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Automated Complex Evaluation System of Physical Health

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Introduction

World health organization is describing health as a physical, mental and social well–being. It depends from lifestyle, gene pool, environment, medicine and health care system and other factors. In this article we are analyzing one of the components of health – physical health and its complexity. Physical health depends directly from the level of physical activity. Investigations of physical activity are being done for a long time. There are a lot of methods for health–related physical activity research. Scientists recommend frequency, intensity, time and type of physical activity according age and gender. This information is incomplete to particular population groups (such as students) for maximum effect of health–enhancing physical activity. A lot of tests and measurements are done in order to evaluate state of physical health, but the main problem for health care specialists is to make "general" conclusion and to "join" several measurements into one complex quantitative conclusion [1]. Human body is a complex system which functioning depends from its components and relations between them [5, 9, 10, 11, 12]. Most of assessment methods describe state of different human body systems (cardiorespiratory, musculoskeletal and others) but in most cases we don't know relations between them [9, 10, 11]. Mathematical modeling of human physiology is a tremendously ambitious task – the complexity of the problems often stimulates the use of innovative mathematical techniques that are able to capture accurately processes that occur at multiple scales in time and space, and that are governed by heterogeneous physical laws [5]. Physical activity influence on health is well known for a long time [7], but its evaluation still provides problems for health researchers for particular population groups. One of the main problems in the researches of physical activity nowadays is to join several measurements into one quantitative conclusion for the complex analysis. As a solution of such a problem automated complex evaluation system of physical health was created. The main task is to create web–based database with the user–friendly interface for the collection, storage and complex analysis of physical health parameters of the students. Such a system could be incorporated to e–health services systems or might be used for local or national physical health monitoring for different population groups.

Description of automated complex evaluation system of physical health

Automated complex evaluation system of physical health was developed in Kaunas University of Medicine, Department of Kinesiology and Sports Medicine. This internet based software system was developed for the data collection, storage, complex analysis and monitoring of student's physical health. It consists of web browser(s), internet connection, server (with installed *PHP 5.2.6*) and installed database (*MySQL 5.0.67*) (Fig. 1).

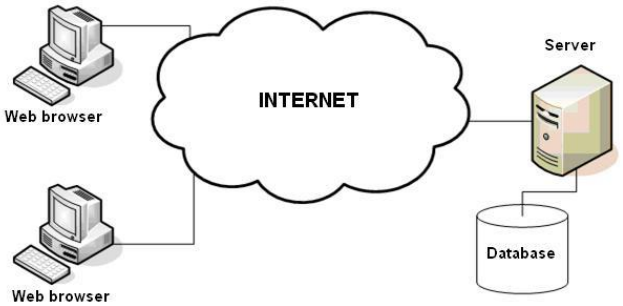

Fig. 1. The principle scheme of developed automated complex evaluation system of physical health

Users can reach the system using most popular internet browsers – *Internet Explorer v7.0; Opera v9.27; Firefox v3.0* and later versions by browsing the web page www.fizinesveikata.lt (web page name in English – physicalhealth.lt). In order to use the system the users must log in only authorized users can do that. Different types of users can log in to the system – it depends on the priority of the users which is limited. Different priority users can do several of actions working with the software. Allowed actions and user types are showed in Fig. 2.

All students attending lectures and practice in the Department of Kinesiology and Sports Medicine at Kaunas University of Medicine are performing different type of physical fitness tests, measuring their own physical health status and filling questionnaires during study subject – "Promotion of Personal Health".

