Method and system for choosing kinds of sport based on human morphofunctional indicators

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Abstract

In recent years, due to Covid-19 pandemic in 2020-2022 and full-scale military operations on the territory of Ukraine due to Russian aggression, the percentage of children who are involved in sport has decreased significantly. This paper presents an overview of the current situation on children and adolescent`s involvement in sports over the world and proposes a method and a concept of the information technology for choosing kind of sport for school age children and teenagers, based on human morphofunctional indicators. Also, the average values for the indicators and weight coefficients for each indicator for the proposed method and algorithm were presented. The aim of the research is to develop an information technology for automated choosing of kind of sport for children and indicate their predisposition to certain kinds of sport based on their morphofunctional indicators.

Keywords

Information System (IS), sport for children, human morphofunctional indicators, IT solutions for sport, mobile application

1. Introduction

As the world recovers from the COVID-19 pandemic, there has been a notable change in the landscape of sports for children and teenagers. Parents and policymakers now have a heightened recognition of the advantages, both physical and mental, that come with staying physically active. This has brought about new obstacles and prospects in effectively promoting active lifestyles.

The Aspen Institute's annual analysis of national trends in the delivery of sport activities for youth in the USA [1] provided the statistics on total sport participation rates among the children ages 6-12 (Figure 1) and teenagers years 13-17 (Figure 2) in team sport, individual sport, team sport at least 1 day and team sport on regular basis. Team sports include: baseball, basketball, cheerleading, field hockey, football, gymnastics, ice hockey, paintball, roller hockey, rugby, swimming on a team, track and field, ultimate frisbee, volleyball (court, grass, sand) and wrestling. Individual sports include: tennis, golf, martial arts, roller skating, skateboarding, running and cycling (road, BMX, mountain bike). A participant is anyone who played sports at least one day during the year, in any form and either organized, unorganized or unstructured. A participant who player on a regular basis (also known as "core participant") is defined by the number of times played per year. The number varies by sport. This type of participation includes a level of organized play.

In recent years, there has also been a tendency to decrease the engagement of school-age children and teenagers in sports sections in Ukraine. This is due to global Covid-19 pandemic in 2020-

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2021, when children were forced to stay at home, as well as with the beginning of a full-scale invasion of Russian troops on the territory of Ukraine.

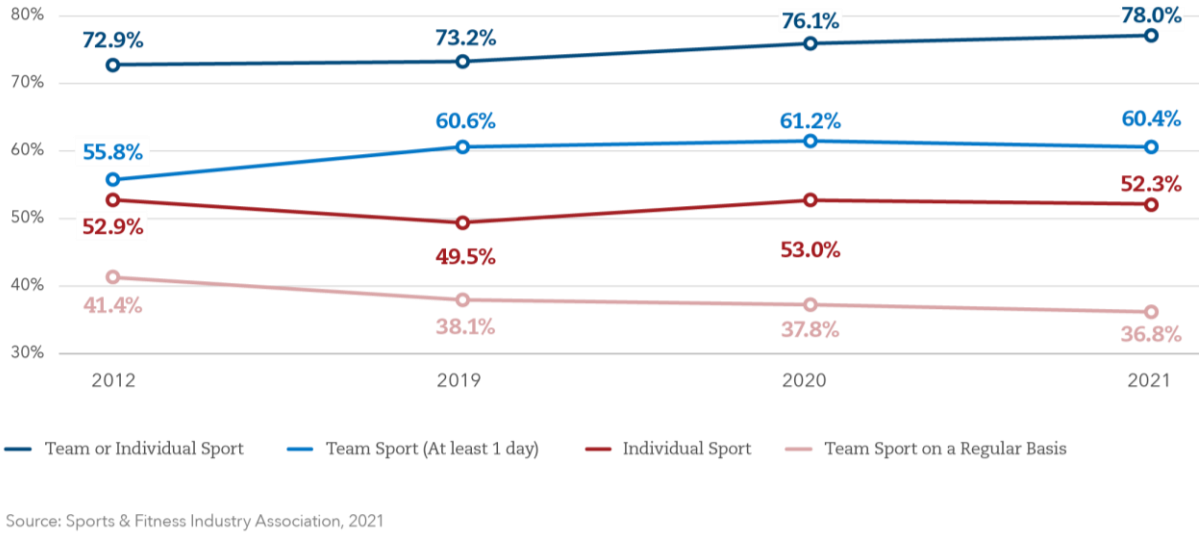

Figure 1: Total sport participation rates among the children ages 6-12 according to [1]

