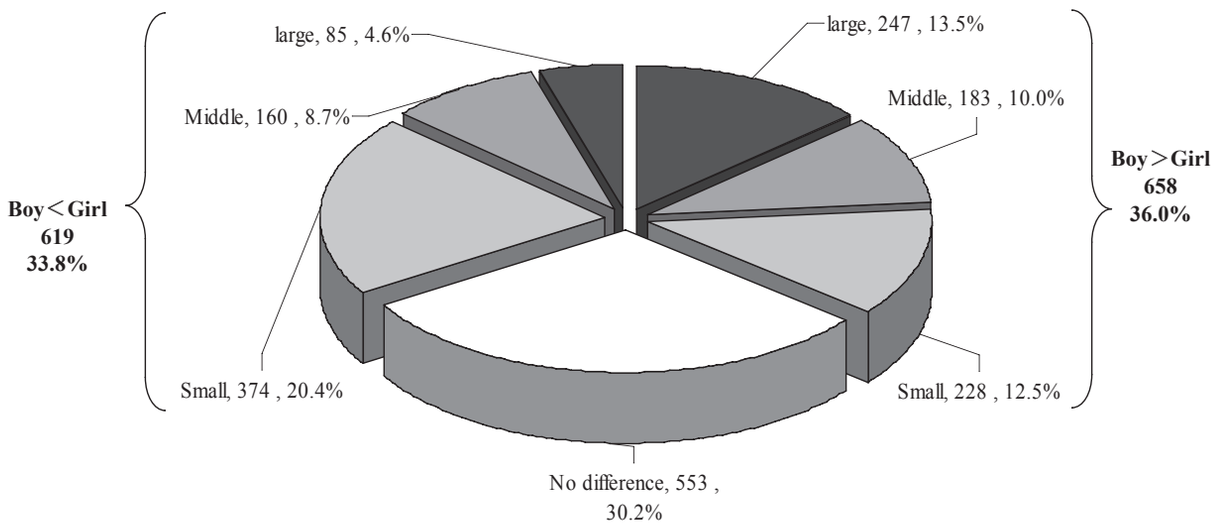


Figure 1 Degree of Effect Sizes (N=1830)

Table 2 Relationship between resource and effect size when excluded and not excluded

Resource	Number of literatures		χ^2	*df*	*p*
	Not including excluded ESs	Including excluded ESs			
1972 or earlier	10	9	4.925	3	ns
1973 to 1985	8	27			
1986 to 1996	9	16			
1997 or later	7	14			
Total	34	66			

divisions, but also a total of 50 items were eliminated as test targets. Regarding *ES** for the remaining 44 items, we conducted the test of homogeneity using formula (4), resulted in a value of 210, which were then eliminated.

3.1.3. Investigation of time differences of the documents based on the test results

The 100 documents that were selected represent the 50 year period from 1957 to 2006. Sugihara, et al., (2006) reported that motor ability in Japanese preschool-aged children has exhibited a declining trend since 1985. Moreover, variation in the change over time change between male and female are described as "very similar" and as showing "almost the same tendency." Such descriptions suggest that motor ability in preschool-aged children shows a declining or stagnating tendency; however, it can be assumed that the gender differences themselves are not changed very much. Therefore, in order to confirm this assumption, the documents that we collect for this study should correspond with the ages that Sugihara, et al., (2006) researched and organized into four periods: the period before 1972; from 1973 to 1985; from 1986 to 1996; and after 1997. In addition, we need to examine the difference in the gender differences between ages.

To investigate the time differences of the documents, we used the results of the test of homogeneity. Regarding the documents for each period, we sorted out all documents which were employed and extracted *ES** and documents which were eliminated by the test that includes *ES**. The results are shown in **Table 2**.

Regarding the existence or nonexistence of Eliminated *ES**, the result of tests which the ages that dividing ages into four periods performed by Sugihara, et al., (2006) show no significant differences between ages (χ^2_o=4.925<χ^2 [0.05, *df*=3]=7.815, ns). The foregoing indicates that the age of the documents exerts no influence and that, therefore, the 100 articles that were selected for this study can be used for meta analysis.

Table 3 The effect sizes ($\overline{ES}$*) in test items of motor ability age 2-6 yrs.

no.	Item	2yr	3yr	4yr	5yr	6yr
1	Crawling		0.042	**0.478**	**0.955**	**0.753**
2	Balance beam walk		-0.019	-0.063	-0.099	
3	10-m shuttle run			0.084	**0.295**	0.152
4	20-m run		0.005	0.146	0.026	0.018
5	25-m run		0.019	0.039	0.051	0.028
6	50-m run					0.085
7	100-m run					-0.139
8	Shuttle run		0.062	**0.278**	0.006	**0.559**
9	Zigzag run		0.001	**0.221**	**0.447**	0.040
10	Jump elastics			0.067	**0.281**	
11	Vertical jump			0.072	0.019	0.045
12	Standing long jump	**-0.226**	-0.008	0.134	0.147	**0.391**
13	Running long jump				**0.211**	
14	Popping [m]		-0.012	0.004	-0.011	-0.046
15	Popping [times]		-0.004	-0.106	-0.117	0.002
16	Popping [sec.]			**0.372**	0.010	
17	Side step		-0.005	0.004	0.002	-0.005
18	Jump rope		**-0.270**	**-0.420**	**-0.556**	**-0.574**
19	Continuous jump over		-0.054	-0.016	0.002	-0.020
20	Kick for target			0.002	-0.074	-0.068
21	Grip strength		**0.251**	0.044	0.110	-0.007
22	Bar gripping reaction time			0.016	0.002	
23	Tennis ball throw		**0.259**	**0.628**	**1.080**	**1.003**
24	Soft ball throw		**0.136**	**0.775**	**1.021**	**1.547**
25	Ball throw		0.026	**0.548**	**1.089**	**0.843**
26	Throw with both hands		0.097	0.057	**0.417**	**0.279**
27	Ball bouncing		**-0.243**	**-0.681**	**-0.770**	-0.147
28	Ball catching			0.003	0.008	-0.023
29	Stepping			-0.155	0.003	
30	Arm hang		**-0.277**	0.015	-0.031	-0.014
31	body supporting duration		-0.004	-0.007	-0.007	0.005
32	Trunk extension [cm]		-0.001	-0.085	**-0.216**	-0.012
33	Standing trunk extension [degree]				-0.043	
34	Back strength		0.093	**0.511**	**0.605**	**0.320**
35	Foot balance		-0.033	-0.003	-0.092	0.110
36	Foot balance with eyes closed		0.090	**-0.346**	-0.154	
37	Foot balance on the bar		-0.049	-0.017	0.027	-0.112
38	Getting up			-0.002	-0.097	0.136
39	Side rolling		-0.061	0.179	-0.133	
40	Sitting trunk flexion		-0.017	**-0.228**	-0.006	-0.020
41	Standing trunk flexion [degree]				-0.017	
42	Standing trunk flexion [cm]			-0.021	**-0.206**	
43	Jump over and crawl under		-0.018	0.011	0.019	0.056
44	Getting up and dash				**0.473**	

3.2. Features of the gender differences in each test item

3.2.1. The gender differences of test items in each age division

We calculated the integrated effect size ($\overline{ES}$*) by formula (3) using the data that was obtained by the test of homogeneity for each age division. As a result, concerning the 44 test items, 141 integrated values were calculated. **Table 3** shows the effect size of each test of the items.

