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Original article

Manipulative skill competency and health-related physical fitness in elementary school students

Weiyun Chen *, Steve Mason, Austin Hammond-Bennett, Sandy Zalmout

School of Kinesiology, University of Michigan, Ann Arbor, MI 48109, USA

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Abstract

Background: Improving motor skill competency and enhancing health-related physical fitness are desired learning outcomes for school-aged children. Achieving motor skill competency and a healthy level of physical fitness lay a foundation for being a physically active person across a lifetime. The purpose of this study was to investigate relationships between levels of manipulative skill competency and physical fitness for elementary school boys and girls.

Methods: In this study, 565 fourth-grade students and their 9 physical education teachers were voluntary participants. The students were assessed in 4 basic specialized manipulative skills and 4 fitness components during regular physical education lessons. Data were analyzed with descriptive statistics, univariate analyses, and multiple R^2 liner regression methods.

Results: Boys were more proficient at the manipulative skills than girls, while girls had significant higher percentages for meeting the healthy fitness zone for the fitness tests than boys. Four manipulative skills significantly predicted progressive aerobic cardiovascular endurance run (PACER), push-up, and trunk lifts tests at $p < 0.05$ level, but not curl-up test for both boys and girls. Boys and girls in the skill-competent group significantly outperformed their counterparts in the skill-incompetent group on PACER, push-up, and trunk lifts tests at $p < 0.05$ level, with an exception of curl-up test.

Conclusion: The more competent in manipulative skills, the higher healthy level in cardiovascular endurance, upper-body muscular strength and endurance, and flexibility the students demonstrated. Demonstrating manipulative skill competence and maintaining a healthy level of physical fitness are 2 major desired learning outcomes for elementary school students to be able to achieve.

Keywords: Fitness assessment; Healthy fitness zone; Manipulative skill competency; Physical fitness; Skill assessment

1. Introduction

Improving motor skill competency and enhancing health-related physical fitness are desired learning outcomes for school-aged children to achieve.[1] Children who are skillfully competent and physically fit are more likely to be active persons compared to their counterparts who are less skillful and unfit.[2–8] Demonstrating motor skill competency and achieving a health-enhancing level of physical fitness are cornerstones for developing a physically active lifestyle throughout childhood and adolescence, and into adulthood.[2–17]

National Standard 1 for K-12 Physical Education (PE) defines that students should "demonstrate competency in motor skills and movement patterns".[1] According to the outcome expectation for grades 3–5, students' achieving the Standard 1 implies to demonstrate mature forms of fundamental motor skills, to combine one skill with another, and to apply the skills in dynamic situations.[1] The fundamental motor skills, consisting of locomotor skills, manipulative skills, and non-manipulative skills, are building blocks for successful participation in many sports and various physical activities (PAs).[1–8] Empirical studies showed that children with adequate motor skill competency spent significantly more time in moderate-to-vigorous PA than children with insufficient motor skill competency.[15–18] Especially, childhood manipulative skill proficiency was associated with adolescents' participation in a variety of PA and organized

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* Corresponding author.

E-mail address: chenwy@umich.edu (W. Chen).

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sports and also significantly predicted their cardiovascular fitness in adolescence.[7,8] However, given a lack of performance-based motor skill assessment tools in previous studies,[2–8,15–18] motor skill competency was evaluated either using product-oriented criteria with a combined product score or merely process-oriented criteria with "yes" or "no" rating scale. To fill the gaps in motor skill assessments, the National Association for Sport and Physical Education (NASPE) published *PE Metrics*: *Assessing the National Standard 1: Elementary*,[19] as a result of conducting 4 years of extensive testing with 4000 students at 90 schools in the US. The PE metrics assessment rubrics are specifically designed to assess levels of students' competency in fundamental motor skills using both process- and product-oriented criteria.[19]

