The Physical Educator Vol. 75 • pp. 165–174 • 2018
https://doi.org/10.18666/TPE-2018-V75-I2-7786

METHODOLOGY

Effect of a Bicycling Unit on the Fitness of Middle School Students

Cathy D. Lirgg, Dean R. Gorman,
Michael D. Merrie, Atyh A. Hadadi

Abstract

Many physical educators today are teaching lifetime sports, including outdoor activities such as cycling. Even though cycling is a low impact exercise that aids stamina and fitness, little is known about additional benefits in other areas including agility, balance, and explosive power. The purpose of this study was to ascertain if there are physical benefits (i.e., static balance, explosive leg power, agility) to students participating in a single bicycling unit in physical education (PE) class. Middle school students in the treatment school rode bicycles during their PE classes for 2 months. Students in the control school did not have access to bicycles during PE classes. Before the bicycle unit began, students in both schools were measured on stork stand with eyes closed, vertical jump, and agility. Students in the treatment school then participated in PE classes that included a bicycling unit, whereas the control school students participated in PE classes that did not include bicycling. Pretest scores were used as covariates, and results showed that students in the treatment group scored higher than students in the control group at posttest on all three tests. Although many schools have begun using lifetime activities in their PE classes, the results suggest that these activities not only may be fun for students but also will help them experience fitness benefits.

Cathy D. Lirgg is an associate professor, Department of Health, Human Peformance, and Recreation, University of Arkansas. Dean R. Gorman is a professor, Department of Health, Human Peformance, and Recreation, University of Arkansas. Michael D. Merrie is a doctoral student, Department of Health, Human Peformance, and Recreation, University of Arkansas. Atyh A. Hadadi is a doctoral student, Department of Health, Human Peformance, and Recreation, University of Arkansas. Please send author correspondence to clirgg@uark.edu

Riding a bicycle can be a fun and invigorating experience for young and old. Throughout history, people have used bicycles as a method of transportation, a way to maintain fitness, and a means of spending quality time with partners or family (Barbour, 2016; Cooper et al., 2006; Menschik, Ahmed, Alexander, & Blum, 2008). The benefits of riding a bicycle have been well documented for adults and include improved cardiovascular fitness, a reduction in risk factors related to disease, and an enhanced feeling of well-being. Gordon-Larson, Boone-Heininen, Sternfeld, Jacobs, and Lewis (2009) found that commuters who cycled to work compared to non–physically active commuters were overall more fit, tended to be less obese, and had more optimal levels of blood pressure, triglyceride, and insulin. Other researchers have reported similar results related to reductions in cardiovascular risk factors, lower blood pressure, and decreased hypertension (Hamer & Chida, 2007; Hu et al., 2002). Additional benefits for adults include lower stress, improved levels of well-being and self-confidence, and reduced tiredness (Appleton, 2011; Boyd, Hillman, Nevill, Pearce, & Tuxworth, 1998).

For a child or adolescent, learning to ride a bicycle can result in an immense feeling of accomplishment second to none (Coulson, 2015). Besides these feelings of accomplishment, other health-related benefits of cycling including body fat reduction, a tendency to be less overweight, and less likelihood of lower back pain have been reported for children (Borrestad, Ostergaard, Anderson, & Bere, 2012; Dudas & Crocetti, 2008; Menschik et al., 2008; Rosenberg, Sallis, Conway, Cain, & McKenzie, 2006; Silva & Lopes, 2008; Sjolie, 2003). According to the President's Council on Fitness, Sports, and Nutrition (2016), over 80% of adolescents do not get enough physical activity to meet the minimum standards for aerobic activity. The American College of Sports Medicine (2012) recommends that children need at least 1 hr of moderate to vigorous physical activity daily combined with 60 min of strength training per week (Centers for Disease Control and Prevention, 2015). A number of school districts throughout the United States have recently implemented in-school bicycle curricula in an attempt to address the growing problem of childhood inactivity. Many of the schools have either fully implemented or have adapted their bicycle curriculum based upon Bikeology (Society of Health and Physical Educators [SHAPE America], 2016). Bikeology is a bicycle safety curriculum that was developed through the collaborative efforts of the National Highway Traffic Safety Administration (NHTSA) and Shape America. The Bikeology curriculum, which was released in May 2014, includes lesson plans, bicycle skill units, skill assessments, safety instruction, bicycle maintenance, rules of the road information, and a parent's guide to bike safety. NHTSA and SHAPE America developed the curriculum for use by middle and high school physical education (PE) teachers, and the curriculum is aligned with the National Standards for K–12 Physical Education.