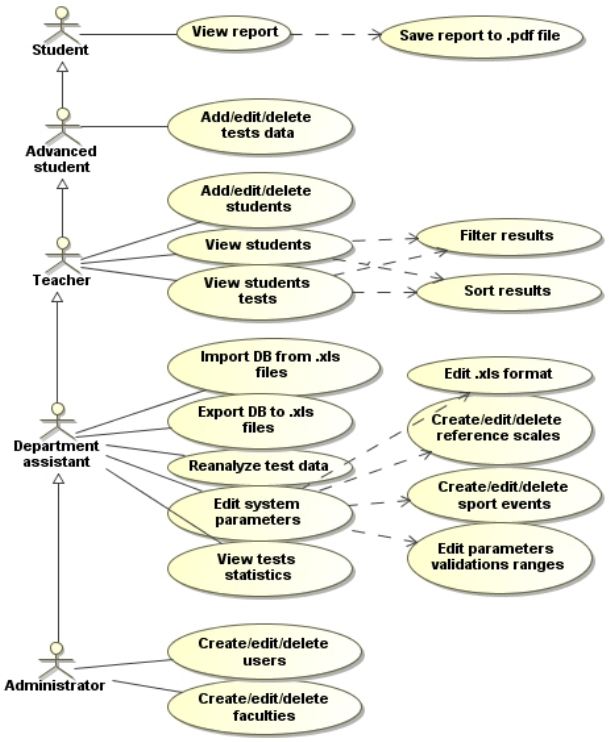

Fig. 2. Types of users and allowed action working with the software

During the semester they are filling special data sheets with their own tests results. Complex evaluation system of physical health consist separate measurements, which are grouped according physiological significance into:

- Evaluation of physical state includes measurements of physical development (height and weight), vital capacity of the lungs, hand dynamometry, pulse and systolic blood pressure at rest, pulse recovery after 20 squats [2, 3].
- EUROFIT – European tests of physical fitness; All the students performed Eurofit tests of physical fitness. Not all the tests from Eurofit test battery were used; bent arm hang test for evaluation of functional strength was eliminated. A lot of students couldn't perform this test at all, so we have decided to extract this test from the sequence of testing procedure. In this research we have used tests of physical fitness [4]:

1. "Flamingo balance" test (number of attempts/1 min) for the evaluation of the total body balance;
2. "Plate tapping" test (sec) for the evaluation of speed of the limb movement;
3. "Hand grip" (kg) for the evaluation of static strength of the hand;
4. "Standing broad jump" test (cm) for the evaluation of explosive power of the leg's muscles;
5. "Sit and reach" test (cm) for the evaluation of the flexibility of the trunk;
6. "Sit – ups" test (times/30 sec) for the evaluation of the trunk strength;
7. "Shuttle run: 10 x 5 meters" test (sec) for the evaluation of running speed – agility;
8. "Endurance shuttle run" (min) for the evaluation of cardio–respiratory endurance.

- Body Composition assessment covers body mass index, measured skinfolds, calculated body fat and fat free mass. Caliper was used to measure skinfolds. Triceps, suprailium and thigh skinfolds were measured for females and chest, abdomen and thigh – for males [8].
- Waist – hip ratio assessment shows the risk of cardiovascular diseases [8].
- Endurance of the trunk muscles consists of the measurement of the endurance of the back and abdomen muscles.
- 2 km walking test shows the level of cardiorespiratory endurance by calculating physical capacity index according walked time, pulse after the walking, age and body mass index [4];
- Baecke Questionnaire of Habitual Physical Activity is a tool to "measure" the level of daily physical activity at work, during sports, leisure time and in general by converting the answers to the questions into the points [6];
- Low back pain questionnaire consist of 3 questions about ever felt low back pain, felt pain in 1 year period and present low back pain;

Each measurement in the groups is converted into points (the more points – the better result is). Intervals of the points were calculated according normal distribution. In the final report each group of measurements has visual form – the graph showing the level.

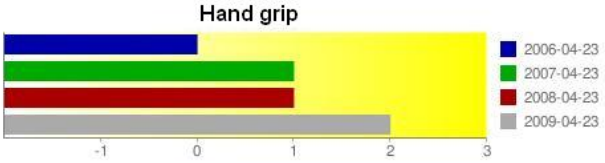

Fig. 3. View of the hand grip test

Group of measurements according physiological significance (for example evaluation of physical state, body composition, Eurofit and others) were showed as a percentage from 0 to 100 %.