The test items for which large gender differences could be seen were "Crawling" (5 years old) , "Tennis ball throw", "Soft ball throw" and "Ball throw" (all 5-6 years old), with male children being superior. The test items for which medium gender differences

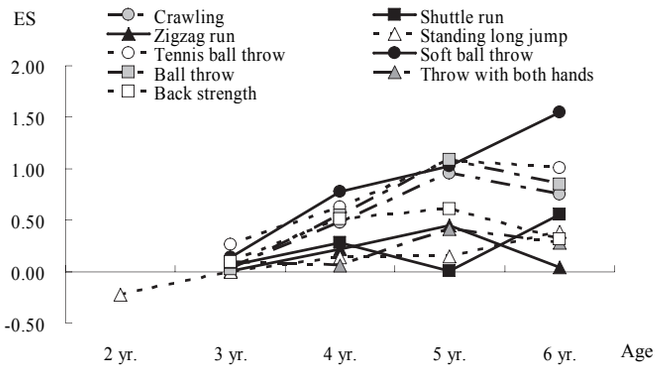


Figure 2 Test items that improve with growth among boys

could be seen were "Crawling" (6 years old), "Shuttle run" (6 years old), "Tennis ball throw", "Soft ball throw", " Ball Throw" (all 4 years old) and "Back strength" (4-5 years old), with male children being superior, and "Jump rope" (5-6 years old) and "Ball bouncing" (4-5 years old), for which female children were superior. The items for which male children were superior by small differences were "Crawling" (4 years old), "10-m shuttle run" (5 years old), "Shuttle run" (4 years old), "Zigzag run" (4-5 years old), "Jump elastics" (5 years old),"Standing long jump" (6 years old), "Running long jump" (5 years old) "Popping[sec.]" (5 years old), "Grip strength" (3 years old),"Tennis ball throw" (3 years old),"Throw with both hands" (5-6 years old),"Back strength" (6 years old) and "Getting up and dash" (5 years old). On the other hand, the items for which female children were superior by small differences were "Standing long jump" (2 years old), "Jump rope" (3-4 years old), "Ball bouncing" (3 years old), "Arm hang" (3 years old), "Trunk extension[cm]" (5 years old), "Foot balance with eyes closed" (4 years old), "Sitting trunk flexion" (4 years old)" and "Standing trunk flexion" (5 years old).

From these results, male children were superior in terms of gender differences in 15 items out of 44 items (34.1%), and effect size was 29 (20.6%) out of 141. On the other hand, the items for which female children were superior in terms of gender differences were eight items (18.2%) and the effect size was 13 (9.2%). Gender differences were seen in the "Standing long jump" for both male children (6 years old) and female children (2 years old). Therefore, gender differences were not seen in any age division for 22 items (50.0%): "Balance beam walk", "20-m run", "25-m run", "50-m run" "100-m run", "Vertical jump", "Popping[m]", "Popping[times]", "Side step", "Continuous jump over", "Kick for target", "Bar gripping reaction time", "Ball catching", "Stepping", "Body supporting duration", "Standing trunk extension [degree]", "Foot balance", "Foot balance on the bar", "Getting up", "Side rolling", "Sitting trunk flexion", "Standing trunk flexion [degree]" and "Jump over and crawl under". Also, in the entire effect size, gender differences were not seen in 99 (70.2%) out of 141.

3.2.2. Tendency of annual changes in gender differences in the test items

In order to examine the tendency of annual changes in gender differences in the test items, we abstracted 33 items for which the effect size was calculated in more than three age divisions in which it was possible to observe a tendency for change out of 44 test items. Furthermore, among these we observed 17 items that showed gender differences of at least one effect size with increasing age.

Figure 2 shows nine items related to annual changes such as "Soft ball throw", "Tennis ball throw", "Ball throw", "Throw with both hands", "Crawling", "Shuttle run", "Zigzag run", "Standing long jump" and "Back strength". Female children exhibit superiority in the "Standing long jump" to the age of two years. Thereafter, while gender differences fade, the effect size is increased, and male children gain superiority at six years of age. With the exception of the "Standing long jump," male children are superior in more than two age divisions. We calculated linear regression for these nine items and an examination of the coefficients revealed that the codes were all positive (+), and we could confirm a range of 0.034-0.261 (average=0.193). The foregoing suggests that the performance of male children increases in superiority with increase in age.

Examinations of "Ball throw" using a tennis ball and a soft ball reported by Aoyagi (2006), Demura (1993), Inoue (2000), Katsube (1979), Otaki (1978) and Takeuchi & Tateishi (1993) all show that male children are superior. In addition, Ueda (1986) reported that male children also show superiority over female children in the mastery of the movement. These findings are consistent with the conclusions of the present study.

Yoshizawa (2002) reported that male child is superior in "Back strength". Also, Kobayashi (1987) pointed out that the tendency toward superiority was stronger from five years of age. This study, however,

