Original Article

Step count and MVPA compendium for middle school physical education activities

TIMOTHY A. BRUSSEAU¹, RYAN D. BURNS²

^{1,2} Department of Exercise and Sport Science, University of Utah, USA

Published online: December 26, 2015

(Accepted for publication October 10, 2015)

DOI:10.7752/jpes.2015.04098

Abstract:

It has been suggested that school physical education (PE) is an ideal setting for promoting physical activity in youth. The purpose of the study was to determine the expected values across units taught during a year of daily middle school PE. Participants included 232 students (Mean age=13.3±0.4 years) from grades 7-8. Lessons included sport skills, games, and fitness. Step counts and MVPA were monitored across 132 days incorporating 792 PE lessons with the NL-1000 pedometer. Means were calculated for step counts and MVPA as well as steps/minutes and percent time in MVPA. Fitness activities and large space invasion games represented the greatest physical activity opportunities. Net-wall games led to the least amount of activity. This compendium is intended to be used as a framework for researchers and practitioners interested in evaluating physical activity in PE classes.

Key words: - exercise; fitness; pediatrics; physical activity; physical fitness; sport

Introduction

The health benefits associated with physical activity (PA) for children and youth are well documented (Janssen & LeBlanc, 2010). As a result it is recommended that youth accumulate 60 minutes of moderate-to-vigorous PA (MVPA) each day (United States Department of Health and Human Services, 2008) with at least 30 minutes of that being accumulated at school (Institute of Medicine, 2013).

Daily PA has been shown to provide numerous benefits in children (Hills, Anderson & Byrne, 2011), yet the majority of the school day is spent in sedentary behaviors. PE provides a vehicle to obtain optimal levels of MVPA during school in children and adolescents, however less than 8% of public middle schools in the U.S. offer daily PE (Lee, Burgeson, Fulton, & Spain, 2007). Ideally, middle school youth will spend 50% of class time in MVPA (Centers for Disease Control and Prevention, 2009) or accumulate at least 82 steps/minute (Scruggs, 2013). For numerous reasons, few students actually meet these recommended levels (Nader, 2003).

Over the past decade the pedometer has become a very popular instrument for surveilling PA patterns in youth (i.e. Brusseau & Hannon, 2013; Matthews, O'Neil, & Kostelis, 2014), as well as for evaluating interventions (i.e. Burns, Brusseau, & Hannon, 2015) because of their low cost and ease of use. Furthermore, many PE practitioners utilize pedometers as a tool for feedback and assessment during classes (Darst, Pangrazi, Brusseau, & Erwin, 2015). In fact, pedometers have been highlighted as a means of promoting PA in PE (Morgan, Pangrazi, & Beighle, 2003) and entire activity guides have been written around pedometer activities (Pangrazi, Beighle, & Sidman, 2003). Unfortunately, little evidence exists highlighting expected values that are being accumulated during PE lessons. To our knowledge only one study (Hannon & Ratliff, 2005) presented steps/minute for three (soccer, flag football, and Frisbee games) activities during high school PE classes. Therefore, the purpose of this manuscript was to establish expected step count and MVPA values for a variety of activities that are traditionally taught during middle school PE.

Material & methods

Participants and Setting

Data were collected on a convenience sample of 232 seventh and eighth grade students (61% Non-Hispanic Caucasian, 39% ethnic minority) from six PE classes (792 total lessons observed) recruited from one public middle-school located in a large metropolitan area in the Southwestern U.S.A. There were 88 girls and 144 boys who participated and the mean age of the sample was 13.3 ± 0.4 years. Written assent was obtained from the students and written consent was obtained from the parents prior to data collection. The University Institutional Review Board and school district approved the protocols used in this study.

Instrumentation

Each student's PA was monitored using NL-1000 piezoelectric pedometers (New Lifestyles Inc., Lee's Summit, MO, USA). The NL-1000 model recorded total number of steps and time (in minutes) of MVPA for the entirety of each PE lesson and has been previously validated for use in a pediatric population (Hart, Brusseau, Kulinna, McClain, & Tudor-Locke, 2011).

Procedures

All data collection took place over an entire school year and involved a total of 132 PE lessons. Each PE lesson was approximately 40 minutes in duration after excluding transition times for changing in and out of gym uniforms. PE was held 5 days a week (Monday through Friday). The curriculum involved a combination of motor skill games and health-related fitness activities. Units ranged in length but were typically 1–3 weeks long and were taught in both indoor and outdoor environments. Skill focused lessons included a warm-up, skill development through individual and small group static practice and small-sided skill games. Game days consisted primarily of a warm-up activity and multiple game playing opportunities. Fitness activities included circuit training, aerobic exercise activities, and flexibility training. Classes averaged 40 students and were designed to maximize participation by avoiding lines and sitting out. A state and regional middle school teacher of the year taught all PE lessons.

