Testing the causal relationship between children’s motor ability and lifestyle: How does life rhythm influence physical activity and motor ability?

Takahiro Ikeda¹ and Osamu Aoyagi²

abstract

Appropriate life rhythm is essential for the healthy development of children. The aim of this study is to examine the relationship between children’s physical activity, life rhythm and motor ability. The sample size of this research are 125 children (61 boys and 64 girls, aged [M ± SD] 4.66 ± 0.29 years old) and their parents. The children's motor abilities were tested in five items. The children’s parents filled out a survey about the children’s life rhythm and physical activity. As a result of exploratory factor analysis, we actually derived “motor ability”, “physical activity”, “morning life rhythm” and ”evening life rhythm”. In these four factors, first, fundamental model which high motor ability influenced to facilitate physical activity were selected. Next, as a result of comparing AIGs, the models were selected, which morning life rhythm, such as early waking time and breakfast time, influenced motor ability and evening life rhythm, such as long hours of sleep and early bedtime, influenced to facilitate physical activity. Finally, we tested the model including ”motor ability”, ”physical activity”, ”morning life rhythm” and ”evening life rhythm”. As a result, the comprehensive model consisting of the four factors indicate a sufficient goodness of fit and have greater accountability than a given criterion (CMIN = 48.990 [df = 41, ns], GFI = 0.928, AGFI = 0.884, CFI = 0.884, RMSEA = 0.040). Though evening life rhythm was no significant relation to physical activity, morning life rhythm influenced motor ability (p < .05) and motor ability affects physical activity (p < .005).

Key words: analysis of covariance structures, exploratory factor analysis, morning life rhythm, motor play, sleeping hours

1 Introduction

Recently, the decline in physical fitness and motor ability of children has become a serious problem (Naito, 2006). Kondo (1995) conducted a comparative study using data on motor abilities of young children in 1973 and 1985. Akimaru (2003) surveyed children at 10-year intervals between 1973 and 1999. They reported decreases in children’s motor abilities to “bear up” and “endure”. Sakai (2004) indicated that young children had less ability to throw. He also explained that a shortage of motor play experiences for young children accounted for their lowered abilities to throw and that opportunity and exposure to active physical play influenced the level of children’s motor abilities. In addition to physical activity, it was suggested that improper eating and sleeping habits also had a negative influence on motor abilities (The Central Council for Education, 2002). Especially in young children, some reports claimed that more than 43.6% of 3-year-old children go to bed after 10:00 pm (Koyama, 2004). Furthermore, delayed bedtime shortens...
hours of sleep (Shimada, 1990). It causes serious health problems which affect growth and development (Inoue, 1999; Noi, 2006).

The Comprehensive Strategy for Improving the Physical Fitness of Young Children (The Central Council for Education, 2002) and Ground Plan for Improving Education for Food (The Cabinet Office, 2006) highlighted the importance of “life rhythm” and promoted eating breakfast, going to bed early and getting up early. Keeping Regular Hours and Lifestyle, is now a national movement (Kageyama et al., 2007, pp.17-27; Koyama, 2007). The idea has been spreading that keeping regular hours promotes children’s physical and mental fitness, which thereby raises their scholastic abilities. This idea is based on the causal relationship between children’s lifestyle and changes in motor abilities.

This study investigates the relationships among children’s physical activity, life rhythm and motor ability. “Life rhythm” is a word synthesized from life and biorhythm; a lifestyle based on biological patterns, such as eating and sleeping (Yoshioka, 2003). In this study, the life rhythm is defined by the time when children get up or go to bed, how long they sleep and when they eat their breakfast (excluding if they do or do not eat breakfast and what they eat for breakfast).

II Hypothesis

1. The relationship between physical activity and motor abilities

Many studies have been conducted on the relationship between physical activity and motor ability in childhood (Kaba and Miyashita, 2003; Minami et al., 1987). About the causality between motor ability and physical activity, Harada (1977) contended that motor play improved motor ability based on the results of examining the physical effects of various exercise loads in motor play. Morishita (1979) also described those children with above average motor abilities tended to engage in very active play. Tokunaga et al. (1982) reported that activity evaluated by a teacher correlated with the motor abilities of boys, and that outdoor play hours contributed to the improvement of motor ability in girls. Similar support is seen in the following statements: "children who liked motor play had excellent motor abilities" (Matsuda et al., 1971), "exercise such as 2 to 4 hours of playing tag or riding a bicycle improved motor abilities" (Matsuura, 1983), "children with better motor abilities were more active and likely to participate in motor play or outdoor play" (Mimura and Kambayashi, 1985), “physical fitness, including motor coordination, were influenced by outdoor play and the amount of exercise” (Ishigo et al., 1987), and “a relationship was found between motor abilities and the quality of motor play” (Seki, 2004). These studies suggested the relationships between motor abilities and motor play, active play, activity and hours of outdoor play. These studies supported the belief that physical activity improved motor ability.

