Research Article

Evaluation of a Physical Exercise Intervention Program in the Youth (PiPy) Among Chinese University Students Based Upon Body Compositions and Phase Angle

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ABSTRACT

Objective: We have recently conducted a physical exercise intervention program in the youth (PiPy) among a cohort of Chinese university students. The current study aimed to evaluate this program based upon the changes of body compositions and phase angle.

Methods: A total of 772 students from in a university, China, were selected with a cluster sampling method. We conducted a cognition and physical exercise in PiPy and analyzed their exercise and ability. In the meanwhile, the changes of body compositions, including BMI, fat, skeletal muscle, phase angle and malnutrition rate were determined. Further analyses of these parameters in subgroups including lean, normal weight and over-weight were done.

Results: After PiPy, BMI in all subjects was slightly increased, while fat weight and malnutrition rate were significantly decreased. Skeletal muscle content in males was increased, while phase angle in females was relatively low. Furthermore, physical performance and nutritional changes were improved.

Conclusions: PHDT model simultaneously improve physical performance and cultural learning performance by improving BMI among Chinese college students. The magnitude of change may be affected by gender, base lined BMI and phase angle.

Keywords: Body composition; Body mass index; Phase angle; Physical Performance; Physical health driving model

Abbreviations: BIA: Bioelectrical Impedance Analysis; BMI: Body Mass Index; PA: Phase Angle; PHDT: Physical Health-Drive Teaching; PiPy: Physical Exercise Intervention Program in the Youth

INTRODUCTION

Physical Health Driven Teaching Model (PHDT) is used to adopt the concept and practice of body composition into the curriculum. Through physical health test- driven planning courses, teachers are needed to conduct body composition test training, and to interpret related indicators. Teachers are then required to master the bio-resistance of body composition [1]. The knowledge of resistance and other systems may help students to plan their daily Locomotive syndrome physical activity levels and to calculate the total energy consumption of each day. It also helps students to encounter the difficulties in practical operations and to achieve a healthy lifestyle. PHDT is a combination of sport planning and learning, effectively integrating physical education and physical health education. Teachers will incorporate the content of physical health indicators through the teaching activities of collective preparation and special seminars in the courses, and design the course content that addresses the physical health of each type of students in each class hour [2,3]. Indeed, PHDT, as a teaching method for body composition recognition, is important for physical education. Bioelectrical Impedance Analysis (BIA) is used to check body composition, which can accurately reflect the body fat and skeletal muscle content [4,5], while Phase Angle (PA) depends on formulas and anthropometric measurements [6,7]. Recent research has demonstrated that higher PA implicates higher proportion of complete cell membrane corresponding to cytoplasm and skeletal muscle [8,9]. Therefore, PA, together with

BIA, is important for judging malnutrition and has a very wide practical application for judging physical and nutritional status of body [10]. In term of physical education, PA, as an important indicator, is an important indicator for analysis of Body Mass Index (BMI), skeletal muscle and other body composition [11]. In school, students can learn and self-evaluate through modern body composition test such as PA to develop a physical exercise plan for the reasonable body composition goals [7,12,13]. In the mainland of China, almost 9 million of students from senior high schools participate in the national higher education entrance examination annually [14]. Due to the strong competition, the students are trapped by heavy homework and exams. Thereby, the inactivity of physical exercise among them is very common [15]. According to national student health standard in China, we have recently carried out a Physical exercise Intervention Program in the Youth (PiPy) in which the freshmen from high schools to a university were recruited [16]. In the present study, we have designed a PHDT model to evaluate the effectiveness of curriculum reform and the rationality of physical education teaching and learning. The main indicators of body composition, including BMI, skeletal muscle content, fat, PA, and physical performance were included for our analyses. Data from this study may provide with experiential practical information to change the ability of physical learning, to improve physical teaching and to solve intelligent sport learning with high initiative.

MATERIALS AND METHODS

Subjects

From September 2016 to June 2018, a total of 446 subjects (371 males and 75 females) in experimental groups were selected from the freshman in Nanjing University of Aeronautics and Astronautics, China by using the cluster sampling method. In addition, the control groups of 326 subjects (238 males and 88 females) were included in the analysis. This study was approved by the Ethics Committee of Nanjing Medical University, and all subjects signed informed consent. According to the "Recommendations on Classification of Chinese Adult Body Mass Index", the above subjects were divided into three groups, including lean (BMI <18.5 kg/m^2), normal weight (18.5 ≤ BMI ≤ 23.9 kg/m^2), and overweight (BMI ≤ 24.0 kg/m^2) [17,18].

