Human Morphofunctional Indicators-Based Decision Support System for Choosing Kind of Sport

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Abstract

The current state of school-age children and adolescents' involvement in sports in Ukraine in the period before the pandemic and full-scale military operations and now was analyzed. The consequences of a sedentary lifestyle and their impact on the health of children and adolescents are reviewed. The method and algorithm of Human Morphofunctional Indicators-based Decision Support System for choosing kind of Sport are proposed. An algorithm for dividing the kinds of sports that are cultivated in the region into sports for which the child has a high, medium, and low propensity based on the analysis of individual morphofunctional indicators of the child is also proposed.

Keywords

Decision Suppors System (DSS), sport for children, human morphofunctional indicators, IT solutions for sport

1. Introduction

The issue of having a healthy lifestyle is important and relevant today, as a healthy youth is needed for a successful country. Modern informatization of society has a negative impact on the health of the young generation. Online classes, social networks and computer games are increasingly leading to a sedentary lifestyle. According to nationwide youth survey results conducted by GFK Ukraine on the order of the Ministry of Youth and Sports and with the support of the UN system in Ukraine in 2015, it is possible to observe rather low indicators of youth involvement in various sports. One of the questions was: "What kind of sport have you been doing during the last 12 months?". The most popular were fitness or physical exercises (45%), jogging (30%), and football (25%) was only in third place. This is followed by swimming (23%) and cycling (21%), which are not at all among the most popular sports in the ministry's annual report. Then volleyball (11%), yoga and basketball (6% each). The results are shown as diagram in Figure 1 (a).

The survey also asked the question "What prevents you from doing sports (various types of physical activity)?", during which 26% of respondents answered that nothing prevents them from doing sports, but for certain reasons they do not do it. And 14% complained about a lack of willpower and self-discipline (Figure 1 (b)). [1].

According to statistical data obtained as a result of a sociological survey conducted by the Friedrich Ebert Foundation in Ukraine in 2017, 33% of young people aged 14-29 do sports in their free time often and very often, 18% never do it, and 46% occasionally or sometimes. In addition, the regularity of classes also decreases with age — from 48% among teenagers to 25% among 25–29-year-olds. The

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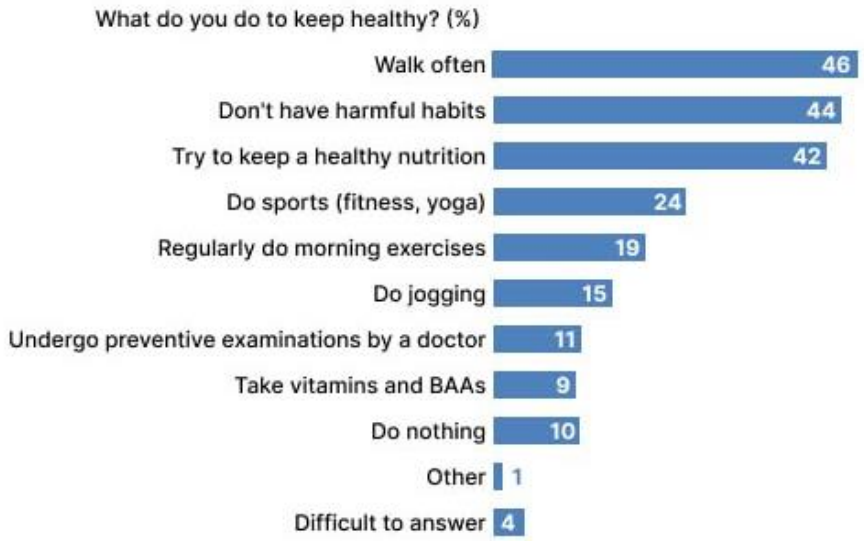
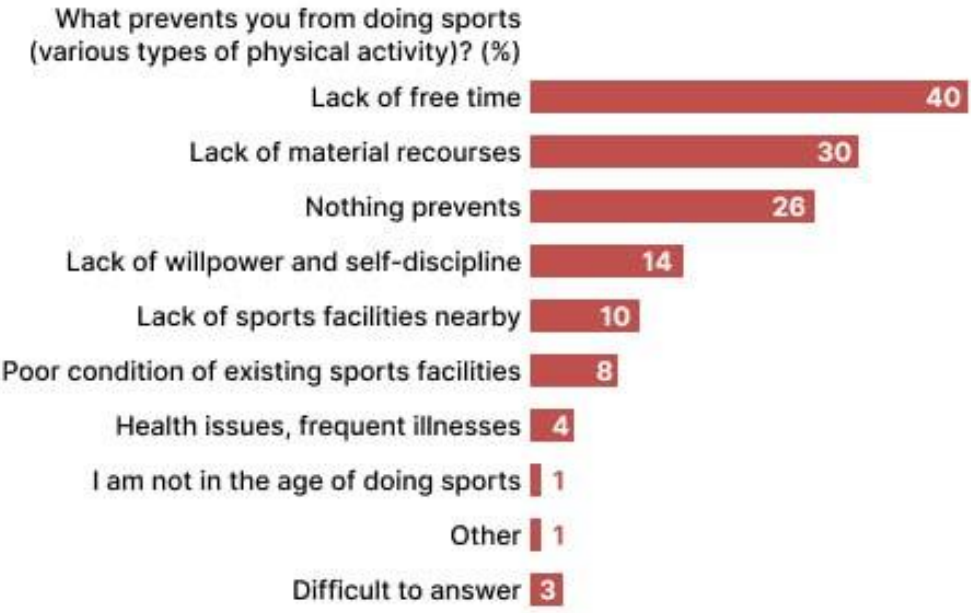
highest level of permanent sports activity is in Kyiv (40%), and the lowest in the South (28%). Involvement in sports among young people in percentage terms is shown in Figure 2.