However, Ishigo (1981) advocated that when young children were motivated to participate in motor play and sports during elementary school, they frequently enjoyed motor play and sports. Sugihara (2000, 2003) concurrently stated that self-determination and self-efficacy were caused by internal motivation. Efficacy coupled with excellent motor ability potentiates selection and actual participation in motor play. These studies supported the belief that motor ability improved physical activity.

We developed two hypotheses assuming that motor abilities and physical activity are corollary. Hypothesis 1, “physical activity as cause hypothesis,” states that physical activity is the origin of causality and influences motor abilities. Hypothesis 2, “motor abilities as cause hypothesis,” is that motor abilities affect physical activity. Although it is possible that the two
hypotheses do not necessarily contradict one another, when we comprehensively examine the relationships among physical activity, life rhythm and motor ability, we sought to discover which hypothesis is the more likely of the two.

2. The relationship between life rhythm and motor ability

Koyama (2004) reported that the sleeping habits of 3-year-old Japanese children were worse compared to children from other countries, and that less sleep, late bedtimes and late waking times were serious problems. Maehashi (2006) also reported the problem of late bedtimes and short hours of sleep for 5-year-old children. The negative physical influence on children from lack of sleep related to late bedtimes has also been published (Inoue, 1999; Kageyama et al., 2007, pp.17-45; The Council of Children's Body and Mind, 2004).

First, let us consider the importance of sleep in relation to life rhythm and motor ability. In comparing children who went to bed between 8:00 and 9:00 p.m. and those who went to bed after 9:30 p.m., Harada (1997, 2004) reported that children who had late bedtimes had poorer motor abilities. When considering children's life rhythms, waking time is contingent to some degree, on the commute to kindergarten or nursery school, so later bedtimes result in less sleep (excluding naps). Late bedtimes and less sleep appear to worsen motor abilities. Ryuo et al. (1990), however, claimed that children who had shorter hours of sleep displayed good motor abilities. In that study, alternative options for bedtime were as follows: before 9:00 p.m., 9:00 to 9:30 p.m., 9:30 to 10:00 p.m., and after 10:00 p.m., with an average of 9.8 hours of sleep for 2- to 5-year-old children. Sakagami et al. (1984), compared two groups of children, one with excellent motor abilities (4-year-olds had 10.10 hours of sleep per night and 5-year-olds had 9.96 hours), and concluded that the children with good motor abilities had shorter hours of sleep. These conclusions contrast with Harada's claims (1997, 2004) as mentioned above, that short hours of sleep do not necessarily result from late bedtimes, but might result instead from early waking times. Actually, the short hours of sleep reported by Ryuo et al. (1990) and Sakagami et al. (1984) were not regarded as extremely short. To be sure, too few hours of sleep are problematic, but long hours of sleep are not always desirable. This suggests that there may be a theoretical ideal number of hours of sleep. At the very least, we assume that waking time, bedtime, and hours of sleep have an influence on motor abilities.

3. The relationship between life rhythm and physical activity

Next, let us consider the relationship between life rhythm and physical activity. Sakai (2004) has advocated improving physical activity by establishing a life rhythm. Shigaki et al. (2001) reported that, not eating breakfast and going to bed late the previous night were relevant to physical activity. He compared children who had early bedtimes (9:00 to 10:00 p.m.) with children who had late bedtimes (after 10:00 p.m.) and found that early sleepers had good life rhythms and habits. Shibuya et al. (2002) pointed out that life rhythm deteriorated in children who went to bed late and lacked sleep; these children had a decline in motivation, interest or effort in motor play. Children who got up early were much more active (Ryuo et al., 1990) and those who were exposed to early morning sunshine could sufficiently exercise during the day (Kageyama et al., 2007, p.70). It would appear that waking time and bedtime, as well as the number of hours of sleep, influence physical activity.
III Method

1. Sample

Table 1 shows the number and age of subjects in the S-kindergarten who participated in this study (the children ranged in age from 4 to 5 years). Total sample size was 125 (61 boys and 64 girls) and mean age and standard deviation was 4.66±0.29 years (4.65±0.30 years in boys and 4.66±0.28 years in girls).

