CHAPTER IV
RESULTS AND DISCUSSIONS

This Chapter presented results that were obtained after implementing methods mentioned in the previous Chapter as well as the discussions of the findings. These were presented separately for the two study aims- one for Aim 1 which involved children's preference for toy, and another was for Aim 2 which investigated the association between type of play materials and children's cognitive development. Therefore, there were 2 sections for each aim- the results and the discussions as follows.

4.1   Aim 1- Toy preference

4.1.1   Results

A total of 4,245 children from 4 regions of Thailand as well as from Bangkok Metropolitan formed a cohort for the PCTC. At their first year of life, 3,983 children made a follow-up visit to the hospitals at where their toy preferences were investigated. The children were born to mothers who were, on average, 27±6 years of age and mainly illiterate or at primary school of education (Table 4.1). There was an equal number of boys and girls, with mean weight of 8,830±.1,186 grams and mean length of 73.6±3.4 centimeters. Most of the children had no sibling, 43.6%, and had an average family size of 5±2. There were 8.7% preterm birth and 8.3% low birth weight infants.

Table 4.1 Characteristics of children and their parents presented as frequency and percentages unless specified otherwise

Characteristics	Number	Percent
Study area		
Central region	740	18.6
Southern region	1,019	25.6
Northeastern region	832	20.9
Northern region	751	18.9
Bangkok Metropolitan	641	16.1
Mother's age (Mean±SD)	3,953	27.0±6.3
Mother's education		
Illiterate/ Primary school	2,092	53.1
Secondary school	1,119	28.4
Commercial college/ University	731	18.5
Parents' income		
Low	936	23.7
Middle	2,036	51.5
High	983	24.9
Gender		
Boy	1,988	49.9
Girl	1,995	50.1
Weight (Mean±SD)	3,974	8,830±1,186
Length (Mean±SD)	3,972	73.6±3.4
Family size (Mean±SD)	3,946	5±2
Number of sibling		
0	1,716	43.6
1	1,462	37.1
2	439	11.2
3+	321	8.2
Preterm (gestational age <37)	318	8.7
Low birth weight (<2500 grams)	318	8.3

Throwing ball was the most attractive toy where there were about a quarter of children, 27.4% (95%CI: 26.0 to 28.8), chose it as the first toy to play (Table 4.2). Rattling sound toys was at the second rank, 16.5% (95%CI: 15.3 to 17.6). All remaining toys were chosen as the first to play for less than 10%, of which, pictorial book was the least, 1.0% (95%CI: 0.7 to 1.3). Both throwing ball and rattling sound toys were also the most common toys being played at any occasions during the 20-minute free-play environment, with percentages of 76.8% and 80.9%, respectively. Children spent the longest play duration with throwing balls (1.27 minutes, 95%CI: 1.20 to 1.33), followed by rattling sound toys (0.97 minutes, 95%CI: 0.93 to 1.02). All remaining toys were played for less than 1 minute duration.

About 18.4% of children played more than half of the provided toys. Most of the children 35.1%, played with 4-5 toys during the 20 minutes free-play context.

Table 4.2 Infants' preference for toys during the observation period of 20 minutes (n=3,983)

Types of toy	Being chosen as the first toy to play			Being played in any occasions[1]		Average duration of playing (minutes)	
	n	%	95% CI	n	%	Mean	95% CI
Soft materials							
Soft human dolls	166	4.2	3.5, 4.8	1,059	26.6	0.13	0.11,0.14
Soft animal dolls	358	9.0	8.1, 9.9	1,979	49.7	0.26	0.24,0.28
Hard materials							
Wooden dolls	94	2.4	1.9, 2.8	1,115	28.0	0.16	0.14,0.17
Sound materials							
Squeeze sound toys	289	7.3	6.4, 8.1	1,452	36.5	0.41	0.38,0.44
Rattling sound toys	656	16.5	15.3, 17.6	3,223	80.9	0.97	0.93,1.02
Push button sound toys	228	5.7	5.0, 6.4	1,900	47.7	0.79	0.74,0.84
Pounding sound toys	292	7.3	6.5, 8.1	1,928	48.4	0.82	0.76,0.87
Move to play							
Pull toys	315	7.9	7.1, 8.7	1,872	47.0	0.43	0.40,0.46
Walker (push along)	188	4.7	4.1, 5.4	1,369	34.4	0.29	0.26,0.32
Throwing balls	1,091	27.4	26.0, 28.8	3,059	76.8	1.27	1.20,1.33
Abacus toys	267	6.7	5.9, 7.5	2,183	54.8	0.87	0.82,0.91
Literacy							
Pictorial books	39	1.0	0.7, 1.3	744	18.7	0.15	0.13,0.17
Total	3,983	100					

[1] One child might play more than one toys either once or repeatedly during the observed duration

Table 4.3 explored roles of gender on preference for toys. Throwing balls and rattling sound toys remain the first two toys being chosen by children of both genders. Comparing between gender regarding the first two toys that children chose as the first toy to play, throwing balls were chosen more by boys than girls, 28.9% vs 25.9%. For rattling sound toys, on the other hands, girls chose them more than boys, 17.0% vs 16.0%.