Physical health-driven teaching model

PHDT used in the present study was designed after reform and divided into five links: The first was to set a number of tasks precisely, such as the relationship between endurance, strength improvement and body composition. Teachers can provide students with their own test data. Students can reflect on and list the changes in the past week. The second was the planning trial link. In this link, teachers need to create communication and sharing situations to guide students to compare the results of their current tasks with other students. The third was the improvement link. Teachers randomly select the corresponding group members to report energy consumption and share with their peers. The teachers then evaluate the students' understanding and understanding of body composition knowledge in physical exercise from a professional perspective. The fourth was the peer

sharing. This kind of reporting member's uncertainty can urge members of the group to actively participate in solving their own problems to a certain extent, so that it can be summarized by self-operation and used outside of the classroom. The fifth was the summary link. It was to guide students to find the differences and gaps between them and other classmates. The students should be given targeted guidance, and consider their own shortcomings and how to improve them better. At the same time, teachers can also use this link as a basis to carry out a new round of capacity-building.

Data test method

The information was collected in the form of online questionnaires, which mainly include general information such as age, gender, eating habits, physical activity and physical education courses. The baseline data collection date was September 2016. Observation of the implementation of PHDT was ended in January 2017 as the first semester, the second semester ended in June 2017, the third semester ended in January 2018, and the fourth semester ended in June 2018. End statistics were compared with baseline surveys. Furthermore, the field composition data were tested on the spots, while Seca mBCA (model 5570021159, Germany) was used to measure body composition data such as PA, skeletal muscle content, and fat content.

Statistical analysis

Statistical analysis was performed using SPSS 20.0 software. Continuous variables are represented by mean standard deviation, while categorical variables are represented by frequency and corresponding percentages. Paired t test was used to analyse whether there was statistical difference before and after the intervention of the same indicator. Two independent sample t-tests and one-way ANOVA were used to compare the differences in each indicator before and after PHDT intervention between different groups. Chi-square test was used to compare the count data after each data change between groups. A two-sided test of P<0.05 was considered statistically significant.

RESULTS

Implementation steps of control and experimental groups in PHDT

We first designed PHDT and applied this teaching model for the students in a university, China, for the period of two years. The implementation steps of control and experimental groups in PHDT are represented in Table 1. Reports on the development of PHDT in different semesters demonstrated that there was a large contrast between the control and experimental groups. In the experimental group, the majority of students had a great development relationship between the use of PHDT models and physical education curriculum.

Changes in all male and female subjects from baseline and after PHDT

We then analysed the changes in various indicators between control and experimental groups before and after PHDT. Comparative tests according to the baseline BMI were stratified for gender difference. Results of all male and female subjects between

control and experimental groups are summarized in Tables 2A and 2B, respectively. Data demonstrated that along with levels of physical exercise were increased from semester 1 to 4; body fat was gradually decreased, while BMI and skeletal muscle were increased in both male and female subjects. Specifically, during the first semester, male subjects in the experimental group had an average body weight reduction of 1.16 kg from 14.49 kg to 13.33 kg, and females from 13.60 kg to 12.73kg. The mean reduction of body weight was 0.87 kg (both P<0.001). Consequently, BMI was increased mainly due to the skeletal muscle was increased while body fat decreased. The composition ratio of the experiment to

control group had improved significantly (all P<0.001). Of all students, the subjects with normal weight were accounted for 473(61.3%), obese subjects were 179 (23.2%), and lean subjects were 117(15.2%). Thereby, we further analysed the data in the subgroups of subjects with normal body weight, over-weight and lean, and the results are attached in Supplemental Tables 1-3. According to the analysis of subgroups according to BMI and gender stratification, the changes of indicators between the control and experimental groups were consistent with the overall population (Tables 2A and 2B).

Table 1: Implementation steps of control and experimental groups in PHDT.

