Overview of the Hungarian National Youth Fitness Study

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The 2012 Public Act on Education in Hungary made daily physical education (PE) a mandatory part of the school day starting in the 2012–2013 school year. This directive was linked to a significant reorganization of the Hungarian education system including a new National Core Curriculum that regulates the objectives and contents of PE. The Hungarian School Sport Federation (HSSF) recognized the opportunity and created the Strategic Actions for Health-Enhancing Physical Education or *Testnevelés az Egészségfejlesztésben Stratégiai Intézkedések (TESI)* project. Physical fitness assessments have been a traditional part of the Hungarian PE program; however, the TESI plan called for the use of a new health-related battery and assessment system to usher in a new era of fitness education in the country. The HSSF enlisted the Cooper Institute to assist in building an infrastructure for full deployment of a national student fitness assessment program based on the FITNESSGRAM® in Hungarian schools. The result is a new software-supported test battery, namely the Hungarian National Student Fitness Test (NETFIT), which uses health-related, criterion-referenced youth fitness standards. The NETFIT system now serves as a compulsory fitness assessment for all Hungarian schools. This article details the development process for the test battery and summarizes the aims and methods of the Hungarian National Youth Fitness Study.

Keywords: FITNESSGRAM, health-related fitness, NETFIT, youth fitness assessment

The Hungarian adult population has one of the worst mortality and morbidity rates globally with the fifth longest life expectancy among the countries in the European Union (Központi Statisztikai Hivatal, 2013). The prevalence of noncommunicable diseases is high (World Health Organization, 2011), and nearly two thirds of the adult population are classified as overweight or obese (Martos, Kovács, Bakacs, Kaposvári, & Lugasi, 2012). These unfavorable population health statistics can also be seen among children and adolescents. The latest Health Behavior of School-aged Children study showed that 15-year-old Hungarian students had the worst health profiles compared with other European youth (Currie et al., 2012). According to the 2012–2013 report of national school health programs, the prevalence of obesity in Hungary nearly doubled in the last 10 years (between 2002–2003 and 2012–2013) in almost every age group. The obesity prevalence is currently 11.52% among 8- to 18-year-olds (Országos Gyermekegészségügyi Intézet, 2014).

Evidence suggests that higher levels of physical activity and an appropriate level of health-related physical fitness have preventative benefits on obesity risks (Must & Tybor, 2005), insulin sensitivity (Shaibi et al., 2005), cardiovascular risk factors (Andersen et al., 2006; Anderssen et al., 2007), bone health (Linden, Ahlborg, Besjakov, Gardsell, & Karlsson, 2006), mental health (Smith et al., 2011), and psychological well-being (Parfitt & Eston, 2005). Furthermore, several studies have confirmed that these factors are favorably associated with academic performance and cognition (Grissom, 2005; Hillman, Erickson, & Kramer, 2008; Welk et al., 2010).

Schools are clearly one of the most promising settings in which to reach and influence large segments of youth. Evidence supports the fact that conscious instructional and promotional efforts at schools can lead to improvements in physical activity, reductions in sedentary behavior (Kriemler et al., 2011), and increases in healthy eating habits (Gortmaker et al., 1999). However, careful planning is needed to facilitate institutionalization of this type of programming on a national/population scale.

There are multiple opportunities at school to increase physical activity levels on a daily basis (e.g., active transportation, recess, extracurricular physical and sport activities); however, it is accepted that physical education (PE) classes should provide the basis for comprehensive school physical activity programming (Institute of Medicine [IOM], 2013). PE contributes directly to providing the recommended level of physical activity, but it is also central to the broader promotion of lifelong physical activity (Stratton, Fairclough, & Ridgers, 2008). Despite these accepted roles, it has proven difficult to accurately quantify the impact of PE on public health. Pate, O'Neill, and McIver (2011, p. 33) concluded specifically that "... the limited evidence documenting the health effects of physical education may reduce society's enthusiasm for prioritizing

physical education as a public health intervention." PE programming presents the most powerful opportunity to systematically influence the health of children and adolescents, but new models and delivery systems are needed to ensure that best practices and assessment systems are effectively deployed on a national scale.