a) The quantitative results of answers for the question “What do you do to keep healthy?” (%)



b) The quantitative results of answers for the question "What prevents you from doing sports (various types of physical activity)?" (%)

Figure 1: Results of the nationwide youth survey conducted by GFK Ukraine on the order of the Ministry of Youth and Sports and with the support of the UN system in Ukraine in 2015 [1]

With the onset of the global coronavirus pandemic in the beginning of 2020 and the onset of a full-scale war in Ukraine on February 24, 2022, children's physical activity has significantly decreased and sports participation rates have also dropped sharply. Currently, there are no statistical data for this period.

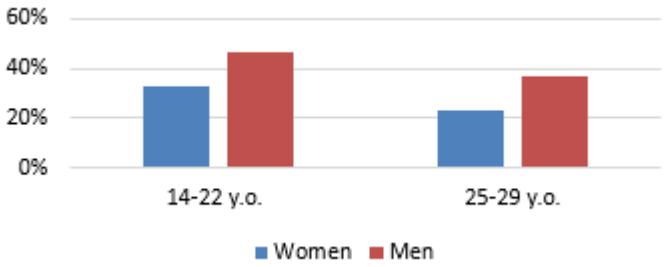


Figure 2: Involvement in sports among young people in percentage terms (%)

Movement and physical activity is an extremely important, fundamental factor in the formation, preservation, strengthening of human health and development, especially in childhood, adolescence and youth. Physical culture is an important means of harmonious human development and the main factor in human physical health. The lack of physical activity of the population prevents the formation of a healthy lifestyle, on which 50% of a person's health depends. The role of medicine in this case is only 8-10%. Ignoring this fact leads to well-known demographic problems and an increase in population morbidity. Numerous studies have proven that under the influence of physical exercises (motor activity), the functional and adaptive capabilities of the cardiovascular and respiratory systems, the musculoskeletal system increase, the activity of enzymatic reactions increases, the intensity of redox processes in tissues increases, and the body's resistance to action increases adverse environmental factors, memory improves, irritability decreases, sleep normalizes.

Development of an effective mechanism for children and adolescents' involvement in physical activity through systematic participation in various sports cultivated in the city and the establishment of a healthy lifestyle in their environment are *urgent and important tasks*. Therefore, *the purpose of this study* is to develop a decision support system that, based on a comprehensive examination, study of morpho-functional indicators, psychological indicators, taking into account the level of physical ability, will help each child to make the most optimal selection of sports that are cultivated in the region.

