Original Article

Methodological approaches to pedagogical control of the functional and motor fitness of the girls from 7-9 grades

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Abstract
The purpose of this study was to build a model for classification of motor and functional fitness in adolescent female students. To achieve this purpose, girls in 7th (n=31), 8th (n=26), and 9th grade (n=28) were recruited with appropriate parental consent. To build the classification model, each adolescent performed and number of motor tests and the Stange, Genchi, Serkin tests of functional state. Canonical discriminant function analyses were conducted to determine the motor and functional fitness contributions. Two significant functions (p<.001) resulted with the first function explaining 86.8% and the second 13.2% of the variance between grade levels. Based on the model, it was possible to classify girls' grade and thus biological age based on the performed tests. Structural coefficients from the first canonical discriminant function pointed to substantial difference between girls in 7th grade compared to 8th and 9th grade at the end of motor coordination's development as well as speed, power, and Stange's test results. Structural coefficients of second canonical discriminant function pointed to substantial difference between girls in 8th and 9th grade based on static and relative arm muscle strength. For improving and fully developing the pedagogic control of girls' motor and functional fitness, the first discriminant function should be used as it explained most of the grade differences.
Key words discriminant function, pedagogic control, classification, simulation, motor fitness, girls.

Introduction

Unquestionably, a great deal of human health and health behaviors are formed in during childhood and adolescence. There is no debating that over many decades, based on numerous data sets from countries across the globe, school children's health has worsened. In addition, there is a global push to increase attention and focus specifically on females. There are seemingly an unlimited number of research studies concerning school children's poor health. For instance from data collected in the Ukraine, Poland, and Canada, nearly 90% of pupils have deviations in health with about 50% with unsatisfactory physical fitness (Krutsevych, & Bezverkhnya, 2010; Arefiev, 2014). In Spain, only 37% of boys and 26% of girls between the ages of six and seven were engaging in at least five hours of physical activity per week (Spanish Sports Council, 2011). In the United States, only 17.7% of female and 36.6% of male high school students surveyed in 2013 indicated that they were active at least 60 minutes a day for the surveyed 7-day period (Centers for Disease Control and Prevention, 2014). Worsening of pupils' health is facilitated by little to no motor regime across segments of physical functioning at school, out of school, at physical culture lessons, in days off (Africa, & Van Deventer, 2015; Kim, & So, 2015). These facts point to the importance of in depth examination of more detailed analyses of adolescents' motor functioning. Unfortunately, in the scientific literature insufficient attention is paid to possibilities of discriminant analysis as method of improving pedagogic lessons directed towards children's and adolescents' motor and functional fitness. Assessment and determination of pupils' functional and motor fitness characteristics is still urgent and important. Therefore, the purpose of the present investigation was to build a model for classification of motor and functional fitness in adolescent female students to further methodological approaches aimed to improve pedagogic teaching practices of motor and functional fitness in adolescent females. Increase of pupils' motor functioning is facilitated by motivation for success, for interest in physical culture practicing (Gavrishova, & Gorelov, 2013; Muhumbe, & Gent, 2014; Liu, 2015); for correct choice of leisure forms (Rafal, 2013; Zaporozhanov et al., 2014); for usage of adequate to age motor tests (Bondarenko, 2011; Kozak, & Ibraimova, 2014; Kopylov et al., 2015; Arziutov, Iermakov, Bartik, Nosko, & Cynarski, 2016). Thus, the improvement in pupils' motor functioning can be achieved from properly structured physical education

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lessons appropriate to age and leisure activities. Concerning physical education, one of conditions of increase of pupils' motor functioning is organization of pedagogic control at physical culture lessons (Khudolii, & Titarenko, 2010; Krutsevych, & Bezverkhnya, 2010; Boraczyńska et al., 2014; Ivashchenko et al., 2016a, 2016b) and in conditions of sports training (Zaporozhanov, & Boraczynski, 2015; Iermakov et al., 2016; Iermakov, Podrigalo, & Jagiello, 2016; Kozina et al., 2016a, 2016b; Podrigalo, Iermakov, Rovnaya, Zukow, & Nosko, 2016). Control procedure acquires important significance in pupils' independent trainings. Research of influence of independently chosen physical loads on adolescents' physical fitness points at demand in correction of these training programs. Such programming interventions focsed on physical functioning facilitates increase of adolescents' physical abilities (Neto et al., 2014). Classification of current state of motor and functional fitness is a procedure of pedagogic control, which influences on taking decisions in monitoring of children and adolescents' physical education.