2. Questionnaire about children's lives

A questionnaire survey concerning the children's lifestyle was administered to the parents in June 2006. All replies were collected and the recovery rate was 100%. The questionnaire items and response options are shown in Table 2. To survey the regular patterns of daily life, we asked about the normal breakfast time, the waking time for weekdays, the bedtime on school nights, and the average number of hours of sleep. In order to investigate children's play, we asked about three plays which children do frequently from a list of 17 items. The total number of "yes" responses following six items, 1) playground equipment, 3) ball games, 4) bicycle or tricycle, 5) tag or kick-the-can, 6) jumping rope or Chinese jump rope, and 7) taking a walk with their pet, were considered motor play and data was used in later statistical analysis. We surveyed for participation in 7 different kinds of children's lesson. The follow responses : 3) swimming classes, 4) baseball, soccer or rugby classes, 5) gymnastics class, 6) ballet, rhythmic gymnastics or dance class or 7) Kendo, Judo or Karate, were considered as motor lesson and tallied number of "yes" in later statistical analysis.

3. Test of motor abilities

Because this study was conducted on children, motor ability test items were chosen to ensure safety and chosen for reliability, validity and practicability. Special attention has been focused on fundamental motor abilities (Mat-suura and Nakamura, 1977; Nakamura and Mat-suura, 1979) in childhood. The test items were as follows : 25 m run, the tennis ball throw, the standing broad jump and vertical jump. Because motor coordination develops in childhood, we adopted the "jump over and crawl under" test based on the Coordination Test (Kurimoto et al., 1981) developed by the Research Center of Physical Education. However, we revised the jumping over and crawling under a rope task to be repeated 3 times for measurement purposes. Measurement units and methods are shown in Table 3.

4. Statistical analysis

SPSS version 15.0 J and Amos version 7.0 were used for data analysis. First, exploratory factor analysis (Toyoda et al., 1992, pp.138-147) was applied to 6 questionnaire items and 5 motor ability test items, with a total of 11 observed variables, in order to derive factor structure and to examine constructive validity. Factor analysis was performed using principal component analysis for factor derivation and the oblique PROMAX rotation method for rotation. Based on the results of the factor analysis, the factor structure among the latent variables was verified using the model with multiple indicators. The parameters of the model were estimated using the generalized least squares method. Furthermore to select the best model, the evaluation was performed from the standpoint of accountability and stability. Indexes

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Girls</td>
<td>64</td>
</tr>
<tr>
<td>Boys</td>
<td>61</td>
</tr>
<tr>
<td>Total</td>
<td>125</td>
</tr>
</tbody>
</table>

Note. N is sample size.
Table 2 Questionnaire about children’s lives

<table>
<thead>
<tr>
<th>Questionnaire items</th>
<th>Response options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast breakfast time</td>
<td>① 6:00 / ② 6:30 / ③ 7:00 / ④ 7:30 / ⑤ 8:00 / ⑥ 8:30 / ⑦ 9:00</td>
</tr>
<tr>
<td>waking time</td>
<td>① 6:00 / ② 6:30 / ③ 7:00 / ④ 7:30 / ⑤ 8:00 / ⑥ 8:30 / ⑦ 9:00</td>
</tr>
<tr>
<td>Sleep bedtime</td>
<td>① 19:00 / ② 19:30 / ③ 20:00 / ④ 20:30 / ⑤ 21:00 / ⑥ 21:30 / ⑦ 22:00 / ⑧ 23:00</td>
</tr>
</tbody>
</table>

The average hours of sleep

- ① playground equipment
- ② playing in the sands
- ③ ball games
- ④ bicycle or tricycle
- ⑤ tag or kick-the-can
- ⑥ jumping rope or Chinese jump rope
- ⑦ nature game
- ⑧ video game
- ⑨ card game
- ⑩ painting
- ⑪ reading book
- ⑫ blocks
- ⑬ puzzle
- ⑭ toy cars
- ⑮ dolls
- ⑯ watching TV
- ⑰ taking a walk with their pet

Three plays which children do frequently

- ① studying class
- ② music or art
- ③ swimming classes
- ④ baseball, soccer or rugby classes
- ⑤ gymnastics class
- ⑥ ballet, rhythmic gymnastics or dance class
- ⑦ Kendo, Judo or Karate