Students put on the NL-1000 pedometer immediately after changing for PE class. Students were assigned an identification number that matched a corresponding identifier located on each pedometer. The pedometers were worn on the right side of the body at waist level on the superior boarder of the iliac crest above the right knee. Before each PE lesson, pedometers were checked to ensure a reading of zero and randomly calibrated using the "shake test" to ensure accurate measurement of step counts. At the end of each PE class, the students returned the pedometers to the researcher.

Data Analysis

Descriptive analysis consisted of mean step counts, and minutes in MVPA as well as average steps per minute (total steps/minutes of PE) and percent time in MVPA (total MVPA minutes/40 minutes of PE). Steps per minute and percent time in MVPA were added as variables for ease of transferability as many PE lessons range in time from 30-120 minutes.

Data Organization

Data are presented by activity type utilizing categories (Mitchell, Oslin, & Griffin, 2013), Invasion, Net/Wall, Target, & Striking/Fielding. Invasion games include most common team sports (i.e. basketball, soccer, football, etc.). Net or Wall games include volleyball, tennis, badminton, etc. Striking and Fielding games include the games of baseball, softball, kickball and other similar in nature. Target games include games that require great accuracy including golf, archery, bowling, etc. Not all PE activities could be properly classified into these categories so two additional categories were developed. "Other games" was utilized as a catch all for activities that did not fit clearly into one of the four above categories. Lastly, fitness was a stand-alone category that included lessons that had a specific focus on either health-related or skill-related fitness. We anticipate that future efforts to expand on this initial compendium will result in greater breadth and specificity of categories.

Results

Table I provides descriptive information for the total sample using calculated means and standard deviations across all activities. Table II provides the step counts, minutes of MVPA, steps per minute and percent of class time in MVPA for each of the 19 games played during the year in addition to the various fitness-related activities.

Table 1. Descriptive statistics for the total sample and within sex groups.

	Total (N = 232)		Girls (n = 88)		Boys (n = 144)	
	mean	s	mean	s	mean	s
Height (m)	1.6	.09	1.6	.08	1.6	.09
Weight (kg)	55.0	15.7	54.4	17.2	55.4	14.8
BMI ^a (kg·m ⁻²)	20.3	4.2	20.8	4.7	20.1	3.9
Pedometer Steps	2021	545	1758	422	2182	498
MVPA ^b (min)	10.9	5.3	9.7	3.1	12.1	2.7

Notes: ^a BMI = Body Mass Index; ^b MVPA = moderate-to-vigorous physical activity, s=standard deviation.

Table 2. Steps, MVPA, Steps/Minute, & % Class in MVPA by physical education Activities.

Activity	Format	Steps	Steps/Minute	MVPA ^a	%Class MVPA
Invasion Games					
Basketball	Game	2201	55	11	28
	Skills	1484	37	7	17.5
Capture Flag	Game	2278	57	13	32.5
Floor Hockey	Game	1863	47	9	22.5
	Skill	1612	40	7	17.5
Flag Football	Game	3383	85	21	52.5
	Skill	2480	62	14	35
Lacrosse	Game	2312	58	13	32.5
	Skill	2083	52	11	27.5
Soccer	Game	2712	68	16	40
	Skill	2448	61	14	35
Tchoukball	Game	1866	47	9	22.5
Team Handball	Game	1989	50	11	27.5
Ultimate	Game	1923	48	12	30
Net/Wall Games					
Bunkerball	Game	1429	36	8	20
Speedminton	Game	1635	41	8	20
	Skills	1543	39	7	17.5
Table Tennis	Game	1602	40	8	20
	Skills	1323	33	5	12.5
Volleyball	Games	1440	36	7	17.5
	Skills	1340	34	7	17.5
Striking Fielding Games					
Kickball	Game	1308	33	6	15
Rounders	Game	1685	42	9	22.5
Target Games					
Disc Golf	Game	2168	54	12	30
	Skills	2126	53	12	30
Other Games					
Free Play Day		1514	38	8	20
Dodge Ball	Game	1404	35	8	20
Four Square	Game	1867	47	9	22.5
Fitness					
Strength/		2231	56	11	27.5
Aerobic Circuit					
Strength/		2125	53	11	27.5
Aerobic/Flex					
Aerobic Fitness		2441	61	14	35
Circuit					
Strength Circuit		1652	41	9	22.5
Heart-Rate		1875	47	10	25
Fitness					
Hip Hop		1766	44	8	20
Insanity		2399	60	14	35
Mile Run		3148	79	19	47.5
Cross Training		1759	44	9	22.5
P90X		2226	56	12	30
PACER ^b		2568	64	15	37.5
Fitness Relays		1705	43	9	22.5
Yoga		802	20	3	7.5