2. Related works

During the research related works in the field of Decision Support in sport domain and methods of choosing the appropriate kind of sport for children and adults [2-17] have been considered. The literature analysis and related works showed that the paper [3] aims to identify PF field-based tests used in young European populations practicing sport to find tools that are adequate for the considered target involving a new battery within the Enriched Sport Activities (ESA) project. The aim of [4] is to propose concrete manifestations of each type of child maltreatment in sport. The main objective of [5] was to evaluate the association between sport participation and self-perceived social competence over 4 years of early adolescence. The book [6] presents recent research on computational intelligence (CI) algorithms in the field of sport. In the modern age, information technologies have greatly reduced the need for human effort in the carrying out of many daily tasks. In [7], psychological support is a complex sports education, which includes a system of professional activities of the coach and psychologist aimed at creating conditions for successful sports activities, the formation and development of the personality of athletes (teams) is considered. The studies [8] evaluated the prevalence of dentofacial injuries (teeth, alveolar bone, jaw, lips, and/or cheekbones) among combat sports participants were considered eligible. The aim of [9] was to systematically review the literature to verify the association between participation in sports (PS) in childhood and adolescence and physical activity (PA) in adulthood. The study [10] examines the medium-term effects of previous experiences during early stages of sport development on physical capacities of under-13 (U-13) talented basketball players and, to identify variables that discriminated under-14 (U-14) national team training camp selection. The aim of [11] is to outline a heuristic model that facilitates movement toward an integrated understanding of the youth sport system. The objective of [12] was to perform a narrative review of the currently available evidence and sports medicine organizational recommendations regarding sport specialization and its effects on health to

guide athletic trainers and sports medicine providers. The article [13] reveals the importance of physical culture and sports in the upbringing of a harmoniously developed personality, and presents the stages of growth of a sports teacher: from professionalism to skill and innovation. The aim of [14] is to evaluate the variability of PhA between different sports and its relationships with sport performance.

The works of Ukrainian scientists [2, 15-17] devoted to the process of selecting a kind of sport for children, taking into account the individual characteristics and physical indicators of the child, were also considered. In particular, the paper [2] deals with issues of health-formation competence of future specialists in physical culture and sports in the process of various field training. The aim is to experimentally check the efficiency of development of health-formation competence of future specialists in physical culture and sports in the process of various field training. The article [15] considers the recreational component of training and pedagogical practices of cultural and sports institutions of Ukraine. In this context, attention is focused on the practical activities of cultural and sports institutions as discursive practices. The purpose of [16] is to reveal the features of the regulatory framework for the education of sports-gifted schoolchildren in Ukraine and Poland. The relevance of the chosen research topic is due to the increased interest of the world scientific community in the education of gifted children. The article [17] proves the need to create an effective system of training athletes, which is the basis for ensuring higher achievements in sports and causes a certain rise in the field of scientific and pedagogical research on the problems of sports pedagogy, physical education, and education of youth. It urges one to optimize educational conditions for training future physical education teachers for physical and sports activities based on the latest neuropedagogical and didactic requirements.

The reviewed works mainly provide an overview of modern approaches in sport domain. However, none of the works proposes the Decision Support System for choosing a kind of sport. Also, the above-mentioned works do not consider the impact of human morphofunctional indicators at decision making process.

An analysis of existing solutions in the form of websites and mobile applications [18-21], which offer assistance in selecting a kind of sport according to the individual characteristics of the user was also carried out. The results of the analysis are shown in Table 1.

Table 1

Review of currently known solutions for choosing a kind of sport

Name	Platform	Description
Strong Workout Tracker Gym Log	Android	The application helps to track user's sports activities. It provides a base of cardio and strength exercises. Has a calculator for calculating the necessary parameters such as maximum weight, warm-up, number of repetitions. It has a body measurement tracker for recording weight and other indicators.
Fitness app: home gym workout	Android, IOS	The application offers a complete workout plan with diets for thirty days, with video tutorials and step-by-step descriptions of the exercises. User can choose which muscle group you want to train, and the app will find the best solution for it. There is a diary function to record your achievements and communicate with the trainers who developed these plans.
Fitbit	Android	The application helps to track user's overall activity. Based on user's lifestyle, the app suggests exercises, sleep patterns, and ROM tracking to improve user's quality of life. The app also works with smartwatches.