Table 4.3   The first toy by gender

Types of toy	Boy		Girl	
	n	%	n	%
Soft materials				
Soft human dolls	64	3.2	102	5.1
Soft animal dolls	131	6.6	227	11.4
Hard materials				
Wooden dolls	57	2.9	37	1.9
Sound materials				
Squeeze sound toys	158	8.0	131	6.6
Rattling sound toys	317	16.0	339	17.0
Push button sound toys	110	5.5	118	5.9
Pounding sound toys	171	8.6	121	6.1
Move to play				
Pull toys	167	8.4	148	7.4
Walker (push along)	102	5.1	86	4.3
Throwing balls	574	28.9	517	25.9
Abacus toys	120	6.0	147	7.4
Literacy				
Pictorial books	17	0.9	22	1.1
Total	1,988	100	1,995	100

Similarly, throwing balls and rattling sound toys remain the first two toys being chosen by children resided at any study areas (Figure 4.1). Boys and girls spent most time with throwing balls (Table 4.4).
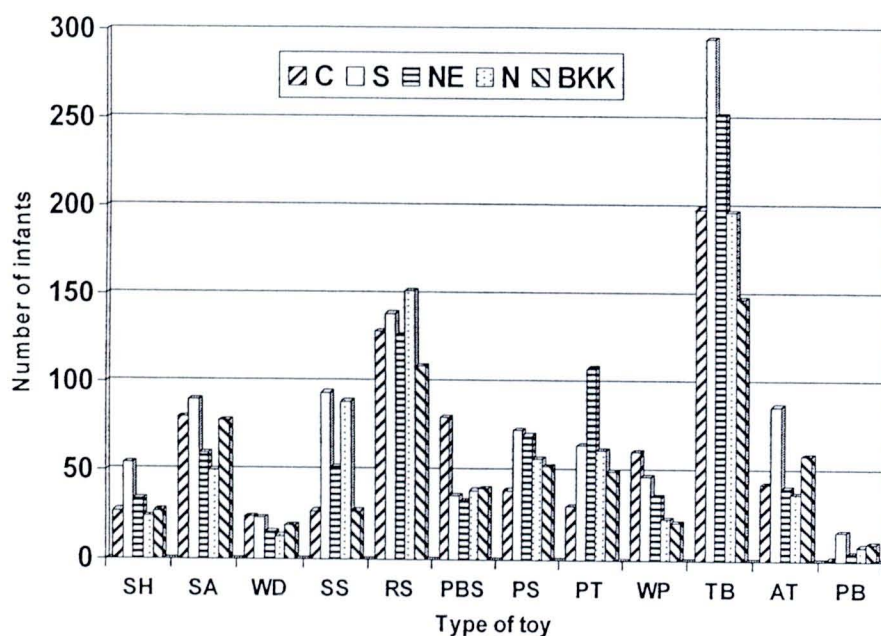
SH=Soft human doll, SA=Soft animal doll, WD=Wooden doll, SS=Squeeze sound toy,
RS=Rattling sound toy, PBS=Push button sound toy, PS=Pounding sound toy, PT=Pull toy,
WP=Walker or push along toy, TB=Throwing ball, AT=Abacus. toy, PB=Pictorial book

Figure 4.1   The first toy by area (n=3,983)

Table 4.4   Average duration of playing (mean and standard deviation) by gender

	Boy		Girl	
	Mean	**SD**	**Mean**	**SD**
Soft materials				
Soft human dolls	0.11	0.45	0.15	0.47
Soft animal dolls	0.20	0.52	0.31	0.78
Hard materials				
Wooden dolls	0.19	0.59	0.12	0.40
Sound materials				
Squeeze sound toys	0.45	1.13	0.37	0.96
Rattling sound toys	0.95	1.47	1.00	1.40
Push button sound toys	0.77	1.60	0.81	1.69
Pounding sound toys	0.94	2.07	0.69	1.53
Move to play				
Pull toys	0.50	1.19	0.36	0.78
Walker (push along)	0.31	0.90	0.27	0.96
Throwing balls	1.34	2.18	1.20	1.95
Abacus toys	0.93	1.70	0.80	1.45
Literacy				
Pictorial books	0.12	0.47	0.18	0.69

4.1.2 Discussions

Play is essential for child growth and development, and toys are the tools of play. Types of toys that are provided and how they are played are important. Toys that promote child's attention-getting and attention-holding could offer children's important developmental benefits and parents' opportunity to fully engage with their children. The authors investigated play in very young children by providing 12 toys to children and observed how they were played in a 20-minute free-play context without interference of parents or caregivers. The authors found that throwing balls and rattling sound toys were the most attention-getters and attention-holders.

According to Glassy and Romano (2003), toys should be safe, affordable, developmentally appropriate, and appealing to engage the child over a period of time [17]. Throwing balls and rattling sound toys matched most of these properties. These are also developmentally appropriate as suggested by Chase (1994) [10] .

Regarding effect of gender on preference for toys [11, 12], in our study, there were slightly more girls (1,995) than boys (1,988). And they showed similar patterns of preference [59], although move to play toys contacts were made more by boys than girls [59, 60]. In one study, ball was the first toy chosen [43]. Thus our study should be robust as far as the gender difference is concerned.

Although this study is not a sampling survey where representativeness is difficult to be assumed, it involved a large number of children in Thailand. Sensitivity analysis had also been done and found similar pattern of playing across all study areas. Therefore, selection bias is unlikely to distort the findings.

The scope of this study was merely exploratory for potential tools for child developments. One should be informed that, as stated by Glassy and Romano (2003), that toys facilitate but do not substitute for the most important aspect of nurture-warm, loving, dependable relationships [17]. Effects of these toys on child growth and development require further study.