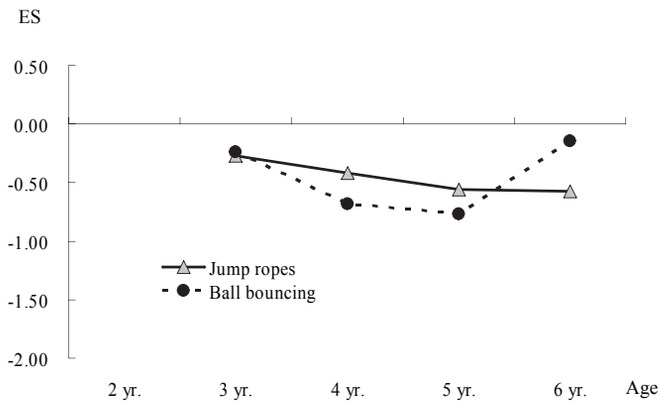


Figure 3 Test items that remain constant over time among girls

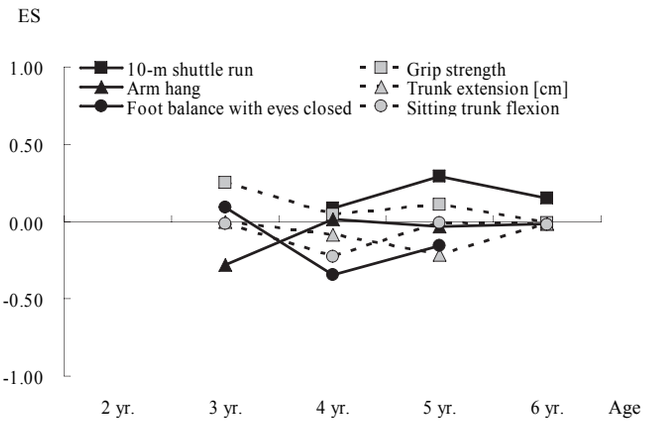


Figure 4 Test items with no specific gender difference

revealed gender differences favoring male children from four years of age. Aoyagi (2006), Demura, et al., (1990), Inoue (2000), Otaki (1978) and Yoshizawa (2002) reported that male children were superior in the "Standing long jump". Regarding changes with age, Katsube (1979) reported that from the early part of the third year, male children were superior. Thereafter, skip distance is going to increase; however, it is reported that the differences are constant. In this study, at the age of two, female children were superior by a small difference, and no gender differences were found from three to five years of age. At the age of six, male children were superior by a small difference and, in a similar manner, with increasing age, the superiority of female children disappeared and the tendency toward the superiority of male children was shown.

Figure 3 shows the changes in gender differences in "Ball bouncing" and "Jump rope". These items show that there is a tendency toward superiority in female children. Furthermore, with the exception of six year olds "Ball bouncing", gender differences were shown to expand with increasing age. With regard to "Ball bouncing", Aoyagi (2006), Takeuchi & Tateishi (1993) reported that female children were superior.

We calculated the average *ES** for these items and examined the differences against *ES*=0, "no gender difference". The results confirmed that the average values exhibit significant differences from ES=0 and 1% standard (t_o=5.789>t[0.01, df=7]=3.499). Therefore, these items indicate that "the superior performance of female children".

Six items, the "10-m shuttle run", "Grip strength", "Arm hung", "Trunk extension [cm]", "Foot balance with eyes closed" and "Sitting trunk flexion" are shown in **Figure 4**. No gender differences are found except in one age division, and these test items do not exhibit any clear tendency for gender difference change.

Regarding "Grip strength", Matsuura (1982) reported that there were no gender differences. However, Demura, et al., (1990) and Yoshizawa (2002) reported that male children were superior. Concerning "Arm hang", Katsube (1979) reported that female children were superior and that the differences expanded with increasing age. However, Kobayashi (1987) reported that there were no gender differences. Regarding "Sitting trunk flexion", female children were reported to be superior (Aoyagi, 2006; Demura, et al., 1990). Otaki (1978) reported that the gender differences disappear when the children become six years old. For these items, it was difficult to confirm the gender differences in the past as well. In this study, it is also difficult to identify clear ages and it is concluded that it is difficult to understand the features of gender difference and growth tendency.

3.3. The gender differences that were classified by the features of the test items

3.3.1. The gender differences by the classified items

In order to examine the gender differences by the features of the test items, we calculated 87 items out of the 100 articles that targeted meta analysis. We classified from the view point of the movement pattern, the movement skills and the physical fitness. The movement pattern and the movement skills model are based on Fundamental Movement Skills proposed by Gallahue and Donnelly (2003), and we

Table 4 Classification by movement patterns, movement skills and physical fitness

Test items	Movement patterns	Movement skills	Physical fitness
Crawling	Locomotion	Walking	Muscular strength & Explosive power/ Dexterity
Balance beam walk/ Straight walking with eyes closed			Balance
Running/ Running straight/ 10-m shuttle run/ 20-m, 25-m, 50-m or 100-m run		Running on straight & short course	Muscular strength & Explosive power/ Dexterity
Shuttle run/ Circle run; right-handed/ left-handed/ Carve run; small/ big/ Zigzag run		Running with turn	Muscular strength & Explosive power/ Agility
Running with weight		Running; else	Muscular strength & Explosive power
Running over blocks			Muscular strength & Explosive power/ Agility
Jump elastics/ Vertical jump/ Standing long jump		Jumping; once	Muscular strength & Explosive power
Jumping with turn/ Running long jump			Muscular strength & Explosive power/ Dexterity
Jumping three times		Repeated jumping	Muscular strength & Explosive power/ Dexterity
Popping [m]/ [times]/ [sec.]			Muscular endurance/ Balance
Side step/ Jumping back and forth			Agility
Jump ropes			Muscular endurance/ Dexterity
Continuous jump over			Muscular endurance/ Agility/ Dexterity
Body reaction time		Jumping; else	Agility
Stepping	Manipulation	Waking	Balance/ Agility
Kick for target		Kicking	Muscular strength & Explosive power/ Dexterity
Kick for distance			Muscular strength & Explosive power
Hitting		Manipulation with upper limbs	Muscular strength & Explosive power/ Dexterity
Tapping/ Moving marble			Agility
Grip strength/ Catching stone			Muscular strength & Explosive power
Bar gripping reaction time/ Times of failing			Agility
Throwing weight/ Tennis ball/ Soft ball/ Ball/ Disc; backhand/ Disc; Forehand/ Throwing ball for target/ Throw with both hands		Throwing	Muscular strength & Explosive power/ Dexterity
Ball bouncing/ Ball catching/ Rolling ball for target		Manipulation with ball without throwing	Dexterity
Stepping	Stability	Waking	Balance
Arm hang/ body supporting duration/ Push up		Hanging or dipping	Muscular endurance
Trunk extension [cm]/ [degree]		Extending trunk	Flexibility
Back strength			Muscular strength & Explosive power
Foot balance/ With eyes closed/ On the bar		Balancing on feet	Muscular endurance/ Balance
Side rolling/ Rolling		Rolling	Dexterity
Trunk flexion; sitting/ Standing [degree]/ Standing [cm]		Bending trunk	Flexibility

classified the main works of the test items. Also, in regard to physical fitness, we classified six elements based on the correspondence relations on test items shown in earlier studies (Asano, 1977; Ikai,1972; Katsube, et al., 1970; Kishimoto & Baba, 1980; Matsui, et al., 1955; Matsuura,1983; Munetaka, et al., 1971; Murase & Demura, 1990; Nakamura, et al., 1980; Research Group on Standard of Physical Fitness, Tokyo Metropolitan University, 2000; Takeuchi, et al., 1968).