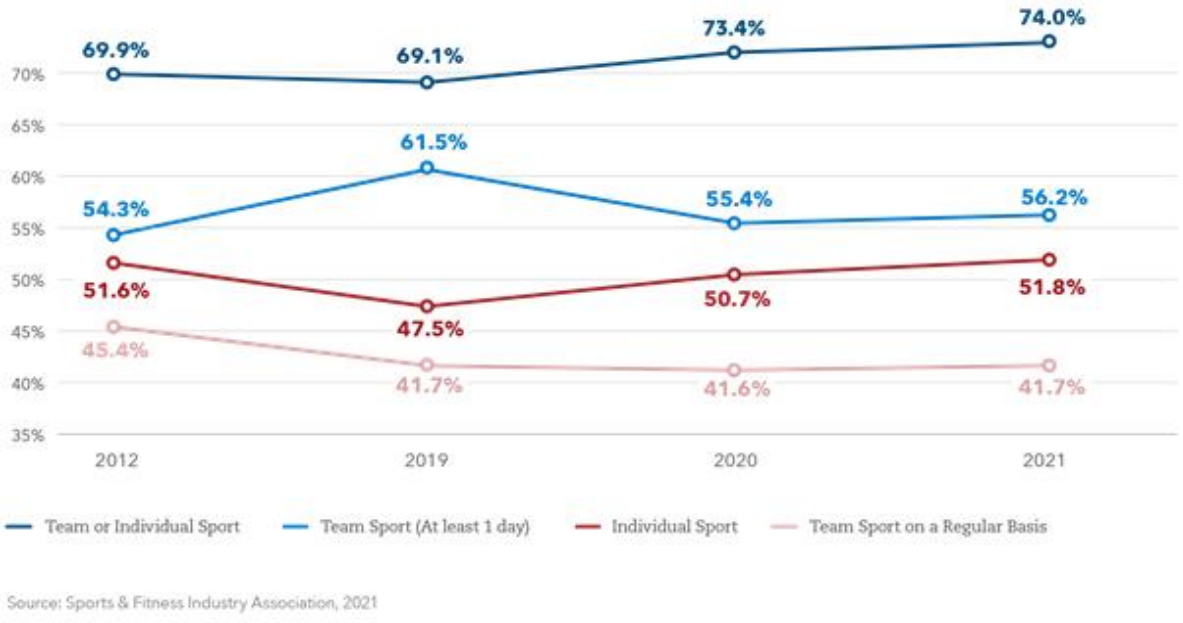

Figure 2: Total sport participation rates among teenagers ages 13-17 according to [1]

Despite the current situation statistics on sports participation of school-age children and adolescents in Ukraine in recent years show a positive trend towards an increase in the number of children involved in sports. Thus, in 2021, 80% of school-age children and adolescents went in for sports, which is 10% more than in 2020. The most popular sports among school-age children and adolescents are football, basketball, volleyball, athletics, and swimming [12].

The factors that also had an impact on this are:

1) growing popularity of electronic devices. Children spend more and more time behind screens, playing games, watching TV or using social media. This leads to less time for physical activity.

2) changes in lifestyle. Many parents are working more hours and have less time to take their children to sports. In addition, many schools have reduced the number of hours allocated for physical education.

3) the growing number of diseases. Some diseases, such as asthma and allergies, can make physical activity difficult.

Lack of access to gyms and other sports facilities. In some areas, there are not enough gyms and other sports facilities, which can make it difficult for children to access sports[10].