4.2 Aim 2- Association between play materials and cognitive development

4.2.1 Results

The PCTC enrolled 4,245 children from 4 regions of Thailand as well as from Bangkok Metropolitan (Table 4.5). Information on cognitive measurements and play materials were available for 4,116 children. The children were born to mothers who were, on average, 27±6 years of age and mainly illiterate or at primary school of education. There was an equal number of boys and girls, with mean weight of 8,827±.1,196 grams and mean length of 73.6±3.5 centimeters. Most of the children had no sibling, 43.4% and average family size of 5±2. There were 8.9% preterm infants, 8.6% low birth weight, 20.2% breast fed less than 3 months, and 10.0% hospitalized during the second half of their first year of life.

Table 4.5 Characteristics of children and their parents

Characteristics	Number	Percent
Study area		
Central region	759	18.4
Southern region	1,061	25.8
Northeastern region	853	20.7
Northern region	772	18.8
Bangkok Metropolitan	671	16.3
Parent's characteristics		
a) Mother's Age (Mean±SD)	4,069	27.0±6.2
b) Mother's education		
Illiterate/ Primary school	2,149	53.0
Secondary school	1,157	28.5
Commercial college/ University	752	18.5
c) Father's education		
Illiterate/ Primary school	1,851	51.9
Secondary school	1,031	28.9
Commercial college/ University	688	19.3
d) Income		
Low	964	23.68
Middle	2,090	51.34
High	1,017	24.98
Children characteristics		
a) Gender		
Boy	2,039	49.8
Girl	2,059	50.2
b) Weight (Mean±SD)	4,074	8,827±1,196
c) Length (Mean±SD)	4,072	73.6±3.5

Table 4.5 Characteristics of children and their parents (cont.)

Characteristics	Number	Percent
d) **Family size** (Mean±SD)	4,110	5±2
e) **Number of sibling**		
0	1,761	43.4
1	1,507	37.2
2	452	11.2
3+	334	8.2
f) **Preterm** (Gestational age <37 weeks)	336	8.9
g) **Low birth weight** (<2,500 grams)	340	8.6
h) **Breast feeding (months)**		
< 3	827	20.2
3-5	600	14.7
6+	2,669	65.2
i) **Hospital admission last 6 months**		
No	3,700	90.0
Yes	410	10.0

The most common materials being played at home include push/pull toys (75.3%), home utensils (75.0%), and sound toys (73.9%) (Table 4.6). Second to those were junk materials (69.7%) and dolls and other soft toys (68.6%). Children rarely played at home with self-invented toys (10.4%), stacking toys (9.9%), and musical cassettes (6.8%).

Table 4.6 Type of play materials found in children's houses

Type of play materials	Number of children	% having play materials	95% confidence interval
Push/pull toys	4,113	75.3	74.0, 76.7
Home utensils	3,729	75.0	73.6, 76.4
Sound toys	4,115	73.9	72.5, 75.2
Junk materials	3,745	69.7	68.2, 71.2
Dolls and other soft toys	4,113	68.6	67.1, 70.0
Natural materials	3,703	49.3	47.7, 50.9
Story books	4,112	32.8	31.3, 34.2
Creative materials	4,111	31.3	29.9, 32.7
Writing materials	4,096	25.9	24.6, 27.3
Self-invented toys	4,105	10.4	9.4, 11.3
Stacking toys	4,106	9.9	9.0, 10.8
Musical cassettes	4,114	6.8	6.1, 7.6
Others	4,103	44.1	42.6, 45.6

Compared with children who did not played, Capute scale was significantly higher among children who played the following materials- push/pull toys ($P<0.001$), home utensils ($P<0.001$), junk materials ($P<0.001$), dolls and other soft toys ($P<0.001$), natural materials ($P<0.001$), story books ($P<0.038$), creative materials ($P<0.001$), writing materials ($P<0.001$), and stacking toys ($P<0.023$) (Table 4.7). Among these, creative materials had the largest effects, with the mean difference of 5.4 (95%CI: 4.3 to 6.4), followed by natural materials (mean difference = 5.1, 95%CI: 4.0 to 6.1) and junk materials (mean difference = 4.1, 95%CI: 2.9 to 5.2). In contrast, children who played musical cassettes had a significantly lower Capute scale than those who did not ($P<0.001$). However, these findings have not yet accounted for effects of other factors.

Table 4.7 Univariate analysis for assessing effects of play materials on Capute scale