Likewise, maintaining and enhancing health-related physical fitness, including cardiovascular endurance, muscular strength and endurance, flexibility, and body composition, lays a foundation for participating in a variety of sports and PA.[1–14] A healthy level of physical fitness is a key indicator of health status.[9–14] Students who demonstrated healthy cardiovascular endurance level had a lower level of overall adiposity and abdominal adiposity[9] and low metabolic risk.[11] It is shown that muscular strength/endurance was associated with established and emerging cardiovascular disease risk factors.[9–11] Improvements in muscular fitness seem to have a positive effect on skeletal health.[9] Healthy physical fitness in children and adolescents tend to track healthy fitness in adulthood.[9–13] Given the essential role of physical fitness in maintaining health, schools should conduct physical fitness testing to determine how well students meet the National Standard 4: Achieves and Maintains a Health-enhancing Level of Physical Fitness.[1] Recently, the FITNESSGRAM® test has been used to assess students' levels of physical fitness.[2–8] It is a nationally recognized, valid, and reliable fitness assessment toolkit specifically designed for assessing cardiovascular endurance, muscular strength and endurance, flexibility, and body composition through a variety of test items.[20] The FITNESSGRAM®[7] test compares the testing scores to the healthy fitness zone (HFZ) standards based on specific age and gender guidelines to evaluate boys' and girls' physical fitness levels on each test and suggest areas for improvement.[20]

Despite that manipulative skills are central to a variety of sports and PA and manipulative skill competency contributed significantly more to children' participation in sports and PA than locomotor skill competency,[2–7] few studies had ever assessed elementary school students' both process and product of performance in manipulative skills using the PE metrics assessments rubrics.[19] Therefore, the impact of manipulative skill competency assessed with both process- and product-oriented criteria on healthy levels of physical fitness in elementary school students remains largely unknown. Thus, this study aimed at examining relationships between levels of manipulative skill competency and levels of health-related physical fitness in elementary school boys and girls. This study will provide empirical insight about what specific manipulative skills contribute to what specific health-related fitness components for boys and girls.

2. Methods

2.1. Participants

Five hundred and sixty-five fourth-grade students and their 9 PE teachers from 9 elementary schools located in a suburban area in the US were recruited as subjects from the third year of the *Healthy Kids and Smart Kids* project. The project was designed to help elementary school students become physically active, mentally healthy, and socially cooperative children through implementing the Coordinated Approach to Child Health (CATCH) PE curriculum and Mileage Club (MC) Recess Program as well as family/community events.[21–23] The project was awarded Carol White Physical Education Program (PEP) grant by U.S. Department of Education.

In this study, the fourth-grade students consisted of 318 of boys and 247 of girls aged 9–10 years old who completed all tests. The social-economic status of the students' family ranged from lower-middle, middle, to upper-middle classes. The fourth-grade students had one 60-min co-ed PE class each week, a total of 72 weeks during an academic year. The regular PE class size ranged from 18 to 28 students. Students with learning disabilities participated in a special education class which was not included in this study. Four male and 5 female PE teachers' ages ranged from 33 to 55 years old and their teaching experience varied from 6 to 26 years. The University of Michigan Health Sciences and Behavioral Sciences Institutional Review Board (IRB-HSBS) and the school district granted the permission for conducting this study. The student's parent/guardian signed the consent form to grant the permission for their child to participate in this study. All 9 PE teachers signed the consent form to indicate their willingness to participate in this study.

2.2. Data collection

2.2.1. Motor skill measurements

Students' performance in 4 manipulative skills was assessed with validated PE metrics assessment rubrics[19] by their PE teachers who underwent 3 days of training in PE Metrics. Each assessment rubric has its specific essential dimensions, performance indicators (assessment criteria for each level of the rating scale) on 0–4 rating scales, and the number of trial for testing.[19] Table 1 presents the criteria for competence (Level 3) on each essential dimension and the total competent score on each skill assessment described in the PE metrics. To learn more detailed information about each skill assessment, please refer to the PE metrics.[19]

Four manipulative skills selected from the PE metrics[19] and assessed in this study were soccer dribbling, passing, and receiving skills, overhand throwing skill, striking skill with a paddle, and basketball dribbling, passing, and receiving skills. The rationales for assessing the 4 manipulative skills are that they are the core PE content taught to upper-elementary school students and they are basic manipulative skills used playing a variety of team- and individual-sports by upper-elementary school students.[1]

Throughout the academic year of 2011–2012, the soccer skills were assessed in the first week of October, the throwing