DEVELOPMENT AND IMPLEMENTATION OF THE TESI INITIATIVE

The passage of the 2012 Public Act on Education in Hungary mandated that daily PE be provided to all Hungarian youth. The plan called for implementation in Grades 1, 5, and 9 in the 2012–2013 school year with new grades sequentially added each year until all grades implemented this requirement. This directive was linked to the significant reorganization of the Hungarian education system in 2013 that established a new National Core Curriculum with specific regulations and objectives for PE. The philosophy of the new curriculum is focused directly on health (rather than performance) and features educational objectives that emphasize knowledge components as well as physical, emotional, and social development.

Making the transition to the new curricular and assessment platform presented a huge challenge for the Hungarian PE system. To ensure a positive outcome, the Hungarian School Sport Federation (HSSF) proposed a training and education program that would directly support the implementation of the new National Core Curriculum. The specific HSSF initiative (Strategic Actions for Health-Enhancing Physical Education or *Testnevelés az Egészségfejlesztésben Stratégiai Intézkedések [TESI]*) was officially launched in 2012 with the financial help of the European Social Fund and the Hungarian government, and it creates the structure for this entirely new model of PE in Hungary. The TESI project focused on three important areas for enhancing PE.

The first area was the establishment of a formalized strategic plan called Physical Education Strategy 2020. This comprehensive plan includes four main strategic goals that capture the conditions for quality PE (e.g., infrastructure, human resources, professional qualifications, and curriculum development). A second priority was the creation of an educational training framework and resources needed for quality PE. This included preparing books, creating videos, and distributing resources needed to implement the new curriculum. The focus of these resources was on content not traditionally covered in PE teacher education programs or in-service trainings in Hungary (e.g., student-centered instructional models, tactical games approach, stress control and relaxation, health education materials, fundamental movement education). The third component of the TESI project was the development of a new, national school-based fitness assessment system. The health-related physical fitness assessment system was planned to fulfill the long-term

need for a standardized evaluation system in the Hungarian PE profession. A background on the history of school fitness assessments in Hungary is provided, followed by the process used to establish the plan and the development and evaluation of the new fitness assessment platform.

Background on the History of School-Based Fitness Assessment in Hungary

Measurement and assessment of physical fitness is a traditional part of the Hungarian PE system. Scientists have examined Hungarian fitness levels since the 1970s (Barabás, 1990; Mészáros, Mahmoud, & Szabó, 1999), but the last nationally representative fitness assessment was conducted from 1982 to 1984 (Eiben, Barabás, & Pantó, 1991). Since the change in the previous government regime to democracy in 1989, a law in 1993 allowed each school to choose the method with which to measure the students' physical fitness. Naturally, schools implemented the law quite differently. Some of them used test batteries created in Hungary (e.g., Arday-Farmosi's method of the "achievement mirror," or Hungarofit), while others created their own assessment based on the individual school's test results. By the end of the 1990s, an increasing number of Hungarian schools started using the EUROFIT test battery (Council of Europe, 1988). In the 2000s, there was considerable debate about which testing battery should be introduced throughout the country. In 2005, the Educational and Cultural Ministry sent out fitness assessment methods to every school to help find a solution for standardizing school fitness assessments. In these materials, the two normative test batteries were the Hungarofit and the Eurofit, which were already implemented by the majority of schools. However, test results were not collected and evaluated centrally. Therefore, there is very little scientific knowledge of the impact on education and public health using the individual schools' data evaluation. The TESI project directly sought to address this ongoing need for a standardized assessment system.

Evaluation of Needs for School-Based Fitness Testing in Hungary

There are two major questions regarding the implementation of school fitness testing: Which fitness component should be assessed? And, which test battery is the best choice for each fitness component? Undoubtedly, both from an educational and public health viewpoint, health-related physical fitness components should be the priority in PE settings (with skill-related physical fitness components as a secondary goal). However, a number of tests are available to assess different dimensions of health-related fitness. Some batteries and individual test items may have more utility for research or surveillance, while others may have advantages for education and promotion (IOM, 2013). Therefore, careful consideration was given to the selection of appropriate test

items. Because the assessments would be completed in schools, the educational purpose and usefulness of the tests had to be a high priority. Validity, reliability, and comparability are important factors, but the tests must also be simple to perform, require minimal equipment, and be motivational for students to complete. Finally, to ensure utility for national surveillance, the assessments also must be linked together in an easy-to-use battery.