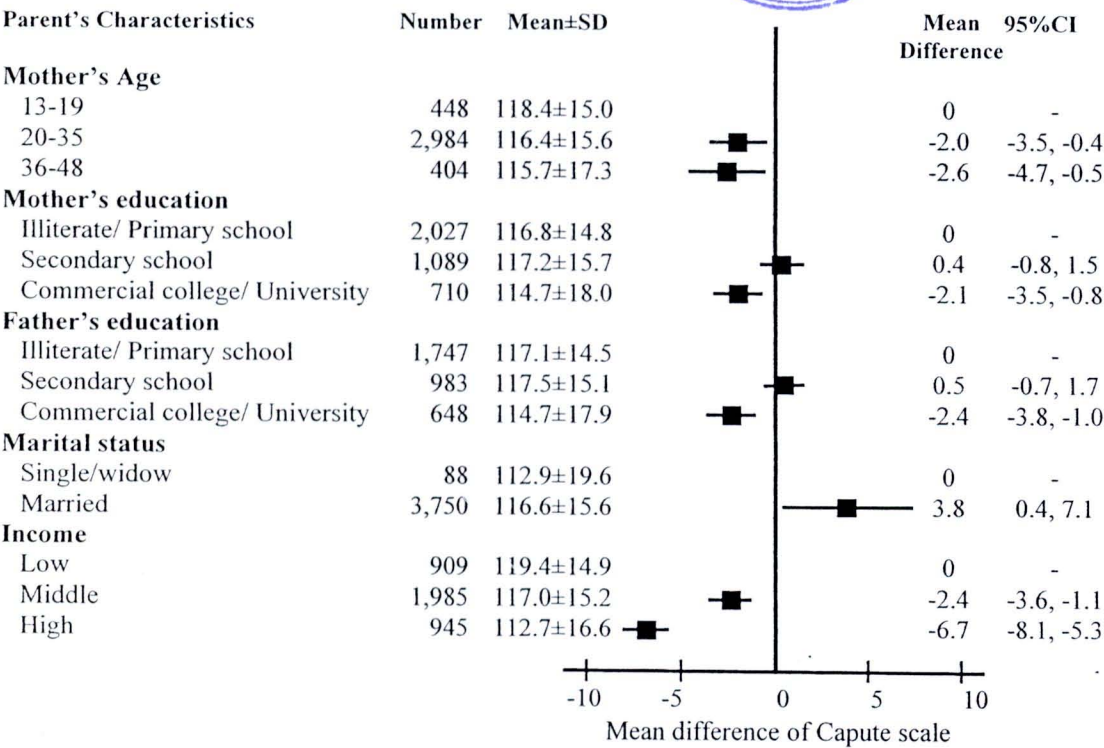| Type of toys	n	Mean	SD	Mean difference	95% CI
Push/pull toys					
Play	2,942	116.9	15.7	2.0	0.8, 3.2
Did not play	920	114.9	15.9	0	-
Home utensil					
Play	2,635	117.9	15.5	2.0	0.8, 3.2
Did not play	850	115.9	16.1	0	-
Sound toys					
Play	2,867	116.6	15.9	0.5	-0.6, 1.7
Did not play	997	116.1	15.1	0	-
Junk materials					
Play	2,466	118.6	15.4	4.1	2.9, 5.2
Did not play	1,033	114.5	16.1	0	-
Dolls and other soft toys					
Play	2,657	117.3	15.9	2.6	1.5, 3.7
Did not play	1,205	114.7	15.2	0	-
Natural materials					
Play	1,730	120.0	14.0	5.1	4.0, 6.1
Did not play	1,729	114.9	16.9	0	-
Story books					
Play	1,258	117.3	15.7	1.1	0.1, 2.2
Did not play	2,603	116.1	15.7	0	-

Table 4.7 Univariate analysis for assessing effects of play materials on Capute scale (cont.)

Type of toys	n	Mean	SD	Mean difference	95% CI
Creative materials					
Play	1,233	120.2	14.9	5.4	4.3, 6.4
Did not play	2,627	114.8	15.8	0	-
Writing materials					
Play	993	118.3	15.5	2.5	1.3, 3.6
Did not play	2,852	115.8	15.7	0	-
Self-invented toys					
Play	409	117.6	14.7	1.2	-0.4, 2.8
Did not play	3,445	116.4	15.8	0	-
Stacking toys					
Play	380	118.2	16.1	1.9	0.3, 3.6
Did not play	3,475	116.3	15.7	0	-
Musical cassettes					
Play	260	110.1	16.7	0	-
Did not play	3,603	116.9	15.6	6.9	4.9, 8.8

Results from univariate analysis revealed that children had significantly higher Capute scale, with a considerably strong effect according to the mean difference of greater than 2 score, if they were born to younger mothers ($P = 0.025$), born to less educated parents ($P = 0.002$) , born to married parents ($P = 0.027$), had low income ($P < 0.001$), were full gestational age ($P = 0.002$), had birth weight of greater than 2,500 grams ($P < 0.001$), had a longer duration of breast feeding ($P < 0.001$), and had never been hospitalized during the second half of their first year of life ($P = 0.003$) (Figure 4.2a and 4.2b). These factors were entered into the final regression model to account for their effects on the relationship between play materials and Capute scale in subsequence analysis.

Parent's Characteristics	Number	Mean±SD		Mean Difference	95%CI
Mother's Age					
13-19	448	118.4±15.0		0	-
20-35	2,984	116.4±15.6		-2.0	-3.5, -0.4
36-48	404	115.7±17.3		-2.6	-4.7, -0.5
Mother's education					
Illiterate/ Primary school	2,027	116.8±14.8		0	-
Secondary school	1,089	117.2±15.7		0.4	-0.8, 1.5
Commercial college/ University	710	114.7±18.0		-2.1	-3.5, -0.8
Father's education					
Illiterate/ Primary school	1,747	117.1±14.5		0	-
Secondary school	983	117.5±15.1		0.5	-0.7, 1.7
Commercial college/ University	648	114.7±17.9		-2.4	-3.8, -1.0
Marital status					
Single/widow	88	112.9±19.6		0	-
Married	3,750	116.6±15.6		3.8	0.4, 7.1
Income					
Low	909	119.4±14.9		0	-
Middle	1,985	117.0±15.2		-2.4	-3.6, -1.1
High	945	112.7±16.6		-6.7	-8.1, -5.3

-10   -5   0   5   10

Mean difference of Capute scale

Figure 4.2a Univariate analysis for assessing effects of parent's factors on Capute scale total score