Table 3 Motor ability test items

<table>
<thead>
<tr>
<th>Test items</th>
<th>Unit</th>
<th>Measurement method</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 m run</td>
<td>1/10 seconds</td>
<td>Two children run 30 m together (elapse time to 25 meters was noted).</td>
</tr>
<tr>
<td>Tennis ball throw</td>
<td>0.5 meters</td>
<td>Distance a tennis ball thrown (overhand throw).</td>
</tr>
<tr>
<td>Standing broad jump</td>
<td>centimeters</td>
<td>Distance of jumping.</td>
</tr>
<tr>
<td>Vertical jump</td>
<td>centimeters</td>
<td>Distance reached when jumping from a standing position.</td>
</tr>
<tr>
<td>Jump over and crawl under</td>
<td>1/10 seconds</td>
<td>Duration of time to jump over and crawl under a 30 cm–high elastic string (3 times).</td>
</tr>
</tbody>
</table>
expressing the fitness of the hypothesized model were $\chi^2$ (CMIN), the Goodness of Fit Index (GFI), the Adjusted Goodness of Fit Index (AGFI), Root Mean Square Error of Approximation (RMSEA) and Comparative fit index (CFI), and the fitness of each index was comprehensively evaluated. Again, a relative comparison among some models was performed using Akaike’s Information Criterion (AIC). AIC can be used to comprehensively, evaluate two or more models and it selects the model with the least AIC criterion as the best model (Toyoda et al., 1992, pp.174–177).

### IV Results and discussion

#### 1. Exploratory factor analysis

To investigate factor structure and construct validity, exploratory factor analysis with oblique PROMAX rotation was performed on 11 observed variables, which included 6 items (e.g., waking time, bedtime, hours of sleep and breakfast time) and 5 motor ability test items (e.g., 25 m run, tennis ball throw, standing broad jump, vertical jump and jump over and crawl under). As a result, 4 factors explaining 65.47% of the total variance were derived. Table 4 shows the factor loading (structure). The first factor was interpreted as a “motor ability” factor because it consisted of 5 motor ability test items. The second factor was named “morning life rhythm” because “waking time” and “breakfast time” showed significant factor loading for this factor and the earlier the “waking time”, the earlier the “breakfast time”. The third factor was composed of “bedtime” and “hours of sleep”, and indicated that the later the bedtime, the shorter the hours of sleep. So, we interpreted this factor as “evening life rhythm”. Finally, the fourth factor was a significant “motor play item” and “sports class”, so we called it the “physical activity” factor. Contrary to our expectation that the cycle of early bedtimes, waking times, and breakfast times and hours of sleep constituted the same life rhythm, exploratory factor analysis identified two different life rhythm factors between morning and evening. As shown in Table 5, the highest correlation among factors was found between “motor ability” and “physical activity” (0.203), followed by “motor ability” and “morning life rhythm” (-0.12). The others were very low and less than |0.1|.

<table>
<thead>
<tr>
<th>Item</th>
<th>F1 Motor ability</th>
<th>F2 Morning life rhythm</th>
<th>F3 Evening life rhythm</th>
<th>F4 Physical activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>x₁</td>
<td>0.811</td>
<td>-0.152</td>
<td>-0.043</td>
<td>0.257</td>
</tr>
<tr>
<td>x₂</td>
<td>0.653</td>
<td>-0.129</td>
<td>-0.155</td>
<td>0.181</td>
</tr>
<tr>
<td>x₃</td>
<td>0.755</td>
<td>0.010</td>
<td>0.046</td>
<td>0.105</td>
</tr>
<tr>
<td>x₄</td>
<td>0.662</td>
<td>0.009</td>
<td>-0.090</td>
<td>-0.011</td>
</tr>
<tr>
<td>x₅</td>
<td>0.713</td>
<td>-0.220</td>
<td>-0.045</td>
<td>0.199</td>
</tr>
<tr>
<td>x₆</td>
<td>-0.139</td>
<td>0.896</td>
<td>0.140</td>
<td>-0.066</td>
</tr>
<tr>
<td>x₇</td>
<td>-0.103</td>
<td>0.908</td>
<td>-0.100</td>
<td>-0.072</td>
</tr>
<tr>
<td>x₈</td>
<td>0.107</td>
<td>0.493</td>
<td>-0.758</td>
<td>-0.091</td>
</tr>
<tr>
<td>x₉</td>
<td>-0.031</td>
<td>0.280</td>
<td>0.855</td>
<td>0.040</td>
</tr>
<tr>
<td>x₁₀</td>
<td>0.280</td>
<td>-0.318</td>
<td>0.025</td>
<td>0.617</td>
</tr>
<tr>
<td>x₁₁</td>
<td>0.059</td>
<td>0.109</td>
<td>0.071</td>
<td>0.829</td>
</tr>
</tbody>
</table>