30 Day Fitness – Home Workout	IOS, Android	The application helps to track a thirty-day fitness marathon with descriptions and videos of exercises
Blog decathlon [18]	Web-site	The site advises how to choose a sport based on user's main goal and what result they expect to obtain.
Kidshealth [19]	Web-site	The site helps students decide which school section to choose based on their soft skills.
The ActivityHero Blog [20]	Web-site	The site helps parents to choose the best sport for their child and provides tips on what to look for when choosing.
Sportingferret [21]	Web-site	The site gives useful tips on how to choose a sport based on user's own abilities and hobbies.

As it can be seen from the table, ready-to use mobile applications are mostly focused on fitness and activity tracking while websites give general suggestions in the form of blog articles. However currently there are no ready-to-use solutions that provide decision support assistance in choosing a kind of sport according to individual morphophysical indicators of the user.

Therefore, the issue of *developing Human Morphofunctional Indicators-based Decision Support System for choosing Kind of Sport is relevant and important today* to maintain the children and adolescents health at an appropriate level, especially in the post-covid period, through sports that are best suited to each personality individually.

3. Method of operation of human morphofunctional indicators-based decision support system for choosing kind of sport

In the course of the research, the target audience or stakeholders for the decision support system for choosing a sport based on the morphofunctional indicators of a person were determined. It primarily includes students - school-age children who are currently most exposed to a sedentary lifestyle, their parents, physical education teachers and coaches of sports schools who are interested in the development of sports and increasing the level of physical activity among children (Figure 3).

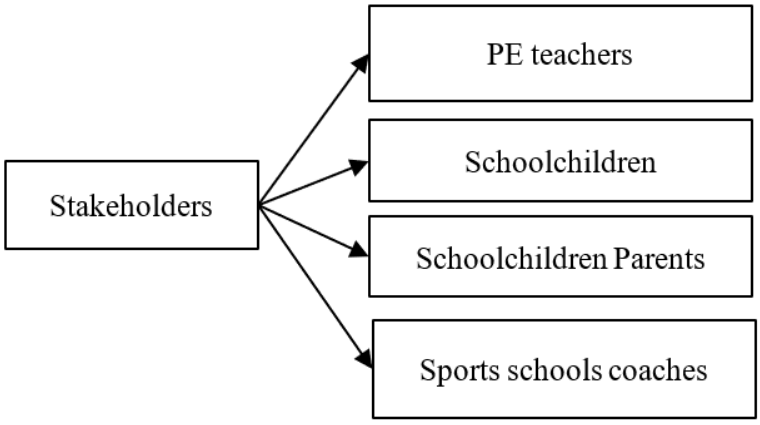


Figure 3: Stakeholders of decision support system for choosing a sport based on morphofunctional indicators of a person

To implement the proposed in this work human morphofunctional indicators-based decision support system for choosing kind of sport, a method of operation of this system was developed, which consists of seven steps:

1. *Analysis of sports cultivated in the region.* At this step, an information base on all types of sports of children's and youth sports schools of the city is being created; information about the coaching staff with contact numbers, photos, sports titles; training schedule, etc.

2. *Development of informative indicators for each type of sport cultivated in the region*. On the basis of the available scientific and educational and methodological materials, in particular, the Educational programs for extracurricular sports educational institutions (DYSSh) in sports, to develop an algorithm that will allow to determine the suitability for a particular sport in percentage terms. Among the main selection criteria, it is planned to use: anthropometric indicators (longitudinal, transverse and circumferential dimensions), morphological (body composition, mass), dynamometry, spirometry, tests to determine the level of development of physical qualities, functional tests, indices of physical development, tests to determine motor capabilities etc.

3. *Creation of a diagnostic complex, taking into account the specifics of each type of sport.* At this step, it is planned to develop a single diagnostic set of tests and standards that will meet the following requirements: all tests must be simple, accessible and informative. The battery of tests should be sufficient so that the obtained information applies to all sports, which are cultivated in the city, without excluding them. All measurements should be carried out on the basis of institutions of general secondary education, without the use of complex measuring equipment.

4. *Development of an algorithm for determining the types of sports that are best suited for an individual student*. In order to establish a weighting factor for each criterion, taking into account the specifics of sports, it is planned to carry out an expert assessment of the importance of the criteria. It is assumed that information will be provided to the student about all types of sports, but the degree of compliance with one or another type of sport will be indicated in percentages.