Even though much is known concerning the health benefits of cycling for adults and children, little is known regarding the possible gains in balance, explosive power, and agility within youth resulting from participation in a cycling unit in school. Specifically, this study investigated the effect of an in-school bicycle program on the static balance, explosive leg power, and agility in children.

Method

Participants

Forty-one seventh grade students from two urban middle schools in northwest Arkansas served as participants. After institutional review board approval, permission was obtained from school principals and their PE teachers, and each child whose data was used submitted a parental consent form. Students in the treatment school (n = 19; 9 male, 10 female; M_{age} = 12.55) participated in a bicycle unit from March until mid-May. The bicycles were new to the school and were included in the school's PE curriculum for the first time. Students in the control school (n = 22; 10 male, 12 female; M_{age} = 12.68) did not have access to bicycles during PE classes.

Tasks

Modified stork stand (Johnson & Nelson, 1986). With shoes on, participants were instructed to put hands on hips and raise the leg of their choice so that the foot was touching the inside of the opposite knee. After attaining this position, they closed their eyes and the stopwatch was started. Participants were required to keep their plant heel on the ground instead of keeping it raised. The task was ended when any of the following occurred: raised foot was moved apart from opposite leg, hands were moved from hip, plant foot was scooted to a different position, eyes were opened, or raised leg touched the floor. Two trials were conducted, the second after a short rest of at least 2 min; the longest of the two time trials was recorded in seconds to the hundredths.

Vertical jump. The vertical jump is a simple test of explosive leg power (Nieman, 2011). For this task, participants were first measured for their reach. With their shoes on, they were asked to stand with their side to the wall and reach up naturally without overstretching. This measurement was recorded to the half-inch. Following this, students were instructed to stand directly under the Vertec jumping apparatus (Sports Imports, Columbus, OH), feet shoulder width apart, and knees flexed. Standing with their nondominant side closest to the apparatus, participants were told to swing their arms up and touch the movable markers as high as possible with their dominant hand (Seminick, 1994). This movement was demonstrated by the researcher, but no other instruction was given. The authors calculated vertical jump by subtracting the highest marker moved from students' standing reach. Participants were given a practice jump and two trials, the best of which was recorded in inches to the half-inch.

Agility run (modified Illinois Agility Run, Cureton, 1951). Four cones were set up at 10-ft intervals in the gymnasium. The starting point was the first cone. In the Illinois Agility Run, participants lie prone at the starting line. So that students could focus specifically on moving in and out of cones efficiently, at the starting position in this study, they were required to stand. Participants weaved in and out two of the cones, ran around the last cone, and weaved back around the cones to the starting line. Two trials were given with a short rest of at least 2 min in between. Time was taken in seconds to the hundredths with the fastest time being recorded.

Procedure

Before the bicycle unit began (late February, early March), students in both schools were measured on two trials of the three tasks: stork stand with eyes closed to test balance, vertical jump to test explosive leg power, and agility run to test agility. The better of the two trials in each test was recorded. During the participants' PE classes at each middle school, three stations were set up for the tasks. Before testing, students participated in warm-up and stretching exercises. Participants were split into three groups and rotated to each station, where they were tested individually. Each class completed the testing in one class period. Students at each school had no other practice on the tests and were given no formal training to help them. Furthermore, these tests were not performed at any time during the study except at pre- and posttest. In fact, they were not told that the testing had anything to do with bicycling. One of the study's authors who was trained in conducting the test through pilot testing administered each test to ensure that the protocols were being followed properly.

Because of weather issues, students in the treatment school participated in their bicycle unit beginning in April. March and early April classes were spent on bike familiarization and safety. Classes met three times a week for 45 to 50 min. Fourteen days were spent specifically on the bicycle unit, during which students rode for the entire class around the campus or in the adjoining neighborhoods on a primarily flat terrain for a minimum of 2 miles/class at moderate intensity. The teacher followed a curriculum created by the Bicycle Coalition of the Ozarks (2016), which progressed students from basic bicycle knowledge, personal safety skills, bike handling skills, and traffic safety, to greater knowledge of the local trails. Quizzes and videos were included in the curriculum. This program was modified from the Bikeology curriculum developed by SHAPE America and the NHTSA. Giant Revel ALUXX bikes (Lewis & Clark Cycling) were used (small and large), but both sizes were equipped with seven gears.

During the time when students were participating in other activities during their PE class, they biked as a warm-up for the first 15 to 20 min. These other activities during that time were archery, softball, and fitness testing. The school district requires fitness testing, but no actual training specifically for the fitness tests was taught. The curriculum during this time was teacher-planned and followed the Arkansas Frameworks for Physical Education and Health (Arkansas Department of Education, 2011) for content.

