Energy Expenditure of Sport Stacking

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Abstract

Sport stacking is an activity taught in many physical education programs. The activity, although very popular, has been studied minimally, and the energy expenditure for sport stacking is unknown. Therefore, the purposes of this study were to determine the energy expenditure of sport stacking in elementary school children and to compare that value to the energy expenditures of other activities often included in physical education curricula. Twenty-five children (mean age = 11 ± 1.6 years, 17 boys, 8 girls) had their expired gases analyzed via a metabolic cart for a 5-minute standing period to establish a baseline reading and for a 5-minute period while they were sport stacking. Energy expenditure was calculated as metabolic equivalents (METs). Repeated measures ANOVA was used to compare the mean METs between standing and stacking and between sex. Mean standing and stacking energy expenditures were significantly different. No significant differences were noted for mean energy expenditure by sex. The mean energy expenditure for sport stacking in elementary school children was 3.1 METs. The MET value for sport stacking is similar to other activities involved in typical physical education courses (e.g., bowling, dance, volleyball, weight lifting).

Physical educators incorporate a variety of activities into their curricula each year to enhance their students' physical development (Kelly & Melograno, 2004). One popular, yet sometimes controversial, activity that is being included in the physical education curriculum is sport stacking (Baumgarten, 2004; Murray & Udermann, 2004; Udermann & Murray, 2006). Sport stacking (previously referred to as cup stacking) originated some 20 years ago and has evolved into a worldwide sport, complete with its own governing body: The World Sport Stacking Association (www.worldsportstackingassociation.org).

Sport stacking has been purported to "result in many direct and indirect benefits" (Hart, Smith, & DeChant-Bruennig, 2006, p. 154). However, the benefits that have been shown to occur through empirical studies are hand-eye coordination (Udermann, Murray, Mayer, & Sagendorf, 2004), reaction time (Udermann et al., 2004; Gibbons, E., Hendrick, J.L., & Bauer, J., 2007; Liggins, Coleman, Solis, & Li, 2007), bilateral coordination (Rhea, Ludwig, & Mokha, 2006), and dualhemispheric brain activity (Hart & Bixby, 2005).

The improvement in hand-eye coordination seems to be related to the time involved in sport stacking. Udermann et al. (2004) found that significant improvements occurred in hand-eye coordination and reaction time when secondgraders participated in sport stacking for 20-30 minutes per day, four days per week, over a fiveweek period. Hart et al. (2006) found conflicting results, where no significant improvements were noted for hand-eye coordination in elementary school children after a three-week instructional unit on sport stacking. It must be noted, however, that Hart et al.'s participants only sport stacked for 10- 15 minutes on each day and that different tests were used to measure hand-eye coordination. Liggins et al. (2007) found that a 12-week sport stacking program that had elementary school children stack cups for 15 minutes daily improved the students' reaction time. As a result, the authors stated, "Cup stacking may be a valuable component of the elementary school physical education curriculum."

The National Association for Sport and Physical Education (NASPE) stated that one of the major purposes of physical education is to develop movement competency and proficiency in students (NASPE, 1995). NASPE defines movement competency as "the development of

sufficient ability to enjoy participation in physical activities and establishes a foundation to facilitate continued motor skill acquisition and increased ability to engage in appropriate motor patterns in daily physical activity" (p. 2). Despite the growing list of research that indicates sport stacking is effective at enhancing key, skill-related components of physical fitness, i.e., hand-eye coordination and reaction time, for developing movement competency, especially objectmanipulation skills, many physical educators still are reluctant to accept the activity. The common reason cited for this reluctance is that sport stacking has "insufficient physical exertion, regardless of whatever other benefits [it] might accrue" (Stork, 2006, p. 4). So, the logical conclusion was to measure the precise amount of "physical exertion" required for one to sport stack and then compare that value to accepted activities that are often included in physical education curricula.

Energy expenditure is standardized by reporting it as a metabolic equivalent (MET). A MET is defined as follows:

MET (Metabolic Equivalent): The ratio of the work metabolic rate to the resting metabolic rate. One MET is defined as 1 kcal/kg/hour and is roughly equivalent to the energy cost of sitting quietly. A MET also is defined as oxygen uptake in ml/kg/min with one MET equal to the oxygen cost of sitting quietly, equivalent to 3.5 ml/kg/min. (The Compendium of Physical Activity, n.d.)