Children's Characteristics	Number	Mean±SD	Mean Difference	95%CI
Gender				
Boy	1,925	115.4±16.0	0	-
Girl	1,939	117.5±15.4	2.1	1.1, 3.1
Weight				
per 100 gram	3,859		-0.1	-0.1, -0.1
Length				
per 10 cm	3,857		-5.9	-7.4, -4.5
Gestational age				
Preterm (<37)	308	114.1±16.4	0	-
Term	3,248	117.0±15.6	2.9	1.1, 4.8
Birth weight				
Low (<2500)	319	112.9±16.6	0	-
Normal	3,412	117.1±15.5	4.2	2.4, 5.9
Breast feeding (months)				
< 3	759	112.7±17.0	0	-
3-5	562	115.0±16.9	2.3	0.6, 4.0
6+	2,528	118.0±14.8	5.4	4.1, 6.6
Hospital admission				
No	3,472	116.8±15.8	0	-
Yes	390	114.2±15.2	-2.5	-4.2, -0.9
Mother's attachment				
Positive action	3,864		1.9	1.3, 2.5
Negative action	3,864		-2.0	-2.9, -1.1
Family size				
2-3	579	115.5±15.5	0	-
4-5	1,757	116.8±16.0	1.4	-0.1, 2.8
>5	1,526	116.5±15.5	1.0	-0.5, 2.5
Number of sibling				
0	1,653	116.4±16.2	0	-
1	1,422	116.4±15.4	0.0	-1.1, 1.1
2	427	115.9±15.6	-0.5	-2.1, 1.2
3+	320	119.1±14.5	2.7	0.8, 4.5
Iodine consumption				
No	1,790	117.6±14.6	0	-
Yes	2,044	115.7±16.6	-2.0	-3.0, -1.0
Life events				
No event	1,013	117.4±15.4	0	-
No effect	1,129	117.2±16.1	-0.2	-1.5, 1.1
Had effect	1,719	115.5±15.6	-2.0	-3.2, -0.7

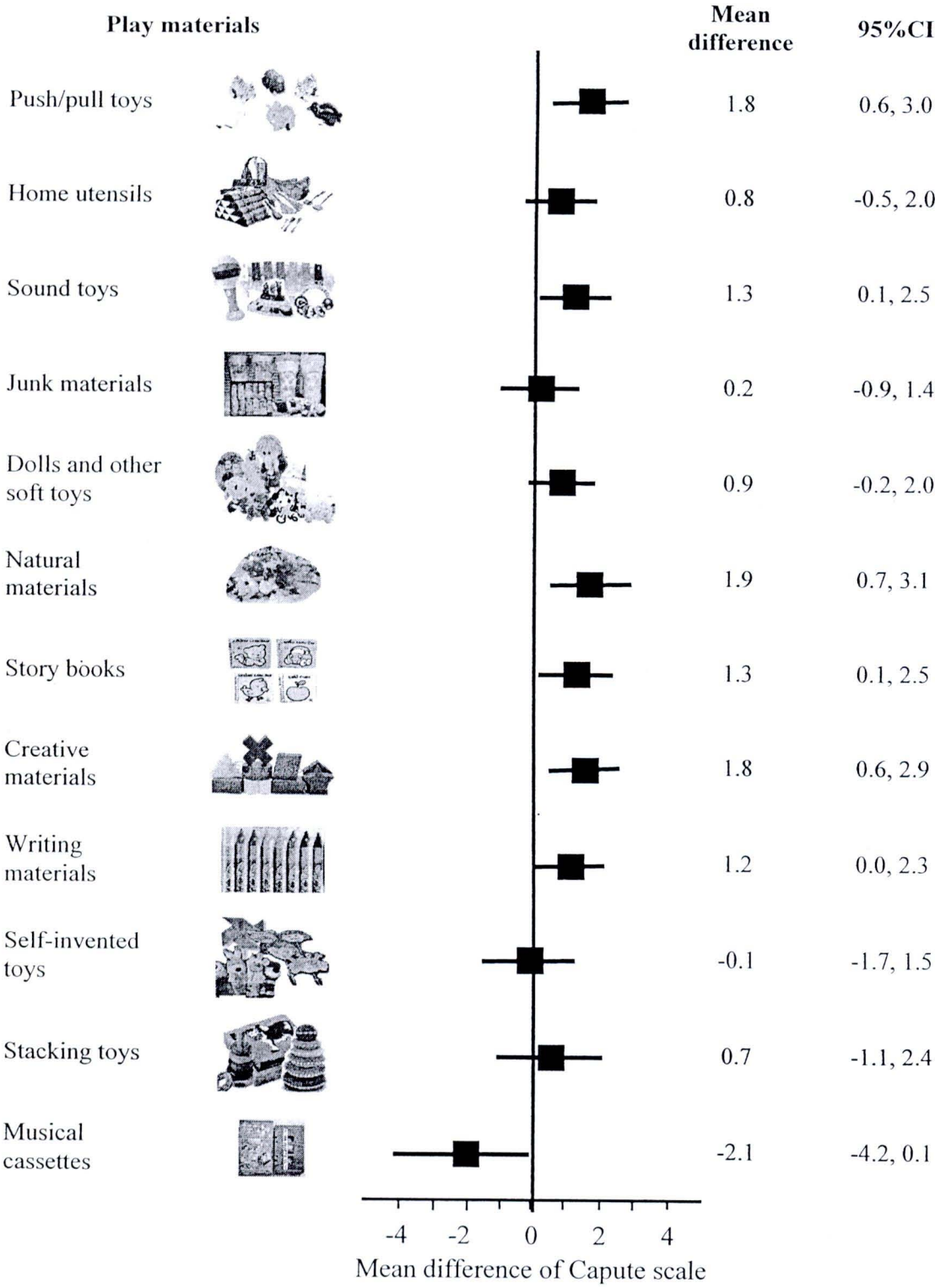Mean difference of Capute scale

(x-axis: -10, -5, 0, 5, 10)

Figure 4.2b Univariate analysis for assessing effects of children's factors on Capute scale total score