Decreased physical activity has a negative impact on children's health. It can lead to obesity, cardiovascular disease, diabetes, and other health problems. In addition, lack of physical activity can negatively affect the emotional state of children, leading to increased levels of anxiety and depression.

The growing popularity of sports among school-age children and adolescents is a positive development, as it contributes to their physical development, health and life skills. Sport helps children develop endurance, strength, agility, speed and coordination. It also helps children learn to work in a team, make decisions, face challenges and achieve their goals.

The state provides significant support for the development of sports among schoolchildren and adolescents. The government finances the construction of sports facilities, organizes sports events and programs, and provides benefits to athletes.

Thanks to the joint efforts of the state, NGOs and parents, the number of children involved in sports in Ukraine is growing every year. This is the key to the health and successful future of our country. The government, in its turn, supports children and teenagers, providing them with the opportunity to play sport in free of charge sports sections according to their preferences in children's and youth sports schools. However sometimes it is difficult for children to determine which sport to choose for themselves in order to succeed in it. Often, they start playing sports, and then leave it because they cannot achieve certain indicators.

Considering the abovementioned, development of a method and system of selecting a kind of sport based on human morphofunctional indicators is currently a relevant and important task, because it allows a child to decide on a sport to which the child has an inclination and in which they can succeed.

2. Related works

In the course of the study, an analysis of the latest scientific publications in the field of providing methods for choosing the appropriate kind of sport for children and teenagers [2-22] was carried out.

The studies [2,3] provide merely theoretical overview. Paper [2] performs 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 research [4] was conducted to measure opinions or separate positive and negative sentiments towards e-sports education, so that valuable information can be sought from social media.

The proposed in [5] platform is currently being adapted and implemented to address patient-centered healthcare and clinical decision support requirements in a sports injury clinic at a not-for-profit private hospital in Melbourne, Australia.

The aim of [6] is to propose concrete manifestations of each type of child maltreatment in sport.

The main objective of [7] is to evaluate the association between sport participation and self-perceived social competence over 4 years of early adolescence.

The review [8] provides an overview of the existing literature on school-aged children’s and youth’s (i.e. 6- to 18-year-olds) personal and social development within the context of physical education and sports.

The work [9] focuses on sport specialization from a public health perspective to elucidate the effect that this practice is having within the United States.

The purpose of [10] is to discuss the psychological, developmental, and economic fallout from the stoppage of youth sports that has touched millions of participants, their families, and a substantial youth sports structural system.

The source [11] reviews psychological, developmental, and economic impacts of Covid-19, including the impact on youth involvement in sports.

The report [12] provides data on physical activity levels among children and adolescents in the United States. The data was collected from the 2017-2018 National Health and Nutrition Examination Survey (NHANES). The report found that only about one-quarter of children and adolescents met the

recommended levels of physical activity. The report also found that physical activity levels declined with age.

This study [13] examined the impact of COVID-19 on physical activity levels among children and adolescents. The study used data from the 2018-2019 National Health and Nutrition Examination Survey (NHANES) and the 2020-2021 NHANES. The study found that physical activity levels decreased significantly among children and adolescents during the COVID-19 pandemic. The study also found that the decrease in physical activity was more pronounced among children and adolescents from lower-income families.

The paper [14] reviews the literature on the role of parents in promoting physical activity in children and adolescents and discusses the factors that influence parental involvement in physical activity promotion, as well as the strategies that parents can use to promote physical activity in their children. The work concludes by highlighting the importance of parental involvement in physical activity promotion for the health and well-being of children and adolescents.

The study [15] summarizes the evidence on how to encourage children to be more active and discusses the factors that influence children's physical activity levels, as well as the strategies that can be used to encourage children to be more active. The paper concludes by providing recommendations for how to encourage children to be more active.

In [16] the evidence on the benefits of physical activity for children and adolescents are reviewed. The article discusses the physical, mental, and social benefits of physical activity, as well as the risks of inactivity. It concludes by providing recommendations for how to promote physical activity among children and adolescents.