All previous fitness tests used in Hungary (both Hungarofit and Eurofit) were norm-referenced tests, and there was limited scientific basis for the items. This was due primarily to the use of old samples and the interpretation of outdated values and norms (e.g., percentiles, percentile ranks, points). The previous samples used to develop these test norms were mostly conducted on highly fit participants and would not be representative of today's typical population. For example, 76.2% of students received very weak, weak, or moderate physical fitness evaluations on the Hungarofit testing in the 2012–2013 school year. Using the norm references of the Hungarofit for evaluation, only 23.8% would meet the fitness expectations. In previous fitness testing initiatives, little consideration has been given to providing education about the findings of the tests and feedback on the importance of test results. The assessments were also often conducted in environments (e.g., tests administered by untrained teachers or officials with no connections to the students) that were psychologically stressful and likely contributed to the general negative attitude among Hungarian students regarding fitness tests.

Zhu, Mahar, Welk, Going, and Cureton (2011) and Zhu (2012) have previously outlined three major limitations associated with the norm-referenced evaluation framework. First is the cost of regularly updating norms and its time and manpower constraints. Second is that interpretation depends on the fitness of the referenced population. The third limitation—the most problematic from an educational point of view—is that the norm-referenced evaluation framework is potentially discouraging for youth who are not fit. Criterion-based standards have been suggested to replace norm-reference evaluation. The FITNESSGRAM® test battery used in the United States adopted this method for interpretation to recognize children and adolescents with acceptable levels of health-related physical fitness as opposed to only those with high levels of performance fitness (Zhu et al., 2011). The utility of the Fitnessgram assessment led to consideration of the possible incorporation of this philosophy and these items and interpretation into a new Hungarian fitness battery. The potential of developing similar criterion-referenced standards to assess current physical fitness in children and adolescents and identify youth at risk for illness and disease was consistent with the strategic directions in the 2020 plan and the planned educational framework. Therefore, the HSSF formulated a plan to construct a new fitness test battery using tests with good validity and criterion-standard interpretation to meet

the needs of the TESI project in developing the Hungarian National Student Fitness Test (NETFIT).

Plan for the Development of the Hungarian National Student Fitness Test (NETFIT)

The NETFIT was established through a systematic plan that included the following 13-step process:

1. Evaluating the political, legal, and professional steps to secure European Union funding
2. Reviewing the literature to identify successful practices
3. Identifying general requirements and special needs regarding the new testing system
4. Contacting potential partner organizations and forming cooperative agreements for research and development, especially negotiating the research and development contract with the Cooper Institute (Dallas, TX)
5. Conducting appropriate scientific research with the chosen fitness field tests and laboratory tests to ensure a strong foundation
6. Analyzing scientific results, drawing conclusions, and finalizing the test battery
7. Creating a test administration handbook and DVD
8. Establishing a comprehensive data management system
9. Organizing and administering in-service training for teachers
10. Preparing test kits with resources for distribution to schools
11. Planning regulations to implement the NETFIT as the mandatory fitness battery throughout the country
12. Continuing professional and scientific communication with professional organizations in the media, online and offline press, and scientific journals and conferences
13. Supplying continuous support by providing professional help and equipment (e.g., help desk) to monitor, maintain, and develop the system.

These steps required significant financial resources and some steps were conducted concurrently during the developmental process to keep the project on schedule. A specific application was made to the European Social Fund to accomplish these steps. The HSSF obtained funding from the framework of a Priority Project (TÁMOP 3.1.13-12-2013-0001) program to engage in these steps and to develop a new school-based physical fitness test battery. After reviewing the literature and international practice, it was determined that the new testing system must meet the following requirements:

- Assess the health-related physical fitness components
- Enable interpretation based on health-related criterion-referenced standards

- Provide supportive and motivational feedback for all students, not just for the best students
- Be simple, inexpensive, and user friendly for teachers and schools
- Facilitate international comparisons
- Have a useful online data management system
- Provide a meaningful reporting system for the schools, for the students, and for their parents to help fitness education
- Be available free of charge for all clients (teachers, schools, students, and parents).

However, the design of a test battery that would meet all of the assessed requirements was a formidable and complex task that required intensive planning and development of scientific research, project management, education and training, financing, legal matters, communication, and information technology hardware and software development.