Eigenvalue | 2.86 | 1.97 | 1.38 | 1.00 |
Percentage [%] | 25.97 | 17.94 | 12.52 | 9.05 |
Cumulative percentage [%] | 25.97 | 43.91 | 56.42 | 65.47 |

*Principal factor analysis and the oblique PROMAX rotation method are used.*
The highest factor of correlation was found between motor abilities and physical activity. This was derived from exploratory factor analysis and we verified the physical activity as cause hypothesis (Hypothesis 1) and the motor abilities as cause hypothesis (Hypothesis 2).

The two models exhibited the same sufficient goodness of fit (CMIN = 7.529, GFI = 0.983, AGFI = 0.963, CFI = 1.000, RMSEA = 0.000, AIC = 37.529). The coefficients of the paths from physical activity to motor abilities and from motor abilities to physical activity were both 0.52, indicating that these factors contributed a great deal to one another. The positive sign of the path coefficients suggested that the better the motor abilities, the higher the level of physical activity.

A statistical comparison of the two path coefficients using a t-test showed that the path in hypothesis 2 was significant at the level of 1% (t = 2.797), but in hypothesis 1 there was no significance (t = 0.930). Although the model which regarded physical activity as a cause and motor abilities as an effect and the model claiming the reverse was sufficiently fit to the same degree. “Motor abilities as cause hypothesis” (Hypothesis 2) showed statistical significance, as shown in Fig. 1.

3. Testing the “morning and evening life rhythm” and “physical activity and motor ability” models

A causal model of life rhythm combining the hypotheses of physical activity and motor abilities is shown in Fig. 2.

Hypothesis 2-1 (#1) is a model that life rhythm affects motor abilities. As the motor abilities influenced life rhythm affects physical activity,
based on fundamental model, there is the series cause-and-effect structure. Hypothesis 2-2 (#2) is a model that life rhythm affects physical activity. Consequently, there is a model that both life rhythm and motor abilities influence to physical activity. Hypothesis 2-3 (#3) life rhythm affects both physical activity and motor abilities.

As exploratory factor analysis derived the two independent factors of morning life rhythm and evening life rhythm, these two life rhythms were added into the three hypotheses. The comparison of the goodness of fit of “morning life rhythm” and “evening life rhythm” within the three models is shown in Table 6.

First, the null hypothesis which states, “that the developed path diagram is right”, was not rejected because the fitness of all models showed high CMIN when morning life rhythm and evening life rhythm were added in. In addition, GFI and AGFI were also greater than 0.9, indicating that these models were fit and had a great deal of accountability.

Next, we compared the AICs in order to choose the optimum model. The AICs of the three models including morning life rhythm were: 53.963 in the Hypothesis 2-1 (#1), 56.131 in the Hypothesis 2-2 (#2) and 55.290 in the Hypothesis 2-3 (#3); therefore the model that life rhythm influences motor ability (#1) could be considered the optimum model. This model shows that getting up and eating in early morning influence to high motor ability levels.

The AICs of the three models including eve-

Table 6 The comparison of the goodness of fit of “morning life rhythm” and “evening life rhythm” within the three models

<table>
<thead>
<tr>
<th></th>
<th>Morning life rhythm</th>
<th></th>
<th></th>
<th>Even evening life rhythm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#1</td>
<td>#2</td>
<td>#3</td>
<td>#1</td>
</tr>
<tr>
<td>df</td>
<td>25</td>
<td>25</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>(p)</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>GFI</td>
<td>0.975</td>
<td>0.971</td>
<td>0.976</td>
<td>0.977</td>
</tr>
<tr>
<td>AGFI</td>
<td>0.955</td>
<td>0.948</td>
<td>0.955</td>
<td>0.959</td>
</tr>
<tr>
<td>CFI</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>RMSEA</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>AIC</td>
<td>53.963</td>
<td>56.131</td>
<td>55.290</td>
<td>52.752</td>
</tr>
</tbody>
</table>

#1: Hypothesis which life rhythm influences the motor ability
#2: Hypothesis which life rhythm influences the physical activity
#3: Hypothesis which life rhythm influences the motor ability and physical activity
ning life rhythm were 52.752 in the Hypothesis 2-1 (#1), 51.378 in the Hypothesis 2-2 (#2) and 52.814 in the Hypothesis 2-3 (#3). These results defined that the model which life rhythm affects physical activity (#2) was the best one. This model shows that going to bed early and long hours of sleep influence to various levels of physical activity.