Notes: ^a MVPA = moderate-to-vigorous physical activity; ^b PACER = Progressive Aerobic Cardiovascular Endurance Run

Dicussion

The purpose of this study was developing a compendium for pedometer step counts and time in MVPA during daily middle-school PE games and activities. The list of games and activities and expected values presented provide and initial document for practitioners and researchers who want to maximize PA or assess efficacy of PE classes. With the continued utilization of pedometers by both teachers and researchers alike, our hope is that this compendium can be of benefit. Our hope is that over time and with the inclusion of additional research, we can update this initial compendium and include a wider array of games and activities and compare these initial results with findings in a variety of populations and age groups. It is also important to note that these are means and students regularly accumulated steps and MVPA both above and below these values. We intentionally did not discriminate between sexes as quality PE should provide equal opportunities for both boys and girls. Our sample including some youth with disabilities but we did not flesh out these data as the sample was very small.

Overall, the descriptive results showed that fitness activities yielded higher levels of step counts and more minutes of MVPA compared to motor skills and games. Health-related fitness has become a priority in PE over the last couple of decades (Piccinno & Colella, 2014). This phenomenon has been due to an emphasis on improving health and attenuating health risk in the pediatric population (Welk, Going, Morrow, & Meredith, 2011). Fitness activities, especially those aerobic in nature, inherently increase ambulatory MVPA due to the repetitive movement of large musculature needed to maneuver the body (Vandendriessche, Vandorpe, & Coelho-e-Silva, 2011). Not to be neglected, motor skills and games are also important for the developing adolescent and thus should not be overlooked in PE curricula (Hardy, Reinten-Reynolds, Espinel, Zask, & Okely, 2011). Additionally, motor skills must be developed for the child or adolescent to be competent in sports and athletic activities and in activities of functional daily living (Stodden, Gao, Goodway, & Langendorfer, 2014). Our descriptive findings indicated that youth were more active during game play when compared to lessons primarily focused on skill development. The results highlight the potential importance for the integration of fitness, skills, and games to optimize both motor development and fitness levels while keeping PA elevated (Stodden, Gao, Goodway, & Langendorfer, 2014).

Findings also suggest that invasion games generally result in more activity when compared to net/wall, striking/fielding or target games. All types of games provide a potential way for youth to be active; it may be desirable for teachers to consider alternating units based on high or low activity. For example, it may be beneficial to follow a low active unit (i.e. volleyball) with a more active unit (i.e. soccer) to avoid lengthy period of time of lower intensity unit especially since previous research has suggested that activity decreases over time in middle school PE classes (Burns, Brusseau, & Hannon, 2014). Previous research has shown that providing youth with structured activities, accessible play equipment, and sufficient play place significantly increases PA during PE and school leisure time (McKenzie, Crespo, Baquero, & Elder, 2010). The results from this study also suggested that outdoor PE has an advantage of yielding a greater number of step counts and time in MVPA, possibly due to the aforementioned factors. Indoor PE may compromise PA because of limited play space and because of the limited types of equipment. Inherently across the school year, a significant portion of PE will have to be spent indoors because of varying weather conditions and colder climates. Outdoor PE may also not be accessible in some schools. The PE teacher must devise strategies to increase PA in the indoors to sustain optimal levels. Teachers and researchers must be aware of the potential decreases in PA and devise strategies to increase PA during indoor activities and when engaging in motor skills and games. Teachers, practitioners, and researchers should be aware of the trends in PA to optimize PA across the school year.

There were limitations to this study that must be considered before the results can be generalized. This study included a sample of seventh and eighth grade students from schools located in the Southwest region of the U.S.A, therefore the external validity of the results is questionable if generalized to younger or older grade cohorts or other regions of the U.S.A. or other countries with different cultures, climates, and ethnic representation. All PE lessons in this study were coeducational, therefore results can only be generalized to middle school daily coeducational daily PE.

In conclusion, physical educators need to know the contributions of various PA and games in order to optimize step counts and MVPA during the year. This compendium is an initial effort to highlight these differences and provides researcher and practitioners an initial guideline for improving curriculum development and maximizing PA in PE.

References

- Brusseau, T. A., & Hannon, J. C. (2013). Pedometer-Determined Physical Activity of Youth while Attending School: A Review. *Sport Science Review*, 22(5-6), 329-342.
- Burns, R. D., Brusseau, T. A., & Hannon, J. C. (2014). Physical Activity Trajectories During Daily Middle School Physical Education. *Journal of Physical Activity & Health*, epub ahead of print. DOI:10.1123/jpah.2014-0151.