Multivariable analysis incorporated the following variables in the final multiple regression model- the 12 types of play materials, study center, parent's factors (i.e., age, education, marital status, and income), children's factors (i.e., sex,

weight, height, gestational age, birth weight, breast fed, hospital admission, mother's attachment, number of member, number of sibling, iodine consumption and life events). There were 5 out of the 12 type of play materials that were significantly associated with Capute scale, namely sound toys ($P < 0.029$), push/pull toys ($P < 0.003$), creative toys ($P < 0.003$), natural materials ($P < 0.002$), and story books ($P < 0.027$) (Figure 4.3). Play materials that had the strongest effect on Capute scale, i.e., children who played had higher score than who did not, was natural materials, with the mean difference of 1.9 (95%CI: 0.7 to 3.1), followed by creative materials (mean difference = 1.8, 95%CI: 0.6 to 2.9), and push/pull toys (mean difference = 1.8, 95%CI: 0.6 to 3.0).
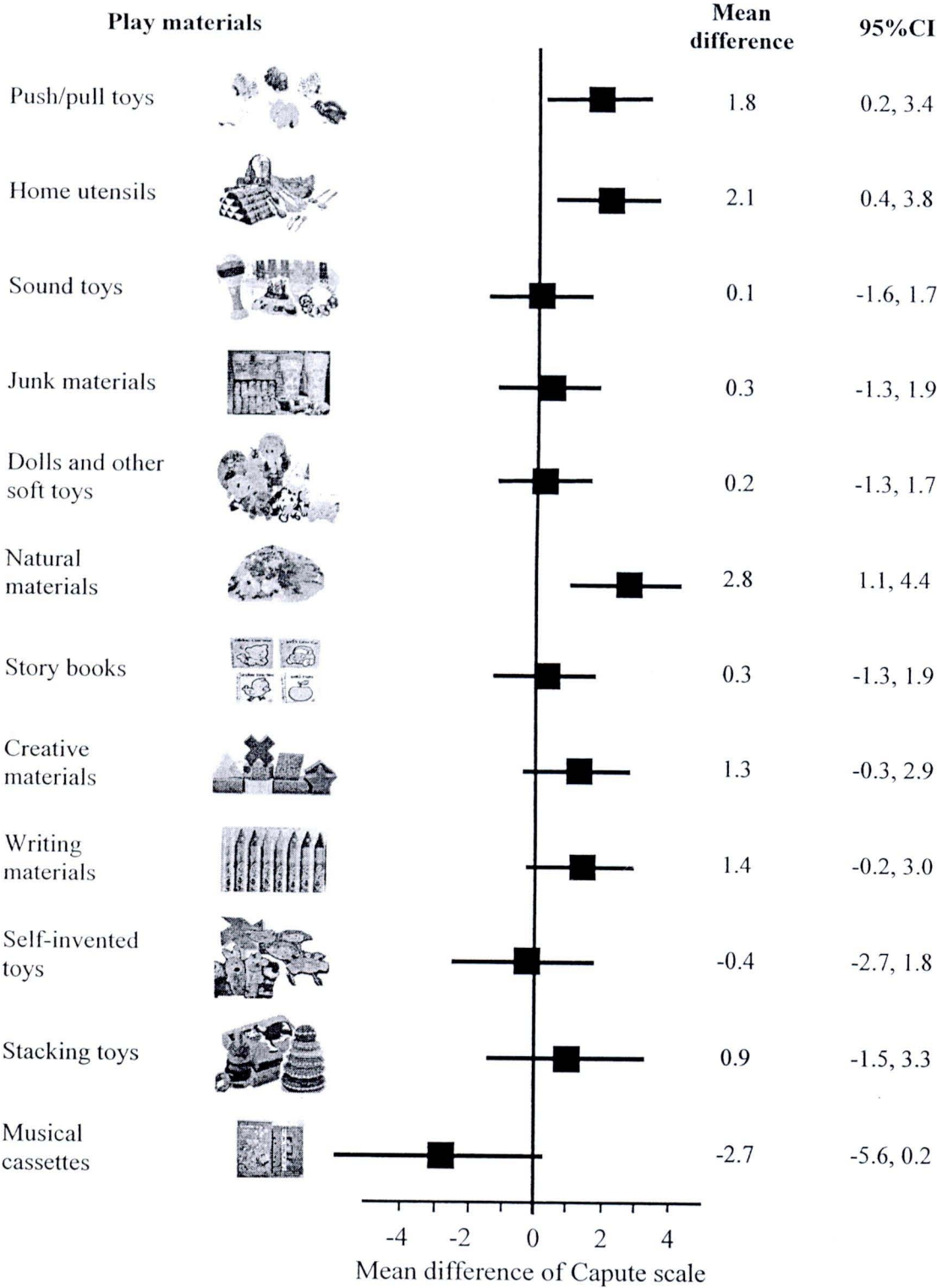
Play materials		Mean difference	95%CI
Push/pull toys		1.8	0.6, 3.0
Home utensils		0.8	-0.5, 2.0
Sound toys		1.3	0.1, 2.5
Junk materials		0.2	-0.9, 1.4
Dolls and other soft toys		0.9	-0.2, 2.0
Natural materials		1.9	0.7, 3.1
Story books		1.3	0.1, 2.5
Creative materials		1.8	0.6, 2.9
Writing materials		1.2	0.0, 2.3
Self-invented toys		-0.1	-1.7, 1.5
Stacking toys		0.7	-1.1, 2.4
Musical cassettes		-2.1	-4.2, 0.1