The testing system also had to be scientifically well-founded and be based on the nationally representative data from Hungarian 11- to 19-year-old youth. The planned online data management software needed to be able to combine data from 1.2 million to 1.3 million students yearly, while providing access according to the operative data protection laws to the students, their parents, and the individual schools. In addition, it was determined that an average of two teachers from each Hungarian school (8,100 teachers) needed to be trained to ensure effective launch and utilization of the test system (30 intensive lessons of in-service training). Lastly, resources had to be shipped to every school to provide all measuring equipment and educational material necessary for the testing (e.g., bio-impedance scale, test administration handbook, digital video disc, and compact disc). Many of these features were already established in the Cooper Institute's Fitnessgram assessment tool. Therefore, the HSSF requested direct assistance from the Cooper Institute to assist in building an infrastructure for full deployment of a national student fitness assessment program.

OVERVIEW OF THE HUNGARIAN NATIONAL YOUTH FITNESS STUDY

The Hungarian National Youth Fitness Study (HNYFS) was developed by the HSSF in partnership with the Cooper Institute. The HNYFS testing was conducted from April 2013 to July 2013. The study had the following aims:

- Aim 1: Determine the levels of health-related physical fitness in a random representative sample of Hungarian youth using Fitnessgram test items.
- Aim 2: Use laboratory measures of body composition and risk factors for cardiovascular disease to evaluate the prevalence of metabolic syndrome in a subset of Hungarian youth.

- Aim 3: Directly evaluate the validity of the Fitnessgram test standards for detecting health risks in Hungarian youth.
- Aim 4: Evaluate the utility of the Fitnessgram test items using both laboratory- and field-based evaluations.

Selection of Participants

For this nationally representative cross-sectional sample, the participants were selected using two stage-stratified random sampling methods. The first stage involved the random selection of 53 schools across seven geopolitical regions in Hungary. The criteria for the selection were:

- Settlement size (village, town, city)
- School size/student population (<200, 200–400, 400–800, >800)
- School type (public, private, church, others).

Of the 53 schools selected in the sample, 3 schools refused to participate and were replaced. The school response rate was 94.4% (50/53).

The second stage of sampling consisted of the random selection of a predetermined number of students from each of the selected schools. The randomized student selection was obtained by a special computerized code system. The HSSF staff performed the same selection procedure in every school. First, the school administrators transferred student lists by grade rank to the code file. Second, the HSSF staff

put the code list and the student list together to facilitate selection of individuals for the field test sample and the lab test subsample in each grade. The selected study sample for the field tests consisted of 2,686 participants aged 11 to 19 years old (Grades 5–12). From this sample, a subsample of 578 was randomly selected for testing in five regional laboratories (Budapest, Pécs, Nyíregyháza, Szeged, and Győr). This study was approved by the ethics committee board at the Hungarian School Sport Federation and a signed consent form (by parent or legal guardian) was required to participate in the study. The measurement procedures were explained verbally to all participants. There were 84 (field tests) and 96 (lab tests) participants who did not participate in the study for different reasons (e.g., illness). The final sample included 2,602 (56.7% boys, 43.3% girls) participants for the field tests (Table 1) and 482 (55.6% boys, 44.4% girls) participants who reported for the lab tests (Table 2).

Field Tests

The field testing was conducted at each of the schools in a gymnasium with sufficient space for testing 16 participants in each of the areas using four separate stations. The tests were administered by HSSF field testing staff who undertook formal training on all test items. A total of seven teams of field testers were formed (one for each region). These teams were supervised by an HSSF test

TABLE 1
Sample Characteristics for Field Tests by Age, Sex, and Region

	Boys		Girls		Total		Decimal Age (Mean $\pm$ SD)
	N	%	N	%	N	%	
Age (Years)							
11	159	48.0	172	52.0	331	12.7	11.6 $\pm$ 0.3
12	198	52.5	179	47.5	377	14.5	12.5 $\pm$ 0.3
13	140	47.1	157	52.9	297	11.4	13.5 $\pm$ 0.3
14	153	52.9	136	47.1	289	11.1	14.5 $\pm$ 0.3
15	188	61.0	120	39.0	308	11.8	15.5 $\pm$ 0.3
16	173	56.5	133	43.5	306	11.8	16.5 $\pm$ 0.3
17	207	64.5	114	35.5	321	12.3	17.5 $\pm$ 0.3
18	153	64.3	85	35.7	238	9.2	18.5 $\pm$ 0.3
19	86	63.7	49	36.3	135	5.2	19.9 $\pm$ 0.8
TOTAL	1,457	56.7	1,145	43.3	2,602	100.0	15.1 $\pm$ 2.5
Region							
CH	308	61.4	193	38.6	501	19.2	14.8 $\pm$ 2.5
NH	105	53.6	91	46.4	196	7.6	14.6 $\pm$ 2.3
NGP	315	52.8	282	47.2	597	22.9	14.9 $\pm$ 2.5
SGP	118	47.0	133	53.0	251	9.6	15.6 $\pm$ 2.5
ST	167	57.8	122	42.2	289	11.1	14.8 $\pm$ 2.9
CT	229	52.5	207	47.5	436	16.8	15.5 $\pm$ 2.4
WT	215	64.8	117	35.2	332	12.8	15.3 $\pm$ 2.1
TOTAL	1,457	56.0	1,145	44.0	2,602	100.0	15.1 $\pm$ 2.5