About the movement which comprises the main works in the test items shown **Table 4**, "Locomotion", "Manipulation" and "Stability", and "Walking", "Running", "Jumping", "Throwing", "Kicking", "Manipulation with ball without throwing", "Manipulation with upper limbs",

Table 5 The effect sizes ($\overline{ES}$*) in movement patterns, movement skills and physical fitness

Classification		2yr	3yr	4yr	5yr	6yr
Movement patterns	Locomotion	**-0.203**	-0.004	0.020	0.021	0.034
	Manipulation	-0.014	0.117	0.060	0.191	**0.337**
	Stability	0.197	-0.016	-0.008	-0.015	-0.006
Movement skills	Walking		-0.004	-0.066	0.004	**0.268**
	Running		0.006	0.055	0.038	0.054
	; on straight & short course		-0.001	0.046	0.040	0.029
	; with turns		0.012	**0.238**	0.048	0.063
	Jumping	-0.195	-0.009	0.015	0.008	0.013
	; once	**-0.226**	-0.002	0.111	0.094	0.175
	; repeated	-0.161	-0.010	0.000	-0.003	-0.011
	Kicking			0.037	-0.066	0.066
	Manipulation with upper limbs		0.177	0.040	0.018	-0.045
	Manipulation with ball		**-0.416**	-0.019	0.000	-0.039
	Throwing		0.099	**0.685**	**1.031**	**1.320**
	Hanging or dipping		-0.018	-0.001	-0.012	0.000
	Extending trunk		0.012	-0.033	-0.069	-0.111
	Balancing on feet		-0.035	-0.009	-0.026	-0.026
	Rolling		-0.125	-0.009	0.003	0.034
	Bending trunk		-0.017	-0.050	-0.121	-0.020
Physical fitness	Muscular strength & Explosive power	-0.002	0.006	0.030	0.048	0.057
	Muscular endurance	**-0.488**	-0.022	-0.004	-0.012	-0.007
	Dexterity	-0.121	0.020	0.083	0.127	0.192
	Flexibility		-0.004	-0.055	-0.141	-0.016
	Balance	**-0.243**	-0.017	-0.011	-0.009	-0.009
	Agility		-0.005	0.001	-0.001	-0.006

"Balancing on feet", "Hanging or dipping", "Rolling", "Extending trunk" and "Bending trunk". We classified the three movement patterns and twelve movement skills. In addition, we further classified the categories, for example, "Running" was further broken down into "Running on a straight & short course" and "Running with turns"; and "Jumping" was further broken down into "Jumping once" and "Repeated jumping". Also, we determined whether the physical strength necessary to perform each test item fell within the categories of "Muscular strength & Explosive power", "Muscular endurance", "Balance" "Flexibility", "Agility" and "Dexterity". Out of 87 items, 69 items were judged to be classifiable from the perspective of movement skills and physical fitness. The test of homogeneity is carried out when integrating effect size by movement pattern, movement skills and physical fitness, and concerning effect size for which homogeneity was confirmed, we calculated the integrated effect size ($\overline{ES}$*), as shown in **Table 5**.

In movement pattern, small gender differences were revealed in "Locomotion" for two-year-old female children and "Manipulation" for six-year-old male children. However, gender differences were not found in other age divisions and "Stability".

Concerning movement skills, a large difference was seen in "Throwing" between five and six year olds, four year olds showed medium degree differences, with male children being superior in all cases. Movement skills that revealed small gender differences and male superiority were "Running with turns" (4 year olds) and "Walking" (6 year olds). On the other hand, the movement skills for which female children were superior were "Jumping once" (2 year olds) and "Manipulation with ball without throwing" (3 year olds). The skills of "Running" and "Jumping" did not reveal gender differences in any age division. However, for differences in running such as "Running a straight & short course" and "Running with turns" or for Jumping movement patterns

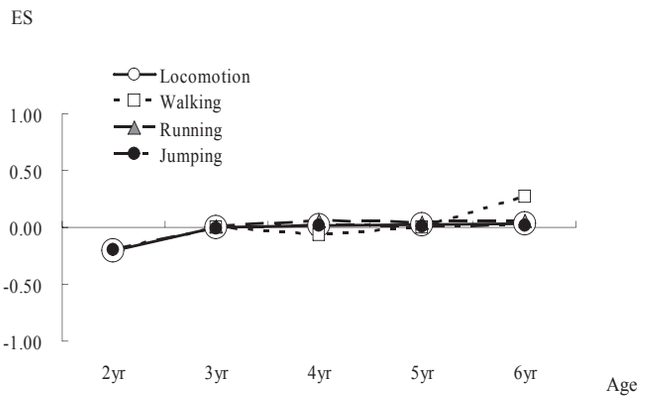


Figure 5 Annual changes in locomotion movement

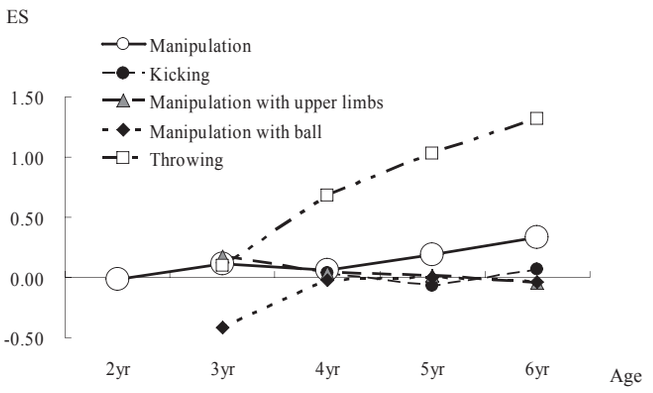


Figure 6 Annual changes in manipulation movement

such as "Jumping once" and "Repeated jumping", we found that each sub-segment revealed gender differences at certain age divisions. In "Jumping once," the gender differences that appeared at two years of age disappeared with increasing age, and we concluded that this could be considered a constant pattern. However, the change of gender difference in "Running with turns" was only seen at four years of age. Therefore, it is difficult to confirm the tendency toward increase with age. We consider that "Running with turns" involves not only the skills required for simple "Running" but also the more complicated skills required for running on a designated course.

Tamiaki & Akimaru (2003) state that at any age male children are superior in running ability. Also, Nakamura & Matsuura (1979) state that at all ages male children are superior to female children in the basic movement of running, jumping and throwing. In this study, we were able to confirm that the gender differences in throwing skills favored male children. However, we were not able to confirm gender differences in running and jumping with the exceptions of "Running with turns "at four years of age and "Jump once" at two years of age.