The control school students participated in a PE class whose activities included tennis, ultimate Frisbee, stunts and tumbling, and softball. They also met every other day for 50 min. This curriculum also followed the Arkansas Frameworks and was teacher-planned. Lesson objectives focused on instruction, drills, and gameplay.

At the end of the bicycle unit and warm-up with bikes (late-May), students at both schools were re-measured on the three tasks following the same protocols as in the pretest.

Treatment of the Data

Prior to the main analysis, a one-way ANOVA was run on the three tasks. It found that students in the two schools scored differently on the tasks. Therefore, the pretest scores were used as covariates in the subsequent analyses. Because of the use of different covariates, each dependent variable was analyzed separately in a one-way ANCOVA. Alpha level was set at .05.

Results

Because of pretest school differences, the pretest scores were used as covariates in each respective analysis. Table 1 shows the estimated means using covariates and the standard error for each task.

Table 1
Means and Standard Errors Posttests for Each Task Based on Estimated Means Using Covariates

	Agility run in seconds		Vertical jump in inches		Stork stand in seconds	
Group	***M***	***SE***	***M***	***SE***	***M***	***SE***
Treatment	6.903	.101	16.411	.436	29.647	3.146
Control	7.257	.093	14.440	.405	18.203	2.824

ANCOVA results showed that students in the treatment group (bicycle group) scored higher than students in the control group at posttest on all three tests: stork stand, $F(1, 35) = 7.18$, $p = .011$; vertical jump, $F(1, 35) = 10.32$, $p = .003$; agility run, $F(1, 38) = 5.76$, $p = .021$.

Discussion

Because no specific studies in the literature were found regarding the effect of a bicycle unit on children's static balance, explosive leg power, or agility, it is virtually impossible to compare the results of other studies with the present findings. However, the authors hypothesized that differences would be found for the control group versus experimental group based upon the inherent value of the activity.

Static balance with a person's eyes closed depends on proprioceptive input from muscles, tendons, and joints, along with information obtained from the vestibular organs. Therefore, they assumed that bicycle riding would naturally stimulate these receptors, ultimately resulting in the child's ability to maintain balance for a longer time. The only related study found in the literature, even though different age group participants (adults) were used, found that those who rode bicycles 1 hr/week experienced improved eyes-open balance and decreased risk of falls when compared to non-cyclists (Rissel, Passmore, Mason, & Merom, 2013). Rissel et al.'s (2013) findings are in line with the present findings. Eyes-open balance, besides relying on vision, also depends on sensory input from proprioceptor and vestibular organs. Furthermore, the ability to control a bicycle and the ability to maneuver quickly and gracefully through an agility course require heavy reliance on balance, weight shift, coordination, and explosive leg power combined with sensory input. This finding may have contributed to the differences in agility scores between the groups. Last, controlling a bicycle and maneuvering through cones (agility) require similar attributes. Both activities rely on the legs, abdominal core, back, and upper body muscles working together to achieve a common goal (Sovndal, 2009). Because people use similar muscles to perform both activities, this may have accounted for differences in agility scores between the groups.

The results of this study were encouraging because of the length of the study. During the 3 weeks of the biking unit and the days when biking was included as a 15- to 20-min warm-up, the students biked about 9.5 hr total. This activity appears to have been instrumental in the static balance, explosive leg power, and agility differences between the two schools. The activities other than biking that were taught at both schools are commonly taught in middle school PE classes. In the future, researchers may consider employing heart rate monitors to also check for moderate to vigorous physical activity. The only measure of cycling intensity was an estimate by the PE teacher. However, the resulting differences in the student scores suggest that the students put effort into the biking activities.

Although many schools have begun incorporating lifetime activities in their PE classes, the results of this study suggest that bicycle riding may be an effective way to improve static balance ability, explosive leg power, and agility in children. Because the cost of procuring bicycles and protective gear for schools may be prohibitive, the authors recommend that physical educators physical educators seek out grant funding to provide for the cost of the equipment. The potential lifelong benefits for children seem to outweigh the costs of the equipment.

References

American College of Sports Medicine. (2012). Youth strength training: Facts and fallacies. Retrieved from https://www.ascm.org/public-information/articles/2012/01/13/youth-strength-training-facts-and-fallacies

Appleton, M. (2011, February 28). Cycle-commuting the secret* to a happy life says New Economic Foundation report. Retrieved from http://road.cc/content/news/31477-cycle-commuting-secret-happy-life-says-new-economic-foundation-report

Arkansas Department of Education. (2011). *Physical education and health: Middle school curriculum.* Retrieved from http://www.arkansased.gov/

Barbour, M. (2016). 30 great benefits of cycling. Retrieved from http://www.bikeradar.com/road/gear/article/30-reasons-to-take-up-cycling-23965/

Bicycle Coalition of the Ozarks (2016). Middle school curriculum. Retrieved from http://www.bconwa.com

Borrestad, L., Ostergaard, L., Anderson, L. B., & Bere, E. (2012). Experiences from a randomized controlled trial on cycling to school: Does cycling increase cardiorespiratory fitness? *Scandinavian Journal of Public Health, 40,* 245–252. https://doi.org/10.1177/1403494812443606

Boyd, H., Hillman, M., Nevill, A., Pearce, L. P., & Tuxworth, B. (1998). *Health-related effects of regular cycling on a sample of previous non-exercisers*. Godaming, Surrey: Cyclists Touring Club and Bike for Your Life Project.