It is important to understand that "multiples of 1 MET indicate a higher energy cost for a specific activity. For example, a 2 MET activity requires twice the energy cost of sitting quietly. A 3 MET activity requires three times the energy cost of sitting quietly, and so forth" (President's Council on Physical Fitness and Sports, 2003, p. 2). Moreover, the energy expenditure for numerous activities is known and reported in METs. The American College of Sports Medicine and the American Heart Association define exercise intensity with respect to METs as follows: light as < 3.0 METs; moderate as 3.0 to 6.0 METs; and vigorous as > 6.0 METs (Haskell, 2007). The purposes of our study were to measure the energy expenditure for sport stacking (in METs) and to compare that value to the METs of other activities often included in physical education curricula.

Methods

Participants Twenty-five children (mean age = 11 ± 1.6 years, 17 boys, 8 girls) participated in our study. The participants reported to the laboratory, were informed of the procedures, and signed consent forms (N.B., parental consent also was obtained for each participant). All procedures and forms were reviewed and approved by the sponsoring university's Institutional Review Board for the protection of human subjects.

Procedures Once the participants were informed of the testing procedures and signed, consent forms were secured, each participant was fitted with a standard head gear and mouthpiece to collect expired gases via a metabolic cart (AEI Technologies). After standing stationary for 5 minutes for baseline readings to be measured, the participant then sport stacked for 5 minutes, performing as many 3-6-3 stacks as possible (Note: the 3-6-3 stack is a fundamental pyramid used in sport stacking; it is described in the World Sport Stacking Rule Book as follows: "Cups are "upstacked" and "down stacked" from left to right or right to left (individual preference) in three stacks made up of three cups on the left, six cups in the center, and three cups on the right (3-6-3)." Each participant was required to complete a 3-6-3 stack in less than 8 seconds in order to be included in the study. The 8-second criterion was used to establish competency in the skill; an outstanding time for the 3-6-3 stack would be 3-4 seconds, and a complete novice time would he 10-12 seconds; thus a time of 8 seconds is of modest competency. Descriptive statistics were used to summarize the mean

and variability of the energy expenditure while standing and stacking for each subgroup. Repeated measures ANOVA was used to compare the mean energy expenditures between standing and stacking and between sex.

Results

The energy expenditure for sport stacking in elementary school children was 10.7 ± 2.2 ml/kg/ min or 3.1 ± 0.05 METs (see Table 1), classifying sport stacking as a moderate-intensity activity. No significant differences were noted in energy expenditure between the boys (6.5 ± 1.0 ml/kg/ min or 1.9 ± 0.3 METs) and the girls (5.8 ± 1.3 ml/kg/min or 1.6 ± 0.4 METs) while standing or while stacking (boys, 10.75 ± 1.78 ml/kg/min or 3.19 ± 0.51 METs; girls, 10.0 ± 2.4 ml/kg/min or 2.9 ± 0.5 METs). Overall, the mean energy expenditure for both the boys and the girls while standing was 6.3 ± 1.1 ml/kg/min or 1.8 ± 0.3 METs. Statistically significant differences were noted between the mean standing and stacking values for both the boys and the girls for intragroup values. The energy expenditure of sport stacking is similar to other activities taught in the physical education curriculum, e.g., bowling, dance, volleyball, weight lifting (see Table 2).

Discussion

Although many physical educators are reluctant to incorporate sport stacking into their curricula because of "insufficient physical exertion" (Stork, 2006, p. 4), our results indicate that sport stacking may be used as another form of a moderate-intensity activity. This, in conjunction with the previously found improvements in reaction time and hand-eye coordination (Udermann et at., 2004; Gibbons et at., 2007), suggests sport stacking would be a good activity to be taught in the physical education curriculum.

One purpose of our study was to ascertain the energy expenditure of sport stacking. Our results show that sport stacking has an energy expenditure of 3.1 METs in elementary school children. This value is comparable to energy expenditure of other activities (see Table 2) that are suggested activities to be taught in physical education curricula across the nation (Kelly & Melograno, 2004).