The current work proposes to use a different approach to the distribution of pupils into groups for organization of proper pedagogic control of their motor fitness based on past research. For instance, research has demonstrated the ability to classify 14 to 15 years in age girls into two groups based on fulfillment of 18 tests that determined distinctions in their morphological characteristics and motor abilities (Lulzim, 2012). Such analysis of discriminant functions permits to classify junior sportsmen in different groups of sportsmanship level. Combining of these results with participants' physiological and biomechanical variables permits to assess general effectiveness of such approach to training of junior sportsmen (Huynh, & Bedford, 2011). Research by Milojević and Stanković (2010) demonstrated that distinctions between that of 14–15 age adolescents. The authors reported four statistically significant distinctions for assessment of coordination, flexibility, explosive power, and strength. Increase of motor abilities in this age was predicted by results of tests for quickness (Milojević, & Stanković, 2010). The authors suggested their results to be logically influenced by genotype on development of motor abilities. However, certainly, there was an influence of education and extra-curriculum school programs on the students' coordination, flexibility, explosive power, and strength.

Models of motor abilities development, which can be used for current and summarizing control of children's and adolescents' fitness, are have been extensively researched (Khudolii, & Ivashchenko, 2014; Nosko, Razumeyko, Iermakov, & Yermakova, 2016). Within this line of research, Kozina and Iermakov (2015) demonstrated that youth may be classified into groups by indicators of functional and psycho-physiological potentials both of which are characteristics of nervous system. Khudolii and Ivashchenko (2014) examined and determined the characteristics of 7 and 8 form girls' motor fitness. The researchers reported that canonical discriminant function is appropriate for assessment and prognostication of motor fitness dynamic of secondary forms' girls. In addition, research from the previously mentioned authors, our determined characteristics of motor fitness dynamic of 7 and 8 forms boys with great success (Ivashchenko, & Khudolii, 2014). Thus, past research strongly supports the current research aimed to build a model for classification of motor and functional fitness in adolescent female students. The purpose of this research is to further methodological approaches aimed to improve pedagogic teaching practices of motor and functional fitness in adolescent females, who typically worldwide are less active than their male counterparts.

Methods
Participants
The participants were 85 girls in 7th (n=31), 8th (n=26), and 9th (n=28) grades that corresponded to an age range of 14 (7th graders) to 16 (9th graders).
Ethical Approval. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.
Informed Consent. All of the participants were involved in school based physical education and sports programming in the Ukraine. The research team fully informed the youth participants and their parents or legal guardians concerning all of the study features. Parents or the legal guardians signed informed-consent document that was approved by the Ethical Committee of University.
Procedure
In planning the research testing protocol, we used conceptual approaches in line with the development of scientific research programs in physical education and sports (Shiian, & Papusha, 2005). The physical tests (tests 1-6 below) from Liakh (2000) were performed: jumps with "additions", shuttle run, push ups, chin ups, bent arm hang, and the standing long jump. For assessment of functional state (tests 7-9 below), we used Stange's, Genchi's and Serkin's tests (Shiian, & Papusha, 2005).
The following equipment and procedures were followed for each test.
1. *Jumps with "additions"* required the following equipment: sector for jumps, chalk, and a measuring tape. The test was conducted as follows. The maximal jump was recorded. Then, 50% and 75% distances from the maximal jump were calculated. At distance the 50% distance, a line was drawn with chalk. For a better visual orientation, small cubes were placed (cones could be used as well) at the side of the line. At distance the 75% distance, a second line was drawn. The marking of these two spots provided the corridor of jumps with

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"additions". Then, within this corridor, pupils completed their jumps with "additions". Counting of additions is stopped, when each participant reached the second line or if in two jumps (fulfilled in succession) the students did not increase the length of jump. Results that were quantified were quantity of jumps with "additions" completed in the individualized corridor. The following general instructions were told to each student, "Do not jump with hard landing. You will get three attempts to determine your maximal jump distance; and for a better understanding of how to complete the the test you will be provided a trial attempt."