Note. CH = Central Hungary; NH = Northern Hungary; NGP = Northern Great Plain; SGP = Southern Great Plain; ST = Southern Transdanubia; CT = Central Transdanubia; WT = Western Transdanubia.

TABLE 2
Sample Characteristics for Lab Tests by Age and Sex

Age (Years)	Boys		Girls		Total		Decimal Age (Mean $\pm$ SD)
	N	%	N	%	N	%	
11	33	55.0	27	45.0	60	12.4	11.5 $\pm$ 0.4
12	39	54.1	33	45.9	72	14.9	12.5 $\pm$ 0.3
13	21	39.6	32	61.4	53	11.0	13.5 $\pm$ 0.3
14	25	46.3	29	53.7	54	11.2	14.5 $\pm$ 0.3
15	41	62.1	25	37.9	66	13.7	15.5 $\pm$ 0.3
16	32	47.0	36	53.0	68	14.1	16.6 $\pm$ 0.3
17	39	70.1	16	29.9	55	11.4	17.5 $\pm$ 0.3
18 +	38	70.3	16	29.7	54	11.2	18.7 $\pm$ 0.7
TOTAL	268	55.6	214	44.4	482	100.0	15.0 $\pm$ 2.3

leader who ensured all protocols were administered consistently throughout the study period and ensured the data were kept confidential and sent promptly to the HSSF office in Budapest.

Upon arrival to the testing area, all participants were given instructions and asked to engage in a standardized 10-min group warm-up activity, which included stretching, calisthenics, and some agility maneuvers. The next phase of testing included measures of standing height, body mass, and waist circumference while concurrently a survey was completed to assess attitudes and behaviors toward physical activity and PE. After that, in the next portion of the field testing, participants were divided into groups of four and assigned to one of four testing stations. At each testing station, a staff member was positioned to demonstrate the task, monitor the test, and record the scores. Four testing stations were used simultaneously:

1. Modified sit-and-reach and body fat measure by bioelectric impedance
2. Pushups and standing long jumps
3. Curl-ups
4. Trunk lift and grip strength.

The modified sit-and-reach, pushups, curl-ups, and trunk lifts were administered using the protocol described in the fourth edition of *FITNESSGRAM® Activitygram®: Test Administration Manual* (Meredith & Welk, 2007). After entering body mass, height, age, and sex into an Omron Model 306 bioelectrical impedance analyzer (BIA), body fat measure was determined while holding the device in outstretched arms (Figure 1). The standing long jump was conducted using both feet measuring the horizontal distance from a tucked position and leaping as far as possible (Figure 2). A tape measure was used to determine the distance from the start point (a tape on the floor) to the location of the heel of the foot nearest the tape (if they stayed on their feet). Grip strength was assessed using a grip dynamometer (Smedley Digital Hand Dynamometer 12-0286) positioned in the hand (measure taken from both

FIGURE 1 Student holding a handheld bioelectrical impedance device.

hands) at the participant's side. The better of two trials for both the left and right hands were recorded on the data sheet.

A fifth station was used to conduct the Progressive Aerobic Cardiovascular Endurance Run (PACER) in which cones were used to mark eight 20-m lanes. Participants were paired and positioned at each lane. Test staff members were positioned at each corner of the test to provide verbal commands to participants near them. The PACER test was administered according to the standard protocol (Meredith & Welk, 2007) using a sound system to prompt each participant when to start each level and stage of the test. Test staff recorded completed laps at the completion of each individual's test using the termination criteria of a second "failed" completed lap in the time period.

These teams were evaluated by an independent quality assurance officer. Eight areas were evaluated including each of the four stations, the larger group PACER test station, the testing environment in general, overall coordination of the testing sequence, and data entry quality. A "satisfactory" or "unsatisfactory" rating was given for each of 50 items. The testing location, date, list of examiners (and team leader), and comments were included for scoring and feedback to the teams. In summary, all of the teams were found to be compliant with the standard protocol (Finn, 2013).