Mean difference of Capute scale

Figure 4.3 Multiple linear regression assessing effects of type of play materials on Capute scale total score adjusted for effects of study center, mother's age, parent's education, marital status, income, sex, weight, height, gestational age, birth weight, breast fed, hospital admission, mother's attachment, number of member, number of sibling, iodine consumption and life events. (n = 2,641; R^2 = 34.4%)

Following are exploratory analysis using each domain of Capute scale as the study outcome- Cognitive Adaptive Test (CAT) followed by Clinical Linguistic and Auditory Milestone Scales (CLAMS). For each domain, results were presented only the multivariable model. Model building was done the same ways as were fore the Capute scale total score.
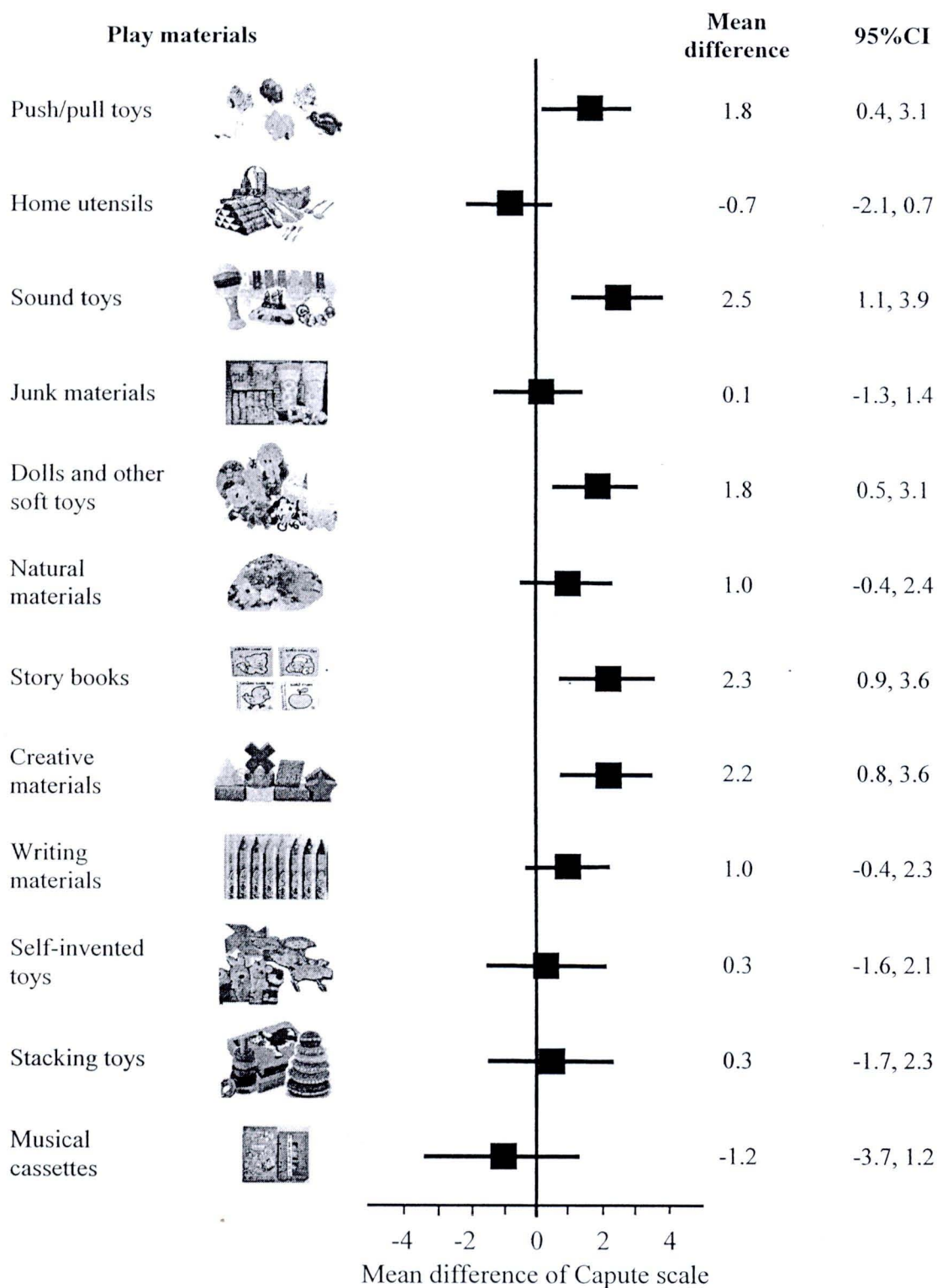
For CAT, there were 3 out of the 12 types of play materials that were significantly associated with it, namely push/pull toys ($P = 0.031$), home utensils ($P = 0.015$), and natural materials ($P = 0.001$) (Figure 4.4). Those play materials had the strongest effect on CAT, i.e., children who played had higher score than who did not, was natural materials, with the mean difference of 2.8 (95%CI: 1.1 to 4.4), followed by home utensils (mean difference = 2.1, 95%CI: 0.4 to 3.8) and push/pull toys (mean difference = 1.8, 95%CI: 0.2 to 3.4).