2. *Shuttle run (4×9 m)* required the following equipment: stopwatch; a level non slippery track of 9 m in length with two parallel lines at each end; and two wooden cubes (5×5×5 cm in dimensions). The shuttle run was conducted as follows. Behind each end line, 2 semi-circumferences, of 50 cm radius with center on the line were drawn. A wooden cube was placed in the center of each circle. Students started in the standing position on one end of the 9 m track. When instructed to begin, the student ran 9 meters up to second line and picked up one of two wooden cubes from semi-circumference and ran back to the starting line. The student then placed the cube in starting semi-circumference (no throwing, only setting down the cube). The student then ran in back in the previous direction, placed the cube down and returned with other cube. This ended the test. Time to complete the shuttle run was recorded to 0.1 of a second. Participants were instructed as follows, "You will be given two attempts. Your average of both attempts will be recorded as your score. The cubes shall be placed not thrown. If this requirement is not fulfilled, the test will be repeated."

3. *Pressing ups in lying position* required a level floor. The test was completed as follows: participant took a lying position with hands resting on the floor. Next, the student's arms were straightened and always shoulder width with fingers pointed forward. The torso and legs made a straight line with the tips of toes resting on the floor. Bending and unbending of the arms equal one successful push up. The number of these cycles was recorded as the result. On the "Go" command, participant began to rhythmically bend and unbend arms being straightened out at the top of each push up. The students were instructed as follows, "Brief contact of your chest with floor is compulsory. It is prohibited to contact your hips to the floor or bend your torso and legs or to stay in the up or down positions more than 3 seconds. Do not lay on the floor."

4. *Chin ups* required a secure horizontal bar sufficiently high enough to perform the test. To perform the test, participants hung on the bar with torso and legs in a straight line. On the "Go" command, the students began to rhythmically bend and unbend arms. Result is quantity of arms bending-unbending without stopping the rhythmic chin up motion. Students were instructed as follows, "When in the up position, it is necessary to contact bar with your shoulders. Please start in the fully extended down position. You are not allowed to stay in the down or up position for more than 3 seconds."

5. *Hanging on bent arms* required a horizontal bar sufficiently high enough to perform the test, a stopwatch, and gymnastic mats. The test was completed as follows: participant took the hanging position with bent arms with the help of instructor; torso and legs were straight in a vertical line; the chin was above bar. On the "Go" command, the students stayed this position as long as they could. Time in this position was recorded to the nearest 0.1 s. Students were instructed as follows, "You will hang as long as you are able. The test will be stopped once you lower your chin below the bar. Your hands will be shoulder width apart."

6. *Long jump* required a non slippery site with start line as well as lines marked in centimeters to record jump distance. The test was completed as follows: students stood with their toes just behind the start line and jumped forward by pushing off with their legs while using back and forward arm movement. The best of two jump was recorded. Students were instructed as follows: "Be sure to start just behind the line. Bend down and then jump forward as far as you are able. Land in a squat position. You will have two attempts. Your best jump will be recorded."

7. The *Stange's test* required each student to be in a seated position making a deep breath and exhalation, then breath (approximately 80% of the maximum), covering the mouth and nose simultaneously clamped fingers, hold your breath (stopwatch is included at the end of inhalation and exhalation is excluded from the start).

8. The *Genchi's test* required each student to repeadily hold her breath. The test required each student to student lie on a bench, takes an exhalation, and hold her breath. At that moment a stop-watch was started. The duration of interval between the each breath is defined by the stop-watch (seconds).The duration of interval between the each breath was measured by a stop-watch. The the time was recorded. This test conducted at least 5-7 minutes after performing the Stange's test.

9. The *Serkin's test* required each student to follow a lengthy procedure:
   1. A student sat on a bench.
   2. A student took an inhalation.
   3. The student was told to hold her breath. At that moment, a stop-watch was started.
   4. The duration of interval between the each breath is defined by the stop-watch (seconds). The stop-watch is stopped at the moment of breath. The result was recorded.
   5. A student then performed 20 squats within 30 seconds.
   6. Then the student repeated procedures 1, 2, 3, and 4.
   7. The student was allowed to rest for 1 minute.
   8. Then rprocedures 1, 2, 3, and 4 were again repeated.