The report [17] provides guidance on the promotion of physical activity among children and adolescents. It discusses the importance of physical activity for the health and well-being of children and adolescents, as well as the factors that influence physical activity levels among this population group. The report also provides recommendations for how to promote physical activity among children and adolescents.

The report [18] provides guidance on the role of schools in promoting physical activity among children and adolescents. The report discusses the importance of physical activity for the health and well-being of children and adolescents, as well as the role that schools can play in promoting physical activity. The report also provides recommendations for how schools can promote physical activity among children and adolescents.

This policy statement [19] provides guidance on the role of parents in promoting physical activity among children and adolescents. The statement discusses the importance of parental involvement in physical activity promotion, as well as the strategies that parents can use to promote physical activity in their children. The statement also provides recommendations for how parents can promote physical activity among children and adolescents.

The paper [20] summarizes the evidence on the benefits of physical activity for children and adolescents and discusses the physical, mental, and social benefits of physical activity, as well as the risks of inactivity. It concludes by providing recommendations for how to promote physical activity among children and adolescents.

The review [21] summarizes the evidence on the impact of COVID-19 on physical activity levels among children and adolescents. This paper discusses the factors that have contributed to the decline in physical activity, as well as the implications for the health and well-being of children and adolescents. It concludes by providing recommendations for how to promote physical activity among children and adolescents during the COVID-19 pandemic and beyond.

As can be seen from the abovementioned overview, the articles provide merely theoretical overview of the situation and to a greater extent highlight the socio-psychological factors external factors influence on school children and adolescents' involvement in sports.

The paper [22] proposes a method and algorithm for selecting a kind of sport based on human morphofunctional indicators, as well as the concept of a decision support system for determining a child's propensity for a certain kind of sport based on its morphofunctional indicators.

Work [23] proposes a methodology for the development and application of knowledge-driven, rule-based, clinical decisions support information technologies with consideration of civil-legal grounds.

In [24] the existing literature on health recommender systems for smart cities is surveyed and a novel approach to help tourists finding the appropriate doctor is proposed.

Taking into account the relevance of this issue, it was decided to further develop a proposed in [22] approach for choosing a kind of sport based on human morphofunctional indicators and develop Therefore, the aim of this study is:

1) to create a method of choosing kind of sport based on human morphofunctional indicators;
2) to develop an algorithm choosing kind of sport using human morphofunctional indicators, that is based on the proposed method;
3) to propose the average values for the indicators and weight coefficients for each indicator for the proposed method and algorithm;

3. Method of choosing kind of sport based on human morphofunctional indicators

In our previous work [22] a method and a concept of a decision support system for determining a child's propensity for a certain kind of sport based on its morphofunctional indicators was proposed. Let us develop an algorithm based on the method of choosing kind of sport and present it in a graphic form (Figure 3).