Concerning physical fitness, we were able to confirm that two-year-old female children were superior by small differences in both "Muscular endurance" and "Balance"; however, there were no gender differences beyond these two elements.

Kobayashi (1987) claimed that female children were superior to male children in terms of motor coordination. In addition, Otaki (1978) reported that female children were superior in "Balance" and "Flexibility", but that male children were superior to female children in "Dexterity". Demura (1995) reported in reference to "Balance" that female children were superior to male children in static activity but that there were no gender differences in dynamic activities. In a similar way, there were many references to the gender differences related to motor coordination. In this time analysis, we were unable to confirm the existence of gender differences prior to three years of age. Also, it has been reported that male children were superior to female child in terms of "Muscular strength & Explosive power" (Yoshizawa, 2002; Inoue, 2000). However, in this study, we were unable to confirm gender differences related to these items. In addition, it has been reported that there is no difference in regard to "Muscular endurance" (Inoue, 2000). In this study, female children were shown to be superior at two years of age; however, this study revealed no difference after three years old.

3.3.2. Tendency of annual changes in gender differences in item classification

We examined the tendency of change in gender differences from effect size of annual changes. In order to examine the movement pattern and the movement skills that are correspond with them, we compared annual changes in "Locomotion", "Walking", "Running" and "Jumping" in **Figure 5**. It is confirmed that two-year-old female children are superior by small gender differences in "Locomotion"; however, this is considered to be a function of the effect size of "Standing long jump" being reflected as it was. Additionally, it was shown that six-year-old male children were superior in terms of gender differences in "Walking"; however, beyond this single exception, "Locomotion" and other movement skills related to that pattern are not believed to exhibit a tendency toward gender differences.

Figure 6 shows the annual changes in

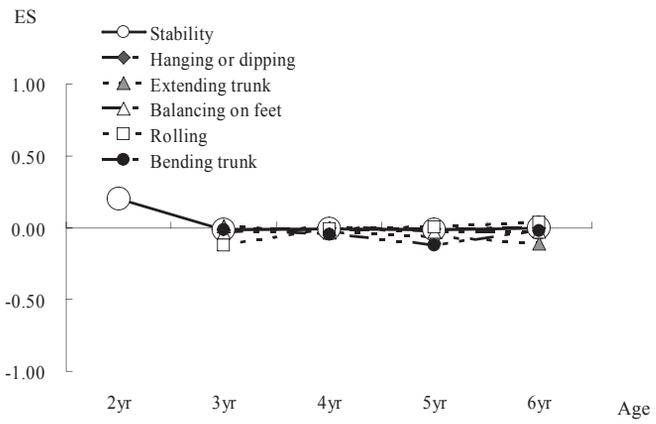


Figure 7 Annual changes in stability movement

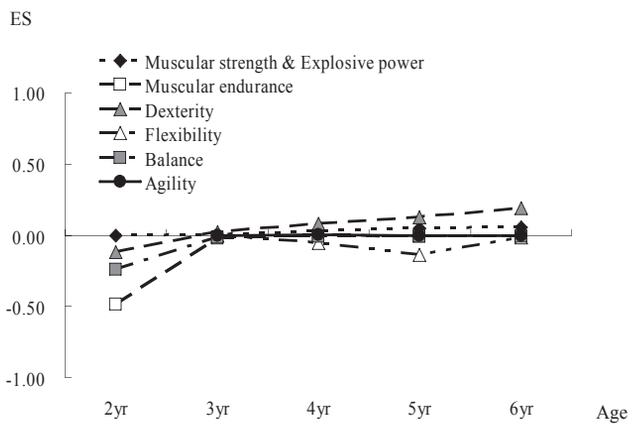


Figure 8 Annual changes in physical fitness

"Manipulation", "Kicking", "Throwing", "Manipulation with ball without throwing" and "Manipulation with upper limbs". "Manipulation" revealed certain exceptions while basically having shown a tendency for an increase with age, effect size increases and it shows the gender differences favoring six-year-old male children as superior. "Throwing" revealed its feature in a dominant manner prior to four years of age, with male children being clearly superior and, with an increase in age the gender differences exhibited a tendency toward expansion. Three-year-old female children were superior in "Manipulation with ball without throwing"; however, beyond four years of age, the gender differences disappeared. Also, with regard to manipulating movement skills, with this single exception, no gender differences could be found. For this reason, the tendency of gender differences that "Manipulation" revealed reflected the tendency of gender differences in throwing skills.

Figure 7 compares "Stability", "Hanging or dipping", "Balancing on feet", "Rolling", "Bending trunk" and "Extending trunk". These movement patterns and movement skills failed to confirm gender differences in any age divisions.

Figure 8 shows the change in the physical fitness of the subjects. Two-year-old female children were superior by small differences in "Muscular endurance" and "Balance"; however, no gender differences were revealed beyond these two exceptions. Otaki (1978) stated that female children were superior in "Balance" and "Flexibility"; however, beyond six years of age, no gender differences were seen, and he went on to remark that male children were superior in "Dexterity" and "Muscular strength & Explosive power", such as instantaneous force and speed. In this study, however, we were unable to confirm gender differences.

When we examined the tendency of annual changes in gender differences in movement patterns, movement skills and physical fitness, for the cases in which female children proved to be superior, it appears that the superiority in performance exhibits itself when the children are at the lower ages, and with increasing age, the tendency is for the gender differences to disappear. On the other hand, however, the time that gender differences favor the male children is during the late preschool aged-childhood period and the tendency is for the differences to expand with increasing age.

Preschool aged-children do not exhibit gender differences in terms of physical size (Gallahue & Donnelly, 2003) or hormone secretion (Matsuura, 1982). However, Ueda (1986) claimed that female children have an admitted tendency to learn faster than male children do in the developmental fields such as language, fine movement, and adjustment. Moreover, in terms of intellect, she also showed that male and female children develop by different processes. The movement required to achieve the assigned item is greatly influenced by the understanding of the required task. In other words, the gender differences that favor lower-aged female children can be seen against the background of their faster development in language and adjustment; however, against the subsequent development of the male children, the gender differences are seen to disappear.

On the other hand, because there is no gender difference in physical fitness with increasing age after three years of age, it is difficult to consider

large gender differences in preschool-aged children's physical fitness that favor male children. Matsuura (1982) pointed out that the gender differences that are clear in the late preschool aged-childhood period are "differences in the child's interest in playing". In addition, Malina & Bouchard (1991) claimed that the child engages in activities in this period that tend to be a reflection of the social expectations for the child. Compared with "Locomotion" and "Stability", the gender differences revealed in "Manipulation" were remarkable, especially "Throwing" movement skills. From this, preschool-aged children are shown to select the play and activity in daily situations in association with social expectations and their own interests. The male children then show their tendency toward superiority in the test item that includes the skills that connect to the activity that they have selected to do; and it is thought that differences in their experience expand with an increase in age.