5. *Development of a computer program (mobile application) that would determine the most optimal types of sports for each student.* The peculiarity of this mobile application is that it is installed on each student's phone (smartphone). This program contains information about the student and test results. According to this data, the student automatically receives information about the most suitable sports for him, based on his morpho-functional capabilities, with the indication of all the necessary additional information (contact details of coaches, address of the sports school, training schedule, etc.). In addition, it is assumed that this mobile application should be updated, changes should be made constantly regarding sports and their coaches. Other information should come to the attention of the students regarding the holding of various competitions, physical culture and sports events, interesting meetings with famous athletes, sports fairs, etc.

6. *Full-scale examination of students of general secondary education institutions.* During physical education lessons, in agreement with the students, school administration, and parents, schoolchildren undergo appropriate briefing, familiarize themselves with the purpose of the examination, perform the proposed tests, install the mobile application on their phones and register in it. Perform the suggested exercises in order to determine the level of physical fitness. The test results for each student are entered into the database by the administrator. At the student's request, he receives in percentages the expediency of practicing sports cultivated in the city (region). The algorithm of the mobile application ensures the confidentiality of information. If necessary, the student receives information about the sport (place of classes, coaches and their contacts, schedule of classes and other information about the sport).

7. *Provision of recommendations regarding sports orientation to students, parents, sports coaches of the Local Youth Sports Schools.* At this stage, it is important to convey the received information to parents, physical culture teachers, sports coaches of children's youth sports schools, in addition to the student. The information should be in a clear and easy-to-understand format, both for parents and students.

The abovementioned steps are presented in the form of a diagram in Figure 4.

Also, based on the proposed method a structure diagram of the information system (DSS) for choosing a sport based on morphofunctional indicators of a person was built (Figure 5). The structure of the proposed DSS consists of the database, server subsystem and client subsystem. The administrator of the system uploads .xls or .csv file with the information about the kinds of sport that are cultivated in the region and that are targeting for the certain age group of students. After taking the measurements of the indicators of students group, the administrator also uploads .xls or .csv file with the results of the measurements for each student in a group. The server-side part consists of an algorithm for selecting the kind of sport by the indicators and software for data processing and the interface for connecting to the client part.

It was decided to implement a client-side part in a form of a mobile application. Since the targeting audience is mostly young people, the most convenient and ready to use is a cross-platform mobile application.

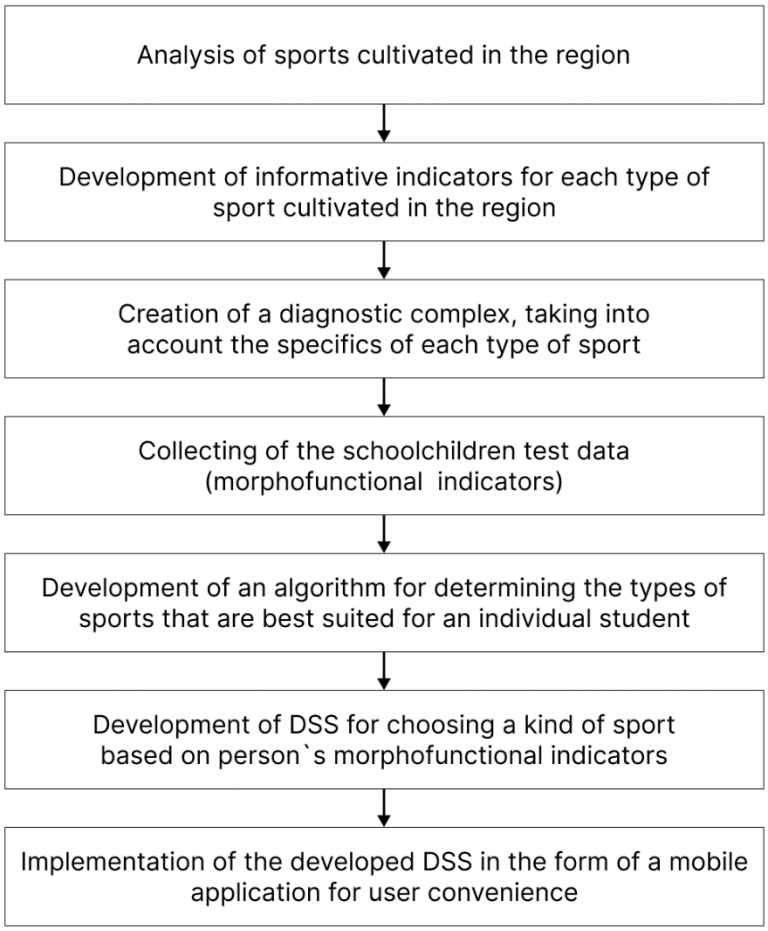


Figure 4: Method of operation of human morphofunctional indicators-based decision support system for choosing kind of sport