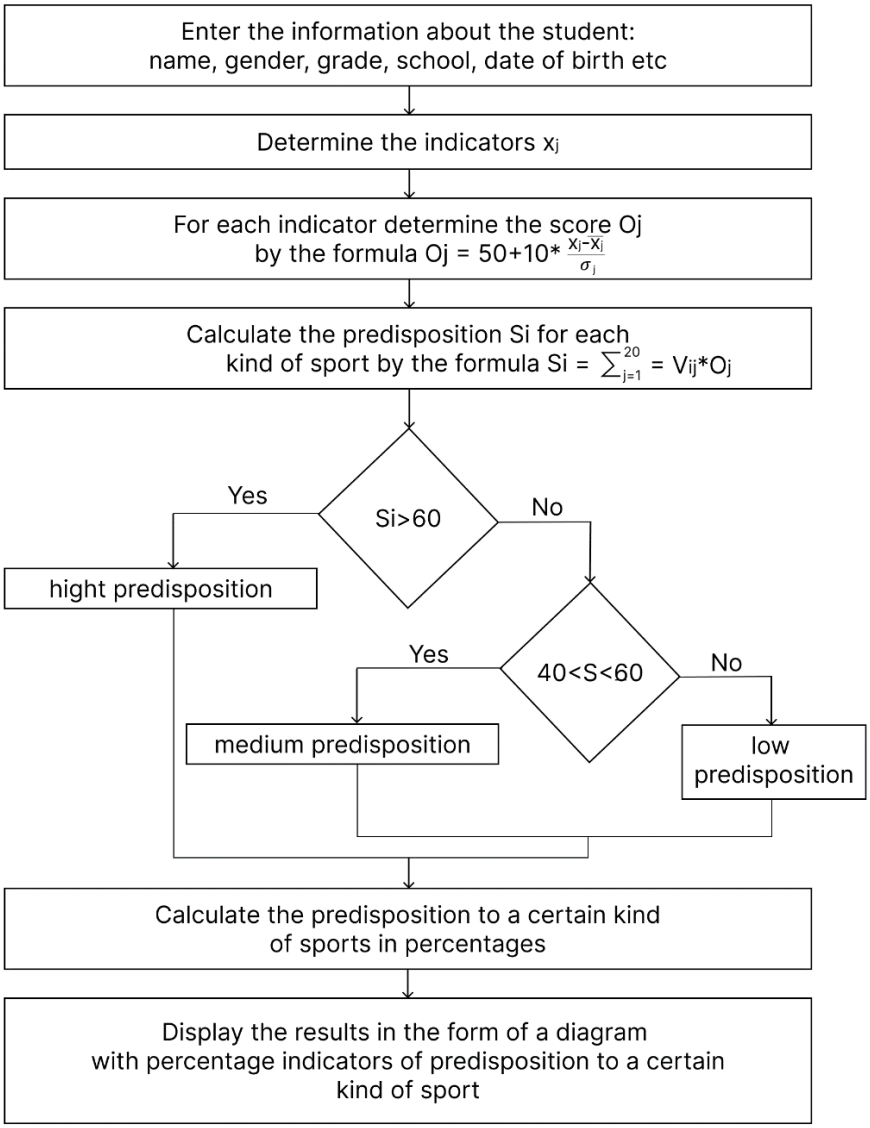

Figure 3: Graphic representation of the algorithm for determining a child's propensity for a certain kind of sport based on its morphofunctional indicators

In the abovementioned algorithm some letter designations are used. Among them are:

X_j is a student's result for each separate indicator;

j is an ordinal number of an indicator (approximately there are 15 to 20 indicators);

$\overline{Xj}$ is the average value for each individual indicator;

G_j is a root mean square (rms) deviation for each individual indicator;

V_{ij} are weight 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.

In [22] a list of indicators (anthropometric data and physical abilities) that are taken into account while doing a test of a student was proposed. To be able to calculate the predisposition, an average value for each individual indicator is needed. We collected the average values $\overline{Xj}$ for all 14 indicators proposed in [22] and presented them in a form of a table (Table 1).

Table 1

Average values $\overline{Xj}$ by standard value for each morphofunctional indicator for determining a child's propensity for a certain kind of sport

№	Indicator	10 y.o				11 y.o			
		m	σ	w	σ	m	σ	w	σ
1	Height, /cm/.	134,7	4,5	134,4	6,2	139	4,7	139,2	5,6
2	Weight and height index (body mass index) /weight (g)/height (cm)/.	219	-28,2	220,2	-33,2	234,5	-28,8	233,5	-32,3
3	Muscle mass index (perimeter of the tense shoulder / perimeter of the relaxed shoulder) $I = \frac{SP_t - SP_r}{SP_r} * 100\%$	8,5	3,5	8,5	3,5	8,5	3,5	8,5	3,5
4	Ratio of arm span to body length while standing, /cm/.	0	1,33	0	1,33	0	1,33	0	1,33
5	Running 30 m /s/.	6,3	-0,61	6,6	-0,61	6,1	-0,49	6,4	-0,62
6	Long jump /cm/	147	22,31	127	17,56	157	23,25	132	19,16
7	Throwing a Wall Ball at a distance (1 kg) /m/	6,5	0,79	6	0,79	7	0,79	6,5	0,79
8	Sit-Ups for 60 s / quantity	28	7,91	28	7,91	29	9,19	29	7,44
9	Floor Push-up /number/	16	7,44	7	3,97	18	7,91	8	5,22
10	Standing torso tilt (torso tilt forward from a sitting position) /cm/.	7	3,96	9	5,86	8	3,65	10	5,7
11	Shuttle run (4x9 m) /s/.	12,3	-1,03	13	-1	12	-0,98	12,8	-0,95
12	Reaction time (catching a stick that has centimeter marks) /cm/.	24	-4	24	-4	22	-4	22	-4
13	Jumping rope for 60 seconds /count/.	92	6,32	100	6,32	98	5,55	106	5,55
14	Unscrewing the measuring tape (difference from the width of the shoulders) /cm/	20	-10	10	-8	20	-10	10	-8