Play materials		Mean difference	95%CI
Push/pull toys		1.8	0.2, 3.4
Home utensils		2.1	0.4, 3.8
Sound toys		0.1	-1.6, 1.7
Junk materials		0.3	-1.3, 1.9
Dolls and other soft toys		0.2	-1.3, 1.7
Natural materials		2.8	1.1, 4.4
Story books		0.3	-1.3, 1.9
Creative materials		1.3	-0.3, 2.9
Writing materials		1.4	-0.2, 3.0
Self-invented toys		-0.4	-2.7, 1.8
Stacking toys		0.9	-1.5, 3.3
Musical cassettes		-2.7	-5.6, 0.2

Mean difference of Capute scale

Figure 4.4 Multiple linear regression assessing effects of type of play materials on CAT adjusted for effects of study center, mother's age, parent's education, marital status, income, sex, weight, height, gestational age, birth weight, breast fed, hospital admission, mother's attachment, number of member, number of sibling, iodine consumption and life events. (n = 2,663; R^2 = 18.6%)

For CLAMS, there were 5 out of the 12 type of play materials that were significantly associated with this domain, namely push/pull toys ($P = 0.011$), sound toys ($P < 0.001$), dolls and other soft toys ($P = 0.006$), story books ($P = 0.001$) and creative materials ($P = 0.001$) (Figure 4.5). Those five play materials had the strongest effect on CLAMS, i.e., children who played had higher score than who did not, was sound toys, with the mean difference of 2.5 (95%CI: 1.1 to 3.9), followed by story books (mean difference = 2.3, 95%CI: 0.9 to 3.6), creative materials (mean difference = 2.2, 95%CI: 0.8 to 3.6), push/pull toys (mean difference = 1.8, 95%CI: 0.4 to 3.1) and dolls and other soft toys (mean difference = 1.8, 95%CI: 0.5 to 3.1).

Play materials		Mean difference	95%CI
Push/pull toys		1.8	0.4, 3.1
Home utensils		-0.7	-2.1, 0.7
Sound toys		2.5	1.1, 3.9
Junk materials		0.1	-1.3, 1.4
Dolls and other soft toys		1.8	0.5, 3.1
Natural materials		1.0	-0.4, 2.4
Story books		2.3	0.9, 3.6
Creative materials		2.2	0.8, 3.6
Writing materials		1.0	-0.4, 2.3
Self-invented toys		0.3	-1.6, 2.1
Stacking toys		0.3	-1.7, 2.3
Musical cassettes		-1.2	-3.7, 1.2

Mean difference of Capute scale

Figure 4.5 Multiple linear regression assessing effects of type of play materials on CLAMS adjusted for effects of study center, mother's age, parent's education, marital status, income, sex, weight, height, gestational age, birth weight, breast fed, hospital admission, mother's attachment, number of member, number of sibling, iodine consumption and life events. (n = 2,670; R^2 = 39.8%)

4.2.2 Discussions

During the first year of life when nervous system is largely developed, play material is one of stimulation tools for cognitive development of the very young infants. This large cohort study examined roles of play materials on cognitive development according to Capute scale measured when children reached their first year of age. Play materials were based on what were found in their houses under their usual settings and uncontrolled conditions, and categorized into 12 types according to Chase (1994) [10]. Capute scales were measured by trained pediatricians when children visited the hospital according to the planned schedule of the PCTC. Several potential confounders, mostly collected since the children were born, were accounted for their effects on the association between play materials and cognitive development. By these, we found that half of the 12 types of play materials were significantly associated with Capute scale. However, three out of these had the strongest effect on Capute scale, i.e. children who played had approximately two score of the Capute scale higher than who did not. These include natural materials, creative materials, and push/pull toys. The corresponding magnitudes for the remaining two significant play materials were approximately one score of Capute scale.

Natural materials remain strongly associated with CAT but not with CLAMS domain of the Capute scale suggesting that roles of this type of play materials might be more on cognitive skills than in language and communication skills. Likewise, story books, creative materials, and sound toys, are strongly associated with CLAMS but not with CAT domain of the Capute scale suggesting that roles of these type of play materials might be more on language and communication skills than in cognitive skills.

To our best knowledge, this is the first and the largest study that assessed effects of play materials on cognitive development. The study also accounted for the largest number of confounders- about 15 factors plus various types of the play materials. Although most of the confounders were measured at birth, play materials was recorded 2 weeks prior to cognitive development measurements. This is because it is the earliest age that cognitive development can be measured and Capute scale is the only measurement available in Thai language. Play materials found at home one week prior to cognitive development measurements are believed to

be the maximum number of them that are available for children to play. Number of play materials left being counted should be at a minimum.

This study found that push/pull toys, home utensils, and sound toys were the most common materials being played at home. This play behavior conformed to Chase (1994) classification that push/pull toys and music toys are suitable for children 12 months or older [10]. At this age, children walk steadily for short distances, and sway and bounce to music. Home utensils such as bowls, plates, spoons, etc., can be classified as the "fill and dump toys" according to Chase (1994) [10]. This reflects Thai rural ways of life where children were surrounded by these materials. In our opinion, these materials are a good choice of play materials for families with limited resources. However safety is the main issue for these to be used as play materials. Interestingly, based on the three most common play materials, there were about three quarters of the children who played them. This proportion can be viewed as the maximum number of children who play toys. Thus the remaining one quarter of children requires further investigation.

There were 6.8% of children who played the musical cassettes. These groups had lower Capute scale than children who did not play the cassettes. Even after adjusted for effects of many potential confounders, this material still tended to associated with the lower Capute scale although it is not statistically significant. Reason behind this is unclear, hence require further investigations.

Like any observational studies, this study could be affected by biases, in particular, confounding bias. Although we accounted for effects of many factors in our multivariable analysis, there might still be a number of unknown confounders that were not included. Play materials in children's house were observed shortly before the cognitive development was investigated. This might not represent the longer period, e.g., during 6 months before reaching an age of 1 year. There are also many factors within the play material itself that left to be considered, for instance, how the children play, for how long, with whom, etc.