Laboratory Tests

The directors of each of the five laboratories met to determine the procedures and order for the laboratory testing. Prior to all testing, laboratory staff were oriented to the test procedures and practiced to ensure consistency among test participants. The test protocols were standar-

dized and attempted to be consistent across the five laboratories and in the case of field measures (i.e., bioelectrical impedance, waist circumference, and grip strength) with the field protocol. Each test was administered by a trained technician with extensive laboratory test experience in youth. An independent quality assurance officer observed the testing sessions and found the laboratory staff to be competent and each laboratory to have high levels of internal consistency. Evaluation of the procedures and feedback to the principal investigator was provided in the quality control report (Finn, 2013). Observation of testing procedures by the quality assurance officer did reveal some variance in the equipment used between labs for blood pressure (manual vs. automated) and the measurement of skinfolds (some differences in common measures) and multifrequency bioelectrical impedance (two types of equipment). However, the overall compliance in protocols was rated favorably by an independent evaluator (Finn, 2013).

Participants entered the laboratory in a fasted state (no food that morning) and were positioned in a waiting area for orientation. Six to nine participants arrived for testing on the days of the laboratory visits. The laboratory test leader provided instruction to the participants (and teachers) on order of the examinations and when to consume food and fluids. One participant entered the measurement area at a time while the others were grouped in a room so they could watch a movie or interact with each other. As planned, the order of testing started with resting blood pressure and blood draws. Blood pressure monitoring was conducted either manually or using a desktop automated monitor (Omron). Blood pressure measures (systolic and diastolic) were

FIGURE 2 Student performing the standing broad jump assessment.

recorded by the technician who conducted the test. The participant then moved to the blood draw area (in the lab), which consisted of a table with three Multi-Care In® devices calibrated to the specific reagents for each blood variable (cholesterol, glucose, and triglycerides). Reagent strips were all from the same “stock” with similar calibration values. A single finger stick was used to provide drops of blood for each monitor to display the values. Values from each device were recorded by the test technician. Then each participant was asked to change into clothing appropriate for taking anthropometric measures.

Examiners at each station provided instruction and took anthropometric measures. The measures of stature (standing height), skinfolds, and waist circumference were all conducted using a standard technique. All skinfold measures were taken using a Lange skinfold caliper using standard sites. As expected, some intertest technician variability was observed. For the skinfold measure, each team member responsible for the skinfold measure was asked to take duplicate measures on the triceps of the quality assurance officer. The range for this measure was 6 mm to 12 mm. The measures of body mass and total body impedance were evaluated at this time using a multi-frequency BIA (Biospace InBody 720 or 520). In addition, the handheld Omron 306 was used (similar to field testing) as well as a measure of waist circumference. Measures from each the BIA device and tape measure were recorded by the examiner. Finally, grip strength measures were taken on each hand (left and right) in duplicate fashion. After these measures, participants returned to the group and were instructed to consume a sandwich, apple, banana, granola bar, and a liter of water.

The final test, the treadmill test, was conducted using a modification of the National Youth Fitness Survey treadmill test from National Health and Nutrition Examination Survey (NHANES). Treadmill testing occurred every 20 min to 30 min in an area separate from the other participants. The first test occurred 30 min to 45 min after meals were distributed.

The NHANES treadmill protocol involves one 2-min warm-up stage of walking followed by two 3-min exercise stages of varied speed and grade. This aerobic fitness test, which is normally terminated after the second exercise stage (at a heart rate $\sim 85\%$ of maximal), was extended by increasing the speed of the treadmill and continuing the grade to obtain a “maximal effort.” Each participant was verbally encouraged to run until fatigue (unable to keep pace with the speed of the treadmill). For this test, heart rate and a measure of oxygen consumption (VO_2) were measured during the test. Four to 10 electrodes were used in the standard modified limb lead and chest leads to monitor heart rhythm and heart rate. A face mask was used to collect expired air for the metabolic measures (minute ventilation, VO_2 , and carbon dioxide production). Each

metabolic system was programmed and integrated to the treadmill and electrocardiograph. The rate of VO_2 was measured at the end of each test and a “peak value” was recorded (in milliliters per kilogram body mass per minute). Heart rate, VO_2 , respiratory quotient, and workload (displayed in speed and grade) were displayed continuously during the testing period. Treadmill testing was terminated when the youth showed fatigue and/or indicated an inability to continue. Recovery occurred in a seated position while measuring blood pressure (once) and monitoring heart rate for 2 min to 3 min. No adverse events were reported, and all equipment was functioning as programmed.