Item	Control group	Experimental group
772 people in the baseline survey.	326 people in September 2016 (238 males and 88 females).	446 people in September 2006 (371 males and 75 females)
Course content setting.	General teaching, physical fitness of the 1st and 3rd semesters is mainly 1000 meters (males)/800 meters (females) of endurance, the 2nd and 4th semesters are mainly 50 meters, and the 1st semester of basic physical education 2, 3, 4 optional courses.	In addition to the normal teaching, the 1st and 3rd semester, physical fitness is mainly based on the endurance of 2400 meters. In the 1st semester, basic physical education and physical health drive integrated education. Normal weight, low weight and super-restructured students are treated differently and practiced in groups. The 2nd, 3rd and 4th semesters are mainly based on extracurricular guidance to help low-weight, super-restructured students gain muscle and reduce fat.
Specific implementation of the classroom.	Student unified learning exercises Teacher explanations, imitations, and group exercises.	In addition to the physical education teaching form on the left, the three groups practice different exercise intensity, and the content includes five links: 1. Precisely set multiple tasks; 2. Planning trial link; 3. Improvement link; 4. Peer sharing link; 5 Summary link.
Four semesters are used to control the quality of students after class.	The extracurricular exercise punch card is arranged by the department of physical education.	Form three different We Chat groups, and combine body composition test results during exercise. Students communicate with each other. Teachers provide timely guidance, including exercise trajectory, pace, heart rate.
Course evaluation.	Mainly based on options and taking into account sports quality assessment, unified standards for teacher assessment.	In the 1st semester, a variety of assessment methods are provided. The combination of the progress of students' sports performance and the good indicators of body composition testing is combined to increase the combination of student self-assessment, student mutual assessment and teacher assessment.
Activity strategy.	No consideration of the student's physical changes, the practical value of the teaching content is not high, lack of timeliness, pertinence, and long-term.	Promoting students' awareness of physical changes through physical health-driven teaching, providing students with opportunities for discussion, cooperation, reflection, multimedia and other methods of learning, learning is time-sensitive, targeted and long-term.
Data testing and collection.	Collect information in the form of an online questionnaire, and use SecamBCA (model 5157021159) to test body composition data such as body mass index BMI, skeletal muscle content, absolute fat, and phase angle. Sports performance of 50m, 1000m/800m, standing long jump test January and June 2017, January and June 2018, respectively, the statistics and baseline survey were compared.	

Table 2A: Changes in all male subjects from baseline and after PHDT.

Item	Baseline	Semester 1	Semester 2	Semester 3	Semester 4
BMI (kg/m²)	22.20/22.13	0.33/0.30*	0.11/0.12	0.52/0.45**	0.31/0.20**
Fat (kg)	11.80/12.02	-0.22/-0.89*	-0.43/-1.05*	-0.94/-1.8*	-0.9/-0.7*
Skeletal muscle (kg)	26.53/26.15	0.21/0.56**	0.23/0.20	0.04/0.08	0.34/0.38*
Phase angle (°)	5.43/5.33	0.19/0.25**	0.20/0.26**	0.23/0.26*	0.29/0.26*
Average grade point	-	3.07/3.30*	2.87/3.11*	3.25/3.21	3.0/3.12**
1000 meters (min)	257.2/256.4	-2.9/-11.7*	-	-12.2/-13*	-
Standing jump (cm)	222.8/213	8.69/19*	3.4/12.6*	-	7.1/20.3**
50 meters (min)	7.52/7.55	-	-0.07/-0.12*	-	-0.06/-0.05*
Malnutrition rate	15.3%/21.8%	0.6666667	0.6044776	0.5878378	0.6618705

Data were the difference means between control (n=238) and experiment (n=371) groups. *P<0.05, **P<0.01.

Table 2B: Changes in all female subjects from baseline and after PHDT.