4. Summary

In order to examine gender differences in preschool aged-children's performance and annual changes in movement test items, using meta analysis, we calculated 1830 effect sizes (*ES**) out of 100 articles reporting preschool aged-children's motor ability. Based on this, we integrated the test items that had multiple *ES** by year. As a result, we calculated 44 items and 141 integrated effect sizes ($\overline{ES}$*). Moreover, in order to examine the gender differences in movement patterns, movement skills and physical fitness and annual changes, we extracted 69 items that could be classified on the basis of the features of the items and calculated each $\overline{ES}$*. In addition, when we integrated effect size, we performed homogeneity tests. The results are as follows:

1. In 44 motor ability test items that were examined for the presence of gender differences, 22 items exhibited clear gender differences favoring either male or female children is at a minimum of one age category. No gender differences were identified in the remaining 22 items. Also, approximately 141 effect sizes, 29 (20.6%) were male children and 13 (9.2%) were female children with gender differences in their favor; however, the remaining 99 (70.2%) were found to exhibit no gender differences.
2. Regarding the gender differences in the items and their annual change patterns, nine items are corresponded to "the performance of male children became superior with increasing age", two items corresponded to "the performance of female children" was superior. Also, six items were considered to be "performance for which it was difficult to identify the gender difference features and growth tendency"; however, other items are not reflected in the gender differences at any age.
3. The examination of the gender differences classified into similar items revealed the tendency for male children to exhibit superior performance in Manipulation, Throwing skills and Walking skills, and for female children to exhibit superior performance in Locomotion, Manipulation with ball without throwing, Muscular endurance and Balance. However, beyond these classifications, no gender differences were found.
4. Male children showed favorable gender differences at older ages. With increasing age, the gender differences appeared or increased. Female children showed favorable gender differences at younger ages. With increasing age, however, there was a tendency for the differences to disappear.
5. The gender differences that favor female children when they are at a younger age are considered to be related to an understanding of the movement assignment as a result of early maturing. Also, the gender differences that favor male children with increasing age, such as throwing skills, are considered to be largely influenced by movement experience.

References

Aoyagi, O. (1987) A study of literatures on the motor performance in childhood. Fukuoka University Review of Physical Education 17 (2): 1-9. (in Japanese)

Aoyagi, O. (2006) Growth and Development of Children and Human Health. Nakanishiya-shuppan; Kyoto, P.26. (in Japanese)

Cohen, J. (1969) Statistical power analysis for the behavioral science. Academic Press: New York.

Demura, S. (1993) Contribution of physical fitness and throw form to ball-throw distance and sex difference in preschool children. Japan Journal of Physical Education, Health and Sport Sciences 37: 339-350. (in Japanese with English abstract)

Demura, S. (1995) Development and sexual differences of static and dynamic balance in preschool children. Japan Journal of Physical Education, Health and Sport Sciences 40: 67-79.

Demura, S., Murase, T. and Okajima, Y. (1990) Development of Motor Ability by Sex Difference in Preschool Children. Japanese journal of school health 32: 532-538. (in Japanese with English abstract)

Gallahue, D.L. and Donnelly, F.C. (2003) Development physical education for all children, 4th.Human Kinetics: Champaign, pp. 24-49.

Hedge, L.V. (1981) Distribution theory for Glass's estimator of effect size and related estimators. Journal of Educational Statistics 6: 107-128.

Ikeda, T. and Aoyagi, O. (2006) A selection of test items for children's physical and motor fitness: Classification and investigation of test items based on Gallahue's model of fundamental movement skills. Kyushu Journal of Physical Education and Sports 21 (2): 1-16 (in Japanese with English abstract)

Inoue, K. (2000) Development of motor abilities. Kondo, M. (ed. Supervision) The new Motor Play for Babies and Infants 3rd edition. Kenpaku-sha: Tokyo, pp.13-16. (in Japanese)

Katsube, A. (1979) The Theory and Practice in Physical Education for Preschool Children revision. Kyorin-shoin: Tokyo, pp.48-49. (in Japanese)

Kawahara, Y., Hatakeyama, T. and Funakawa, H. (1981) Development and evaluation of motor functions of children. Memoirs of the Japan Women's University. Faculty of Home Economics 28: 121-130. (in Japanese with English abstract)

Kobayashi, K. (1987) Motor instruction and effects in children. Bessatsu Hattatsu [The development separate volume] 6: 167-177. (in Japanese)

Kurimoto, E., Asami, T., Shibukawa, R., Matsuura, Y. and Katsube, A. (1981) The final version of the field test of motor coordination by Research Center in Physical Education; The report of Committee of Motor Coordination. Report of Research Center in Physical Education 9: 207-212. (in Japanese)

Malina, R. M. and Bouchard, C. (1991) Growth, maturation, and physical activity. Human Kinetics Books:Champaign, pp.187-204.

Matsuda, I. (1961) Studies on motor development during early childhood. Bulletin of the Faculty of Physical Education, Tokyo University of Education 1: 38-53. (in Japanese with English abstract)

Matsuda, I. and Kondo, M. (1968) A study on the motor abilities of preschool children; a composition of a standard of the development of the motor abilities of preschool children. Bulletin of the Faculty of Physical Education, Tokyo University of Education 7: 33-45. (in Japanese with English abstract)

Matsui, M., Matsuda, I. and Mori, K. (1955) Studies on motor ability tests for children. Research Journal of Physical Education 9:523-533. (in Japanese)

Matsuura, Y. (1982) Development of physical fitness. Asakura-shoten: Tokyo. pp.43-44. (in Japanese)

Miyaji, K., Katsube, A. and Harada, S. (1970) The studies on the motor ability of kindergarten children (Part 1). Annual report of Natural Science and Home Economics, Kinjo Gakuin College 11: 31-44. (in Japanese with English abstract)

Mullen, B. (1989) Advanced BASIC meta-analysis. Lawrence Erlbaum Associates: New Jersey, pp.1-14.