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Statistical analysis

We performed the statistical analyses with IBM SPSS 20 (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.). We specifically used discriminant analysis to answer our research question. By using discriminant analysis, we were able to produce a prognostic model of group belonging. This model constructs a discriminant function or if more than one group, then sets of discriminant functions, in the form of a linear combination of predictor variables that ensure the best distribution of groups. The function or functions were built based on set of observations from which their belonging to groups is known. Most importantly for future research, it will be possible to use these functions to predict group classification with the collection of the physical test variables. For every variable, the following statistics were calculated: mean, standard deviations, single-factorial dispersion analysis for every variable, Box's M test, intra-group correlation matrix, co-variation matrices for separate groups, and general co-variation matrix. For every canonical discriminant function, we calculated own value, dispersion percentage, canonical correlation, Wilks' Lambda, and Chi-square. For every step, we reviewed the following statistical information: a priori probabilities, coefficients of Fisher's function, non-standardized coefficients of function, and Wilks' Lambda for every canonical function.

Results

The descriptive data for all of the test by each form group are found in Table 1. In addition, the test for equality of group means if found. All of the tests differed significantly (p<0.001). In the differentiation of motor space characteristics, the 7 form girls results were best (p<0.001). Across the form levels, test 1 perform deteriorated while speed-power abilities in 7-9 form girls statistically improved (p<0.001). Results of functional tests also statistically improved by form. The descriptive data suggested that 9 form girls were healthy. In Tables 2 and 3, the results of discriminant analysis, which permit to classify 7-9 forms' girls by functional state and motor fitness, are found. In Table 2, normalized coefficients of canonical discriminant function, which permit to determine correlation of variables' contribution in function's results, are presented. The highest contribution to canonical function 1 is made by variables of tests №2, №1 and №6. The higher is the value of these variables the higher is the value of function. The highest contribution to canonical function 2 is made by variables of tests №5, №4 and 8. Again, the higher is the value of these variables the higher is the value of function. First function explained 86.8% (p<0.001) of the variation in results and the second explained 13.2% (p<0.001). Thus, it was possible to classify age distinctions of 7-9 form girls on the base of functional, power and coordination fitness tests conducted.

Table 1. Results of analysis of motor and functional fitness test of 7-9 form girls

№ of test	Description of test	7 form (n=31)		8 form (n=26)		9 form (n=28)		Equality criteria of group means		
		x	s	x	s	x	s	λ	F	p
1	Jumps with "additions" (times)	3.8	.83	2.3	.78	1.7	.95	.483	43.846	.000
2	Shuttle run 4×9 meters, sec.	13.9	.73	11.9	.58	11.9	.22	.237	132.007	.000
3	Pressing ups in lying position (times)	10.8	3.07	16.0	9.27	19.5	4.98	.731	15.085	.000
4	Chin ups (times)	3.6	.75	5.2	2.53	4.4	1.79	.881	5.520	.000
5	Hanging on bent arms, sec.	18.5	3.29	14.6	9.40	31.1	12.34	.618	25.333	.000
6	Long jump from the spot, cm.	151.4	5.71	174.4	10.98	191.0	13.90	.282	104.338	.000
7	Stange's test, sec.	32.6	4.22	56.9	19.50	61.8	10.51	.474	45.556	.000
8	Genchi's test, sec.	20.2	3.29	31.4	10.80	39.3	11.18	.548	33.825	.000
9	Serkin's test, sec.	14.7	3.02	18.6	4.50	21.7	5.04	.673	19.922	.000

Notes: x – mean value; s – mean square deviation; λ –Wilks' *Lambda;* F – criterion; p – level of significance.

The structural coefficients of first canonical discriminant function, which are correlation coefficients of variables with function, are found in Table 2. The function correlates were the largest with variables in tests № 2, 6, 7, 1. These correlates suggested substantial difference between 7 form girls and 8-9 form girls with regard to motor coordination, speed, power, and Stange's test. Structural coefficients of second canonical discriminant function results suggested that the function correlates were the largest with respect to tests № 5 and 4. These function correlates indicated substantial difference between 8 and 9 form girls was observed in static and relative strength of arms' muscles.

Table 2. Results of discriminant analysis of functional and motor fitness of 7-9 forms' girls

№ of test (variables)	Description of test	Normalized coefficients Function 1	2	Structural coefficients Function 1	2	Coefficients of function for girls' classification Form 7	8	9
1	Jumps with "additions" (times)	.420	.354	.306	.001	9.618	5.922	6.249
2	Shuttle run 4×9 meters, sec.	.697	.453	.514	.334	60.009	51.143	51.224
3	Pressing ups in lying position (times)	.311	.557	-.177	.071	2.945	2.452	2.638
4	Chin ups (times)	.324	-1.046	-.079	-.191	-4.892	-4.591	-6.787
5	Hanging on bent arms, sec.	-.006	.988	-.125	.503	-.121	-.367	-.019
6	Long jump from the spot, cm.	-.837	.136	-.465	.205	1.522	1.941	2.138
7	Stange's test, sec.	-.342	-.116	-.310	-.072	.626	.801	.826
8	Genchi's test, sec.	-.370	.658	-.265	.115	.375	.442	.754
9	Serkin's test, sec.			-.214	.086			
	(Constant)					-573.744	-516.379	-567.189