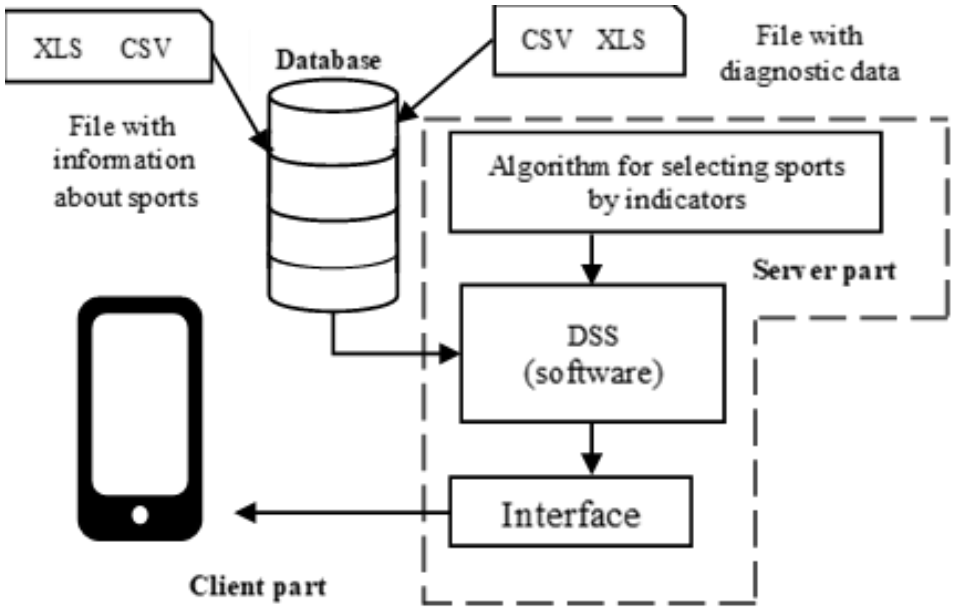


Figure 5: Structure diagram of human morphofunctional indicators-based decision support system for choosing kind of sport

4. Algorithm for calculating individual propensity for sports for Human Morphofunctional Indicators-based Decision Support System for choosing Kind of Sport

To be able to calculate the propensity for sports the following Morphofunctional Indicators (approximately there will be from 15 to 20 indicators) are proposed to be taken into account:

Anthropometric data:

1. Height
2. Weight and height index
3. Muscle mass index (perimeter of the tense shoulder / perimeter of the relaxed shoulder)
4. The ratio of the arm span to the length of the body standing

Physical abilities:

5. 30 meters - run
6. Standing Vertical or Long jump
7. Throwing a Wall Ball at a distance (2 kg)
8. Sit-Ups/crunches for 30 s.
9. Floor Push-up
10. Trunk tilt
11. Shuttle-run (4x9 m)
12. Reaction Time (catching a stick)
13. Jumping rope for 30 s.
14. Unscrewing the measuring tape

The algorithm for abovementioned method operation consists on five steps:

1. Enter the information about the student: name, gender, grade, school, date of birth, etc.

2. Determine the indicators that characterize morphofunctional and motor capabilities of the student X_j;

where X_j is a student's result for each separate indicator,
j is an ordinal number of an indicator (approximately there will be from 15 to 20 indicators).

3. For each indicator, we determine the score Oj by the Formula 1:

$$Oj = 50 + 10 * \frac{Xj - \overline{Xj}}{\sigma_j}, \quad (1)$$

where: $\overline{Xj}$ is the average value for each individual indicator,
σ_j is a root mean square (rms) deviation for each individual indicator.

The values of $\overline{Xj}$ and σ_j are selected from the table data according to age and gender. It is assumed that the students will be 10 and 11 years old, so we will have four groups of numbers $\overline{Xj}$ and σ_j, two for boys and two for girls. According to the date of birth, if the child is younger than 11 years old, we take the values that correspond to the table average for 10 years old, taking into account the gender. Accordingly, for children older than 11 years, we take into account the average values of indicators and root mean square (rms) deviation for 11-year-olds.