- Burns, R. D., Brusseau, T. A., & Hannon, J. C. (2015). Effect of a Comprehensive School Physical Activity Program on School Day Step Counts in Children. *Journal of Physical Activity & Health*, epub ahead of print. DOI:10.1123/jpah.2014-0578
- Centers for Disease Control & Prevention (2009). Recommended community strategies and measurement to prevent obesity in the United States. *Morbidity and Mortality Weekly Report* 2009, 58, 1–29.
- Darst, P. W., Pangrazi, R. P., Brusseau Jr, T., & Erwin, H. (2014). *Dynamic physical education for secondary school students*. Benjamin Cummings: San Francisco.
- Hannon, J. C., & Ratliffe, T. (2005). Physical activity levels in coeducational and single-gender high school physical education settings. *Journal of Teaching in Physical Education*, 24(2), 149-164.
- Hardy, L. L., Reinten-Reynolds, T., Espinel, P., Zask, A., & Okely, A. D. (2012). Prevalence and correlates of low fundamental movement skill competency in children. *Pediatrics*, 130(2):e390-e398.
- Hart, T. L., Brusseau, T., Kulinna, P. H., McClain, J. J., & Tudor-Locke, C. (2011). Evaluation of low-cost, objective instruments for assessing physical activity in 10–11-year-old children. *Research Quarterly for Exercise and Sport*, 82(4), 600-609.
- Hills, A. P., Andersen, L. B., & Byrne, N. M. (2011). Physical activity and obesity in children. *British Journal of Sports Medicine*, 45(11), 866-870.
- Institute of Medicine. *Educating the Student Body: Taking Physical Education to School* (2013). Washington, DC: The National Academies Press.
- Janssen, I., & LeBlanc, A. G. (2010). Review Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, 7(40), 1-16.
- Lee, S. M., Burgeson, C. R., Fulton, J. E., & Spain, C. G. (2007). Physical education and physical activity: results from the School Health Policies and Programs Study 2006. *Journal of School Health*, 77(8), 435-463.
- Matthews, T., O'Neil, E., & Kostelis, K. (2014). Physical activity levels and attitudes towards physical activity and eating habits in an urban elementary school setting. *Journal of Physical Education and Sport*, 14(1), 16-21.
- McKenzie, T. L., Crespo, N. C., Baquero, B., & Elder, J. P. (2010). Leisure□Time Physical Activity in Elementary Schools: Analysis of Contextual Conditions. *Journal of School Health*, 80(10), 470-477.
- Mitchell, S. A., Oslin, J. L., & Griffin, L. L. (2013). Teaching sport concepts and skills: A tactical games approach for ages 7 to 18. *Human Kinetics*: Champaign, IL.
- Morgan, C. F., Pangrazi, R. P., & Beighle, A. (2003). Using pedometers to promote physical activity in physical education. *JOPERD*, 74(7), 33-38.
- Nader, P. R. (2003). Frequency and intensity of activity of third-grade children in physical education. *Archives of Pediatrics & Adolescent Medicine*, 157(2), 185-190.
- Pangrazi, R. P., Beighle, A., & Sidman, C. L. (2003). *Pedometer Power. 67 Lessons for K-12*. Human Kinetics, Champaign, IL.
- Piccinno, A. & Colella, D. (2014). Physical fitness level in Italian high school adolescents: A cross-sectional study. *Journal of Physical Education and Sport*, 14(3), 431-437.
- Scruggs, P. W. (2013). Quantifying physical activity in physical education via pedometry: A further analysis of steps/min guidelines. *Journal of Physical Activity and Health*, 10, 734-741.
- Stodden, D. F., Gao, Z., Goodway, J. D., & Langendorfer, S. J. (2014). Dynamic relationships between motor skill competence and health-related fitness in youth. *Pediatric Exercise Science*, 26(3), 231-241.
- U.S. Department of Health & Human Services (2008). *Physical activity guidelines for Americans* (Report). Washington, DC: Author.
- Vandendriessche, J. B., Vandorpe, B., Coelho-e-Silva, M. J., Vaeyens, R., Lenoir, M., Lefevre, J., & Philippaerts, R. M. (2011). Multivariate association among morphology, fitness, and motor coordination characteristics in boys age 7 to 11. *Pediatric Exercise Science*, 23(4), 504.
- Welk, G. J., Going, S. B., Morrow, J. R., & Meredith, M. D. (2011). Development of new criterion-referenced fitness standards in the FITNESSGRAM® program: rationale and conceptual overview. *American Journal of Preventive Medicine*, 41(4), S63-S67.