The results of the group classifications are found in Table 3. The classification of groups was very high as 96.5% of the observations were classified correctly. In addition to the classification statistic, the coordinates of centroids for the three groups was provided in Table 3. These centroids permit the interpretation of the canonical function with respect to its role in the classification process. On positive pole there is centroid for 7 form and on opposite pole is the centriod for 8 and 9 forms suggesting substantial difference in fitness between the 7 form and 8 and 9 form girls.

Table 3. Results of classification of groups

Results of classification of groups		Predicted belonging to group 9	10	Total 9	Functions in groups' centroids Form	Function 1	2
Outputs	Classificator						
	Frequency 7	31	0	31	7 form	4.260	.406
	8	0	24	0			
	9	0	1	0	8 form	-1.416	-1.870
	% 7	100.0	.0	100.0			
	8	.0	92.3	.0	9 form	-3.401	1.287
	9	0	3.6	.0			

Discussion

The purpose of this study was to build a model for classification of motor and functional fitness in adolescent female students. In past research focused on physical education and sports, discriminant function has been used for classification of pupils by motor functioning (Gert-Jan, & Benjamin, 2011), for classification of groups into sportsmen and not sportsmen (Lulzim, 2012), for determination of physical condition dynamic of 9–12 years' age children under influence of fitness programs (Dorita et al., 2011). Specfically, we found two functions. The functions made it possible to classify age distinctions of 7-9 forms girls on the base of functional, power and coordination fitness testing. Structural coefficients of first canonical discriminant function point that substantial difference between 7 form girls and 8 and 9 form girls in motor coordination, speed power abilities and Stange's test results. Structural coefficients of second canonical discriminant function point to substantial difference between 8 and 9 form girls in level of static and relative strength of arms' muscles. Thus, our methodology and results supported the continued use of discriminant function analysis.

Application of discriminant analysis in our research allowed us to group pupils. This approached provided an answer to how confidently it was possible to separate one grade of girls from the other by the tested variables as well as answering which of the tested variables influence the distinguishing of grades to the largest extent. In addition, it permitted to classify the girls on the base of the discriminant function results. Results of our research point to the need for structural and functional analysis of children and adolescents' motor fitness. Several past research efforts (Kozina, & Popova, 2013; Kravchuk, & Kurochka, 2013; Tkachenko, 2014; Kuzmin et al.,

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2015) supported our results. Our conducted analyses confirm to separate 7 form or grade girls from 8 and 9 form or grade girls is possible with the tested set of variables focused on functional tests and tests of speed-power fitness. Our analysis showed that in testing 7 to 9 form or grade girls there are statistically signficant distinctions in functional fitness of respiratory and cardiovascular systems. We also observed statistically confident distinctions in coordination and speed-power fitness. By functional fitness girls were assessed as healthy though not trained.

Our results supplement past data specific to the importance of development of motor abilities in adolescents (Khudolii, & Titarenko, 2010; Solianik, 2013); to obtaining new information with the help of simulation method (Khudolii, & Ivashchenko, 2014; Ivashchenko et al., 2016), and to guide theory of optimal teaching (Podrigalo et al., 2015a, 2015b; Bliznevsky et al., 2016; Iermakov et al., 2016a, 2016b). Our results also supplemented past research findings concenring methodologic approaches to summarizing control of functional and motor fitness of adolescents (Ivashchenko et al., 2015a, 2015b, 2015c; Khudolii et al., 2015a; 2015b).

Conclusions

In conclusion, worldwide children and adolecents do not engage in recommended amounts of daily physical activity. Physical educaiton classes should be structured to teach motor skills that in general if develeoped would help encourage children and adolescents to be active. The present investigation provides a concrete roadmap for physical education class pedagogy concenring of motor and functional fitness specific to 7 to 9 form girls to help continue their physical development.

Conflict of interest

The authors report no conflict of interests.

Acknowledgements

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