Murase, T. and Demura, S. (2005) Discussion on further studies to measure and evaluate fitness and motor performance for preschool children; summary and previous studies in Japan and future consideration. Japan Journal of Test and Evaluation of Physical Education and Sports 5: 5-13. (in Japanese with English abstract)

Nakamura, E. and Matsuura, Y. (1979) The development of fundamental motor ability of boys and girls aged four to eight. Japan Journal of Physical Education, Health and Sport Science 24: 127-135. (in Japanese with English abstract)

Nakamura, S., Tsunoda, S., Sugiyama, M., Funato, N., Yoshimura, T. and Miyazaki, M. (1980) A study on teaching physical education in kindergarten: part five.The Annual Report of Physical Education12: 16-27. (in Japanese with English abstract)

Nishijima, N. (2005) Motor ability test for children. Growth and Development of Children 3 (2): 70-77. (in Japanese)

Otaki, T. (1978) Development of physics, motor abilities and mind. Ikuta, S. and Imaizumi, N. (Ed.) Instruction of Health for Babies and Infants, Kitaohji-shobo: Kyoto, pp.42-44. (in Japanese)

Shiba, S. and Haebara, T. (1990) Methods of statistical analysis for behavioral science. University of Tokyo Press: Tokyo, pp.245-252. (in Japanese)

Sparling, P.B. (1980) A meta-analysis of studies comparing maximal oxygen uptake in men and woman. Research Quarterly for Exercise and Sport 51:542-552.

Sugihara, T. Kondo, M., Mori, S. and Yoshida, I (2004) Children's Motor abilities by national research in 2002. Journal of Health, Physical Education and Recreation 54: 161-170. (in Japanese)

Takeuchi, H. and Tateishi, A. (1993) The body and motor function of children. Kindai-bungeisha: Tokyo, pp.124-130. (in Japanese)

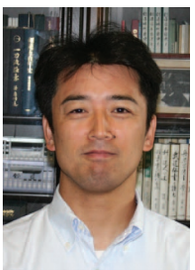
Tamiaki, G. and Akimaru, T. (2003) The Contents of Child Care. Kitaohji-shobo: Kyoto, pp.44-46. (in Japanese)

Tomas, J.R. and French, K.E. (1985) Gender differences across age in motor performance: A meta-analysis. Psychological Bulletin 98:260-282.

Tomas, J.R. and Nelson, J.K. (2001) Research methods in physical activity. Human Kinetics: Champaign, pp.237-259.

Ueda, R. (1986) How do Human Develop?; Thinking on Growth of Adults and Children. Kodansha: Tokyo, pp.149-150. (in Japanese)

Yoshizawa, S. (2002) Aerobic capacity in young children. Kyorin-shoin: Tokyo, pp.30-31. (in Japanese)



Name:
Takahiro Ikeda

Affiliation:
Department of Early Childhood Education and Care, Saga Junior College 1)
Graduate School of Health and Sport Science, Fukuoka University 2)

Address:
1) 3-18-15 Kamizono, Saga 840-0806 Japan
2) 8-19-1 Nanakuma, Jyonanku Fukuoka 814-0180 Japan

Brief Biographical History:
Born in 1967
1989-1992 Master program, University of Tsukuba
1992-1997 Physical Education teacher, KEIO CHUTOBU junior high school
1997- Lecturer, Department of Early Childhood and Care, Saga Junior College (Now, Associate professor)
2006- Doctoral program, Fukuoka University

Main Works:
- Construction of the test battery of motor ability in childhood; Investigation by reliability, validity and practicability. Research Journal of Physical Arts. 13(1): 11-29. 2008
- A selection of test items for children's physical and motor fitness; Classification and investigation of test items based on Gallahue's model of fundamental movement skills. Kyushu Journal of Physical Education and Sport. 21(2): 1-16. 2006

Membership in Learned Societies:
- Japan Society of Physical Education, Health and Sport Sciences
- The Japanese Association of Health Psychology
- The Japanese Association of School Health
- Japanese Society of Test and Measurement in Health and Physical Education
- Japan Society of Human Growth and Development
- Japan Society of Research on Early Childhood Care and Education
- Japanese Academy of Budo
- Society for Studies of Physical Arts