4. Testing a comprehensive cause-and-effect model

We have examined the contributions of morning life rhythm and evening life rhythm, laying a foundation for testing the cause-and-effect relationship between physical activity and motor ability. Finally, we examined a comprehensive causal model including all factors investigated. Fig. 3 demonstrated the cause-and-effect models of life rhythm, motor ability and physical activity.

For this model, we obtained CMIN = 48.990 [df = 41, ns], GFI = 0.928, AGFI = 0.884, CFI = 0.884, RMSEA = 0.040, indicating a sufficient goodness of fit and having greater accountability than a given criterion. There were significant relations between "motor ability" and "physical activity" and between "morning life rhythm" and "motor ability". However, there was no significant relation between "evening life rhythm" and "physical activity". This result revealed the structure of the cause-and-effect relationship among life rhythm, physical activity and motor ability, postulating to be fundamental model which motor ability affects physical activity. Thus, appropriate morning life rhythm may be required for development of excellent motor ability. While
it is unclear that evening life rhythm is needed for facilitating physical activity.

If we think only morning, relationship between motor ability and physical activity is reinforced by appropriate life rhythm. We estimate that forming the life rhythm facilitates more marked developing motor ability and facilitating physical activity.

V Summary

In order to examine the relationships among physical activity, life rhythm and motor ability, a cause-and-effect model incorporating the three factors was developed and tested and based on the hypothesis that factors were related to one another. The variables observed were 5 motor ability test items administered to 125 young children between 4 to 5 years of age and 6 questionnaire items concerning their lives which were completed by their parents, for 11 variables in total. We applied exploratory factor analysis with oblique PROMAX rotation to the data. Thus, the model with multiple indicators was conducted using the generalized least squares method in order to derive the structure of cause and effect among the factors. From this, we obtained the following results:

1) As a result of exploratory factor analysis, we actually derived motor ability, physical activity, morning life rhythm, and evening life rhythm.

2) As a result of the examination of the cause-and-effect relationship between motor abilities and physical activity, we chose the basal model suggesting that motor abilities had a direct causal relationship on physical activity.

3) We tested the model including morning life rhythm, evening life rhythm, motor ability and physical activity. As a result, the comprehensive model consisting of the four factors indicate a sufficient goodness of fit and have greater accountability than a given criterion.

4) Even morning life rhythm, such as long hours of sleep and early bedtime, was no significant relation to physical activity.

5) However morning life rhythm, such as early waking time and breakfast time, influenced motor ability. And motor ability affects physical activity.

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幼児の生活と運動能力に関する因果モデルの検証
—正しい生活リズムは身体活動や運動能力にどのように影響するのか—

池田 孝博 青柳 領

抄録
正しい生活リズムは、子どもの健全な発育に不可欠である。本論文の目的は、幼児の身体活動と生活リズムおよび運動能力の関係について検討することである。研究対象は、幼児125名（男児61名、女児64名、年齢[M±SD] 4.66±0.29歳）とその保護者である。幼児には5項目の運動能力テストを実施した。また、保護者には、幼児の生活リズムと身体活動に関する調査を実施した。探索的因子分析の結果、「運動能力」「身体活動」「朝の生活リズム」「晩の生活リズム」の4つの因子が抽出された。これらの因子構造は、まず、高い運動能力が身体活動を多くするという基本モデルが選択された。次に、AICで比較した結果、早起きや早い朝食の生活リズムは、運動能力が高くなるに影響を与え、早寝や長い睡眠時間の生活リズムは、身体活動の多さに影響を与えるモデルが選択された。最後に、「運動能力」「身体活動」「朝の生活リズム」「晩の生活リズム」の総合的なモデルを検証した。その結果、4つの因子から構成される総合的なモデルは、十分な説明力（CMIN＝48.990 [df＝41, ns], GFI＝0.928, AGFI＝0.884, CFI＝0.884, RMSEA＝0.040）を満たすことが確認された。晩の生活リズムと身体活動において有意な関連は認められなかったが、運動能力と身体活動（p<0.005）、朝の生活リズムと運動能力（p<0.05）には有意な関連が認められた。

Key words：共分散構造分析、探索的因子分析、朝の生活リズム、運動遊び、睡眠時間