Item	Baseline	Semester 1	Semester 2	Semester 3	Semester 4
BMI (kg/m²)	20.61/20.64	0.47/0.09*	0.42/0.13**	0.65/0.42**	1.36/0.62**
Fat (kg)	16.73/16.81	-0.20/-0.87*	-1.07/-1.16*	-1.29/-1.76*	-0.79/-0.60*
Skeletal muscle (kg)	16.71/16.09	0.20/0.86*	0.36/0.49*	0.10/0.02**	0.31/0.43**
Phase angle (°)	4.53/4.44	0.07/0.24*	0.20/0.24	0.21/0.26*	0.29/0.31*
Average grade point	-	3.07/3.23*	2.87/3.10**	3.25/3.28	3.0/3.10*
800 meters (min)	254.0/246.3	-13.9/-19*	-	-11.7/-13.1*	-
Standing jump (cm)	167.3/163.9	1.1/10.7*	-3.3/6.1**	-	1.0/7.6**
50 meters (min)	9.38/9.4	-0.36/-0.44*	-	-0.23/-0.45*	-
Malnutrition rate	81.8%/82.7%	0.482085	0.752	0.85034	0.99375

Data were the difference means between control (n=88) and experiment (n=75) groups. *P<0.05, **P<0.01.

Evaluation of PDHT in comparison with traditional teaching model

We finally evaluated the effects with PDHT in comparison with traditional teaching model. Table 3 demonstrates the teaching content and action of students who achieve physical fitness and drive BMI in physical education course. Characteristics of BMI, skeletal muscle content, body fat, and PA of the four semester students from the baseline and after PHDT were analysed (Tables 2A and 2B). The muscle gain of students in the third semester was not as good as the second and fourth semester. Students lose a certain amount of muscle, so muscle development and content may have semester characteristics. For teachers, in order to avoid the effect of long distance running on muscle gain, the actual situation of students should be fully considered during the two semesters. On the one hand, teachers design more flexible strength exercises to increase muscle and guide Students focus on muscle gain. The achievement of exercise goals through extracurricular activities. In the classroom, students are provided with a scientific physical exercise experience, which enables students to harvest knowledge in a pleasant atmosphere to achieve teaching goals. According to the students' physical fitness, body composition, and learning effects, it is feasible to implement the content-driven teaching model of physical fitness for college students. The traditional teaching model neglected the student's subject status, neglected the students 'healthy and coordinated development in the future, neglected the improvement of students' personality and ability, neglected the use of modern instruments, and neglected the scientific development concept. Through the application of PHDT model, the learning atmosphere of the entire classroom is very lively, and the extracurricular participation rate is high. Survey statistics of effects with PDHT in comparison with traditional teaching model is summarized in Table 4. It can be seen that 72.4% of the students in the experimental group like physical activities, and 81.8% of the students like physical education. The number of students who like physical activities and lessons is low.

Table 3: Teaching content and action of students who achieve physical fitness and drive BMI in physical education course.

Course session	Course goals	Status quo	Teaching content	Teaching action
Precisely set up multiple tasks.	Everyone is educated.	Individual characteristics and physical abilities Vary.	Lean students are mainly based on the proportion of power load. Overweight students are mainly based on the proportion of aerobic endurance load.	Teachers provide students with their own test data, classmates reflect and list the changes over the past week.
Planning session.	Effect of BMI on human health.	Focus on physical fitness.	Rising phase angle-weight gain-muscle growth- sleep quality improvement-reduce water accumulation in the body. Decreased phase angle-weight loss-muscle loss-malnutrition-possible heavy exercise-edema.	In this session, teachers need to create a situation of communication and sharing, and guide students to compare the results of their current tasks with other students.
Improvement session.	Gain muscle and lose weight.	Change students' misunderstanding of light weight.	The contraction of skeletal muscles supports any physical activity and physical activity of the human body, and directly determines the strength and endurance of the human body.	Energy consumption report to share with peers. Teachers then evaluate students' knowledge of body composition knowledge from a professional perspective.
Peer sharing session.	Successful changes of body composition.	Personal characteristics for exercise.	Analysis of the learning results of students with good body composition in culture and physical education.	To a certain extent, you can urge all team members to actively participate in solving their own problems, which is convenient for the use of extracurricular self-operation.
Summary session.	Thinking deficiencies for better improvements.	Know clearly what I need.	Develop self-learning ability.	Guide students to discover their differences and gaps with other students, and give students targeted guidance.

Table 4: Survey statistics of effects with PDHT in comparison with traditional teaching model.