Appendix

1. Abe, et al., 2006. Memoirs of Osaka Kyoiku University. IV, Education, psychology, special education and physical culture 54.
2. Akimaru, et al., 2001. Journal of humanities and social sciences 11.
3. Amano, et al.,1985. Bulletin of Tokai Women's Junior College 11.
4. Aoyagi 1990. Yonetani, M. (ed.) Health: Practice version. Sankou-shobo: Tokyo.
5. Aoyagi 2005. Toka-shobo: Fukuoka.
6. Asami & Shibukawa 1975. Report of Research Center in Physical Education 3.
7. Asami, et al., 1976. Report of Research Center in Physical Education 4.
8. Demura, et al., 1990. Japanese Journal of School Health 31.
9. Ebashi 1972. Journal of health, physical education and recreation 22.
10. Fujie 1984. Journal of health, physical education and recreation 34.
11. Fujishiro 1968. Journal of health, physical education and recreation 18.
12. Furuhata 1975. Bulletin of Nagano Junior College 30.
13. Gao 2004. Journal of Health and Human Ecology 70(4).
14. Goshi, et al., 1995. Annual report of the Institute of Early Childhood Education, Miyagi Gakuin Women's College,Miyagi Gakuin Women's Junior College 4:25-30.
15. Goshi, et al., 1999. Japan journal of physical education, health and sport sciences 44.
16. Goto 1977. Baika literary bulletin. Humanistic, social & natural sciences 14.
17. Gotoh, et al., 1976. Annual Reports in Japan Society of Research on Early Childhood Care and Education 29th Conference.
18. Harasaki 1986. Bulletin of Miyazaki Women's Junior College 12.
19. Harasaki & Suzuki 1991. Bulletin of Miyazaki Women's Junior College 17.
20. Hatakeyama 1975. Bulletin of Yasuda Women's University 7.
21. Hirose, et al., 1969. Annual Reports in Japan Society of Research on Early Childhood Care and Education 22nd Conference.
22. Honma 1978. Bulletin of Nippon Sport Science University 7.
23. Ikeda, et al., 2005. Journal of Nishikyushu University & Saga Junior College 35.
24. Ikeuchi, et al., 1974. Bulletin of Matsuyama Shinonome junior College 6.
25. Imanaka, et al., 1981. Japan journal of physical education, health and sport sciences 26.
26. Inoue 1968. Journal of health, physical education and recreation 18.
27. Inuihara, et al., 1977. Treatises and studies by the Faculty of Kinjo Gakuin University 2.
28. Ishigure & Satou 1989. Bulletin of Heian Jogakuin (St. Agnes') College 20.
29. Ishii 1970. Annual Reports in Japan Society of Research on Early Childhood Care and Education 24th Conference.
30. Ishii & Goto 1971. Annual Reports in Japan Society of Research on Early Childhood Care and Education 24th Conference.
31. Ito, et al., 1987. Bulletin of Tokai Women's Junior College 13.
32. Itoh, et al., 1990. Proceedings of the Congress of the Japanese Society of Physical Education B.
33. Iwasaki 1985. The Bulletin of Tsurumi College. Part.3 Studies in Infant Education, Health and Dental Hygiene 22.
34. Kaji, et al., 1976. Bulletin of Matsuyama Shinonome junior College 7.
35. Kanbe & Narushima 1988. Journal of Matsusaka Women's Junior College 26.
36. Kanno 1974. The Research bulletin of the Faculty of General Education 6.
37. Katsube & Konishi 1968. Bulletin of the Nagoya College 8.
38. Katsuki & Takahashi 1989. Research reports, Himeji College of Hyogo 34.
39. Kawaguchi 1978 .Journal of the Natural Scientific Society of Icimura Gakuen Junior College 12(2).
40. Kawahara, et al., 1981. Japanese Journal of Physical Fitness and Sports Medicine 30.
41. Kobashigawa & Miyagi 1966. Bulletin of College of Education, University of the Ryukyu 9.
42. Kobayashi 1991. Bulletin of Physical Education, University of Tokyo 25.
43. Kobayashi & Yagi 1991. Bulletin of Physical Education, University of Tokyo.
44. Kobayashi, et al., 1987. Report of Research Center in Physical Education 15.
45. Kobayashi, et al., 2003. Bulletin of Faculty of Education, Center for Educational Research and Development, University of the Ryukyu 10.
46. Kondo, et al., 1987. Journal of health, physical education and recreation 37.
47. Kondo, et al., 1998. Journal of health, physical education and recreation 48.
48. Kurimoto, et al., 1981. Journal of health, physical education and recreation 31.
49. Kuwahara, et al., 1990. Proceedings of the Congress of the Japanese Society of Physical Education B.
50. Maruyama, et al., 1998 Annual Reports in Japan Society of Research on Early Childhood Care and Education 51st Conference.
51. Matsuda 1961. Bulletin of the Faculty of Physical Education, Tokyo University of Education 1.
52. Matsuda & Kondo 1968. Bulletin of the Faculty of Physical Education, Tokyo University of Education 7.
53. Matsuda, et al., 1975. Bulletin of the Faculty of Physical Education, Tokyo University of Education 14.
54. Matsui, et al., 1974. Report of Research Center in Physical Education 2.
55. Matsumoto 1984. Annual Reports in Japan Society of Research on Early Childhood Care and Education 37th Conference.
56. Matsuura 1986. Report of Research Center in Physical Education 14.
57. Matsuura & Miyamaru 1987. Report of Research Center in Physical Education 15.
58. Miyaguchi 1983. Journal of Kanazawa College of Economics 16.
59. Miyaguchi 1990. Journal of Kanazawa College of Economics 24.
60. Miyaji, et al., 1971. Annual report of natural science and home economics, Kinjo Gakuin College 11.
61. Miyake 1984. The journal of Hyogo Women's Junior College 17.
62. Miyake & Tokuda 1982. The journal of Hyogo Women's Junior College 15.
63. Mizuma 1968. Bulletin of the Hiroshima Jo Gakuin University 18.
64. Mizuma, et al., 1972. Annual Reports in Japan Society of Research on Early Childhood Care and Education 25th Conference.
65. Munetaka 1972. Annual Reports in Japan Society of Research on Early Childhood Care and Education 25th Conference.
66. Munetaka & Takeuchi 1970. Annual Reports in Japan Society of Research on Early Childhood Care and Education 23rd Conference.
67. Munetaka, et al., 1971. Japan journal of physical education, health and sport sciences 16.
68. Murase & Baba 2000. The Journal of Education and Health Science 46.
69. Murase & Demura 1990. Japan journal of physical education, health and sport sciences 35.
70. Muro & Morisaki 1992. The journal of science of culture and humanities and nature of Shinai Women's Junior College 32.
71. Muto, et al., 2004. Bulletin of the Gifu City Women's College 54.
72. Nakae, et al., 1974. Annual report of natural science and home economics, Kinjo Gakuin College 14.
73. Nakamura 1957. Bulletin of the Ehime University. Section V, Educational sciences 4(1).
74. Nakamura & Matsuura 1979. Japan journal of physical education, health and sport sciences 24.
75. Narushima 1975. Journal of Matsusaka Women's Junior College 11.
76. Sakamaki 1980. The bulletin of liberal arts & sciences, Nippon Medical School 1.
77. Sakaue, et al., 1983. Annual Reports in Japan Society of Research on Early Childhood Care and Education 36th Conference.
78. Sakuragi & Hara 1994. Annual Reports in Japan Society of Research on Early Childhood Care and Education 47th Conference.
79. Shichida 1991. Bulletin of the Yokohama Women's Junior College 9 .
80. Shimada 1984. Annual Reports in Japan Society of Research on Early Childhood Care and Education 37th Conference.
81. Suetoshi & Senda 1979. Report of Research Center in Physical Education 7.
82. Sugihara, et al., 2004. Journal of health, physical education and recreation 54.
83. Suzuki & Harasaki 1989. Bulletin of Miyazaki Women's Junior College 15.
84. Suzuki & Harasaki 1992. Bulletin of Miyazaki Women's Junior College 18.
85. Suzuki, M. 1975. Bulletin of Morioka College. Home economics, preschool education & liberal arts 26.
86. Suzuki, Y. 2000. Nagoya Ryujo (St. Mary's) College annual report of studies 22.
87. Takayama 2005. Research reports of Niigata Seiryo University Junior College 35.
88. Takeuchi, et al., 1968. Japan journal of physical education, health and sport sciences 13.
89. Tanaka, C. 2005. Studies in childhood education 24.
90. Tanaka, C. & Sakuma 2002. Journal of physical education and medicine 3.
91. Tanaka H. 2004. Memoirs by the members of Senzoku Gakuen College of Music, Senzoku Gakuen Junior College 33.
92. Toritsu Kyoiku Kenkyujo 1999. Kyoiku Jiho 619.
93. Wakayama 1980. Bulletin of Kanazawa College of Art 24.
94. Wang, et al., 1997a. The Journal of Education and Health Science 42(4).
95. Wang, et al., 1997b. The Journal of Education and Health Science 43(2).
96. Watanabe & Kuze 2000. Science report of the Faculty of Education, Gifu University. Natural science 24.
97. Yagi & Kobayashi 1990. Bulletin of Physical Education, University of Tokyo 24.
98. Yagi, et al., 1987. Bulletin of the Faculty of Education, Mie University. Natural science 40.
99. Yamada 1985. Bulletin of Ohtani Women's University 20.
100. Yanagihara 1969. Bulletin of Shimane Women's College 7.