Quality control was evaluated on the treadmill test results and indicated little differences in participant technique (some participants held the guard rails while others did not); however, values in the interpretation of maximal aerobic capacity were consistent. Some differences in equipment were evident because existing instrumentation was used for this aspect of the study. Treadmill and metabolic systems varied (two labs had the same Schiller system); however, all followed standard calibration procedures (same calibration gas standards). The quality assurance officer examined the laboratory testing procedures and found they had high internal consistency. Although there was evidence of interlaboratory variability, it was not thought to be a factor in the test data (Finn, 2013).

Data Analyses

All data were processed in a central office of the HSSF using standard data reduction methods and statistics appropriate for the study aims. The data were then shared with representatives from the Cooper Institute for collaborative data analyses. Concerns in interlaboratory and between-team data collection methods were shared with the Cooper Institute in the quality control report (Finn, 2013). A series of specific study questions was identified to test the validity of the field measures, describe the fitness levels of Hungarian youth, and test the utility of the Fitnessgram standards in Hungarian youth. The research articles in this *Research Quarterly for Exercise and Sport* (RQES) supplement summarize the key findings of these study questions for the HNYFS.

OVERVIEW OF RESEARCH PAPERS

The key findings of the HNYFS are reported in this RQES supplement. The article by Laurson et al. provides a cross-validation of Fitnessgram health-related standards in Hungarian youth in detecting metabolic syndrome in this representative sample. This article shows the prevalence of metabolic syndrome in Hungary and establishes relationships among the various fitness indicators of this condition (aerobic fitness, body composition, body mass index)

measured in the laboratory. The article by Welk et al. examines the distribution of health-related fitness by age, sex, and region based on the Fitnessgram interpretation using data from field measures. Two articles by Saint-Maurice et al. present the handgrip strength and standing broad jump standards from the field measures and use centile-specific scores to propose norm-referenced standards for Hungarian youth.

A key strength of the study is that a pool of participants randomly selected from those completing the field measures completed the laboratory testing. This subsample ($n = 482$) allows for comparison of test results in which to test the utility of certain field tests. Saint Maurice et al. examined the predicted versus measured peak VO_2 to cross-validate the PACER algorithms on an independent sample of youth. The direct measure of aerobic fitness (in the laboratory) allows for comparison between the peak VO_2 measured and estimated from the PACER. Finn et al. tested the agreement between the field and laboratory body composition assessment methods. The article showed that two alternative BIA devices provided different estimates of total body fat, and therefore, caution is needed when selecting a device or assessment for body composition.

The final article in the supplement provides input on the students' attitudes toward PE. Kaj et al. describe results from a PE attitude scale based on responses of high school students and examine how this scale is associated with aerobic fitness as measured by the PACER.

Collectively, this series of studies provides the foundation for the continued evolution and refinement of PE and school activity programming. The results provide baseline information about health-related fitness while also building the infrastructure for evaluating changes over time. The TESI project provides a platform to facilitate the specific goals outlined in the Physical Education Strategy 2020.

WHAT DOES THIS ARTICLE ADD?

This article provides an introduction to the HNYFS including the background by which to identify the rationale for such a study. In addition, the sampling method and measures used to obtain the data are described. This article serves as a model for other countries planning to engage in national fitness testing using school-based assessment and criterion health standards for interpretation. In many countries, the transition from normative performance-based standards to health-related criterion standards is still in progress. This partnership between the HSSF and the Cooper Institute helped to establish a model that could be systematically replicated in other countries. There is considerable interest in youth health issues worldwide, and some assessments in the Fitnessgram test battery have already been incorporated across the world (i.e., PACER).

This facilitates more effective international comparisons and collaboration.

In the coming years, sharing of information around the world will be forthcoming as cultures collaborate for economic and educational purposes. The ability to develop an assessment system by which to make decisions in educational and health initiatives is essential.

FUNDING

The NETFIT is implemented in the framework of a Priority Project (TÁMOP 3.1.13-12-2013-0001) of the HSSF with the financial support of the Hungarian government and the European Union.

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