Therefore, as a result, we get 20 ratings for each individual indicator.

4. Based on the weighting coefficients V_{ij}, we calculate the predisposition S_i - for each sport;
where: V_{ij} are weighting coefficients for each individual sport for each indicator;
S_i is a predisposition for the certain kind of sport;
i is the index (serial number) of each sport. It is assumed that there will be 27 kinds of sport.

The weighting coefficients are calculated on the basis of expert opinion of practitioners. In our case, the experts are coaches in the respective sports. During the expert evaluation, each coach in the chosen

sport choses the most informative indicators from the proposed indicators that determine the aptitude for this kind of sport. In addition, each important indicator, in the expert's opinion, was assessed on a ten-point scale according to the degree of importance for the sport in question. 10 points were given in the case when this indicator has the most significant value for sports selection and orientation in a particular sport. 1 point was given in case of the lowest value of this indicator. If this indicator, in the opinion of the coach, unimportant for a particular sport, then 0 was given or the indicator was not evaluated at all. After that, all scores for individual sports were converted into weighting coefficients so that the sum of all positively assessed indicators was equal to 1(the unit).

That is, $\sum Vj$ for each individual sport was equal to one (the unit).

Accordingly, S_i can be calculated by the Formula 2:

$$Si = \sum_{j=1}^{20} Vij * Oj; \quad (2)$$

that is, *Si=Vi1*O1+Vi2*O2+Vi3*O3+Vi4*O4+…+ Vi20*O20*

Thus, we calculate the propensity for all 27 kinds of sport.

5. Display the results of the calculations on the screen in a in visual form.

For the administrator of the system and coaches the results for each indicator for a student can be presented, taking into account the norms, and indicate their level of appropriateness development for this indicator. Again, we use tabular data for each indicator, we know the average values and root mean square (rms) deviation, taking into account age and gender.

The results can be presented in the form of a following table (Table 2)

Table 2

Representation of the Algorithm for calculating individual propensity for sports for Human Morphofunctional Indicators-based Decision Support System for choosing Kind of Sportin a tabular form

№ Indicator	Indicator name	Student's result	Average value	Developmental level
1	30 meters - run	***	***	***
2	Shuttle-run	***	***	***
		……		

Developmental level is determined according to the scale (Figure 6):

Low level - is less than (- 1.5 σ)

Below average – is from [-1.5 σ) to (-0.5 σ)

Average level – is from [-0.5 σ) to (0.5 σ)

Above average - is from (0.5 σ) to (1.5 σ)

High – is above (1.5σ)

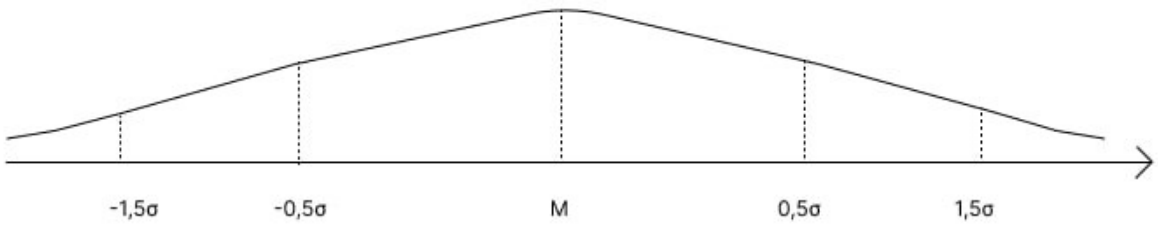


Figure 6: A scale for calculating the student's level of development to determine the propensity to a certain kind of sport

The next step is the implementation of the proposed algorithm in the decision support system for

choosing kind of sport and development of a client-side part in the form of a cross-platform mobile application.

5. Results & Discussion

Since the target audience for the proposed DSS is mainly school-age children and their parents, the form of visualization of the results should be as simple and understandable as possible. For example, based on the results of morphofunctional testing, it is possible to determine a child's propensity for a certain type of sport using the following algorithm:

All kinds of sport are divided into three groups depending on the level of aptitude for sports. We start by rating, first with the highest aptitude, then in descending order.