Traditional teaching model (n=326)	PDHT model (n=446)
59.9% students like physical activities, and 51.4% students like physical education course.	72.4% students like physical activities, while 81.8% students like physical education course.
52.1% of students have exercise goals.	71.2% of students have exercise goals.
27.4% are active 0.5 hours per day.	60.0% are active 0.5 hours per day.
37.1% have almost no physical activity every day.	Only 13.1% left with almost no physical activity.
The average rate of participation in sports clubs is 18.7%.	The average rate of participation in sports clubs is 41.7%.
All teachers scored 82.4.	All teachers scored 91.5.
32.6% of students agree that exercise can change unhealthy life.	76.6% of students agree that exercise can change unhealthy life.
32.1% of students think they have learned exercise methods.	82.3% of students think they have learned exercise methods.
14.7% students will design exercise programs for themselves.	89.6% students will design exercise programs for themselves.
84.3% pass rate in sports.	96.4% pass rate in sports.

DISCUSSION

Su et al. [16] designed a PHDT model to evaluate the effectiveness of curriculum reform and the rationality of physical education teaching and learning, based upon an intervention program named as PiPy in China. Results demonstrated that BMI in subjects, after physical education with PHDT, was slightly increased, while fat weight and malnutrition rate were significantly decreased. Skeletal muscle content in male subjects was increased, while phase angle in females was relatively low. Furthermore, physical performance, learning performance, and nutritional changes were improved. According to the 1985-2014 student physique and health survey data, Chinese college students have increased their height and weight, their physical fitness has continued to decline, and the obesity detection rate has continued to increase [19]. The present study also implicated that correctly guiding the learning and training through specific situations had a significant effect on weight loss. Thus, PHDT allowed students to master the skills of self-learning and develop the ability of self-learning. The magnitude of PA determines a person's nutrition and fatigue status, and to some extent is a comprehensive reflection of changes in body composition indicators [7]. In the present study, we further analysed PA and found that subjects with more physical activity had higher PA and better nutritional status in both males

and females (Tables 2A and 2B). After PHDT intervention, PA of males in the experimental group was increased by 0.25 degrees, females increased by 0.24 degrees (both P<0.001), while males in the control group increased 0.19 degrees, and females increased 0.23 degrees (both P<0.001). The malnutrition rates of baseline indicators in the control and experimental groups were 38.7%/34.0% for males and 22.7%/0.7% for females. The experimental and control composition ratios (both P<0.001) had been improved significantly. Malnutrition is a serious problem for the health of college students, while young people should have moderate fat because it is essential for energy storage and nerve pads to support internal organs. Abdominal organs in students are prone to sagging, poor muscle nourishment, indigestion and fasces, fatigue, and endurance [20]. We thus guided students to strengthen their muscle strength and exercise with a reasonable dietary intake. Consequently, students found malnutrition and took corrective measures in a timely manner, so that they could truly understand that health and beauty are the foundation of physical beauty. We evaluated PHDT and found that in the experimental group, the average score of two-year in male subjects was 3.12, which was 0.17 points higher than that of the control group, and that of the females 3.45 was 0.20 points higher than that of the control group. In parallel, the physical performance of males and females in experimental group was increased. PHDT model requires students to pay attention to their physical health. Physical health is a prerequisite to ensure good learning for college students. This model is mainly to cultivate students 'self-learning ability, so students' physical learning ability has improved, and cultural learning performance has also improved.

CONCLUSION

We also evaluated PHDT by comparison with traditional physical education. Traditional physical education has neglected the light body reorganization crowd. For light body reorganization students, we must recognize that reasonable nutrition and physical exercise are both means to improve human health. Nutrition is the basis of human health. Physical exercise plays a solid role in training students. The two together escort human health. Physical health-driven teaching model requires students to combine reasonable nutrition with physical exercise in order to finally achieve the goal of human health. We have proven in the process of physical education that through specific design of classroom situation training, students can master the skills of autonomous learning and develop the ability of autonomous learning. Therefore, PHDT has realized the concept of lifelong physical education in school physical education, achieving a good effect. In conclusion, data from the present study indicate that two years of physical education intervention based on body composition and PA, the PHDT model can simultaneously improve physical education and cultural performance by improving college students' BMI, while the magnitude of change is affected by gender and baseline BMI and PA influences.

COMPETING INTERESTS

None declared.

ETHICS APPROVAL

The ethics approval of the present study was obtained from Research Ethics Committee in Nanjing Medical University, China (No. 2016-290).

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