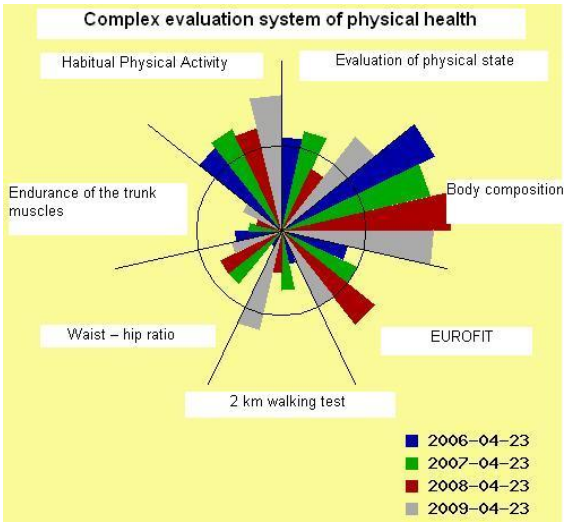

Fig. 4. Radar graph of complex parameters in the final report

At the end of the study semester all tests results entered to the system and saved in the database. Each student, teacher, department assistant or administrator (according to the given priority) is able to review student's tests results and to print a report with conclusions (.pdf file). Student is able to review only his personal data and to compare his own results with the mean of university students and to compare present results with own earlier results (if there is more than one record).

Results

Developed automated complex evaluation system was practically implemented for the analysis of student's data of 12 years period (1997 – 2009). We have imported 1972 records of female and 876 records of male students into the software in order to test the system and to calculate complex percentage parameters. We have analyzed data of students in all faculties of the university: faculty of nursing, faculty of pharmacy, faculty of odontology, faculty of medicine and faculty of public health. Complex analysis of female results showed similar tendencies in all faculties. The highest (more than 80%) complex parameter was body composition (BC); it means that females had normal values of the body composition (normal distribution and proportion of fat, muscles and bones in the body). Level of habitual physical activity was over 60% (HPAQ) and it means that female students were physical active. It explains normal body composition; the more people are active during a day, the more energy they are "burning" for the movements. Unfortunately level of physical fitness (Eurofit) and endurance of the trunk muscles (ETM) were the lowest (about 20%) (Fig. 5). It points to the future risk on health. Low level of the endurance of the trunk muscles (ETM) may lead to the low back problems and pain in the future. According to the calculations we can state that students are enough physical active and they are burning enough energy during their activities, but they are not fit and strong enough, which may lead to the physical health problems and cardiovascular or musculoskeletal disorders in future.

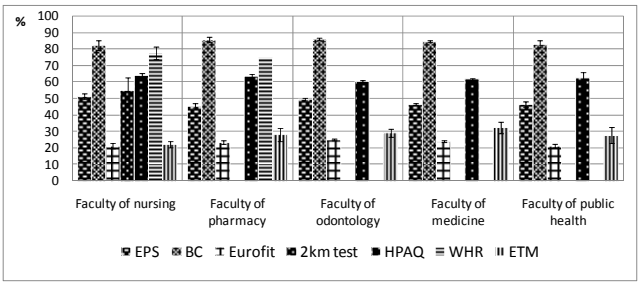

Fig. 5. Complex parameters of physical health of female students during 12 years period in 5 faculties at Kaunas University of Medicine. EPS – evaluation of physical state; BC – body composition assessment; EUROFIT – European tests of physical fitness; 2km test – 2 km walking test; HPAQ – Baecke Questionnaire of Habitual Physical Activity; WHR – Waist – hip ratio assessment; ETM – Endurance of the trunk muscles.

Similar tendencies of complex parameters were observed in the male students. The highest scores (over 60%) were observed in the body composition (BC) parameters. Students in the faculty of pharmacy had lowest waist–hip ratio (WHR), which shows low risk of cardiovascular diseases. Level of habitual physical activity (HPAQ) was over 60% in all faculties except among students in the faculty of public health. Level of physical fitness (Eurofit) didn't reached 50% among students in all faculties. This shows poor physical capacity of students. Most of the assessments were done in the first years of the studies and poor level of physical fitness might be associated with the lack of physical exercises in the school. Endurance of the trunk muscles (ETM) of the male students was measured only in faculty of nursing and odontology and the level of ETM was only 20% (Fig. 6). Low level of endurance of the trunk muscles reflects high risk of low back pain, which is one of the most widespread risk factors of musculoskeletal system among dentists.