Centers for Disease Control and Prevention. (2015). How much physical activity do children need? Retrieved from http://www.cdc.gov/physicalactivity/basics/children/index.htm

Cooper, A. R., Wedderkopp, N., Wang, H., Anderson, L. B., Froberg, K., & Page, A. S. (2006). Active travel to school and cardiovascular fitness in Danish children and adolescents. *Medicine and Science in Sports and Exercise, 38,* 1724–1731. https://doi.org/10.1249/01.mss.0000229570.02037.1d

Coulson, J. (2015). Why cycling makes us happy: The positive psychology of being on a bike. Retrieved from https://cyclingtips.com/2015/why-cycling-makes-us-happy-the-positive-psychology-of being-on-the-bike-3/

Cureton, T. K. (1951). *Physical fitness of champion athletes.* Urbana: University of Illinois Press.

Dudas, R., & Crocetti, M. (2008). Association of bicycling and childhood overweight status. *Ambulatory Pediatrics, 8,* 392–395. https://doi.org/10.1016/j.ambp.2008.08.001

Gordon-Larsen, P., Boone-Heininen, J., Sternfeld, B., Jacobs, D. R., & Lewis, C. E. (2009). Active commuting and cardiovascular disease risk. *Archives of Internal Medicine, 169,* 1216–1223. https://doi.org/10.1001/archinternmed.2009.163

Hamer, M., & Chida, Y. (2007). Active commuting and cardiovascular risk: A meta-analytic review. *Preventive Medicine, 46,* 9–13. https://doi.org/10.1016/j.ypmed.2007.03.006

Hu, G., Pekkarinen, H., Hänninen, O., Yu, Z., Guo, Z., & Tian, H. (2002). Commuting, leisure-time physical activity, and cardiovascular risk factors in China. *Medicine and Science in Sports and Exercise, 34,* 234–238. https://doi.org/10.1097/00005768-200202000-00009

Johnson, B. L., & Nelson, J. K. (1986). *Practical measurements for evaluation in physical education* (4th ed.). Edina, MN: Burgess.

Menschik, D., Ahmed, S., Alexander, M. H., & Blum, R. W. (2008). Adolescent physical activities as predictors of young adult weight. *Archives of Pediatrics and Adolescent Medicine, 162,* 23–28. https://doi.org/10.1001/archpediatrics.2007.14

Nieman, D. C. (2011). *Exercise testing and prescription*. Boston, MA: McGraw-Hill.

President's Council on Fitness, Sports, and Nutrition. (2016). Facts and statistics: Physical activity. Retrieved from http://www.fitness.gov/resource-center/facts-and-statistics/

Rissel, C., Passmore, E., Mason, C., & Merom, D. (2013). Two pilot studies of the effect of bicycling on balance and leg strength among older adults. *Journal of Environmental and Public Health, 2013,* 1–6. https://doi.org/10.1155/2013/686412

Rosenberg, D. E., Sallis, J. F., Conway, T. L., Cain, K. L., & McKenzie, T. L. (2006). Active transportation to school over 2 years in relation to weight status and physical activity. *Obesity, 14,* 1771–1776. https://doi.org/10.1038/oby.2006.204

Seminick, D. M. (1994). Testing protocols and procedures. In T. R. Baeche (Ed.), *Essentials of strength training and conditioning* (pp. 258–273). Champaign, IL: Human Kinetics.

Silva, K., & Lopes, A. (2008). Excess weight, arterial pressure, and physical activity in commuting to school: Correlations. *Archives of Brazilian Cardiology, 91,* 84–91.

Sjolie, A. (2003). Active or passive journeys and low back pain in adolescents. *European Spine Journal, 12,* 581–588. https://doi.org/10.1007/s00586-003-0557-4

Society of Health and Physical Educators. (2016, November 16). Bicycle safety curriculum. Retrieved from http://www.shapeamerica.org/publications/resources/teachingtools/qualitype/bicycle_curriculum.cfm

Sovndal, S. (2009). *Cycling anatomy*. Champaign, IL: Human Kinetics.