Also, a table of weight coefficients V_{ij} for each morphofunctional indicator that impacts each kind of sports that is cultivated in the region under study was developed (Table 2).

Table 2

Weight coefficients V_{ij} for each morphofunctional indicator that impacts each kind of sports that is cultivated in the region under study

№	Kind of sport / Indicator	Weight coefficients V_{ij}													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Basket-ball	0,3			0,15	0,05	0,2	0,15	0,05			0,1			
2	Boxing				0,1		0,2			0,3			0,15	0,25	
3	Freestyle wrestling						0,1		0,25	0,3	0,2				0,15
4	Weight-lifting		0,5	-0,2		0,2				0,4	0,1				
5	Cycling	-0,2			0,45	0,4		-0,2				0,2		0,15	
6	Rowing		0,2	0,15					0,25	0,3					
7	Volley-ball	0,1				0,25	0,15	0,1	0,15			0,05			
8	Handball		0,1		0,15	0,15	0,1		0,1	0,1		0,15			
9	Judo		0,15		0,1	0,2			0,05	0,05	0,1	0,15	0,1	0,1	
10	Karate				0,1	0,05			0,1	0,25	0,2	0,15	0,15		
11	Kick-boxing			0,15	0,05	0,05			0,1	0,2	0,1		0,2	0,15	
12	Athletics (running)	0,2			0,3	0,15		0,2				0,15		0,1	
13	Athletics (jumpin)	0,2			0,2	0,25		0,2				0,1			
14	Athletics (throwing)		0,25	0,15			0,25		0,1	0,15					0,1
15	Pank-ration			0,15	0,05		0,1		0,15	0,25	0,05		0,2	0,05	
16	Power-lifting	-0,1		0,35	-0,1		0,25		0,25	0,35					
17	Swim-ming	0,2	0,15	0,1	0,15			0,05	0,1		0,1				0,15
18	Rugby			0,15		0,25	0,1	0,1		0,15		0,25			
19	Self-defense			0,2			0,15			0,2	0,1	0,15	0,15	0,05	
20	Shooting sports	-	-	-	-	-	-	-	-	-	-	-	-	-	-

21	Tennis				0,25	0,2	0,15	0,1			0,3		
22	Table tennis				0,15	0,2		0,1			0,25	0,3	
23	Taek-wondo				0,1	0,1		0,1	0,25	0,1	0,15	0,2	
24	Fencing			0,15	0,1	0,1				0,1	0,2	0,25	0,1
25	Futsal				0,2	0,15			0,1	0,1	0,3	0,15	
26	Football	0,15			0,3	0,15			0,1	0,1	0,2		
27	Chess		0,15	0,05		0,1							

As can be seen from the Table 2, such kinds of sports as artistic gymnastics, gymnastics, shooting sports and chess do not have weight coefficients. For artistic gymnastics, gymnastics children are selected at the age of 3 and 4 y. o. Since the age of target audience for this research is 10 and 11 y. o., the proposed method does not work. As for shooting sports and chess – it is impossible to indicate the weight coefficients since the indicators that have been chosen do not have the impact and do not determine the child's predisposition to these kinds of sports.

3. Results & Discussion

To conduct the experiment, let us develop tables for collecting student data. Conducting the experiment will be entrusted to an intern student majoring in "Human health and physical rehabilitation" of Khmelnytskyi National University, who is undergoing pedagogical practice in one of Khmelnytskyi city schools.