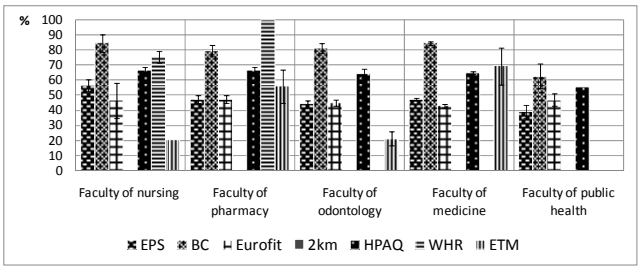

Fig. 6. Complex parameters of physical health of male students during 12 years period in 5 faculties at Kaunas University of Medicine. EPS – evaluation of physical state; BC – body composition assessment; EUROFIT – European tests of physical fitness; 2km test – 2 km walking test; HPAQ – Baecke Questionnaire of Habitual Physical Activity; WHR – Waist – hip ratio assessment; ETM – Endurance of the trunk muscles.

Created automated complex evaluation system of physical health implemented to the system allows joining several measurements into one conclusion converting measured units into percentage. It enables a possibility for complex analysis of different measurements with different units and to compare these parameters.
Web–based analysis system might be incorporated to the e–health services or might be used for the monitoring of physical health of students or other population groups.

Conclusions

1. Automated complex evaluation system of physical health was created in order to collect, store and analyze parameters of physical health.
2. Web–based database was created for the easier and controlled collection and storage of the data.
3. Complex evaluation of physical health parameters was developed and incorporated to the analysis software.

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Л. Шюпшинскас, А. Мичулис. Автоматизированная комплексная система оценки физического здоровья // Электроника и электротехника. – Каунас: Технология, 2009. – № 8(96). – С. 103–106.

В этой статье мы анализируем один из компонентов здоровья – физическое здоровье и его комплексность. Одна из главных проблем в исследованиях физической активности в настоящее время заключается в том, чтобы объединить несколько измерений в одно количественное заключение для комплексного анализа. Для решения этой проблемы была создана автоматизированная система комплексной оценки физического здоровья. Основная задача заключается в том, чтобы создать интернет–базу данных с удобным для пользователя интерфейсом для сбора, хранения и анализа комплексных физических параметров здоровья учащихся. 1. Автоматизированная система комплексной оценки физического здоровья была создана в целях сбора, хранения и анализа параметров физического здоровья. 2. Интернет–база данных была создана для простой и контролируемой сборки и хранения данных. 3. Комплексная система оценки параметров физического здоровья была разработана и включена в программное обеспечение. Ил. 6, библ. 12 (на английском языке; рефераты на английском, русском и литовском яз.).

L. Šiupšinskas, A. Mičiulis. Automatizuota kompleksinė fizinės sveikatos vertinimo sistema // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2009. – Nr. 8(96). – P. 103–106.

Viena iš nūdienos problemų, su kuria dažniausiai susiduria sveikatos tyrėjai – kompleksiška atskirų matavimų analizė apibendrinant įvairiais matavimo vienetais išmatuotus parametrus, turinčius fiziologinę prasmę. Kaip vienas iš šios problemos spendimo būdų buvo sukurta automatizuota kompleksinė fizinės sveikatos vertinimo sistema, kurios tikslas – interneto ryšiu pagrįsta duomenų bazė su vartotojui palankia sąsaja studentų fizinės sveikatos vertinimo duomenims rinkti, saugoti ir analizuoti. Sukurta duomenų bazė su duomenų įvedimo kontrole ir patogia vartotojo sąsaja, taip pat sukurta ir integruota į programinę įrangą kompleksinė duomenų vertinimo sistema. Il. 6, bibl. 12 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).