To be consistent with the quoted opinion expressed by Stork (2006) concerning sport stacking and physical exertion, those similar, moderateintensity activities (e.g., bowling, dance, volleyball, weight lifting) would have to be prohibited from inclusion in the physical education curricula because of "insufficient physical exertion." We, however, respectfully disagree with that opinion. We believe that many activities can help to promote children in movement competency, and we are in agreement with Kelly and Melograno (2004) who state:

Given the changing needs of learners, a wide variety of activities offers an opportunity to facilitate growth. Exposure to various activities enhances self-testing, exploration, and new interests. (p. 58)

While it is true that physical exertion is important for the development of cardiorespiratory endurance-one of the key components of physical fitness and wellness (Murray, 2007)-it is not the sole criterion by which an activity should be judged. Skill-related components, i.e., agility, balance, coordination, power, reaction time, and speed (Murray, 2007) also are of importance. So, in light of the findings in our study that illustrate sport stacking has a moderate intensity level (i.e., 3.1 METs), we suggest that one should couple these findings with the fact that sport stacking is a unique activity-perhaps with the ability of enhancing student participation - that has been shown to improve elementary children's skill-related

fitness components, particularly reaction time and hand-eye coordination. Thus, working sport stacking into the physical education curriculum can result in elementary school children engaging in moderate-intensity physical activity as well as potentially improving their skill-relate fitness components.

Table 1.

Energy Expenditure while Standing and Sport Stacking for Boys and Girls (Mean ± SD)

	Energy Expenditure Standing		**Energy Expenditure Sport Stacking**	
	ml/kg/min	**METs**	**ml/kg/min**	**METs**
Boys	6.5 ± 1.0	1.9 ± 0.3	11.1 ± 1.8*	3.2 ± 0.5*
Girls	5.8 ± 1.3	1.6 ± 0.4	10.0 ± 2.4*	2.9 ± 0.5*
Both	6.3 ± 1.1	1.8 ± 0.3	10.7 ± 2.2*	3.1 ± 0.5*

* denotes statistically significant difference between standing and stacking values ($p < 0.0005$)
Note: No statistically significant differences were noted between boys and girls for any values.

Table 2.

Metabolic Equivalents (METs) of Various Activities Often Found in the Physical Education Curriculum

METs	**Activity**
3.0	bicycling, stationary, 50 watts, very light effort
3.0	weight lifting (free, nautilus or universal-type), light or moderate effort
3.0	dancing, slow (e.g., waltz, foxtrot, slow dancing)
3.0	bowling
3.0	frisbee, ultimate
3.0	golf, miniature, driving range
3.0	shuffleboard, lawn bowling
3.0	volleyball, non-competitive, 6-9 member team, general
3.3	walking, 3.0 mph, level, moderate pace, firm surface
3.3	canoeing, rowing, 2.0-3.9 mph, light effort
3.0	diving, springboard or platform
3.0	sailing, Sunfish/Laser/Hobby Cat, Keel boats, ocean sailing, yachting
3.0	water volleyball

Note: All data taken from The Compendium of Physical Activity. (n.d.). Retrieved February 14, 2008 from The University of South Carolina's Web site: h://prevention.sph.sc.edtools/compendium.htm.

Sport stacking can be an excellent "instant activity" to get students moving and ready to begin a physical education class. For instance, sport stacking can be used for students who have arrived early and want to simply get moving and be active. Second, sport stacking can be worked into a number of other activities. Physical educators can set up stations involving sport stacking and other, more vigorous activities, like rope jumping and have students spend specific amounts of time at each station, and rotate at certain intervals. These are but two, of many possible, examples of how sport stacking could be included into the physical education curriculum; we are confident in the creativity of many physical educators to find meaningful ways of successfully interweaving sport stacking into their respective curricula to enhance their students' movement competency.

In the end, we believe that sport stacking can improve key skills that help with future object manipulation, and the skills can be developed in conjunction with other activities to develop overall physical fitness and movement competency. Moreover, we believe that sport stacking can be an excellent activity to use in a conceptual model of physical education. The conceptual model involves working on specific "concepts," hence the name, and "[i]t is expected... [to] transfer to new skills and situations" (Kelly & Melograno, 2004, p. 61). What is not known, however, is if sport stacking has a carry-over effect for increased reaction time or hand-eye coordination applicable to other activities?

Future studies should examine the carry-over effect of sport stacking on other activities.

In conclusion, the results of our study show that sport stacking has a similar energy expenditure as other activities that are commonly taught in physical education courses today (Kelly & Melograno, 2004). If one couples this finding with the fact that past research has shown sport stacking to be effective in enhancing key skills such as hand-eye coordination and reaction time for developing movement competency, especially object-manipulation skills, it is our belief that sport stacking can be a valuable component of the physical education curriculum.

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