Let us develop two tables – the first table (Table 3) will be used for collecting personal data of the student. The second table (Table 4) will be used for filling it with the results of child's morphofunctional indicators collection by measuring and passing simple sports standards. We put some sample values in the second column of table 4 to be able to demonstrate how the weight coefficient affect each indicator.

Table 3

Student`s personal data that need to be collected during the experiment

№	Personal data	Value
1	Date of examination	***
2	Last name	***
3	First name	***
4	Gender	***
5	Date of birth	***
6	School	***
7	Class	***

Table 4

Measurement indicators (X_j) of child's morphofunctional indicators with the sample values

№	Measurement indicator	Value
1	Height, cm	170
2	Weight, gr	84000
3	Perimeter of the tense shoulder, cm	35
4	Perimeter of the relaxed shoulder, cm	32
5	Arm width, cm	175
6	Running of 30 m /s/.	4,5
7	Long jump /cm/	230
8	Throwing of a Wall Ball at a distance (1 kg) /m/.	6,3
9	Sit-Ups for 60 s / quantity	55
10	Floor Push-Up/ quantity/	23
11	Torso tilt while standing (torso tilt forward from a sitting position) /cm/.	12
12	Shuttle run (4x9 m) /s/.	8,5
13	Reaction time (catching a stick which has centimeter marks) /cm/.	25
14	Jumping rope for 60 s / quantity	76
15	Shoulder width, cm	35
16	Unscrewing the measuring tape, cm	40

Using the weight coefficients V_{ij} from Table 2 *and* X_j from Table 4, let us build a table with pre-prepared results of child`s morphofunctional indicators measurement (Table 5).

№	Measurement indicator	Value
1	Height, /cm/.	170
2	Weight and height index (body mass index) / weight (g) / height (cm)	494,1176471
3	Muscle mass index	9,375
4	The ratio of arm span to body length standing, /cm/.	5
5	Running 30 m /s/.	4,5
6	Long Jump /cm/.	230
7	Throwing of a wall ball at a distance (1 kg) /m/.	6,3
8	sit-up for 60 s / quantity /	55
9	Floor push-up / quantity/	23
10	Torso tilt while standing (torso tilt forward from a sitting position) /cm/.	12
11	Shuttle run (4x9 m) /s/.	8,5
12	Reaction time (catching a stick which has centimeter marks) /cm/.	25
13	Jumping rope for 60 s / number /.	76
14	Unscrewing the measuring ruler (difference from the width of shoulders) /cm/.	5

Table 5 contains pre-prepared data that can be used for further calculations of child`s propensity to each kind of sports that is presented in Table 2.

The further efforts of the authors will be aimed at:

1) conducting theoretical experiments to verify and improve the performance of the proposed method;
2) development of information system architecture for choosing a kind of sport based on human morphofunctional indicators;
3) implementation of the proposed information system in the form of a cross-platform mobile application.

4. Conclusions

The existing situation and trends regarding the involvement of school-age children and teenagers in sports in Ukraine and the world have been reviewed. Statistics have shown that due to the global Covid-19 pandemic in 2020-2021, there was a sharp decrease in the level of children participation in sports sections around the world. Also, due to Russian aggression on the territory of Ukraine and full-scale military operations, in 2022, a sharp decrease in sports activity among children and adolescents was observed in Ukraine.

Since playing sports is very important for the health and development of children, it was decided to propose an innovative approach to selecting a sport for a child based on their morphofunctional indicators and to implement it in the form of cross-platform mobile-based software, which is currently the most convenient form of presentation for children and teenagers.

This study presents an algorithm for choosing a type of sport based on human morphofunctional indicators, and introduces average values for each indicator and weight coefficients for each indicator according to kinds of sports they affect.

Further efforts of the authors will be directed to conducting theoretical experiments to verify and improve the performance of the proposed method, development of information system architecture for choosing a kind of sport based on human morphofunctional indicators and implementation of the proposed information system in the form of a cross-platform mobile application.

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