The "High propensity" group includes sports in which S_i was higher - equal to 60. The example is shown in a Table 3.

In the range from 40 to 60, we place sports that are characterized as "Medium propensity". The example is shown in a Table 4.

Accordingly, less than 40 will be characterized as "Low propensity ". The example is shown in a Table 5.

Table 3

An example of sports that are positioned as those for which the child has a high propensity

Kind of sport	S_i value	Link to the information page about the sport
Volleyball	70	https://www.dush1.com/
Kayaking	63	https://www.facebook.com/sportschool2/?locale=ua

Table 4

An example of sports that are positioned as those for which the child has a medium propensity

Kind of sport	S_i value	Link to the information page about the sport
Basketball	50	https://www.dush1.com/
Fencing	43	https://www.facebook.com/dyussh3

Table 5

An example of sports that are positioned as those for which the child has a low propensity

Kind of sport	S_i value	Link to the information page about the sport
Tennis	35	https://www.facebook.com/dyussh3
Rugby	27	https://www.dush1.com/

Below user can find information about other sports that are not included in the predisposition system. For example, chess, artistic gymnastics, rhythmic gymnastics.

For better visualization it is proposed to present three kinds of sport with highest propensity in a form of a diagram with the percentage of the propensity (Figure 7.1). The results of the morphofunctional indicators measurement will also be available for the users on their profile pages in a tabular form, including date of the measurement, name of the indicator and its value (Figure 7.2).

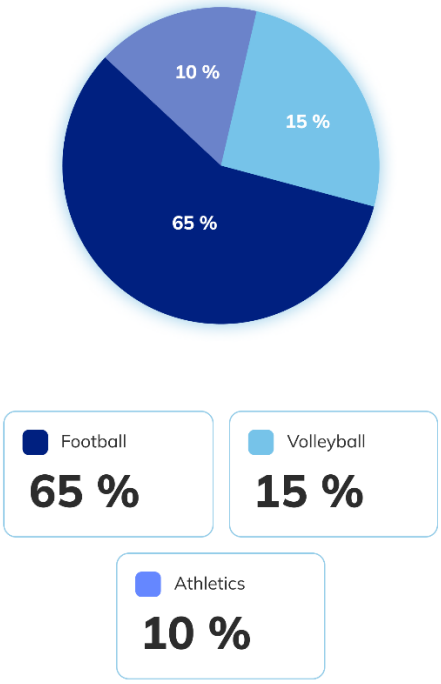


Figure 7.1: Example of three kinds of sport with the highest propensity in a diagram form

Date	**13.11.2021**
Pulling up	11 times
Running 100 m	14.7 s
Push-ups	10 times
Cross 1000 m	3.1 min., s
Cross country 2000 m	5.54 min., s

Figure 7.2: Results of the morphofunctional indicators measurement in a tabular form

6. Conclusions

In this work the current state of school-age children and adolescents' sports participation in Ukraine in the period before the pandemic and full-scale military operations and now was analyzed. The consequences of a sedentary lifestyle and their impact on the health of children and adolescents are reviewed.

Since in all regional centers of Ukraine (Khmelnytskyi was taken as an example) there are children's and youth sports schools that offer children and adolescents a wide variety of sports for classes on a free basis, it was decided to develop a human morphofunctional indicators-based decision support system for choosing kind of sport that will provide a consequence on a propensity to certain kinds of sport that are cultivated in a given region and will help children to make a choice in favor of the sport that best suits thim in terms of indicators and the most to their liking.

In the course of the study, a method of functioning of the proposed decision-making support system and an algorithm for determining a child's propensity to a certain type of sport based on individual morphofunctional indicators were developed. The algorithm makes it possible to divide all kinds of sport that are cultivated in the region into sports for which the child has a high, medium and low inclination, based on the determined coefficients and individual morphofunctional indicators. It is proposed to present the results in a form convenient for children to perceive, namely in the form of a diagram with three sports to which the child has the highest inclination and tables with the results of measurements of individual morphofunctional indicators of the child. Since the target audience is mainly children and teenagers, a form of cross-platform mobile application was chosen to implement the proposed decision support system, which is the most convenient for users to access their data.

Further efforts of the authors will be directed to the implementation of the method and algorithm proposed in this work in the form of a server part of the human morphofunctional indicators-based decision support system for choosing kind of sport.

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